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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 second number of the sixth volume of IJISPM. In this issue readers will find important contributions on sustainability in projects, reusing project knowledge, governance of inter-organizational systems, and IT program management challenges.

As Rutger T. Peenstra and A. J. Gilbert Silvius state in the first article "Considering sustainability in projects: exploring the perspective of suppliers", projects play an important role in the development towards a more sustainable society. Companies are integrating sustainability in their strategies, processes and actions. The relationship between sustainability and project management is therefore being addressed in a growing number of studies and publications and sustainability can be considered one of the recent trends in project management. However, there is still a gap between the literature on sustainability in project management and what is carried out in practice. A logical enabler for the consideration of sustainability in projects may be the demand of the client in the project, although the supplier's strategy may also be an enabler of sustainability. This article reports a study into the enablers of the integration of sustainability in projects as perceived by project suppliers. The authors discovered three distinct patterns of enablers of the integration of sustainability, that were labelled as "Benefits driven", "Demand and intrinsic motivation driven" and "Demand and Strategy driven". The study found that for project suppliers, integrating sustainability in projects is strongly dependent on the demand and willingness of the customer to pay for sustainability. However, adoption of sustainability could also be a differentiator for suppliers.

The second article, "Perspectives on reusing codified project knowledge: a structured literature review", is authored by André Coners and Benjamin Matthies. Project documentation represents a valuable source of knowledge in project-based organizations. The practical reality is, however, that the knowledge codified in project documents is hardly re-used in future projects. A central problem in this context is the extensive amount of usually textual material. As a consequence, computer-assisted processes are indispensable in order to analytically manage the constantly growing and evolving databases of available project documents. The goal of this paper is to summarize the current research focusing on the computer-assisted reuse of textually codified project knowledge and to define the corresponding state-of-the-art in this this specific field of information systems research. This study structures the body of research contributions and outlines what kinds of computer-assisted techniques are incorporated, what practical application areas these solutions address, and in what business domains they are applied. It also points out research opportunities and thereby make a contribution to the further development of knowledge management in project environments.

An increasing use of inter-organizational systems, as Port Community System (PCS), can be observed in port collaborations. As multiple organizations often rely on PCS, even for business-critical processes, proper governance of these systems is crucial. The third article "Governance of inter-organizational systems: a longitudinal case study of Rotterdam's Port Community System", authored by Dissa R. Chandra and Jos van Hillegersberg, aims to explain the governance of inter-organizational port collaborations using a lifecycles paradigm. The governance is explored using three points of view – i.e. governance mechanisms, governance aspects, and governance models – and by describing the actors' roles in collaborations. A case study in the port of Rotterdam is analyzed to explain how these actors affect the governance models through the mechanisms to govern the aspects in each lifecycle stage. This case study analysis of Rotterdam's port collaboration provides an example of how a systematic approach could help to discuss and communicate the governance of inter-organizational port collaboration systems and gives some lessons learned for other collaborations.

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The fourth article, "IT program management challenges: insights from programs that ran into difficulties", is authored by R. Alexander Teubner. The use of IT to drive organizational change has gained momentum in both for-profit and not-for-profit organizations, and currently culminates in a vivid discussion on what many call "Digital Transformation". It is not surprising then that practitioners seek guidance on how to manage such transformation. Professional bodies have addressed this need by issuing best practice standards for Program Management (PgM), but we know little about their value in managing programs in general and IT programs in particular. Academic research on IT PgM is still in its very infancy. Taking this as motivation, this paper investigates the challenges that managers faced in five IT programs that encountered problems. The analysis reveals a set of management issues and shortcomings including, among others, a lack of architectural overview, difficulties in dealing with scope changes, stakeholder interest, diverse business groups and cultures, as well as a lack of internal PgM competences and unclear management responsibilities. In this paper, it is presented a first checklist for managing IT programs across their life cycle.

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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João Varajão is currently professor of information systems and project management at the *University of Minho*. He is also a researcher of the *Centro Algoritmi* at the *University of Minho*. Born and raised in Portugal, he attended the *University of Minho*, earning his Undergraduate (1995), Masters (1997) and Doctorate (2003) degrees in Technologies and Information Systems. In 2012, he received his Habilitation degree from the *University of Trás-os-Montes e Alto Douro*. His current main research interests are in Information Systems Management and Information Systems Project Management. Before joining academia, he worked as an IT/IS consultant, project manager, information systems analyst and software developer, for private companies and public institutions. He has supervised more than 80 Masters and Doctoral dissertations in the Information Systems field. He has published over 300 works, including refereed publications, authored books, edited books, as well as book chapters and communications at international conferences. He serves as editor-in-chief, associate editor and member of the editorial board for international journals and has served in numerous committees of international conferences and workshops. He is co-founder of CENTERIS – Conference on ENTERprise Information Systems and of ProjMAN – International Conference on Project MANagement.

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Considering sustainability in projects: exploring the perspective of suppliers

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Abstract:
Projects play an important role in the development towards a more sustainable society. Companies are integrating sustainability in their strategies, processes and actions. In the implementation of strategies, projects play an essential role. The relationship between sustainability and project management is therefore being addressed in a growing number of studies and publications and sustainability can be considered one of the recent trends in project management. However, there is still a gap between the literature on sustainability in project management and what is carried out in practice. A logical enabler for the consideration of sustainability in projects may be the demand of the client in the project, although the supplier's strategy may also be an enabler of sustainability. This article therefore reports a study into the enablers of the integration of sustainability in projects as perceived by project suppliers. The study used Q-methodology to explore different subjective patterns of perceived enablers. Based on the factor analysis of 19 Q-sorts, we discovered three distinct patterns of enablers of the integration of sustainability, that we labelled as "Benefits driven", "Demand and intrinsic motivation driven" and "Demand and Strategy driven". As expected, the study found that for project suppliers, integrating sustainability in projects is strongly dependent on the demand and willingness of the customer to pay for sustainability. However, adoption of sustainability could also be a differentiator for suppliers. It should therefore be questioned whether a contractor should wait for the customer to ask for sustainability, or whether he should proactively take action himself.

Keywords:
sustainability; project management; project suppliers; Q-methodology.

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1. Introduction

Concerns about the sustainability of natural resources may date back as far as the early 18th century. Already in 1713, the Saxon Mining Officer Hans Carl von Carlowitz published the first comprehensive treatise about sustainable yield forestry [6]. Despite these early warnings about the effects of human actions on the balance of nature, the more contemporary concerns about sustainability and the use of natural resources did not attract broad attention until the second half of last century. The 1972 book "*The Limits to Growth*" [34] predicts that the exponential growth of world population and world economy will result in overshooting the planet's capacity of natural resources. Today, it is estimated that mankind is using up 1.5 to 1.6 times earth's annual bio capacity every year [47]. The concerns about the (un)sustainability of mankind's ecological footprint inspired leading companies to integrate sustainability into their cultural values and corporate strategies. These companies "*address sustainability throughout their business operations and make it core to the way they do business*" [22].

One of the critical competencies to realize these strategies is the "ability to lead and mobilize change" [22]. Development towards a sustainable society requires change [43] and it is argued that projects play a crucial role in the sustainable development of organizations and society [31]. Consequently, the relationship between sustainability and project management is being discussed in a growing number of publications [1][41]. Nevertheless, Økland [36] concludes that still a gap exists between the literature on sustainability in project management and what is carried out in practice. "*Sustainability thinking in project management seems to be regarded as extrinsically motivated; it must be pushed onto the project either by external stakeholders, policies or legislation*" [36].

This extrinsic motivation can logically be expected when the execution of a project is contracted to an external supplier. A situation that is frequently found in for example construction, consulting, information technology or event management projects. The project 'owner' in this situation outsources the realization of the project to a more specialized contractor or supplier [23]. The supplier performs the project to the specifications and criteria of its client, the project owner. The extent to which sustainability is considered in these specifications and criteria is primarily decided by the project owner, although Goedknegt [23] concludes that the project organization itself "*can wield influence to adhering to the sustainability principles*". "*By having knowledge of sustainability, skills to operationalize the knowledge and grasp opportunities and the attitude to show example behavior, they can wield a lot of influence within their own scope of the project and sometimes even beyond their own scope.*" [23]. An interesting question for the supplier of the project will be whether this 'pushing' of sustainability in the project is appreciated by the project owner and pays off.

As the suppliers may be balancing their own sustainability ambitions and the consideration of sustainability that is included in the project specifications, this paper reports an explorative study into the suppliers' perspective of the enablers for integration of sustainability in projects. In order to be able to identify different subjective perspectives, the study deployed Q-methodology as research strategy. Q-methodology has shown its usability in the context of project management research and provides a foundation for the systematic study of subjectivity [5].

The remainder of this article is structured as follows. The following section provides a brief review on the barriers and enablers of sustainability, as found in the literature. Section 3 describes the research approach the study deployed and develops the Q-sort statements. Section 4, presents the findings of the study and describes three factors that were found in the analysis. The closing section, section 5, presents the conclusion of the study and the recommendations that were derived from this.

2. Background

2.1. Sustainability and projects

The earlier mentioned "*Limits to Growth*" report, fuelled a public debate, leading to installation of the UN 'World Commission on Development and Environment', named the Brundtland Commission after its chair. In their report, the Brundtland commission defines sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" [52]. By stating that "*In its broadest sense, sustainable development strategy aims at promoting harmony among human beings and between humanity and nature*", the report implies that sustainability requires also a social and an environmental perspective, next to the economic perspective, on development and performance. In his book "*Cannibals with Forks: the Triple Bottom Line of 21st Century Business*", John Elkington identifies this as the 'Triple Bottom Line' (TBL) or 'Triple-P (People, Planet, Profit)' concept: Sustainability is about the balance or harmony between economic sustainability, social sustainability and environmental sustainability [15].

The Triple Bottom Line helped in operationalizing the concept of sustainability. However, this operationalization also introduces the risk that the interrelations between the three perspectives are overseen and that the social, environmental and economic perspectives are each considered in isolation. A holistic understanding of the integration of economic, environmental and social perspectives is therefore considered one of the key-concepts of sustainability [30].

Dyllick and Hockerts [12] conclude that sustainability is about consuming the income and not the capital. This aspect is a common realm in business from the economic perspective. However, from a social or environmental perspective, the impacts of human actions and behaviour may not be visible in the short-term. In order not to compromise "*the ability of future generations to meet their needs*", as stated in the Brundtland definition, sustainability therefore requires a balance between both short and long term and a life-cycle orientation. Sustainability implies that "*the natural capital remains intact. This means that the source and sink functions of the environment should not be degraded. Therefore, the extraction of renewable resources should not exceed the rate at which they are renewed, and the absorptive capacity of the environment to assimilate waste, should not be exceeded*" [21].

The International Institute for Sustainable Development elaborated on the Brundtland definition of sustainable development in a definition more focused on sustainable management of organizations: "*Adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future*" [8]. Next to the concepts of Triple Bottom Line and life-cycle orientation discussed earlier, this definition also mentions the interests of stakeholders. In the so called 'stakeholder theory', Freeman [18] developed the notion that all stakeholders of a company or an organization, and not just the shareholders/financiers, have the right and legitimacy to receive adequate management attention that takes into account their interests [25]. The interests of all stakeholders should be embraced by the organization and win-win situations should be sought [16].

In the context of organizations, sustainable development relates to the concepts of (Corporate) Social Responsibility (CSR) [13]. (C)SR is defined by the International Organization for Standardization (ISO) 26000 as the "*responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behaviour that: contributes to sustainable development, including health and the welfare of society; takes into account the expectations of stakeholders; is in compliance with applicable law and consistent with international norms of behaviour; is integrated throughout the organization and practiced in its relationships*" [24].

Next to the concepts mentioned before, this definition highlights the responsibility or accountability that an organization has for the societal impact of its decisions and actions, and the transparency and ethicality of its behaviour. With the mentioning of ethics and norms of behaviour, a normative aspect is introduced. Sustainability is a value based concept, reflecting values and ethical considerations of society [38]. And its integration into business decisions and actions

should go beyond being compliant with legal obligations. Dahlsrud [7] therefore points out the voluntariness dimension of CSR.

With the growing attention for the role of projects in sustainable development [31], it appears that the relationship between sustainability and project management can be interpreted in two ways [42]: the sustainability of the project's *product* (the deliverable that the project realizes) and the sustainability of the project's *process* (the delivery and management of the project).

The Triple Bottom line perspectives provide input for integrating sustainability requirements into the content related aspects of the project, such as the specifications and design of the project's deliverable [1][14], materials used [2], benefits to be achieved [43], quality and success criteria [33]. Studies on the integration of sustainability into project management that take this content related perspective, often focus on operationalizing the Triple Bottom Line by developing sets of indicators on the different perspectives (for example Bell and Morse [3]; Fernández-Sánchez and Rodríguez-López [17]; Keeble et al. [26]; Martens and Carvalho [32]). Considering sustainability in these aspects will most of all result is a more sustainable project in terms of a more sustainable *deliverable*, however, this approach bears the risk of lacking the holistic approach of the integration of the economic, environmental and social perspectives.

Some studies focus on the integration of the dimensions of sustainability into the *processes* of project management and delivery, such as the identification and engagement of stakeholders [16], the process of procurement in the project [35], the development of the business case [49], the identification and management of project risks [39], the communication in and by the project [37], and the selection and organization of the project team [41]. Gareis et al. [19], observe that this perspective has received less attention than the content oriented perspective. A potential explanation for this is the temporary nature of projects [19]. This temporariness of projects may lead to the view that the sustainability, or unsustainability, of the project's process is less impactful. However, Labuschagne and Brent [29], point out that in the process of developing and delivering the project, also many content related aspects are decided and that therefore a project's process and product interact.

2.2. Barriers and enablers for sustainability adoption

Several studies (for example Kumar and Rahman [27] and Stewart et al. [45]) addressed the barriers and/or enablers of the adoption of sustainability in organizations. Where a barrier is defined as a factor that hinders implementation of a sustainability approach or measure [45], an enabler is defined as a factor that helps the implementation of sustainability [28]. Enablers and barriers, therefore, can be considered as opposites.

Kumar and Rahman [27] performed a systematic review of existing literature on the adoption of sustainability practices through supply relationships. Table 1 shows the enablers and barriers they found.

Table 1: Enablers of and barriers to the adoption of sustainability (based on Kumar and Rahman [27]).

Enabler	**Barriers**
Awareness	Lack of awareness
Top management commitment and support	Lack of top management commitment
Competitive and marketing advantage	Perception of low economic return
External pressure Demand of customer and other stakeholders	Poor demand forecasting
Incentives and support by various agencies	No support from government Lack of money
Capacity building and development	No capability Lack of training Lack of education Lack of human resources capability

Enabler	Barriers
	Lack of knowledge No technology sharing
Sharing resources	Lack of resources
Joint efforts and planning	Lack of integration Resistance from suppliers
Monitoring and auditing supply chain partners	Outdated auditing standards
Information sharing	No information sharing
Knowing and solving supply chain partners' problems	Cultural difference
Trust and commitment among partners	Lack of partner trust
Long term partnership	Poor supplier commitment Focus on short term profitability
Cost reduction	Increased cost of adoption

The results of Kumar and Rahman [27] confirm that enablers and barriers are mostly different ends of the same variable. In our study, we will therefore focus on enablers and reformulate the barriers found in earlier studies as enablers. In their study, Stewart et al. [45] found a total of 59 barriers, distributed over eight categories. They categorize the barriers in *internal or organizational-related* barriers and *external or industry-related* barriers. The internal related barriers consist of *structural dimensions*, *political dimensions*, *human dimensions* and *cultural dimensions*. The external related barriers consist of *regulation*, *market*, *technology and tools* and *value network* (Table 2).

Table 2: Categorization of enablers of and barriers to the adoption of sustainability (based on Stewart et al. [45]).

Internal enablers	
Structural dimensions	The structural dimension focuses on the structural element of the organization. Examples are the strategy, the design of its units and subunits, the rules and roles as well as the goals and policies.
Political dimensions	The political dimension focuses on the way to allocate scarce resources, the competing interests, building power bases and the fights for power and advantage.
Human dimensions	The human dimension focuses on understanding people, their strengths and weaknesses, their rationale and emotion as well as their desires and fears. It emphasizes support, empowerment and development of people.
Cultural dimensions	The cultural dimension focuses on meaning, beliefs and faith, for example how humans make sense of the chaotic and ambiguous world in which they live, take responsibility and getting room for out of the box ideas.
External enablers	
Regulation	Regulation focusses on prescribing and encouraging regulation, like labor legislation, environmental legislation, standards and subsidies.
Market	Market focusses on the demand of the customer, influence of the customer, level of competition in the market and knowledge amongst customers.
Technology and Tool	Technology and Tool focusses on eliminating risk, making things measurable and comparable. Examples are dependency on available technology, tool customization, frameworks and benchmarks.
Value Network	Value Network focusses on the complexity of implementing sustainability approaches and the related high dependence on factors whose control is located beyond the company boundaries. Intense collaboration within the value network is often required for implementing sustainability.

The non-adoption of performance measurement systems is highlighted as a common internal barrier across approach types and the lack of industry-specific information, benchmark or reference cases is outlined as a recurrent challenge. It is suggested to perform future research that could focus on identification of criticality and priority areas depending on parameters such as company size or sector as well as groups (of employees).

In a study on enablers of green procurement in construction projects, Wong et al. [51] found 36 enablers that correspond mostly with the categories of Stewart et al. [45]. Other studies on enablers and barriers were performed by Akadiri [2] and George et al. [20]. These studies all found sets of enablers and barriers that were specific to the situations and context they studied. As the enablers of and barriers to the adoption of sustainability that organizations experience are logically context dependent, it may not be possible to develop a generic list of enablers/barriers. We therefore selected the categorization of enablers/barriers as summarized in Table 2 for the exploration of the supplier's perspective on enablers for the integration of sustainability in projects.

3. Research approach

This section presents the research strategy and research design of the study. As the nature of the study is explorative, we selected Q-methodology as research strategy. Q-methodology analyzes different patterns of behavior that may appear, instead of focusing on a single average behavioral pattern. Q-methodology has its roots in psychology and in social science to study people's subjectivity and has shown its usability in the context of project management research [40]; [46]. Q-methodology differs from R-methodology (surveys and questionnaires) in that the latter asks participants to express views on isolated statements, whereas Q-methodology identifies participants' views on statements in the context of the valuation of all statements presented [11]. Furthermore, as opposed to R-methodology, Q-Methodology intends to show different answering patterns among the population.

In Q-methodology, the participants are presented with a set of statements about the topic of the study [50], called the Q-set. Participants, called the P set, are asked to rank-order the statements from their individual point of view, according to some preference, judgment or feeling about them, mostly using a quasi-normal distribution. By 'Q-sorting' the statements, the participants give their subjective meaning to the statements, and in this way they reveal their subjective viewpoint [44] or personal perspective [4]. As conceptual model of the enablers of the adoption of sustainability by suppliers, we selected the categorization proposed by Stewart et al. [45], as provided in Table 2. In the Q-set of statements, each statement was related to one of the categories of enablers of our conceptual model. The statements were formulated as answers to the 'umbrella question' that was formulated as "*It is possible for me to integrate sustainability into my project when…*". For example: "It is possible for me to integrate sustainability into my project when… I am more aware of sustainability". In Q-methodology there is no clear rule for the number of statements in the sort. However, generally speaking, a Q-set of around 40 statements is considered satisfactory [50]. In line with this, we formulated 39 statements for our study. The numbering of statements was not visible during sorting, to prevent the participants categorizing them as representing behavioral, normative or control beliefs.

As the generation of potential statements for the Q-set does not need to be theory driven [50], the statements were formulated by the research team and validated in a pilot with three respondents. In the formulation of statements, it was ensured that all statements were written in the same style, extreme statements were avoided and double negatives were avoided [10]. In this way, a balanced Q-set was obtained which is presented in Table 3.

The statements were printed on individual cards [9], that the participants were asked to rank-order from "Strongly disagree" to "Strongly agree" on a Q-sort diagram as illustrated in Figure 1. We used a symmetrical diagram, as is normally preferred in Q-methodology.

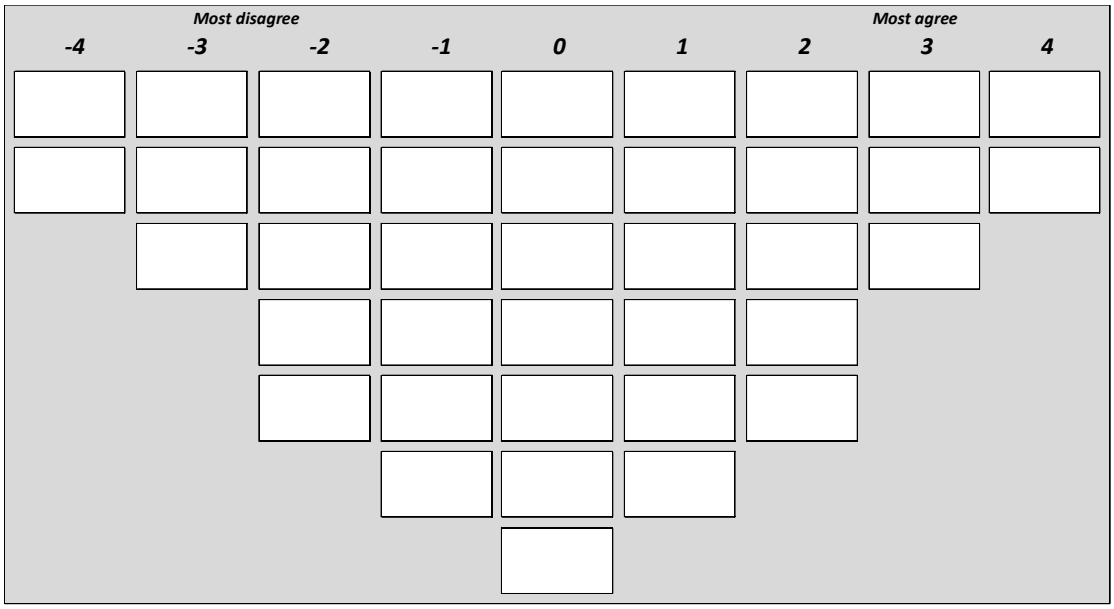

Figure 1: Q-sort diagram

Table 3: Overview of categories and statements

Category			Statement
Internal enablers	Structural dimensions	1	extra money is available
		2	sustainability is integrated in the processes of our company
		3	it is clear how liability is arranged
		4	sustainability is integrated in the vision and strategy of my company
		5	there is measurement system for sustainability
	Political dimensions	6	it reduces costs
		7	extra resources (people) are available
		8	the organisation focuses on the long term
		9	I can motivate choices better
		10	there are departments of the organisation that support me
	Human dimensions	11	management supports sustainability
		12	I can attend a training or education concerning sustainability
		13	I had more knowledge of sustainability
		14	I am more aware of sustainability
		15	the uncertainties caused are being accepted by stakeholders
		16	it has my interest
	Cultural dimensions	17	I get room for trying things
		18	there is more commitment for sustainability in my company
		19	there is more commitment for sustainability in my project team
		20	sustainability is considered as company's responsibility

Category			Statement
External enablers	Regulation	21	it is forced by legislation
		22	it is supported or encouraged by the government
		23	there is certification for sustainability of projects
	Market	24	my client wants to pay extra for sustainability
		25	my competitor or colleague does it as well
		26	the client asks for sustainability
		27	I can influence my client
		28	it is expected by society
	Technology and Tool	29	risks of sustainable alternatives are known
		30	there are sustainable alternatives
		31	there is method for comparing the sustainability of alternatives
		32	it does not cost extra resources
		33	a sustainable technique has other advantages for the company
	Value Network	34	I can work closer together with suppliers
		35	I know that suppliers are willing to help
		36	I know that it is not worsening my bargaining power
		37	I can trust my suppliers
		38	I know that stakeholders of the project support sustainability
		39	I can assess my supplier objectively on their sustainability performance

Data collection was done in structured face-to-face interviews. Before the sorting of the statements, the participants were asked a number of initial questions about their demographical information and their work context. After the sort, the participants were asked some post-questions, these questions were designed to find more details about the motivation of the participants to rank certain statements.

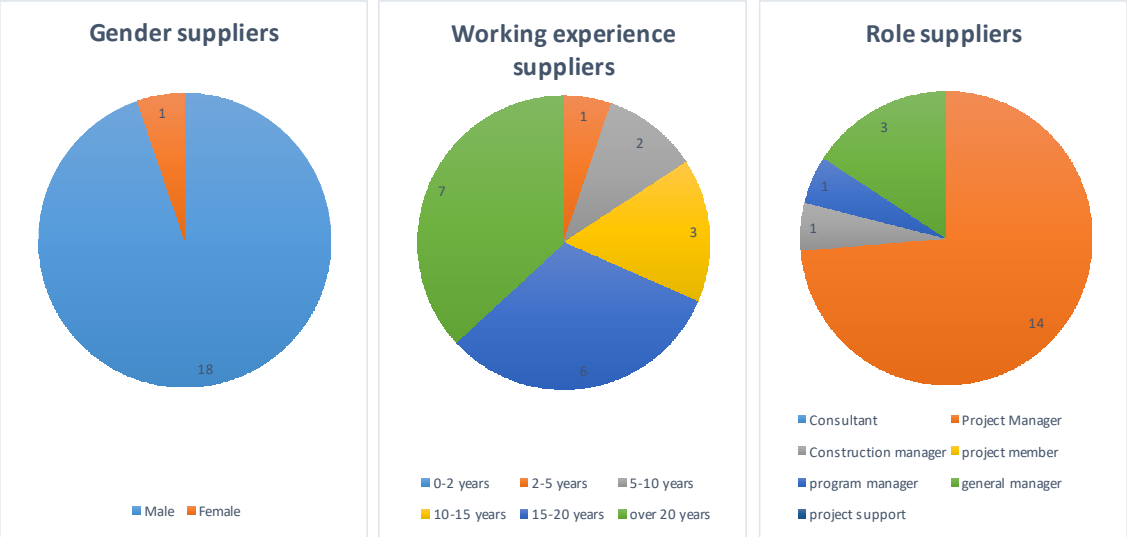

Figure 2: Gender, working experience and role of suppliers

As Q-methodology aims to reveal (and to explicate) some of the main viewpoints that are favored by a particular group of participants, large numbers of participants are not required for a Q-methodological study [24]. In our study, 19 participants of 9 companies participated. Sampling was done using purposive sampling by inviting a mix of engineering companies and construction companies. As presented in figure 2, 18 of them were male and one is female. Over 80% has more than 10 years of working experience and 75% qualified themselves as project managers. Three qualified themselves as general managers, one as program manager and one as a construction manager. Data collection took place in the Netherlands, in the Fall of 2016.

4. Findings

Based on the Kaiser-Gutmann criterion, significant factor loading and a less strict applied Humprhey's rule, three factors could be extracted from the data, resulting in sum of variance explained of 36%, which is satisfactory [24]. Based on a varimax rotation with additional manual rotations, 12 participants could be related to the factors. Table 4 presents the top 10 ranked statements for the three factors. The bottom 10 ranked statements of the factors are presented in table 5. Bold statements are distinguishing statements per factor, the italic statements are consensus statements for all three factors.

Table 4: Overview of top 10 ranked statements per factor.

Factor 1		Factor 2		Factor 3	
6	**it reduces costs**	26	the client asks for sustainability	26	the client asks for sustainability
24	*my client wants to pay extra for sustainability*	*24*	*my client wants to pay extra for sustainability*	*24*	*my client wants to pay extra for sustainability*
11	management supports sustainability	**22**	**it is supported or encouraged by the government**	4	sustainability is integrated in the vision and strategy of my company
4	sustainability is integrated in the vision and strategy of my company	8	the organisation focuses on the long term	*20*	*sustainability is considered as company's responsibility*
8	the organisation focuses on the long term	1	extra money is available	*17*	*I get room for trying things*
20	*sustainability is considered as company's responsibility*	*20*	*sustainability is considered as company's responsibility*	*1*	*extra money is available*
33	**a sustainable technique has other advantages for the company**	**19**	**there is more commitment for sustainability in my project team**	*38*	*I know that stakeholders of the project support sustainability*
32	**it does not cost extra resources**	*17*	*I get room for trying things*	6	it reduces costs
38	*I know that stakeholders of the project support sustainability*	**21**	**it is forced by legislation**	11	management supports sustainability
26	**the client asks for sustainability**	**16**	**It has my interest**	30	there are sustainable alternatives

Table 4 shows that statements 20 and 24 score relatively high in all three factors. This means that suppliers in general consider it important for the integration of sustainability in a project, that the client wants to pay for sustainability and that sustainability is considered as a responsibility within the company. The overview of bottom ranked statements in table 5 shows that there are no consensus statements which appear in all factors' bottom 10. Consensus statements that appear are statements 13, "Having knowledge about sustainability", 39, "Being able to assess suppliers on their sustainability performance" and 31, "there is a method for comparing the sustainability of alternatives". They all score at the bottom half of the ranking, which cause them to be indicated as consensus statements.

The distinguishing statements indicate that the viewpoint of factor 1 is more focusing on reducing costs and making benefits out of a sustainable technique, and although the demand of the client in the top 10 ranking, it does not score as high as in the other factors. Interest and whether choices can be motivated are less important. If it saves costs or generates extra benefits, motivation of sustainability might sell itself.
The distinguishing statements of factor 2 indicate that legislation, support of the government, commitment for sustainability in the project team and interest are important aspects for integration of sustainability. The commitment seems to be more important than integration in the vision and strategy of the company, indicating that structures are less important than culture.
In the top 10 statements of factor 3, there are no distinguishing statements, this means that these statements score also high in one or all other factors. Distinguishing statements on the bottom 10 show that the focusing on the long term, certification of sustainability and interest are seen of less importance than in other factors. Table 6 presents the Z-scores for the three factors as a result of the data analysis.

Table 5: Overview of bottom 10 ranked statements per factor.

Factor 1		Factor 2		Factor 3	
34	I can work closer together with suppliers	*13*	*I had more knowledge of sustainability*	25	my competitor or colleague does it as well
31	*there is a method for comparing the sustainability of alternatives*	*39*	*I can assess my supplier objectively on their sustainability performance*	5	there is measurement system for sustainability
25	my competitor or colleague does it as well	35	I know that suppliers are willing to help	27	I can influence my client
16	**it has my interest**	34	I can work closer together with suppliers	**8**	**the organisation focuses on the long term**
14	I am more aware of sustainability	5	there is measurement system for sustainability	*13*	*I had more knowledge of sustainability*
39	*I can assess my supplier objectively on their sustainability performance*	12	I can attend a training or education concerning sustainability	14	I am more aware of sustainability
15	the uncertainties caused are being accepted by stakeholders	**36**	**I know that it is not worsening my bargaining power**	12	I can attend a training or education concerning sustainability
9	**I can motivate choices better**	**4**	**sustainability is integrated in the vision and strategy of my company**	**23**	**there is certification for sustainability of projects**
37	I can trust my suppliers	3	it is clear how liability is arranged	37	I can trust my suppliers
3	it is clear how liability is arranged	**25**	**my competitor or colleague does it as well**	**16**	**It has my interest**

Table 6: Overview of Z-scores per factor.

Internal enablers					External enablers				
Category	**Statement**	**Z-score factor 1**	**Z-score factor 2**	**Z-score factor 3**	**Category**	**Statement**	**Z-score factor 1**	**Z-score factor 2**	**Z-score factor 3**
Structural dimension	1	0,467	1,387	1,091	Regulation	21	0,001	0,957	-0,487
	2	0,495	-0,178	0,197		22	-0,574	1,469	-0,711
	3	-2,228	-1,763	0,178		23	0,082	-0,602	-1,849
	4	1,421	-1,546	1,516	Market	24	1,551	1,543	1,733
	5	0,057	-1,231	-0,759		25	-0,904	-1,823	-0,755
Political dimension	6	1,990	0,352	0,866		26	0,682	1,553	1,868
	7	0,500	-0,320	-0,665		27	-0,673	0,524	-0,909
	8	1,327	1,399	-0,936		28	-0,474	0,068	0,290
	9	-1,472	0,029	-0,155	Technology and Tool	29	-0,654	-0,163	0,468
	10	0,627	-0,245	0,267		30	-0,291	0,738	0,670
Human	11	1,519	0,455	0,851		31	-0,821	-0,134	-0,158

Internal enablers				
Category	**Statement**	**Z-score factor 1**	**Z-score factor 2**	**Z-score factor 3**
dimension	12	-0,517	-1,428	-1,381
	13	-0,417	-0,779	-1,091
	14	-0,953	0,131	-1,269
	15	-1,253	-0,773	0,375
	16	-0,909	0,805	-2,023
Cultural dimension	17	0,631	0,985	1,288
	18	0,395	0,200	0,580
	19	-0,201	1,241	-0,042
	20	1,305	1,359	1,381

External enablers				
Category	**Statement**	**Z-score factor 1**	**Z-score factor 2**	**Z-score factor 3**
	32	0,885	-0,397	-0,174
	33	1,274	0,719	-0,294
Value Network	34	-0,723	-0,990	0,197
	35	-0,502	-0,929	0,487
	36	0,283	-1,482	0,472
	37	-1,633	-0,579	-1,892
	38	0,804	0,296	1,022
	39	-1,097	-0,847	-0,248

Based on this distribution and on interviews with participants related to the factors, the factors will be described in more detail in the sections 4.1, 4.2 and 4.3.

4.1 Factor 1

The distribution of Z-scores for this factor are presented in Figure 3. This figure shows per category of statements the cumulative Z-scores of the two highest scoring statements plus the scores of statements that score relative high compared to other factors and the cumulative Z-scores of the two lowest scoring statements plus the scores of statements that score relative low compared to the other factors.

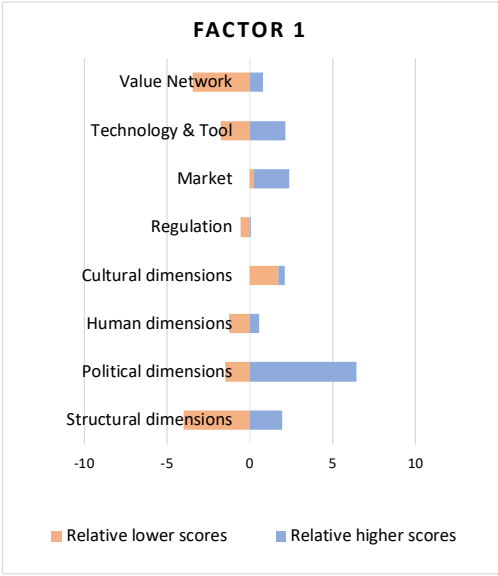

Figure 3: Distribution of statements over categories for Factor 1.

Figure 3 shows that factor 1 has high scores on structural dimensions, political dimensions, market and technology & tool. The biggest peaks in the relative low scores are in the structural dimension, cultural dimension, technology & tool and value network. Both higher scores and lower scores are distributed over internal and external categories. This

means that the enablers for integrating sustainability in projects for factor 1 are considered to be both in the internal organization and in the external organization.

From the interviews, it turns out that there are tensions between costs and benefits in the projects executed. Cost reduction is supported by focusing on the long term, which allows for more investments in sustainable tools and techniques. This viewpoint causes the dominant relative higher score on the political dimension. If a sustainable technique has other advantages for the company, considering sustainability is further enabled and together with the enabler that sustainability does not cost any resources, this viewpoint causes the relative high score in the category technology & tool. In order to improve the benefits, it is seen as an enabler when the client asks for sustainability and is willing to pay for it, causing a high score on market. Integration of sustainability in processes, vision and strategy and management support are facilitating to considering sustainability in the projects causing the relative higher scores on the structural and human dimension.

Commitment for sustainability in the project team and getting room to try things are not relatively low awarded in this factor, which causes the relative low score in the cultural dimension. In the structural dimension, liability issues and availability of money are considered to be of low influence. Participants indicate that money should be paid by the customer and should not come from the internal organization. Risks and being able to compare the sustainability on the one hand and cooperation with suppliers, trusting suppliers and being able to assess suppliers objectively on the other hand cause relative low scores on the categories technology & tool and value network respectively.

The participants related to factor 1 are focused on generating money from sustainability, either by saving costs or generating extra money by the preparedness of the customer to ask and pay for sustainability. We labelled this factor therefore as "Benefits driven" (*Sustainability if it has benefits*).

4.2 Factor 2

Figure 4 presents the distribution of Z-scores per category for factor 2. This factor has high scores on regulation and market. The low scores are in the structural dimension, human dimension, cultural dimension, market and value network. The higher scores are rather external oriented and the lower scores are both internal and external oriented. This means that the enablers for integrating sustainability in projects for factor 2 are highly in the external organization and not in the internal organization.

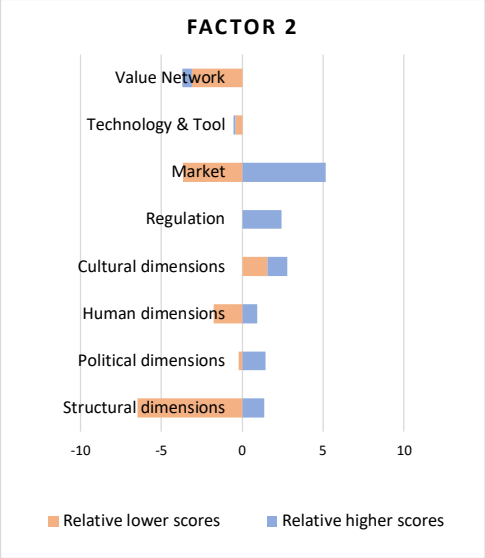

Figure 4: Distribution of statements over categories for Factor 2.

Participants associated to factor 2 see intrinsic motivation for implementing sustainability as the driving force for integrating sustainability in projects, it has to be there. These participants have interest for sustainability, that is why they do not see interest as an enabler. As a result, they have a lot of knowledge, causing training, education and having knowledge not to be awarded as enabler. This results in a relative lower score on the category human dimension. Knowing how means also that getting support of the organization is not seen as an enabler. Together with the conviction that sustainability cost (initially) money, which is contrary to saving costs, causes it a higher score on the political dimension. The importance of intrinsic motivation also causes commitment of the company for sustainability, seeing it as a company's responsibility, integrating sustainability in processes and vision and strategy not to be awarded as important enablers, relative to other factors. This results in relative lower scores in the cultural and structural dimension. Although the score in the cultural dimension is relative lower, it is still awarded with a cumulative positive Z-score.

Relative high scores in the market category are the result of the high awarding of the enablers that clients are asking and willing to pay for sustainability. It helps when the client can be influenced based on arguments in this respect. Support is experienced when legislation and support or encouragement of the government is in place. This forces clients to look into sustainability. This causes a relative high score on the category regulation.

Intrinsic motivation distinguishes participants related to this factor, they are motivated and award other internal enablers for that reason relative low. In the external enablers, the willingness of the client to pay or sustainability and whether the client is asking for sustainability is awarded high. For this reason, we labelled this factor as "Demand and intrinsic motivation driven" (*Willing to integrate sustainability if it is asked and paid for*).

4.3 Factor 3

Figure 5 presents the distribution of Z-scores per category for this factor.

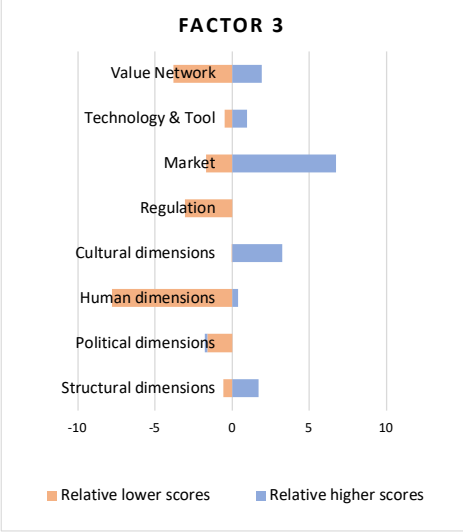

Figure 5: Distribution of statements over categories for Factor 3.

Factor 3 has high scores on cultural dimensions, market, technology and tool and value network. The low scores are in human dimensions and cultural dimension. The higher scores are external oriented and the lower scores are distributed

over internal and external categories. This means that the enablers for integrating sustainability in projects for factor 3 are considered to be rather in the external organization than in the internal organization.

The demand of the customer and the willingness to pay for sustainability are important enablers for participants related to factor 3, causing the relative high score in the category the market. If that is in place, room for trying things emerges, together with commitment of the company for sustainability and seeing sustainability as a company's responsibility causing relative high scores in the category cultural dimension. Whether sustainability is integrated in the vision and strategy of the company is also important to the participants related to this factor. Participants are then enabled to choose for sustainable alternatives if available and if those alternatives can be assessed on their sustainability and if the risks of those alternatives are known, considering sustainability is further enabled. This results in a relative higher score in technology and tool category. Participants see possibilities to cooperate with suppliers, such that the supplier can be trusted and can be assessed objectively on their sustainability performance, although the value of that contribution is considered limited and that other suppliers should be selected if they cannot be trusted. This causes a relative higher score in the category value network.

Participants argue that there is enough knowledge of sustainability, knowledge, training and education is there for relative low scored, causing a high relative lower score in the category human dimension. It is subsequently questioned whether the government or governmental organisation should try to influence integration of sustainability. This results in a low score on the regulation category.

Demand of the customer is very important for participants related to factor 3. The demand enables participants related to factor 3 to bring sustainability in the vision and strategy into practice. This factor is therefore labelled as "Demand and Strategy driven" (*Sustainability if it is asked for and fits our strategy*).

In general, it can be seen that the factor's scores in the individual categories differ, this is in line with the characterizations of the statements. It can also be seen that the higher scores are dominant on the external categories and that the lowest scores are on the internal categories. The high score on the political dimension for factor 1 is an exception to the described pattern. This high score is merely caused by statement 6: "it reduces costs". This means that suppliers in general perceive more enablers outside the organization than inside the organization, although they see enablers in the cultural and structural dimension as well.

5. Conclusions

The study reported in this paper set out to investigate: "What enablers for integration of sustainability in projects are perceived by project suppliers?" The study found that the enablers perceived by suppliers in general are both internally oriented and externally oriented. High ranked enabler categories are the market, structural dimension and cultural dimension. Specific enablers which are high rated and thus strongly perceived are "my client wants to pay extra for sustainability" and "the client asks for sustainability". Both enablers are in the category market. In the cultural dimension, "sustainability is seen as a company's responsibility" is high rated and in the structural dimension the rating of the enablers differs per factor, but in general "sustainability is integrated in the vision and strategy of my company" and "extra money is available" score high. It can be concluded that suppliers perceive enablers for integrating sustainability the most in the external organization in the category market and thus see enablers in the demand of the customer and influence of the customer. Other important enablers are internal oriented in the categories, structural dimension and cultural dimension and thus focus on strategies, rules, roles, goals, policies but also on meaning, beliefs and faith.

Next to these generic findings, our study also found three different patterns of enablers, that we labelled:

- Factor 1: Benefits driven (*Sustainability if it has benefits*);
- Factor 2: Demand and intrinsic motivation driven (*Willing to integrate sustainability if it is asked and paid for*);
- Factor 3: Demand and Strategy driven (*Sustainability if it is asked for and fits our strategy*).

As it appears from this study, for suppliers integrating sustainability in projects is strongly dependent on the demand and willingness of the customer to pay for sustainability. On the one hand, customers can take that into account into contracting strategies. On the other hand, adoption of sustainability in the supplier's policy could be a successful measure for integration of sustainability in projects as well. In that respect, it should be questioned whether a contractor should wait for the customer to ask for it or should take action by himself and differentiate himself from its competitors.

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Perspectives on reusing codified project knowledge: a structured literature review

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Abstract:
Project documentation represents a valuable source of knowledge in project-based organizations. The practical reality is, however, that the knowledge codified in project documents is hardly re-used in future projects. A central problem in this context is the extensive amount of usually textual material. As a consequence, computer-assisted processes are indispensable in order to analytically manage the constantly growing and evolving databases of available project documents. The goal of this study is to summarize the current research focusing on the computer-assisted reuse of textually codified project knowledge and to define the corresponding state-of-the-art in this this specific field of information systems research. As a result of a literature review, this study structures the body of research contributions and outlines what kinds of computer-assisted techniques are incorporated, what practical application areas these solutions address, and in what business domains they are applied. In particular, this should point out research opportunities and thereby make a contribution to the further development of knowledge management in project environments.

Keywords:
project knowledge management; knowledge management; project documentation; codified knowledge; text mining.

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1. Introduction

In general, there are two strategies for managing and transferring knowledge in an organization [1]: codification strategy (i.e., transferring codified knowledge via documents) and personalization strategy (i.e., sharing tacit knowledge directly from person to person). In regard to the codification strategy, project-based organizations usually invest a lot of time and effort in the preparation of diverse project documents [2-4] such as project appraisals, requirement specifications, or post-project reviews [5]. The knowledge codified in such documentations fundamentally represents a valuable source of lessons learned, concepts, and interdependencies that can be relevant for future projects [6-9]. Consequently, in the sense of a continuous learning process, the PMBOK® guide and PRINCE2 framework specifically recommend archiving all project documentation produced in publicly accessible organizational knowledge databases as a rich trove of expertise [10, 11]. The reuse of this constantly growing base of knowledge allows a project-based organization to develop continuously by disseminating the lessons learned and best practices from completed projects and thus avoiding the repetition of errors and extra work in future projects [12-14]. In this context, a consequent project knowledge management plays a vital role in creating, archiving, sharing, and finally utilizing such knowledge in project-based organizations [13].

The practical reality is, however, that the knowledge codified in project documents is hardly reused in project-based organizations [2, 15-17], which are characterized by the fact that business functions are primarily performed in interdisciplinary, temporal, and constantly evolving projects rather than in functional organizations [18]. A central problem in this context is the extensive amount of usually textual material [15, 19-21]. As a consequence of this, the main challenges in reusing such textually codified knowledge are: (1) the effective identification and efficient retrieval of relevant knowledge content and (2) the combined, i.e. summarizing analysis and presentation of various knowledge sources. The first challenge results from the circumstance that the extensive and constantly evolving knowledge repositories lead to an information overload in project-based organizations [2, 17, 22, 23]. The databases of material are too large for project managers to handle manually – in a reasonable amount of time –, meaning for them to read and interpret all potentially relevant document contents. Moreover, project managers find the search for relevant knowledge frequently to be a "waste of time" and are not very motivated to search electronic document databases for relevant pieces of knowledge [24]. The second challenge results from the fact that the isolated analysis of individual cases often does not supply any representative insight into the standard risks, success factors and their relationships [19, 20]. Project managers therefore need to combine and synthesize the knowledge described in several contextually related project documentations in order to ultimately achieve a profound information basis for decision-making [25]. As a consequence, these described challenges usually lead to the fact that the potential for reusing codified knowledge sources often remains untapped. Specifically, this means that the available project knowledge is lost in the evolving environment of project organizations – the phenomenon of so-called "project amnesia" – and that mistakes already made are repeated in the worst case or that already solved problems must be solved again.

As a consequence of the practical problems described, research has increasingly focused on effective reuse of textually codified project knowledge. In particular, the implementation of computer-assisted text analyses has gained importance and established itself as a particular field of research in the meantime [26, 27], which involves the systematic classification, structuring, retrieval, summarizing and visualization of textual knowledge content (see e.g., [20, 25, 28]). Since there has been an increasing amount of recommendations for such computer-assisted reuse of knowledge in recent years, this study follows the call of Almeida and Soares [2], who recommend the structured summary of research efforts in the field project knowledge management. Although several forms of knowledge transfer exist, this study specifically focusses on the technical perspectives on reusing codified project knowledge in this context. The goal is to bring to light what research has contributed to solving the above-mentioned problems and what concrete concepts and approaches have been incorporated. For this purpose, a structured literature review is used to provide a summary of related research contributions, providing an overview of the technical approaches, practical application cases and business areas of use.

The following three research questions (RQ) are asked for this:

RQ1: *What computer-assisted technologies are employed for reusing textually codified project knowledge?*

RQ2: *What practical areas of application are recommended for the implementation of appropriate computer-assisted solutions in project management?*

RQ3: *In what business domains are appropriate computer-assisted solutions used?*

Answering these questions should allow for a representation of the state-of-the-art in the computer-assisted reuse of textually codified project knowledge. In general, this creates awareness of textual project documents as valuable knowledge carriers and describes the practical options of such knowledge reuse scenarios. In particular, this structured overview should also serve as a reference for defining future research opportunities. Finally, this should make a contribution towards the further development of knowledge management in project environments (see [29-31]).

This paper is structured as follows: Section 2 introduces the theoretical background, explaining the role of project documentation as a source of knowledge and discussing the fundamentals of computer-assisted text analyses. Section 3 describes the design of the literature review. Section 4 summarizes the results of the literature review. Section 5 contains a critical discussion of the findings and their implications for the project management. Section 6 provides the final conclusions and outlook.

2. Research background

2.1 Project documentation as a source of codified knowledge

According to the knowledge codification strategy (see [1]), project documentation is intended for the purpose of explicitly saving experience implicitly gained by the project employees, transferring it to organizational knowledge databases and thereby making such experiences available for subsequent projects as a valuable source of knowledge [16]. A special role is played by so-called post-project reviews [6, 9, 12, 14, 32], which can be defined as "the final formal review in the course of a project that examines any lessons that may be learned and used to the benefit of future projects" [32, p. 256]. As this definition already suggests, the "lessons learned" from the projects are the focus of interest in such reports. Lessons learned can be described as "key project experiences which have a certain general business relevance for future projects. They have been validated by a project team and represent a consensus on a key insight that should be considered in future projects" [14, p. 220]. Lessons learned are experience reports codified textually and describing not only the questions of "what?", "where?" or "how many?", but rather also the questions of "how?", "why?" and "with what effect?" [14]. Such codified project knowledge usually contains innovative knowledge that can be useful in various ways for future projects [5]:

- It is a starting point for conceptualizations and for feasibility studies of future projects.
- It is a reference to the planning of work packages, project milestones and project costs.
- It provides instructions for executing project management functions.
- It is a training resource for new project managers or inexperienced team members.
- It allows for a collective analysis of the causes of failed or problematic projects.

The established project management guidelines explicitly recommend that the knowledge codified in project documents be secured and systematically reused [10, 11]. The PMBoK® guide refers to such project knowledge as "organizational process assets" that should act as a fundamental basis of knowledge for projects [11]. Likewise, the PRINCE2 framework recommends the reuse and analysis of codified project knowledge in order to summarize the relevant lessons learned in a so-called "lessons log" during the project planning phase [10]. Multiple empirical studies in this context have already been able to prove that the systematic reusing of available project knowledge can have a significant positive impact on project performance (see, e.g., [33-36]). However, the true potential of such project-based learning is often not fully exploited. In this context, the term "project amnesia" stands for the untapped potential of profiting from past (and documented) successes and failures [14]. The reasons are, among others, insufficient willingness for learning

from documented experiences, difficulties in retrieving relevant knowledge content, or lacking enforcement of the project knowledge management procedures [14].

2.2 Knowledge discovery in textual databases

In order to analytically manage extensive textual databases, computer-assisted processes are indispensable [15, 20, 25]. Computer-assisted, i.e. (partially) automated analyses of textual databases have made great progress over the last decade and are often referred to by the term text mining, although there are also very different descriptions in this context (see, e.g., [37-40]). Text mining, however, is less an individual technique than a generic term for multiple complementary techniques from various sub-disciplines such as classical data mining, (computer)-linguistics or information retrieval [39]. Text mining combines such competencies and can be described collectively as "[t]he semiautomated process of extracting patterns (useful information and knowledge) from large amounts of unstructured data sources" [39, p. 1023].

For the purpose of this study, a differentiation shall be made between six fundamental text mining areas (according to [39, pp. 29-41]):

(I) Search & information retrieval: The computer-assisted naming, searching and retrieval of content in extensive, textual databases.

(II) Document classification: The partially automated (supervised) classification of text content or entire documents in predefined thematic categories based on trained classification models.

(III) Document clustering: The automated (unsupervised) grouping of text content or entire documents according to their semantic similarity based on clustering algorithms.

(IV) Information extraction: The targeted extraction of specific facts from unstructured (textual) databases in structured, relational data formats (e.g., data tables).

(V) Concept extraction: The statistical extraction and summarization of interpretable content structures and relationship patterns (e.g., semantically connected words) from textual databases.

(VI) Natural language processing: The automated processing and analysis of linguistic facets in texts.

The use of such text mining techniques has been proposed multiple times in the context of project management. Choudhary et al. [20] stress here that the lack of efficient computer-assisted tools can make the reuse of textually codified project knowledge a time- and cost-intensive process. Therefore, computer-assisted processes are indispensable in order to analytically manage the constantly growing and evolving databases of available project documents.

3. Literature review design

A literature review is a suitable method for providing a structured summary of the current research efforts in a specific discipline [41]. Since there may be differences between the design and execution of such a review, a detailed documentation of the review process is required [42]. To understand the idea of the following review design, therefore, it is necessary to address the six characteristics proposed by Cooper [43] in the following: (1) *goal*, (2) *focus*, (3) *perspective*, (4) *coverage*, (5) *organization*, and (6) *audience*.

(1) The *goal* of this literature review is to summarize and structure the research to date focusing on the computer-assisted reuse of codified knowledge in project management. Specifically, this involves answering the question of what concrete text analysis techniques are used (RQ1), what practical application areas are conceivable in project management (RQ2) and in what business domains such solutions are used (RQ3).

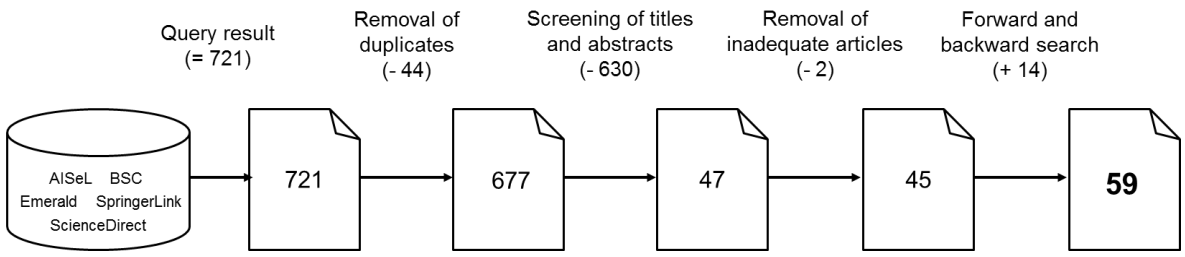
(2) The *focus* lies on scientific journals and conference proceedings reviewed by professionals (peer-reviewed), which propose practical solutions for the computer-assisted reuse of textual documentation in project

environments. In general, the resulting literature mainly derived from the fields of information systems and management (e.g., *Automation in Construction*, *Computers in Industry*, *Decision Support Systems*, *Expert Systems with Applications*), project management (e.g., *International Journal of Project Management*, *International Journal of Managing Projects in Business*), and knowledge management (e.g., *Journal of Knowledge Management*, *Knowledge Management Research & Practice*).

(3) A neutral *perspective* is adopted, i.e. the research papers are solely structured and summarized in terms of content, without taking a critical position in regard to their proposed solutions.

(4) The *coverage* of the review includes a systematic keyword search in five literature databases (see Table 1 for details). The corresponding retrieval combined two content dimensions by making typical terms for project documentation (cited from [12] and [5]) and typical terms in data mining (based on [39]) appear closely together (search fields: title, abstract or keywords). The corresponding search led to a comparatively large number of articles being discovered (721 with duplicates; 677 without duplicates). Potentially relevant articles were then selected on the basis of a screening of the titles and the abstracts (total: 47) and then analyzed in full. In this process, two articles were removed from the database on account of a lack of relevance and scientific suitability. Additionally, a reference search (forward- und backward search; as recommended by [44]) was conducted on the basis of the remaining 45 relevant articles. By this means, it was possible to identify another 14 relevant reference articles so that a collection with a total of 59 articles was ultimately available for the review.

Table 1. Literature review design: retrieval and determination of relevant research contributions



Notes:

Databases:	AIS electronic Library, EBSCO BSP, Emerald, ScieneDirect, SpringerLink
Keyword search:	("project review" OR "post-project" OR "post project" OR "postmortem review" OR "project appraisal" OR "project reflection" OR "project evaluation" OR "project debriefing" OR "project document*" OR "project knowledge" OR "project experience*") AND ("content analys*" OR "text analys*" OR "discovery" OR "textual analys*" OR "mining" OR "detection" OR "modeling" OR "mapping" OR "extraction" OR "classification" OR "clustering" OR "grouping" OR "synthe*" OR "retriev*" OR "reusing" OR "reuse" OR "coding")
Search fields:	title, abstract, keywords
Search restrictions:	peer-reviewed research (scientific journals and conference proceedings)

(5) The *organization* of the review is based on a primarily methodological procedure, with the articles being assessed and categorized independently by two experts according to their content. The creation of these categories is fundamentally based on a qualitative content analysis (i.e., reading, interpreting, and grouping findings into meaningful thematic categories; see [45]). By comparing the respective groupings (three grouped categories according to RQs 1-3), it was possible to evaluate the inter-coder agreements (between 78 and 91% in the course of three groupings), which were on an acceptable level. Then the differences were discussed and specific articles categorized by consensus. Initially, the respective papers were categorized according to which of the six typical text mining techniques were used (see Section 2.2). This categorization offers insight into the

dissemination of technical procedures and methods. Then the articles were grouped on the basis of the respective practical areas of application (such as the assessment of project risks or the evaluation of project documentation quality). Here, the underlying question was: What is the practical purpose of the proposed solution? The last groupings were based on areas of use (business domains) for the proposed solutions (such as, e.g., construction or industrial engineering).

(6) The *audiences* of interest in this review are researchers and practitioners of the project management and knowledge management disciplines in the broader sense and experts in project knowledge management in the narrower sense.

4. Findings

The 59 proposed solutions identified in the literature review were initially organized according to the six typical text mining areas (see Figures 1), whereby the solutions can also use multiple techniques at the same time. As a result of this categorization, a qualitative overview of the most widespread techniques in project management was created (RQ1). This shows that the solutions proposed in the context of project management are largely focused on techniques in the area of *search & information retrieval* (43 papers), which support the systematic finding and efficient retrieval of specific knowledge content. *Document classification* (21) and *document clustering* (16) are also quite common for thematic classification or semantic grouping of textual content. A total of 21 papers used techniques related to *concept extraction* in order to create new and enriched content concepts from a combined and summarized corpus of project documents. Relatively less widespread are the techniques of *information extraction* (4) for transferring facts from unstructured information in structured formats and the *natural language processing* (2) for the analysis of linguistic facets in documents.

Figure 1. Quantitative results of the literature review: text mining areas

Text mining areas

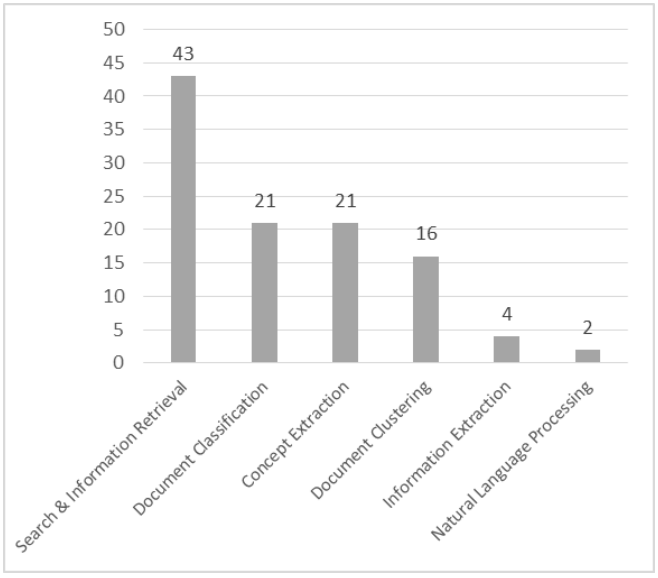


Figure 2. Quantitative results of the literature review: application areas

Application areas

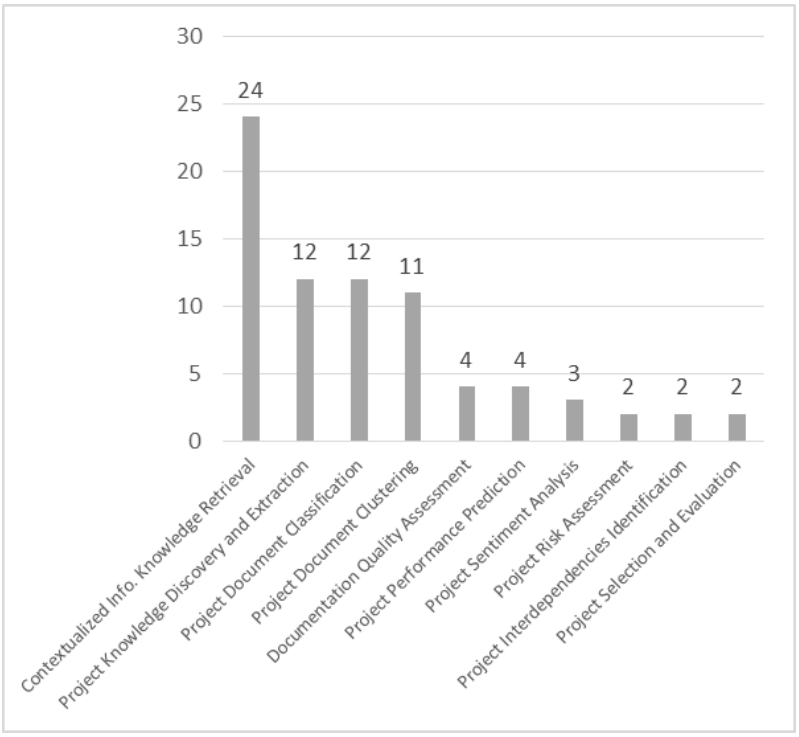
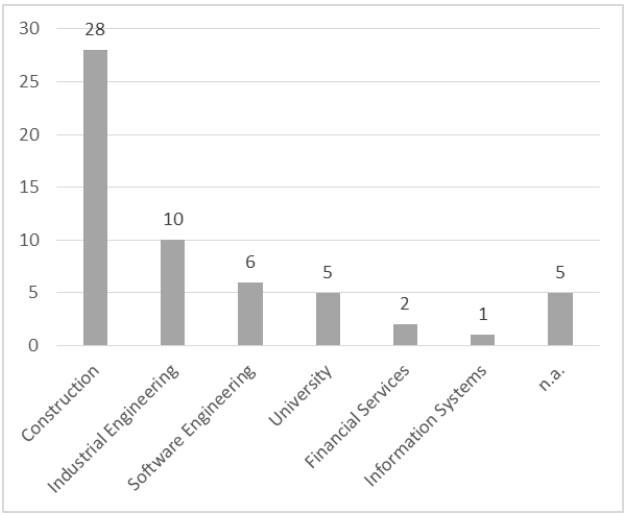


Figure 3. Quantitative results of the literature review: business areas

Business areas



The next step involved a qualitative content analysis, in which the proposed solutions were categorized in practical areas of application for which the corresponding tools were used (RQ2). The proposed solutions here can also address multiple cases of applications simultaneously. A total of 10 practical application areas could be identified, which stand for different problems or tasks as part of the reuse of the codified project knowledge (see Figure 2 for quantitative results and Table 2 for a complete description of the areas with references). In the following these application areas (frequencies in brackets) shall be described in more detail.

Contextualized information and knowledge retrieval (24): Multiple authors have stressed the need for conceptualized knowledge structures, i.e. an organization of the documents and individual knowledge content according to thematic focal points such as project phases or processes, products or specific situations (see, e.g., [46-49]). As demonstrated by Demain and Balatsoukas [46]), for example, such contextualized as-needed information can be the facts related to the project tasks or problems (i.e., a specific piece of information) or a large number of references for decision-making (e.g., for identifying standard procedures or finding the best option among alternatives). The proposed solutions in the application area of contextualized information and knowledge retrieval aim to give project employees appropriately targeted access to contextualized and thus task-specific knowledge content. On the basis of such contextualized databases, more user-oriented search strategies can be developed for project managers, with these strategies allowing for systematic keyword searches for relevant documents and document content, for example (see [50]). In this context, multiple papers describe the underlying conception of domain-specific taxonomies or, even more specifically, technical ontologies that can be referred to as "a body of formally represented knowledge" [51, p. 199]. In ontological databases, domain-specific knowledge areas and technical terms are defined and their relationships are mapped [52]. Thus, they act as a content framework and simultaneously as a technical basis in order to save project documents and content in databases in a contextualized way (e.g., according to specific project themes, tasks or problems). To give an example, Kamara et al. [53] use XML-based structures here in order to implement a so-called "project-in-context" model according to project-specific task stages and thus to contextualize the codified project knowledge in databases accordingly (see also [48] and [49]). Ma et al. [54], to cite another example, integrated knowledge context parameters into project management tools such as PERT (using a so-called building-block approach) in order to record and reuse project task knowledge according to the knowledge context. As another functionality, frequency analyses of subject-specific keywords can also be carried out in order to identify important concepts or trends, for example (see [20]). To this end, Ozorhon et al. [55] developed, for example, a framework with project-specific term dictionaries that can systematically design keyword searches and summaries.

Project knowledge discovery and extraction (12): In regard to the reuse of codified project knowledge, Oluikpe et al. [56] stress that the isolated consideration of individual cases does not offer any representative insight into typical project success factors or errors. Rather, the combined, i.e. summarizing analysis of multiple documented experiences allows for the extraction of new and more enriching knowledge such as thematic patterns and typical connections hidden in a larger corpus of project reports. In particular, the techniques of concept extraction can be used for this, as they combine larger corpora of documentation in an inductive process and summarize the codified knowledge in interpretable concepts [39]. Such concepts extracted can be described as semantic patterns (e.g., a bundle of highly correlated words, i.e. words frequently used together) that can be interpreted as widespread thematic concepts included in the examined corpus of project documents. For example, Carrillo et al. [19] used link analyses where correlations between a set of keywords and phrases were revealed in order to formulate the rules for connections in project business. For example, such analyses highlighted the importance of maintaining a good relationship with construction parties, which leads to substantial discounts and cheap rates. Information extraction techniques can also be used in order to transfer certain facts (e.g., names, techniques or dates) from unstructured databases of texts and transfer them to structured formats (e.g., relational data tables). This is helpful in the discovery of sources and networks of expertise, for example. Liu and Hsu [57] used such techniques to extract relevant facts from a body of relevant documentation, such as project members, activities, tools and costs, and to define relationship rules beyond this (e.g., “john“ has skills in “java“ and assisted in “Marketing, CRM“). Carrillo et al. [19] also describe the possibility of extracting information such as deadlines or supplier names and using it in subsequent steps for correlation and trend analyses.

Project document classification (12): In order not to lose the overview of the large databases of heterogeneous project documents, Frey et al. [33] stress that a clear organization of documents is initially of central importance. In order to organize orderly access to relevant project documents, document classification techniques are useful for classifying heterogeneous project documents in predefined thematic categories. Document classification is based on a semi-automatic process in which the analyst initially predefines thematic categories that are then learned algorithmically on the basis of a sample set of documents preorganized by content so that following documents can be automatically classified in appropriate categories according to their content context (see [39]). Such categories can represent many subjects in the daily project work, such as specific project products or attributes. Multiple papers proposed corresponding procedures for such an organization of project documents (see, e.g., [28, 58, 59]). Ur-Rahman and Harding [60] demonstrated, for example, an approach that analyzes content statement patterns and makes it possible to differentiate between project documents that report on project success or failure. Jiang et al. [61] also describe an automatic classification of content according to domain-specific standards for projects in the construction industry (BIM; Building Information Models).

Project document clustering (11): Multiple solutions incorporate clustering methods in order to group heterogeneous project documents in a completely automatic way on the basis of their semantic similarity and thus to ultimately facilitate organized document management. Such techniques are suited in particular for overcoming the limits of document classification techniques, which only function when sufficiently suitable documents are available for training (algorithmic learning) of the thematic categories. Al Qady and Kandil [62] used document clustering techniques accordingly, for example, in order to organize an unorganized body of project documents in the construction sector according to textual similarity. Document clustering techniques are also used as a preparatory work step in order to arrange heterogeneous document databases for additional analyses in homogeneous project document groups. In this context Liu and Hsu [57] stress the structuring of large heterogeneous document databases in conceptually homogeneous groups that maximize the content similarity of the textual data and thus minimize distortions in the following statistical analyses as a result of unsuitable document content (statistical "noise"). Wu and Lin [48, p. 131] used clustering techniques accordingly in order to group a large database of project documents in "conceptually highly homogeneous documents" so that the individual content concepts of these appropriately separated documents groups can be analyzed in isolation in the next step and summarized (among others, with the techniques of concept extraction).

Documentation quality assessment (4): Reviewing the content of project documentation pursues the goal of ensuring the quality, completeness, and richness of documented content. The content completeness of documentation can be defined on the basis of specific taxonomies and subsequently verified. To this end, Mena-Nieto et al. [63] developed, for example, the eXtensible Project Documentation Reporting Language (XPDRL) which maps specific documentation standards in the construction sector and thus facilitates the effective exchange of documents and also the subsequent verification of the completeness of documents. Arthur and Stevens [64] pursued another approach by calculating the "goodness" of software documentation on the basis of so-called "documentation quality indicators" (i.e., accuracy, completeness, usability, and expandability). To record the content richness, Campbell et al. [65] used topic analyses in order to examine documented project descriptions in terms of whether certain relevant topics in documentation are inadequately covered. Deficient documentation was identified in software developments by comparing extracted and potentially relevant topics in the stack overflow with the topics actually treated in the documents.

Project performance prediction (4): The forecast of the developments in projects is a field in which negative issues in current project documentation are identified in particular and used in order to counter their potentially negative impact in due time. Williams and Gong [66] as well as Singla and Kakkar [67] have focused here on the prediction of cost overruns by using semantic analyses to identify typical indicators for cost problems and then classifying projects with potential deficient developments. Prieto [68] also used comparable semantic analyses in order to identify so-called "negative performance precursors" and to draw attention early on to problems and potential project failure.

Project sentiment analysis (3): Project sentiment analyses are intended for extracting project-specific sentiment patterns from the textual project communications and thus promoting "emotional awareness" in project management. The emotions expressed in connection with a specific subject (e.g., project changes) can be evaluated and support in

particular the reactions to negative developments. Prieto [68] as well as Guzman and Bruegge [69] use lexical sentiment analyses, i.e. evaluations of specific emotional terms (positive/negative) in order to examine the emotional state in project communication. Prieto [68] used the corresponding analyses for the calculation of specific "project sentiment indices," while Guzmann and Bruegge [69] primarily used visualizations of emotions in projects.

Project risk assessment (2): The organizational lessons learned databases can be incorporated for the assessment of potential project risks. The evaluation, linking and modeling of experiences gained in past projects allows the project manager to gain an overall picture of the sources of problems, causal connections, interdependencies and vulnerability factors for the planning of future projects. For this purpose Dikmen et al. [70] developed a risk-related information taxonomy in lessons learned databases that allows the orderly saving and modeling of project-specific risks in knowledge databases and, building on this, facilitates systematic risk assessment throughout the project life cycle. Yildiz et al. [71], as another example, recommend a comparable risk mapping tool that makes it possible for the user to search systematically for relevant sources of risks, past problematic cases and potential vulnerability factors and to also identify relationships.

Project interdependencies identification (2): The discovery of patterns and similarities in project documents makes it possible to identify interactions and interdependencies between projects for the most part automatically. For this purpose, Lin et al. [72] used, for example, information retrieval and concept extraction techniques in order to visualize project team coordination patterns (e.g., task categories, execution sequences, connections and durations) for the support of a multi-project management. Meier [73], as another example, recommended a document clustering approach in order to evaluate overlapping project descriptions and thus to identify project output interactions in project portfolios.

Project evaluation and selection (2): The selection of projects can also be supported by having project proposals presorted automatically, e.g., by grouping them according to content similarity or in predefined classes (e.g., research disciplines or consistency of proposal descriptions), or on the basis of content indices. Such proposals were made by Ma et al. [74] and Zhu et al. [75].

In a final categorization, the articles were arranged according to their business domains (RQ3), for example, by construction, industrial engineering, or software development. As a result (see Figure 3), it can be stated that a large share of the research papers (28) comes from the area of construction or address such projects specifically. The second-largest share of papers comes from the area of industrial engineering (10), followed by domains with less frequent papers (software engineering, university, financial services and information systems development).

Table 2. Qualitative results of the literature review

Application Area	Description	References
Contextualized information and knowledge retrieval	Computer-assisted search and retrieval of documents or specific knowledge content relevant for specific project contexts (e.g., project phases or tasks).	[24], [25], [46], [47], [48], [49], [53], [55], [57], [61], [72], [76], [77], [78], [79], [80], [81], [82], [83-85], [86], [87], [88], [89], [103]
Project knowledge discovery and extraction	Extraction of new knowledge by revealing semantic patters contained in combined project documents for the modeling of content relationships and extraction of thematic concepts.	[19], [20], [48], [50], [57], [56], [59], [76], [82], [90], [91], [92]
Project document classification	Semi-automated classification of project documents and document contents according to manually predefined and trained thematic categories.	[28], [58], [59], [60], [61], [82], [90], [93], [94], [95-97], [98]
Project document clustering	Automated organization of project documents or document contents in hierarchical groups and structures according to content similarity.	[19], [20], [48], [50], [56], [57], [59], [62], [74], [76], [92]

Application Area	Description	References
Documentation quality assessment	The evaluation of content quality, richness and completeness of textual project documentation.	[63], [64], [65], [99], [100]
Project performance prediction	The forecast and evaluation of future project performance on the basis of performance indicators codified in project documents.	[66], [67], [68], [101]
Project sentiment analysis	The discovery, evaluation and visualization of sentiment patterns in project communication.	[68], [69], [102]
Project risk assessment	Support of risk analyses through the discovery, organization and modeling of risk factors codified in project documents.	[70], [71]
Project interdependencies identification	The identification of project interactions and interdependencies on the basis of similarities and overlaps in content across project documents.	[72], [73]
Project evaluation and selection	Support of the evaluation and selection of projects through thematic analysis and content-related grouping of project descriptions.	[74], [75]

5. Discussion

The findings brought to light through the literature review can feed into the discussion of future paths of development. Fundamentally, the examination of the reuse of project knowledge is an interesting and promising field of research (see, e.g., [24, 29]). In their work on project knowledge reuse, Schacht et al. [24] stress that the usual knowledge management literature to date has primarily focused on the creation, storing and the transfer of knowledge. Knowledge reuse is often viewed implicitly as a natural result of available, saved and transferred knowledge and is underrepresented in the literature. Having this in mind, the results of the literature review should be summarized, research questions answered, and research prospects discussed below.

RQ1: First, it became apparent that a large part of the research focusses on the development of techniques to identify and organize (contextualized) knowledge fragments, which can then be retrieved by project managers according to their specific information needs. In contrast, techniques regarding the discovery and prediction of previously unknown and potentially useful issues from the textual data are underrepresented in the reviewed body of literature. Here, recent advances in predictive text mining (see [40]) hold interesting and untapped potentials for the project management discipline. Several contributions, such as Williams and Gong [66] or Prieto [68], exemplified the potentials of such techniques for predicting project cost overruns or discovering hidden sentiment patterns in project communication.

RQ2: Second, it became clear that a majority of the research papers concentrate on individual application areas as well as text mining techniques. Only a few papers cover a range of multiple problem and application areas. Nonetheless, it could be of great practical interest if research contributions could offer complete solution packages that give project management a more comprehensive range of functions. Such packages could combine multiple application areas as part of an electronic document management (EDM) in project environments and provide solutions that, for example, not only group or classify the available project documents automatically and provide efficient access to individual contextualized knowledge content, but also simultaneously place new knowledge concepts, i.e. combined and therefore enriched knowledge, corresponding to the problem context, at the disposal of the project managers.

RQ3: Third, it could also be discovered that the construction sector in particular supports intensive efforts to reuse codified databases of knowledge. This could be explained, among others, by the fact that construction projects are particularly complex and knowledge-intensive in which historical documentation is also very extensive (see [58]). In

light of this finding, a cross-disciplinary exchange between the business domains (such as construction and software engineering) could be recommended and promise interesting learning effects.

Finally, the reviewed solutions rarely proposed specific procedures or guidelines for integrating the identified knowledge into typical planning and decision-making processes for projects. This is necessary, however, in order to ensure systematic, standardized and thus consistent learning in project-based organizations. In this context, Barclays and Oseri-Bryson [16] criticize the circumstance that even if relevant lessons learned from past projects are at the disposal of project managers, this knowledge often flows into decision-making and learning processes only implicitly, meaning at the discretion of the individual project managers. Systematic, non-intuitive and standardized procedures could therefore result in additional added value for the primarily technically-oriented approaches. Furthermore, the acceptance of such advanced business intelligence processes (e.g., perceived usefulness and ease of implementation) needs to be kept in mind in order to ensure a consequent usage of the solutions by end users [104].

6. Conclusion

In the literature there is widespread agreement that the lack of efficient (i.e. computer-assisted) tools makes the reuse of knowledge codified textually in project documents a time- and cost-intensive process. The goal of this study was to structure the previously proposed research contributions and define the corresponding state-of-the-art in this special field of project knowledge management. The study outlined what computer-assisted techniques are used (RQ1), what application areas these solutions address (RQ2) and in what business domains they are applied (RQ3). The subsequent discussion also provided paths for the use, dissemination and targeted development of these solutions.

The implications for practice are that a summarizing overview of possible solutions for the reuse of knowledge codified in organizational databases is placed at the disposal of practical project management – a task for which no specific procedures have been recommended in the standard project management guidelines. In general, this should create awareness of textual project documents as valuable and also exploitable source of knowledge. In particular, this should provide impulses for the widespread use of such solutions and ultimately also for the further development of project-based learning in organizations. In this regard, a cross-domain exchange between different areas of use (e.g., construction and software engineering) could also supply interesting ideas.

There are implications for research, particularly in the further development of appropriate solutions. First, techniques regarding the discovery and prediction of previously unknown and potentially useful issues (e.g., project cost overruns or sentiment patterns) are underrepresented in the analyzed body of literature. However, several contributions, such as Williams and Gong [66] or Prieto [68], exemplified the potentials of such techniques in the project management context. Second, the combination of application areas has promising potential. For example, the identification of contextualized knowledge with the simultaneous synthesizing of multiple historical sources of knowledge could support a project manager by allowing him or her to receive not only the desired particles of knowledge, but rather also combined, i.e. new and enriched knowledge in a certain context. Third, the development of procedures for the structured implementation of the extracted knowledge in the project management's decision-making processes offers potential hardly tapped to date.

The limitations of this study include, above all, the typical limits of a literature review. In general, a structured literature review cannot identify all potentially relevant research contributions. For example, comparable articles from other domains such as product development or marketing could be of interest as well. Nonetheless, this review focused specially on solutions discussed in the project management context, which were gathered on the basis of relatively broad-based search on databases. In order to address the limitations of a literature review and to gain additional insight into the subject discussed here, it would also be advisable to pursue more related studies, e.g., in the form of expert interviews or surveys conducted with project managers. In this context, it could also be of interest to further study the relationships to other forms of knowledge transfer (e.g., the person-to-person transfer of tacit knowledge), which were out of scope of this study.

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Governance of inter-organizational systems: a longitudinal case study of Rotterdam's Port Community System

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Governance of inter-organizational systems: a longitudinal case study of Rotterdam's Port Community System

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Abstract:
An increasing use of inter-organizational systems, as Port Community System (PCS), can be observed in port collaborations. As multiple organizations often rely on PCS, even for business-critical processes, proper governance of these systems is crucial. This study aims to explain the governance of inter-organizational port collaborations using a lifecycles paradigm. The governance is explored using three points of view – i.e. governance mechanisms, governance aspects, and governance models – and by describing the actors' roles in collaborations. A case study in the port of Rotterdam is analyzed to explain how these actors affect the governance models through the mechanisms to govern the aspects in each lifecycle stage. The port collaboration in Rotterdam has gone through three full governance lifecycles and has entered the fourth iteration after the set-up of Portbase. During the last two cycles, the collaboration has maintained its Network Administrative Organization governance model. This case study analysis of Rotterdam's port collaboration provides an example of how a systematic approach could help to discuss and communicate the governance of inter-organizational port collaboration systems and gives some lessons learned for other collaborations.

Keywords:
collaboration; governance; inter-organizational system; lifecycle; Port Community System.

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1. Introduction

Inter-organizational collaboration systems have emerged to address the operational and information system related challenges of traditional collaborations [1]. Companies expect benefits and competitive advantages from their collaborations, such as network expansion, business process simplification, cost reduction, or other benefits that are unique for each domain. In maritime port collaborations, ports are critical hubs in which Supply Chain (SC) activities are drawn together. The performance of the port authorities, companies, government, and other entities in carrying out their SC activities largely depends on the effectiveness of their collaborations. A port collaboration's physical, information, and financial flows are interdependent, thus causing a lot of coordination challenges for parties in the port [2]. To address these challenges, a port collaboration is commonly supported by a Port Community System (PCS), which is the state of the art in information systems and connects SC actors in port environments using inter-organizational services.

As multiple organizations rely on a PCS, even for business-critical processes, effective governance of the collaboration is crucial. Inter-organizational governance is the act of coordinating a collaboration of multiple companies [3, 4]. Current literature has acknowledged the lack of attention on governance of inter-organizational collaborations which are supported by information systems [3]. The governance ensures that the diverse coordination needs of the different members in a collaboration are met. Moreover, even though there is quite a consensus in the definition of governance of inter-organizational collaborations, prior studies have been using the term "governance" but actually only address a specific part of governance. Some studies focus on the governance mechanism [5], the governance aspects [3], or the governance models [4]. Most studies do not specify their points of view on inter-organizational governance and often jump on the trend of "governance" as a buzzword. This loose use of the "governance" term leads to a lack of a comprehensive understanding of inter-organizational governance. In addition, the paradigm of collaborations' governance is shifted from a static perspective towards a dynamic context-dependent perspective, which introduces the governance lifecycles [6].

This fragmentary knowledge of inter-organizational governance has been exacerbated by the increasing complexity of collaborations. Despite being the result of joint agreements between companies, inter-organizational collaborations do not eliminate the competition between these companies. Moreover, the global competition nowadays has urged port collaborations to expand over the boundary of industry sectors, countries, and continents. SC activities at ports are increasing, but so is competition in global SCs [7].

Designing governance is viewed as a crucial step in developing a PCS [8]. Thus, to design effective PCSs, an understanding of inter-organizational governance is needed. A study by De Langen [9] has focused on the governance of port collaboration, but this study only addresses the governance as coordination mechanisms. Another study by Srour et al. [10] discusses the lifecycles of port collaborations. However, this study has not shown how the theory of dynamic governance could be used in analysing the evolution of governance in depth. Other empirical studies on inter-organizational systems, such as Rodon, Pastor, and Sesé [11], have emphasized the importance of in-depth longitudinal study in this area. This study aims to fill this gap by demonstrating the theory of dynamics governance. The case study presented gives an understanding of port collaborations' changing governance models and how each actor involved shape dynamic mechanisms in order to govern the collaboration's aspects.

This research uses a single case study to apply the theory of dynamic governance for port collaborations. A single case study is selected because of the context-dependent characteristic of port collaboration. Thus, the lesson learned from this single case study will enrich the-state-of-the-art knowledge on the governance of inter-organizational collaborations, especially the port collaborations.

2. Inter-organizational Port Collaborations

A port collaboration is the act of independent organizations working together to execute their SC activities related to one or multiple ports. To coordinate this cooperation, port collaborations can adopt a PCS. "A PCS is an electronic platform which connects the multiple systems operated by a variety of organizations that make up a seaport, airport or inland port community. It is shared in the sense that it is set up, organized and used by firms in the same sector – in this case, a port community" [8]. Going beyond traditional function of PCS to share information, nowadays PCS offers modules to support a variety of SC activities [2]. The recent development of PCS includes the cloud services, which is growing to be the most significant factor in the historical development of information technology outsourcing [12].

In explaining inter-organizational collaborations in ports, it is important to understand the roles of each organization related to the collaborations. Wagenaar in van Baalen, et. al. [2] categorizes organizations involved in container transport into five groups based on the organizations' activities in the SC arrangement; the categories are: customer group, organizing group, physical group, authorizing group, and financial group. However, this categorization has not taken the adoption of a shared information system into consideration. Further, Chandra and Hillegersberg [1] proposed five general roles of organizations based on the analysis of several Supply Chain Collaborations (SCCs) which implement cloud-based systems. This classification is suitable to analyze the port collaboration context and to systematically communicate the collaborations' boundary design, business model, and governance to potential members or other parties. The five roles of organizations in a port collaboration are:

- *Member*. Entities which are the members of a port collaboration can be involved in the operational, tactical, or strategical activities of the collaboration. The members adopt the shared services to support their SC activities in the port *environment*. In order to maintain their access to these services, the members can invest into the PCS or/and pay access fees per transaction. Any organizations that are directly involved in the SC activities can be members in a port collaboration – the arrangement is determined by the port collaboration's business model. Thus, the members' size, type of organizations, culture, experience, or other criteria can be homogenous or diverse. The potential members are presented in Table 1.

Table 1. Potential members of port collaborations [2]

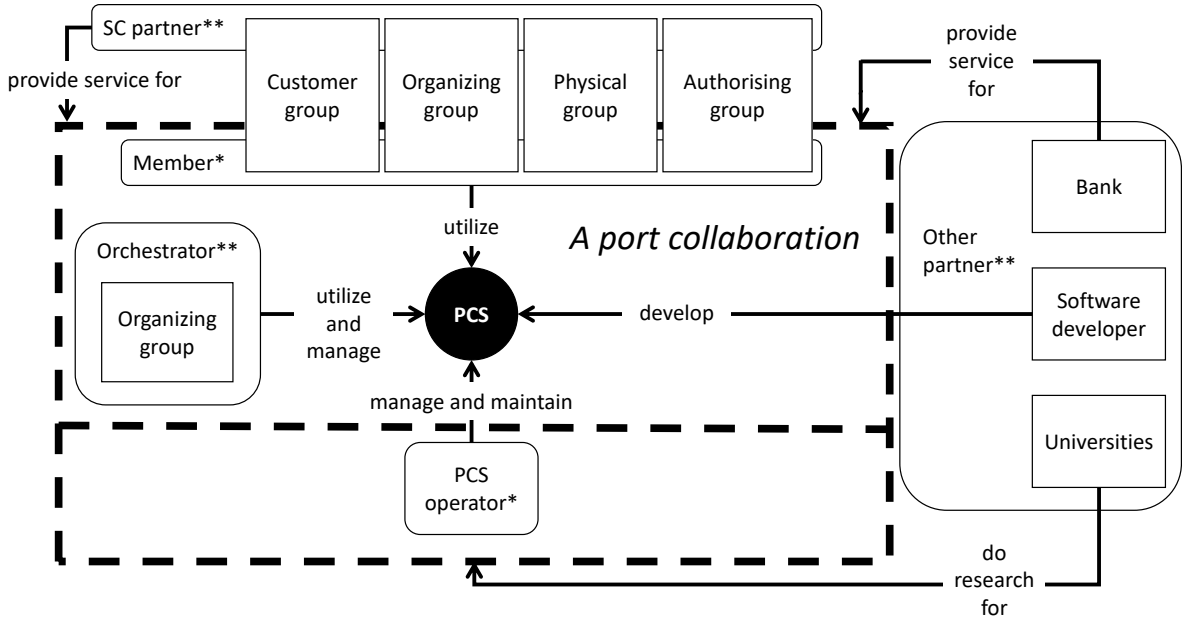
Group based on the organizations' activities in the SC arrangement	Examples of organizations
Customer group	Shipper; Consignee
Organizing group	Forwarder (merchant haulage); Shipping line agent (carrier haulage); Logistics service provider (4PL)
Physical group	Sea terminal operator; Shipping line/sea carrier; Pre- or On-carrier: carrier inland transport, i.e., barge operator, rail operator, road carrier; Inland terminal operator; Logistics service provider (3PL); Empty container depot operator
Authorizing group	Customs; Port authorities; Seaport police; River police; Inspection authorities

- *PCS operator*, is a provider who delivers the PCS, either software as a service or on premises with web access, for supporting the coordinated SC activities of port collaborations' members and enabling the collaborations. PCS operator is responsible to manage and maintain the PCS according to Service Level Agreements (SLA) with the members [8].
- *SC partner*. Outside port collaborations there are organizations which perform SC activities related to the collaborations. These organizations are not members of port collaborations, but may get access to the shared system. However, their benefits are not a priority for the collaborations. As a consequence, these organizations will not be expected to pay fees for using the system.
- *Other partner*, is an organization that support port collaborations besides the SC partner and the PCS operator. Examples of organizations with this role are bank, insurance company, internet providers, software developers to

whom PCS operators outsource a part or all of their software and/or platform development, universities, research institutes, associations, and labor organizations.

- *Orchestrator*, is a company that coordinates the SC activities inside the port collaboration.

These roles can be classified into *essential roles* − members and PCS operators − and *potential roles* − SC partners, other partners, and orchestrators. The existence of PCS and companies with the essential roles indicates that the collaboration is a PCS-enabled inter-organizational port collaboration as shown in Figure 1. On the other hand, a port collaboration does not necessarily have any SC partners, other partners, or orchestrators. The boundary of a port collaboration is determined by its' business model, which defines who can be the collaboration's members (customers). Based on this business model, the PCS operator may be related to the port collaboration as an internal entity, which has power over the PCS' development and management, or as an external entity, which is interchangeable.



*essential roles **potential roles

Fig. 1. Roles and example of organizations in a port collaboration

3. Inter-organizational Governance

In this study, several points of view on inter-organizational governance are used to address the dynamic and context-dependent governance – i.e. the governance mechanism, the governance aspects, and the governance models. In each stage of a collaboration's lifecycles, these points of view are interrelated; the understanding of a collaboration's governance using one point of view cannot be separated from the understanding of the same governance using other points of view.

3.1 Governance Mechanism

As stated by Ebers (1997) in Cropper, Huxham, Ebers, and Ring [13], governance mechanisms are the means (instruments) through which entities manage the content flows and coordinate their relationships. Governance

mechanisms are classified into formal and informal mechanisms of coordination [6]. These mechanisms complements each other in the governance of inter-organizational collaborations [14].

Formalized mechanisms can take the form of monitoring, control, and reporting systems through which organizations structure their interaction in an explicit way [6, 14]. Formalized mechanisms have been advocated in conditions of high asset specificity [6], to reduce risk and uncertainty [5] and prevent dissolution of inter-organizational collaborations [3]. Thus, formalized mechanisms become the foundation for the collaborations' stability.

The most common formalized mechanism in inter-organizational collaborations is a *contract*. Contracts entail an anticipation to make explicit both payoffs and task coordination [5, 14]. Other mechanisms that could be used by collaborations are *regulations, policies, and procedural approaches* in: decision making [14, 15]; partner selection [14]; joint information and communication systems [15]; shared marketing, planning or implementation of services [14, 15]; joint activities [14, 15]; integrated service capacities (e.g. a one-stop entity at the service of network clients) [15]; organization of meetings [15]; incentive structures [6, 13]; and administrative controls [6, 13]. In addition to contracts, *documented formalized mechanism* could also exist in the form of Service Level Agreements [16], costs and benefits analysis [17], definition of the network agenda [15], documented dispute resolution procedures [6], and standard operating procedures [6].

Informal mechanisms are characterized by relationships rather than by bureaucratic structures [6]. Consequently, the mechanisms are not legally enforced in inter-organizational collaborations. The moderating effect of informal mechanisms on the need for formal contractual mechanisms [6] are evident in the inception of a collaboration. Later, these effects become more inconspicuous in collaborations with a hierarchical governance, but never entirely go away. A comprehensive contract may not be possible because of bounded rationality and the cost of writing, negotiating, and implementing such a contract [5]. As a consequence, informal mechanisms provide flexible adjustment procedures to handle future contingencies in the collaborations [5], especially when monitoring and formal controls are difficult and costly [6].

Some forms of informal mechanism are: personal and informal contact between collaborations' members [15]; reciprocity and equity, as well as other norms [6, 13] which are developed through social exchange in the past and based on future expectation [5]; commitment [5, 6]; flexibility [5]; information exchange [5]; and trust [5, 6, 13]. According to Zaheer (1998) *trust* is the expectation that the counterpart will behave in a reliable, predictable, and in a fair manner [6]. Along the phases in the governance lifecycles, trust between members of inter-organizational collaborations could be established and nurtured.

3.2 Governance Aspects

Markus and Bui [3] developed a framework of six characteristics for mapping specific type of governance models for information-system-based inter-organizational collaborations. Fundamentally, the characteristics are governance aspects of inter-organizational collaborations. Table 2 demonstrates how these characteristics correlate with the corporate governance assets identified by Weill and Ross [18]. Weill and Ross [18] distinguish companies' six key assets that need to be governed to accomplish their strategies.

Table 2. Comparison between corporate and inter-organizational governance aspects

	Weill and Ross [18]					
Markus and Bui [3]	Human	Financial	Physical	Intellectual Property	IT	Relationship
Organizational form and legal status	--	--	--	--	--	--
Who can be members?	--	--	--	--	--	X
Who can be equity owners?	--	X	--	--	--	X
Capital investment and operational funding	--	X	X	--	--	--
Board composition and decision making	X	--	--	--	--	--
Data governance	--	--	--	X	X	--

This comparison justifies that Markus and Bui [3] characteristics are basically key assets of collaborations. Some of the connections are loosely defined, but those are not imprudent. The gap is explained by the nature of collaborations. First, collaborations mainly concern members' coordination, so the human assets are not strongly reflected in the collaborations' governance. Second, because collaborations involve multiple companies, the legal forms are not always carved in stone and require careful planning and coordination. Therefore, the Markus and Bui [3] study is used as a foundation to explore the governance aspects of inter-organizational collaborations, as follows:

- *Membership.* The value of collaborations is determined by the members. Thus, membership governance in a collaboration is strongly concerned with the member selection. A larger number of members usually results in a higher organizing cost. Collaborations have to decide the number of members based on added value of additional members and the balance between coordination costs and complexity of the network [19]. After being selected, the members must be able to interoperate swiftly. This interoperability includes the capability to quickly connect and their compatibility to enable a superior response speed. Decision rules and logic with regard to connection and disconnection will be a crucial component for the success of the collaboration [19]. After selecting the members, collaborations need to ensure members' participation. The members are required to participate by making investments and/or sharing information. Success as well as effectiveness of collaborations depends on the ability to encourage and sustain participation. Collaborations need to attract their member' participation by ensuring membership benefits. Markus and Bui [3] observe three ways to attract participation of members:
  - Ensuring that owners do not profit financially at the members' expense;
  - Drawing owners from all major segments of the community;
  - Providing for participants to have a say in decision making.
- *Capital investment.* The purpose of a collaboration would be defeated by excluding members that do not contribute to building the collaboration. Consequently, organizations may not be willing to fund the development of collaborations, and organizations may wait to join a collaboration until their partners join [3]. The adoption of cloud services, instead of on-premise systems, by inter-organizational collaborations could reduce a significant amount of investment needed. However, collaborations still need capital to provide services with a specific quality standard. Collaborations need a formalized governance to provide the legal authority required to amass and disburse funds and to protect the physical and intellectual properties involved in the information system and standards. Collaborations need to attract capital to fund their technological and organizational requirements and would need to find a way to overcome their shareholders' reluctance.
- *Operational funding.* Collaborations have non-trivial ongoing operating and maintenance costs, which may involve the employees' salaries, rents, and multiyear contracts with the system providers. To fund these costs, inter-organizational collaborations could use mixed revenue streams composed by [8]: (1) annual or monthly subscription fee by services or for all services; (2) fee per unit charge specific for the collaborations' fields (tons, watts, km, etc.), per service charge, or per EDI transaction charge; and (3) fee per stakeholder.
- *Decision making.* In a decision making process several plans are created, evaluated and ranked by an objective function to identify the best one [20]. The investors naturally gain decision making capabilities, which might be unattractive to some members due to limitations in resources, geographical locations, or experiences.
- *Data governance.* Inter-organizational collaborations amass substantial data resources from interactions between members. The system provider or the leading members could potentially use this data to gain a competitive edge over the other members. Therefore, collaborations need formal governance to address members' concerns about who owns the data, how the data is protected, and who can access the data.
- *Governance entities* are responsible to coordinate the members' activities. In a port collaboration, these entities also engage in contracts with PCS operators to acquire the required PCS. Governance entities could be all of the members, a particular leading member, or a separated legal form; the selection depends on the governance models of a particular collaboration. Important factors for the choice of organizational form could be taxation [3], field-specific law, and the members' past experience.

In addition, there are governance aspects that are specific to collaboration with a separated governance entity; those are:

- *Equity owners.* If a specific governance entity is established in a collaboration, there are three alternative ownership models for the entity: member-owned [21], investor-owned [21], and a hybrid combination of both [3]. The two factors that are most influential in the choice are diversity among the member organizations and competition with other stock exchanges [21]. Member-owned stock markets are limited in terms of available capital. This problem is compounded, according to Hart and Moore [21], by the slow and possibly contentious process of collective decision making in member-owned cooperatives. In investor-owned companies (such as publicly listed stock corporations), there is greater availability of capital for investment, whether it comes from issuing equity or undertaking debt. Moreover, ownership plays an important role because it goes hand in hand with decision making capabilities [3]. The authoritative style of decision making associated with investor-owned companies promotes a speedy decision process. One major advantage of member-owned is the fact that it is more responsive to the members' preferences. Although authoritative decision making in investor-owned may be faster than collaborative decision making in member-owned, the latter may be preferred by members. In fact, democratic governance structures may actually help motivate potential members to join and participate in a collective undertaking like open source software development [22].
- *Board composition.* In a separated governance entity, the board composition determines how decision-making capabilities are divided among owners and members. If the governance entity has a large number of owners, exercising control on a day-to-day basis would be ineffective. In that case, owners of a governance entity might be un-fit to take on decision making responsibilities and represent members.

3.3 Governance Models

Even though differences in naming and classification are present, there are four basic governance models for inter-organizational collaborations [1]. These models are illustrated in Figure 2.

- *Market,* is formed by contractual relationships between suppliers and buyers [23]. A market has certain features such as multiple suppliers of the same product or service [16] and short-term partnerships which mainly occur during the transaction. In this governance model, inter-organizational system providers can be seen as suppliers of a coordinating service and members can be seen as customers.
- *Shared governance*, in which members participate in network governance without a separate and unique governance entity [4]. Collaborations applying this governance model are governed by regular meetings among members. In these collaborations, the members are collectively responsible for making decisions.
- *Lead organization*, in which a particular member coordinates major network-level activities and decision making in a network [4]. This particular member takes sole responsibility of its inter-organizational collaboration. In a collaboration applying a lead organization governance model, the leading member should have adequate power – which could be acquired through market domination, law enactment, or buyer-supplier relationship dependencies – over the remaining members. Centralized data in the inter-organizational system could be used by the leading member to gain a competitive advantage. For this reason, a study by Markus and Bui predicts that inter-organizational collaborations will most likely be governed by organizations that are not one of the members [3].
- *Network Administrative Organization* (*NAO),* which is a separate entity that is established to govern the network [4]. "Capturing and leveraging a position in a business network does not mean one must own or control the platform on which those networks run" [22]. The NAO model provides inter-organizational collaborations with the benefits of having a neutral governance entity.

Fig. 2. Governance models

3.4 Lifecycles of Inter-organizational Collaborations

Below, we describe four phases in the lifecycles of inter-organizational collaborations, adapted from Lowndes and Skelcher [23]:

- *Pre-partnership collaboration.* A collaboration's lifecycle begins when an initiator decides to dedicate its resources – e.g. finance, human resources, and network – to develop a collaboration. In this initial phase, the scope of the collaboration is defined by assigning roles to each company involved, inviting potential organizations, and defining the business requirements. Next, how to govern the collaboration is discussed. During these activities, collaborations initially rely mostly on informal governance mechanisms [6], supported by trust and a sense of common purpose [23]. This is against the common view that collaborations start with formalized governance and proceed to cycles which reinforce trust between actors [6].
- *Partnership creation and consolidation*. After the partnerships are established, collaborations which decided on hierarchical governance design an assertion of status and authority differentials, as well as the formalization of procedures [23]. The design of formalized governance mechanisms can also occur in other collaborations which aim at less hierarchical governance. However, the less hierarchical collaborations will focus on intensifying the partnership between the companies to prepare for the program delivery. During this phase, the alternative services are assessed. At the end of this phase, the selected service should be implemented and made ready to be used. The success of collaborations in this phase depends on the members' willingness to financially contribute to the set up as well as the willingness to exchange their information with other partners [10].
- *Partnership program delivery*. In this phase, after connecting the collaborations' members using inter-organizational services, the business processes of the partners are executed. The market (or quasi-market) mechanisms of tendering and contract, with low levels of cooperation between providers dominate collaboration in this phase [23]. These mechanisms can be reinforced by informal governance, depending on the collaboration design. During this phase, the system providers, such as a PCS operator, can request members to pay fees for accessing the system. Usually, this fee is mainly meant to cover the development and maintenance expenses [17].
- *Partnership termination or succession* is characterized by a re-assertion of an inter-organizational governance mechanism as a means to maintain the actor's commitment, community involvement, and staff employment [23]. This phase can be triggered by any changes inside the collaboration or around the collaboration.

4. The Governance of Rotterdam's Port Collaboration

This section presents the history of Rotterdam's PCS. The port of Rotterdam and the community around it have been selected as a case study for this research. This port collaboration is selected because: (1) the collaboration has a fairly long history in operating a PCS, (2) the port of Rotterdam is the largest port in Europe and it is one of the leading ports in the world [24] with four different containerized on- and pre-carriage transport modalities – road, rail, inland shipping, and short sea shipping [2], and (3) many studies on this port have been published, which enriches the analysis in this

study. Data used in this study is a combination of an interview with the Managing Director at Portbase (the PCS of the port of Rotterdam) and secondary data collected by reviewing reports, studies, as well as industry magazines and journals.

The history is divided into three period: (1) pre-PCS, (2) Port Infolink, and (3) Portbase. The pre-PCS period is the era of initiative. During this time, the port community collaborated to establish an inter-organizational system. As a result of the port community's collaboration, the first PCS in Rotterdam port community – which was developed and maintained by Port Infolink – was established in the second period. Later, this PCS was replaced by Portbase's PCS.

4.1 Pre-PCS

The port of Rotterdam, located in the Netherlands, was the biggest port in the world in 1962 [25] and has been the biggest logistic hub of Europe ever since. The port infrastructure is owned by the municipality of Rotterdam and managed by the Port of Rotterdam Authority [26]. The Port Authority – a joint-venture between the Municipality of Rotterdam and the Dutch government – is responsible to develop, manage and exploit the port in a sustainable way and to render speedy and safe services for shipping [27]. In 1989 the port and companies in its community employed about 70,000 people who handled 291.8 million tons cargo that came from and distributed to 31,343 sea-going vessels and 120,000 inland vessels; this throughput positioned the port of Rotterdam on the highest position among the world's other major ports [26].

In the 1980s, a system of Electronic Data Interchange (EDI) – consisting of a network, standard messages, and a software – developed in the Netherlands for the port of Rotterdam [25, 26]. The project called INTIS (International Transport Information System) was established in 1985 by the port community, the Municipality of Rotterdam, and the Dutch PTT Telecom [26]. The system aimed to handle the information flows between all the parties involved in transportation and shipping in the port community use standardized messages in accordance with EDIFACT [2, 25]. In 1989 more than 80 companies were connected to the INTIS network [26]. This number increased to 120 companies in 1992 [28]. Despite of the positive results generated, INTIS floundered. The main problem were not technical, but organizational. INTIS' biggest challenge was to convince potential users of the short-term benefits of automated business systems [28]. In the end, the project did not result in a PCS [2].

After INTIS ended, the port of Rotterdam's community focused on a bilateral data transfer on a lower scale than INTIS [2]. Prior to the PCS implementation, data was managed on a bilateral basis via an assortment of EDI tools, faxes, emails, or by making telephone calls [7]. Information systems development resulted in disconnected systems, many bilateral exchange systems, and a low rate of data reuse [2].

In the 1990s, the port of Rotterdam and its community established the Port Community Rotterdam (PCR) project [29]. As stated by the Rotterdam Municipal Port Management in Lakshmanan [29] PCR aimed to "create a faster, smarter design for a container transport logistical chain by developing, simulating, implementing, and managing port-wide information technology applications". This attempt and a later attempt called PCR-RIL to develop a PCS failed because there was not enough enthusiasm and support from the port community [2].

By the end of the 1990s, there was general discontent with the state of the port of Rotterdam's information system [10]. In 2001 the port of Rotterdam decided to analyse the scope and potential solutions for a PCS in Port of Rotterdam Main Information Services (PROMISE) project, which concluded that the PCS for the port of Rotterdam should be developed specifically (tailor-made) for the port of Rotterdam with the latest proven technology [2].

4.2 Port Infolink

The *pre-partnership collaboration phase* was initiated by the Port of Rotterdam Authority [7]. The Port Authority began by identifying the most critical problem hampering the efficient flow of goods through the port, which is the import processes [10].

Port Infolink B.V. was set up in 2002 as a separated governance entity. The Customs department and the Association of Rotterdam Shipbrokers and Agents, Deltalinqs, joined the initiative *informally* in the *partnership creation and consolidation phase* [30]. It was decided that the Port Authority will be the one and only *owner* of Port Infolink [30]. This ownership means that the Port Authority will bear the initial *investments* to develop the information system [10]. Port Infolink had a *Supervisory Board* – consisting of representatives of the Port of Rotterdam Authority, Dutch Customs, Deltalinqs, and the companies in the port collaboration – which decided on the strategy and set the priorities for the collaboration [2]. The existence of these representatives enabled Port Infolink to gain a neutral position in the port collaboration [2].

This project involved other stakeholders in the *partnership program delivery phase*, such as software development firms based in Rotterdam [10] working with Port Infolink based on *contracts*. The import SC, which was the focus of Dutch government at that time, was supported by communication modules connecting the Harbourmaster and the Dutch Customs [2]. The developed PCS succeeded to leverage the existing dissatisfaction of the Port Authority and Customs in order to promote a paperless import process [10]. As the two main parties agreed on the urgency of the problem, the first services of the new PCS were developed and implemented successfully [10]. This system implementation was easily accepted because the Dutch Customs already had planned to automate the import SC [2].

In 2005, Port Infolink had been in the middle of developing a single PCS. The challenge was to transform a wide range of message formats to a single, common XML format, which is enabled by Xenos terminalONE solutions [7]. There were two designs of connectivity to the PCS [2]:

- Users sent data in EDI or XML format, which would be converted to the internal XML-format for the PCS and stored in the PCS database; later these data could be sent and reused by any parties in the collaboration.
- By utilizing Web-based applications, users could see, enter, or adjust the information on their Web screen.

The PCS was connected to OTP (Overheidstransactiepoort/The Public Transaction Gateway) to send and retrieve information on the behalf of the companies in the port collaboration to and from Customs, Food & Consumer Product Safety Authority, and Plant Health Department. The PCS was designed to [7]:

- Provide any-to-any data exchange connectivity between any disparate platforms, which is the foundation of the PCS service.
- Provide *regulations*, *policies*, and *procedural approaches* for *data governance* by: (1) authenticating every data exchange, in every protocol and format, to ensure that no data is sent or received unless both the recipient and the data type for that recipient have been pre-approved*;* (2) determining the communications *protocols and business rules* required for each specific data exchange between a shipper and the port and ensures that communications are sent using those same protocols and rules; (3) storing the data centrally [31]; (4) making the data available to all parties who have access to the information [31]; (5) securing all data exchanges with standard, key-based security; (6) manipulating and delivering data to appropriate back office systems, based on *business rules;* and (7) re-sending data when acknowledgement is not received in defined intervals until such acknowledgement is received, or a timeout period has been reached.

The PCS provided by Port Infolink was developed using a modular implementation approach, which is referred to as the next generation of PCS that was getting implemented [17]. In 2006, the PCS consisted of 15 services (including import, export, communication between organizations in the community, communication with governmental organizations, carrier haulage, and merchant haulage) which were available for 1,000 companies with 2,500 users who exchanged about 1 million transactions each month [2]. According to Port Infolink, the modular architecture had three advantages [2]:

- Relatively low development costs. The development cost of this system was estimated to be roughly 35 million euros, which were divided into two categories, i.e. the central platform development and modules developments. The platform provided standard functionalities – messaging, authorization, and authentication – so its

development cost was high. On the contrary, the modules were built relying on these standard functionalities, thus the development costs were relatively low.

- Stable maintenance cost of the PCS. The maintenance cost was not sensitive to the change in the number of modules and transactions.
- Possibilities to reuse the existing functionalities in new services. Consequently, the cost and time to develop new modules were cut to minimal.

Later, Port Infolink adopted an architecture which provides mechanism for the *data governance*.

"The virtual agent can pull information from the barge or terminal databases, but does not directly share this data with any other agent. Instead all agents meet in a type of virtual market place where the barge agents negotiate with the terminal agents for appointments. In this way, the system design mirrors current point-to-point communication and negotiation practices, but improves the speed at which they occur" [10].

With the new system, the SC activities in the port of Rotterdam were getting faster and more efficient. The Port Authority could pass along the significant cost reductions to other entities in the port environment [7]. The *benefit sharing* was controlled by Port Infolink. Lower costs increased traffic and additional savings realized when the electronic transaction systems were integrated with e-Government systems for Customs [7]. "At that time we stepped in the middle, [we do] not only automate and optimize the business-to-government flow but also make it more attractive to reuse the information", Portbase Managing Director. Only three years after the establishment, the enthusiasm for Port-Infolink was mutual between the port of Rotterdam and Deltalinqs. "At the most recent consultation, Deltalinqs, the Association of Rotterdam Shipbrokers and Agents, quite unequivocally called Port Infolink a great success" Pieter Struijs, Rotterdam's director of infrastructure and maritime [7].

Next, Port Infolink changed its *revenue stream*. The Port Authority believed that the market itself needs to invest [7]. Thus, Port Infolink started to charge the *members* for accessing the services in 2007. "In the beginning, there were some resistances, but we were strict on what we were going to charge and how we were going to charge, so no companies left us" (Portbase Managing Director). During this *partnership program delivery phase*, Port Infolink also maintained close formal and informal relationships with other actors in Dutch SCs.

During this *partnership program delivery phase*, Port Infolink also maintained *close formal and informal relationship* with other actors in Dutch SC field. For example, Port Infolink participated in PROTECT (2005-2008), a research project funded by the Dutch transport research fund Transumo together with Dutch Customs, the shippers branch organization EVO, Transport and Logistics Netherlands, Holland Distribution Council, Det Norske Veritas, RSM Erasmus University, TNO, Technical University Delft and Buck Consultants [31]. This project aimed to increase the security of global supply chain – which included the information system security, supply chain structure, and strategies – to address the threat of criminality and terrorism.

In the end of Port Infolink's lifecycle, the collaboration entered the *partnership succession phase*. This succession was incited by the thriving Dutch maritime SC activities and the growing concern to preserve the competitive position of Dutch ports. By this point in time, Port Infolink had already offered 24 different services, with around 4500 users who sent more than 20 million electronic messages a year [30].

4.3 Portbase

As of early 2009, the next governance lifecycle was marked by the merger of Port Infolink in Rotterdam and PortNET in Amsterdam, which provided the Ports of Rotterdam and Amsterdam with one joint PCS [30]. This merger aimed to actualize a vision of single national PCS in Dutch ports [2].

PortNET's history started eight years before the merger – in 2000. PortNET was a public-private partnership organization which successfully encouraged the development and use of ICT in the ports of the Amsterdam North Sea Canal area [30]. Even though Port Infolink was younger than PortNET, Port Infolink had developed more functions in its PCS, which were logistic and navigation functions [17]. The merger *contract* guaranteed that the PortNET *members*

would be able to use the services of Port Infolink for the exchange of data in the mid-2009 [32]. Even though PortNET had maintained a centralized governmental PCS for business and various government agencies for six years [17], it was decided that Port Infolink's PCS would be the foundation for their future service.

In the beginning, Portbase's *board of management* consisted of a director from Port Infolink and another director from PortNET [33]. It was after the Portbase B.V. established that the "neutral" notion began to be used in describing the company. Portbase has roles as a neutral *PCS operator* and *orchestrator* for Dutch port communities. At its' launching, Portbase offered 25 different information services and had approximately 1300 clients in all port sectors [33]. "Portbase's main objective is to create a competitive edge for Dutch ports by reducing SC costs and increasing the quality. We provide better information in [an] easier way for all its users", (Portbase Managing Director).

At present, Portbase is in the *partnership program delivery phase*. The *ownership* is shared between the Port of Rotterdam Authority (75%) and the Port of Amsterdam Authority (25%). Portbase's *Management Board* and its team are supported by a *Supervisory Board* and an *Advisory Board*. Both Port Authorities are represented on the *Supervisory Board*, together with other Portbase's main business partners. The *Supervisory Board* is responsible for evaluating Portbase's performance and deciding on its PCS development strategy [34]. This responsibility regarding the development of Portbase's PCS is shared with the *Advisory Board*, which is initiated by Deltalinqs. The *Advisory Board* gives advice, proactively or reactively, on the Portbase's PCS and the services that are to be developed in the PCS [34].

Portbase' PCS has four PCS functions: dangerous goods declaration, customs, logistics, and navigation [17]. The major development in the PCS is the digitalization of export processes. The services provided through each function are available by using several application modules [17]. Thus, Portbase's PCS retains Port Infolink's PCS modular architecture approach. These services are built on top of a platform provided by Oracle. Besides the main services *members* also have access to build their own services on top of Portbase's platform – e.g. ProRail's Wagonload Information System. In order to develop these services, Portbase collaborates with IT companies and service providers which support its *members*. The services are used in all Dutch ports to guarantee synchronized data between its *members*. Nowadays Portbase offers 43 services to support its community. By offering these services, Portbase provides a standardization of information that is being exchanged in the port community.

To support these services, Portbase emphasizes the importance of system and data security. According to Portbase's website, "information is visible only to those in certain roles (need-to-know basis)" [35]. This statement proves that Portbase implement a strict *data governance*, which had been practiced by Port Infolink beforehand. Moreover, Portbase offers a data encryption for Web interface connection, and a free User Management service to the *members* to help the organizations in enforcing the *data governance* procedure [35].

The generic infrastructure and services are developed in-house by Portbase in project working groups. The infrastructure and platform are *supported financially* by its *owners* – i.e. the Port Authorities. Meanwhile, the *members* pay Portbase *access fees* based on their transaction for exploitation and development of the services on Portbase' platform, based on two packages [36]:

- Portbase Basis Plus. The *members* can decide to pay *subscription fees* for the services for lower *transaction fees*.
- Portbase Basis. *Members* that do not subscribe will pay higher *transaction fees* for using the services.

Portbase issues monthly invoices for the *members*; the settlement takes place once a year [36]. With this *revenue flow*, Portbase's balance sheet is break-even and proves its standing as a *non-for-profit* company.

Nowadays, Portbase's community has expanded – i.e. agents, barge operators, shipbrokers, Customs, empty depots, exporters, importers, forwarders, Food & Consumer Product Safety Authority, inspection stations, Port Authorities, selection points, companies, rail infrastructure managers, rail infrastructure operators, traction suppliers, road haulers, and terminals. The port of Rotterdam still maintains its influences in the import and export SCs that pass through the port. The Port Authority is one of the founding members of a cooperation which aimed to reduce traffic on the main road leading to the port during rush hours [37]. By the end of 2016, Portbase had 3900 companies as members and 14000 users that were involved in 82 million transactions within the system [38]. Today Portbase' PCS has been

implemented in The Rijkswaterstaat Maritime Navy and several Dutch ports: Rotterdam, Amsterdam, Harlingen, Zeeland Seaports (Vlissingen and Terneuzen), Dordrecht, Scheveningen, Den Helder, Gronigen Seaports (Delfzijl and Eemshaven), and Moerdijk.

5. Discussion

The PCS-enabled Rotterdam's port collaboration had been through three full lifecycles of inter-organizational governance and is now in the fourth lifecycle as illustrated in Figure 3. The first and second lifecycle occurred in the 1990s, which was indicated by the establishment of PCR and PCR-RIL projects. Following the failed attempts to develop a PCS, the Port of Rotterdam Authority initiated the third lifecycle by the end of the 1990s. Thus, the third lifecycle was started and resulted in the establishment of Port Infolink in 2002. This lifecycle lasted until Port Infolink was merged with PortNET in 2009. The last phase of Port Infolink overlapped the *pre-partnership phase* of its successor, Portbase.

PCR and PCR-RIL projects did not scale because the Port of Rotterdam Authority did not manage to gather support from the port community. At that time, this challenge was not a novel issue. The INTIS project, which was initiated a decade earlier, was also terminated due to the organizational failure in convincing potential users to join the project. The lifecycles of PCR and PCR-RIL projects were terminated prematurely before the project entered the *partnership program delivery* phase. Both projects did not develop a PCS and a solid port collaboration. Because there is a limited information regarding the governance of both projects, the discussion in this study focus on the third and fourth lifecycles.

In the beginning of the third lifecycle, the Port of Rotterdam Authority was the sole initiator and powerhouse of the collaboration. *Formal governance mechanisms* had not been enforced yet in the *pre-partnership collaboration* phase. Consequently, the Port Authority depended on *informal governance mechanisms*, such as *contacts* between the Port Authority's employees and the Dutch Customs' employees and *trust* on the Port Authority. In the second phase, the establishment of Post Infolink was an indicator that the Rotterdam's port collaboration adopted a *NAO governance model*. The organizations' roles in the collaboration are illustrated in Figure 4.

In this cycle, Port Infolink adopted an EDI-based PCS and later a web-based PCS. The collaboration made the *data governance* their priority in the *partnership program delivery* by establishing strict *documented rules, procedures, and policies*. Port Infolink connected the Port of Rotterdam Authority, shipping lines, agents, carrier inland operators, and the port terminal, mainly throughout the import processes. During this lifecycle, the port collaboration exercised *formalized and informal governance mechanisms* to govern the governance aspects that are presented in Table 3, which successfully lead the collaboration to the *succession phase*.

In the fourth lifecycle, the *pre-partnership collaboration* phase was started and ended together with the third lifecycle's *partnership succession* phase. During this period, Port Infolink's PCS continued functioning for the Rotterdam's port collaboration. In addition to the usual day-to-day activities, the port collaboration was also engaged in the discussion and preparation for the merger. The collaboration depended on the *informal mechanism* before the *formal mechanism* was enforced through the merger. In the next phase, Portbase was established to substitute Port Infolink and PortNET. Portbase maintains the governance best practices from Port Infolink, preserving the *NAO governance model* and exercise *formalized and informal mechanisms*. The governance model and the organizations' roles in the collaboration are presented in Figure 5.

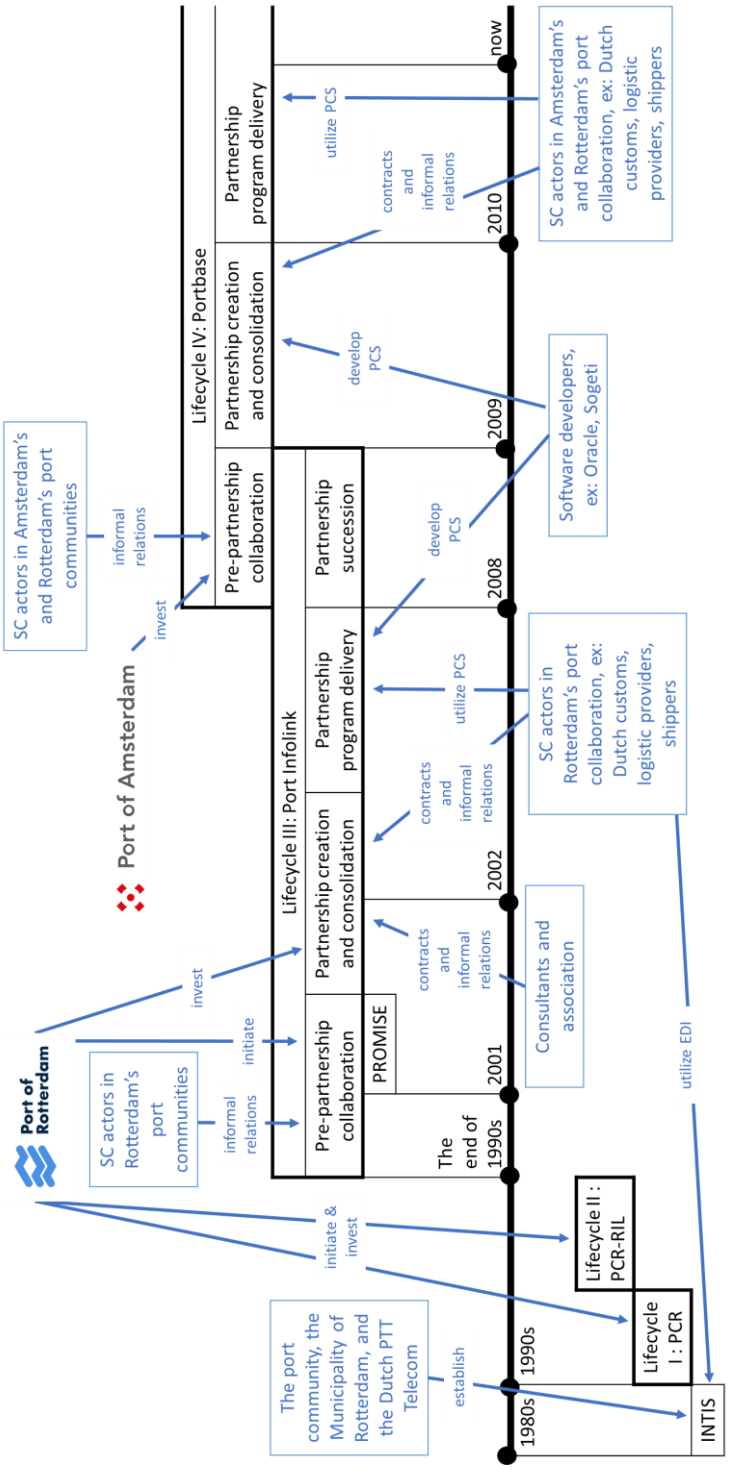


Fig. 3. The governance lifecycles of the Rotterdam's port collaboration [39, 40]

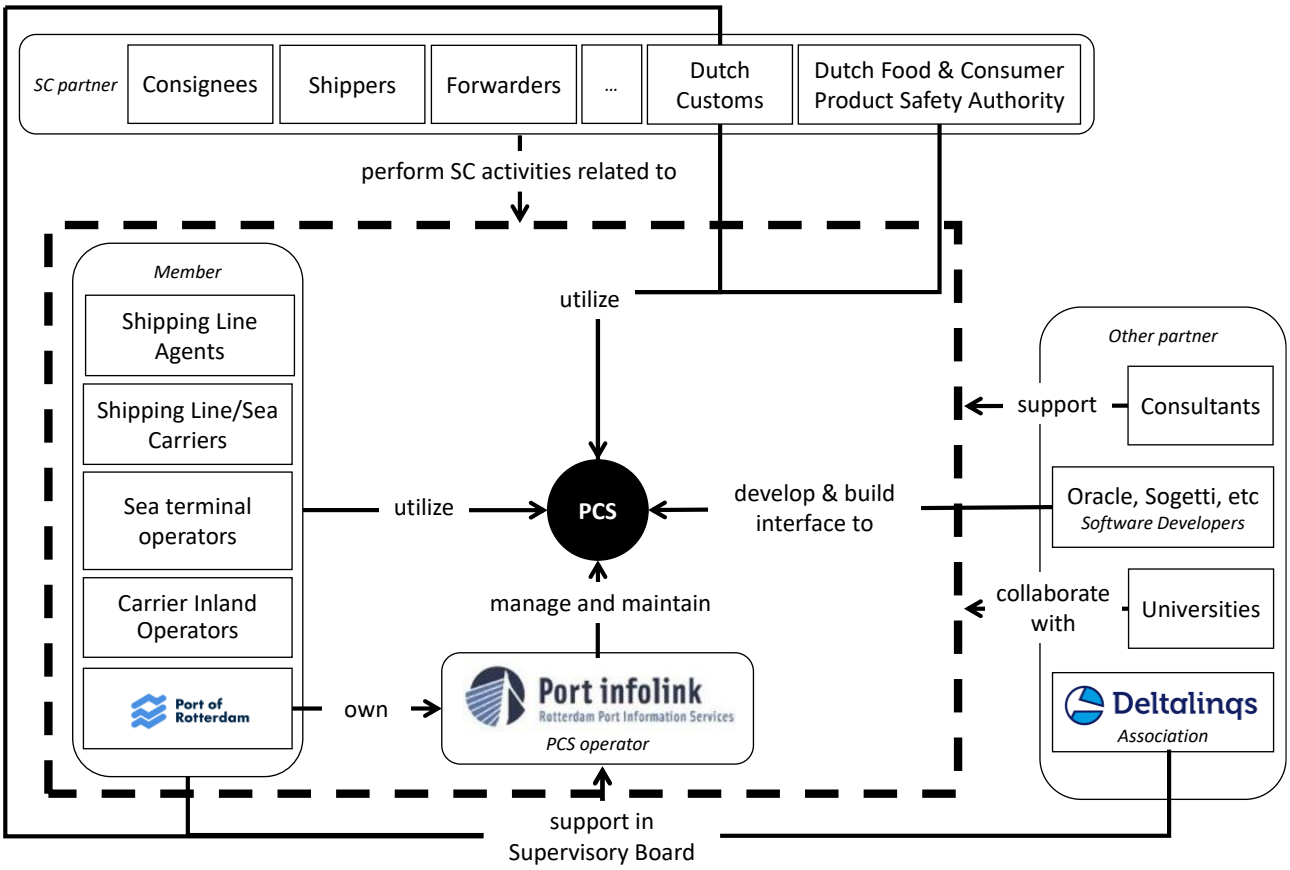


Fig. 4. Lifecycle III: the governance model of the Rotterdam's port collaboration [39, 41, 42]

The differences between the governance models in the third lifecycle (Port Infolink) and fourth lifecycle (Portbase) are: (1) the addition of the Port of Amsterdam Authority, which together with the Port of Rotterdam Authority owns and invests in Portbase; (2) Portbase claims to be an *orchestrator*, which is a development from Port Infolink's role that is limited to *PCS operator*; (3) Portbase manages to include the shippers, consignees, and forwarders in the PCS-enabled port collaboration; and (4) Portbase has an *Advisory Board* and the arrangement of representatives in Portbase' Supervisory Board is different from Port Infolink's *Supervisory Board*.

Furthermore, stark distinctness can be observed in Table 3. Table 3 compares the arrangements of governance aspects in the third and the fourth lifecycles, which port collaborations are governed by Port Infolink and Portbase, respectively. First, Portbase enlarged its collaboration. The collaboration *membership* is not limited to the Rotterdam's port community anymore. The data sources – the shippers, consignees, and forwarders in import and export SC – are included in the current Portbase's collaboration. Second, the *investment* for Portbase come from two port authorities, which are the *equity owners* – the Port of Rotterdam Authority and the Port of Amsterdam Authority. Third, Portbase offers two financial plans for funding the *operational cost*. These plans give the *members* flexibility in deciding on the plan that fits their needs. Fourth, Portbase's organization structure consists of a *Management Board* and its team, a *Supervisory Board*, as well as an *Advisory Board*. There is a clear distinction between the *documented responsibility* of the *Supervisory Board* and the *Advisory Board*. This distinction helps both Boards to focus on the issues in the respective levels of *decision making*.

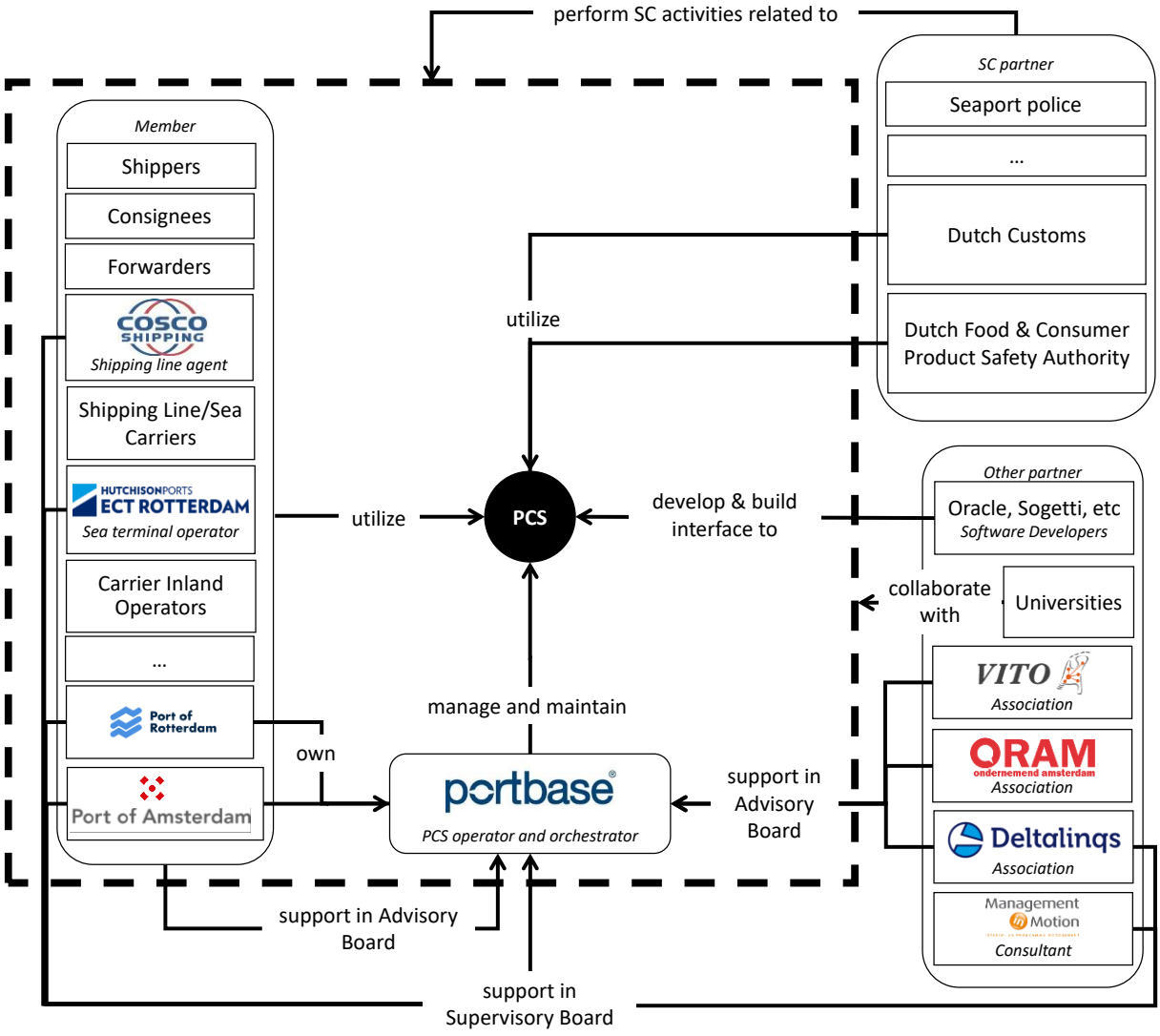


Fig. 5. Lifecycle IV: the governance model of the Rotterdam's port collaboration [39-47]

Table 3. The governance aspects' arrangements in the third and fourth lifecycles

Governance Aspect	3rd Lifecycle (Port Infolink)	4th Lifecycle (Portbase)
Membership	• The membership was limited to organizations that conducted SC activities in or related to the Port of Rotterdam (location-based membership). • Port Infolink's PCS managed to connect shipping line agents, sea carriers, sea terminal operators, carrier inland operators, and the Port of Rotterdam Authority to each other and with the Dutch Customs and Dutch Food & Consumer Product Safety Authority.	• In the beginning, the membership was limited to organizations that conducted SC activities in or related to the Port of Rotterdam and Port of Amsterdam (location-based membership). Later, other Dutch ports are also included. • Portbase' PCS manages to connect the shippers, consignees, dan forwarders, which were not connected by Port Infolink's PCS.

Governance Aspect	3rd Lifecycle (Port Infolink)	4th Lifecycle (Portbase)
Capital investment	The Port of Rotterdam Authority was the sole investor.	The Port of Rotterdam Authority and the Port of Amsterdam Authority share the investment for Portbase.
Operational funding	• 2002 – 2007: The Port of Rotterdam Authority paid the operational cost. • 2007 – 2009: Members paid access fees.	Members pay Portbase access fees based on their transaction and can opt to pay subscription fees.
Decision making	• The benefit and cost sharing was decided by Port Infolink's Management Board and Team. • The Supervisory Board decided on the strategy and set the priorities for the collaboration.	• The Management Board and Team decide on the operational, tactical, and strategical decision, such as: benefit and cost sharing (via access fees and subscription fees), infrastructure maintenance and development, as well as selection of software developer and other partners. • The Supervisory Board is responsible for evaluating Portbase's performance and deciding on its PCS development strategy. • The Advisory Board gives advice, proactively or reactively, on the Portbase's PCS and the services that are to be developed in the PCS.
Data governance	Regulations, policies, and procedural approaches were enforced.	Regulations, policies, and procedural approaches are enforced.
Governance entities	Port Infolink B.V. coordinates the PCS-enabled information sharing collaboration in the port of Rotterdam.	Portbase B.V. coordinates the PCS-enabled information sharing collaboration in several Dutch ports.
Equity owners	Port Infolink's shareholder is the Port of Rotterdam Authority.	Portbase's shareholders are: • The Port of Rotterdam Authority (75%) • The Port of Amsterdam Authority (25%).
Board composition	Port Infolink had a Supervisory Board: Port of Rotterdam Authority, Dutch Customs, Deltalinqs, and the major companies in the port collaboration.	In the beginning, Portbase was supported by board of directors from both prior companies. Today, Portbase is supported by: • A Supervisory Board: Port Authorities, Deltalinqs, Cosco, ECT, and Management in Motion. • An Advisory Board: Port Authorities, Deltalinqs, ORAM, VITO, and the major companies in the port collaboration.

Portbase has become a successful *PCS operator* and *orchestrator* in European maritime port collaboration. The success can be observed from the increase in the number of Portbase's *members* from 3700 to 3900 companies [38] and the financial stability of the port of Rotterdam [24], which is the central hub of the port community. This success is related strongly to the ability of Portbase in attracting potential members and engaging its *members*. This ability was a trait that is inherited by Portbase from its predecessor, Port Infolink. Moreover, the port of Rotterdam declares that there is a room for improvement in terms of the *members'* ease of doing business [24]. Thus, this is an opportunity for Portbase in developing its support for Rotterdam's port community.

In the beginning of Port Infolink establishment, Port Infolink chose an ideal process – import process – to be automated by the first version of PCS. This choice was proven to be an excellent decision. The import process is favorable by the Dutch Custom. Therefore, Port Infolink had a strong support from the Dutch government. This support helped Port Infolink in attracting the port community, establishing *trust* and *contacts* in the *pre-partnership collaboration* phase, as well as gaining data and information regarding the process for the PCS development. Later, Port Infolink managed to save the time and decrease the cost of the import process. This benefits realization was a concrete example for other potential members that had not joined the collaboration at that time.

Port Infolink addressed the recurrent organizational issues in previous projects by the establishment of a *NAO governance model*. Thus, Port Infolink inaugurated a neutral position in the collaboration. Port Infolink as a separated governance entity maintained its neutrality through:

- giving equal opportunity to join the *membership* to all eligible potential members.
- being open about the non-for-profit status in publishing the *investment* and the *operational funding.*

- implementing a strict and transparent *data governance.*
- communicating clear *rules, policies, and procedures* regarding the collaboration's operation for example, the access fees.
- involving the members and Deltalinqs in a *Supervisory Board.*
- having the Port of Rotterdam Authority, a public limited company, as the single *equity owner.*

Retaining the governance model and most of the governance aspects' arrangements, Portbase evolved and develop more sophisticated details. Portbase identified the best practices in maintaining the governance entity's neutrality. Furthermore, Portbase uses the "neutral" word in communicating its value to its *members*, potential members, and *partners*. This wording emphasizes the importance of Portbase's neutrality to preserve the collaboration's performance.

However, the use of Portbase's PCS does not mean that Rotterdam's port community is problem-free. The port of Rotterdam is struggling for years with delays in the container on barges, and the problem has been persistent in 2017 [48]. Another challenge that needs to be addressed is the sustainability issue. The port of Rotterdam has announced its vision to be a zero-emission port by 2050 [49]. This vision is in line with the trend to support low-carbon shipping in the global supply chain. In addition, the global supply chain is also leading the port of Rotterdam into a greater inter-organizational collaboration that involves other ports around the world. All of these problems and challenges have to be addressed by the port community as an integrated collaboration, and Portbase should participate in the process as well.

6. Conclusion

In the first part of this study, a structured way to define a governance of inter-organizational collaborations with a lifecycles paradigm is proposed. There are three points of view used: governance mechanisms, governance aspects, and governance models. These points of view are used in analyzing a case study in the port of Rotterdam. The port collaboration's dynamic governance are explored using the framework that is introduced in the first part of this study.

The PCS-enabled Rotterdam's port collaboration had been through three full lifecycles of inter-organizational governance and is now in the fourth lifecycle. The first two lifecycles were terminated prematurely before a PCS developed. The last two lifecycles were successful in implementing a PCS in the port collaboration. A NAO governance model was established in the third lifecycle and sustained throughout the fourth lifecycle to coordinate the governance aspects using the formal and informal governance mechanism. In the third lifecycle, the governance entity was Port Infolink. Later, Port Infolink merged with PortNET to establish Portbase, which is the governance entity in the fourth lifecycle. Portbase flourishes to be a successful neutral PCS operator and orchestrator in European maritime port collaborations. Nowadays Portbase supports not only Rotterdam's port collaboration, but also several other Dutch port collaborations.

The case study analysis of Rotterdam's port collaboration gives an example of how a systematic approach could help to communicate and give a comprehensive overview of the governance of inter-organizational collaboration. This analysis can also serve to discuss future adaptations to the governance model and as an inspiration to other inter-organizational governance designs. The systematic approach proposed in this study could be beneficial for researchers, consultants, and companies that are working on establishing an inter-organizational collaboration to identify the important roles of each party involved in both pre-partnership collaboration as well as partnership creation and consolidation phases. Having the roles clearly defined, all parties can decide on the suitable governance model for the collaboration. In the subsequent phases, the approach can be beneficial to explain the dynamic governance within the collaboration.

This study is limited to one case study. In the future, a cross-case analysis will be conducted. Using the cross-case analysis, the critical success factors of the governance of inter-organizational collaboration would be an interesting topic to be analyzed further. Moreover, future research could consider adopting a multi-dimensional success metrics of an inter-organizational collaboration to assess the success of a collaboration and the influence of the governance on the

collaboration's success. Thus, the future research could develop an approach in designing appropriate governance for inter-organizational collaboration taking the collaboration's evolution into account.

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IT program management challenges: insights from programs that ran into difficulties

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Abstract:
The use of Information Technology (IT) to drive organizational change has gained momentum in both for-profit and not-for-profit organizations, and currently culminates in a vivid discussion on what many call "Digital Transformation". It is not surprising then that practitioners seek guidance on how to manage such transformation. Professional bodies have addressed this need by issuing best practice standards for Program Management (PgM), but we know little about their value in managing programs in general and IT programs in particular. Academic research on IT PgM is still in its very infancy. Taking this as motivation, we have investigated the challenges that managers faced in five IT programs that encountered problems. Our analysis reveals a set of management issues and shortcomings including, among others, a lack of architectural overview, difficulties in dealing with scope changes, stakeholder interest, diverse business groups and cultures, as well as a lack of internal PgM competences and unclear management responsibilities. In this paper, based on our findings, we present a first checklist for managing IT programs across their life cycle. Though still tentative and not necessarily comprehensive, we were able to confirm that our checklist provides relevant guidance for managing IT programs in practice.

Keywords:
IT program; IT project; IT program management; IT project management; IT-based infrastructure; organizational change; Technochange.

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1. Introduction

The rapid pace of development in Information Technology (IT) directly and indirectly shapes the turbulent economic environment and societal disruptions we face today. The use of prefixes such as "Information" or "Digital" in combination with "Age", "Society", or "Economy" highlight the role of IT as a fundamental driver of societal and economic change. In this situation, organizations cannot help but embrace IT as an important enabler and catalyst for continually adapting to such changing conditions and reinventing themselves. Consequently, the use of IT to drive organizational change has gained momentum in both for-profit and not-for-profit organizations throughout the past years [1, 2]. The practical relevance of this issue is also evidenced by the running debate on "Digital Transformation", which is highly topical and prominent in IT management consulting and professional magazines alike [3, 4].

While Information Systems (IS) researchers widely acknowledge the importance of studying interrelationship between IT and organizational transformation [5, 6], they are just beginning to investigate this relationship in detail. A literature study by Besson and Rowe [6, p. 108], which investigated 29 academic journals over a 16-year period from 1995 to 2011, was not able to identify more than 62 papers in total that dealt with this topic in some way. Of these 62 contributions, the vast majority were devoted to "IT fashions" [7] such as Application Service Providing, Business Process Reengineering, Customer Relationship Management, E-Commerce, Groupware, Knowledge Management, Data Warehouse and Enterprise Resource Planning [6, p. 114]. Additional publications either focused on single cases and specific IT applications or tackled the phenomenon of IT transformation only conceptually. While such research provides some insight into the diverse challenges of implementing IT in organizations, it is far from providing a common theory base to guide managers in leading IT-driven change initiatives successfully.

The academic debate on IT-based organizational change and, in particular, the emerging debate on "Technochange" clearly acknowledge such a lack of theory. The term "Technochange" has been coined by Markus [8] to refer to the use of "IT in ways that can trigger major organizational changes". It acknowledges that IT is not only a given technology that can be "introduced" into the organization, but in many cases challenges established organizational arrangements, routines, and practices. Technochange researchers assume that such change is not well addressed by the established discipline of organizational change management which tends to misconceive IT as a given, "deterministic artefact" thus ignoring the organization's potential to interpret, appropriate and ultimately shape its use in a variety of ways [9]. At the same time, they doubt that Technochange can be brought about by IT projects alone, because such projects have typically been viewed as "exercises in technical change, rather than socio-technical change" [9, p. 2]. As such, IT projects center on the implementation and delivery of an IT product, and only then, if at all, worry about its adaption in a specific organizational context [8]. In sum, Technochange researchers hold that "merely combining IT project management and organizational change management approaches does not produce the best results" [8, p. 4]. In response, they prompt for integrating and extending traditional research into organizational change management and IT project management to address the specific challenges posed. Unfortunately, such research is still in its infancy and hence not yet able to provide managers with practical recommendations and effective practices for managing IT-based change initiatives [9, 6].

Given the crucial role that Technochange plays in the digital transformation of today's organizations, practitioners are urgently seeking guidance on how to manage such change. In professional practice, Program Management (PgM) has emerged as an approach to fill this need. Professional institutions such as the Project Management Institute (PMI) and the Office of Government Commerce (OGC) have promoted PgM as a field of professional training and expertise for more than 20 years. They have also issued related bodies of knowledge in several editions [10, 11], which clearly indicate the widespread incidence of PgM in practice. PgM as an approach is specifically devoted to large-scale organizational endeavors above the project level and, in particular, broad change and transformation initiatives [12, 13, 14]. It is therefore surprising that academia so far has paid little attention to the PgM approach to bring about IT-based organizational change. In an extensive literature review, we were not able to identify more than a handful of studies specifically concerned with IT program and their management. One early study presents a list of skills for and competencies of successful program managers based on experiences made, among others, in the IT industry [15]. Two

further studies investigate management challenges in a single programs in detail. One is concerned with the implementation of a large-scale standard software solution [16], the other with an IT transformation program [17]. The latter study has a narrow focus on challenges caused by paradox and ambidexterity in programs. A final study by Jiang et al. [18] builds on survey data of 183 firms, but has an even narrower focus on conflicts and specific aspects of conflict management in IT programs.

In face of the challenges imposed by digital transformation and the role of IT as a driver of organizational change, we perceive a strong need to widen our understanding of IT programs and the management challenges involved. In response, we analyzed the challenges in five different IT programs that ran into difficulties, pursuing two research objectives:

- First, we intended to lay a broader empirical basis for understanding the challenges involved in IT PgM with respect to both the number of studied programs and the range of management challenges included.
- Second, based on a more comprehensive understanding of IT PgM challenges, we sought initial insight into how managers can and do respond effectively.

We present our empirical investigation and the resulting findings as follows: We begin by clarifying the terms IT project and program and by delineating the associated management domains of Project Management (PM) and Program Management (PgM). In the third section, we describe our research approach and the data basis of our exploratory empirical study. In the fourth section, we present practical insights from our case studies in an actionable way. We do this by discussing challenges that the IT program managers in our five cases had to face. In addition, we introduce the reader to ways that program managers responded to these changes. In a last section, we summarize the contribution of our study and draw conclusions for practice.

2. Managing IT-based Change through Programs and Projects

IT PgM is quite a new concern in Information Systems research and the academic debate still suffers from some ambiguity surrounding the notion of an IT program. Ribbers and Schoo [16], for example, emphasize technical features as being characteristic of an IT program, while Gregory et al. [17] highlight organizational transformation and change invoked by IT programs as distinctive feature. Reason enough for us to first clarify the concept of an IT program for the purpose of our research. We do this by first introducing the more common concept of an IT project (Section 2.1). We then distinguish projects from programs in general (Section 2.2), before we finally clarify the particular concept of an IT program (Section 2.3).

2.1 IT Project Management

From a historical perspective, IT PM can be conceived as a variant of PM specifically attuned to IT products or IT-based solutions as project outcomes. The PM discipline emerged in the latter half of the 20th century in response to the need for organizing (engineering) work in a way that allows for creating a unique (technical) product effectively and efficiently [19]. The early development of the PM field of study had been driven by disciplines such as Engineering and Operations Research and was much concerned with the development of techniques for planning project work such as product and work breakdowns, bar charts, activity diagrams, resource allocation, scheduling or critical path calculation methods [20, 21]. Accordingly, the domain of PM is traditionally perceived as dealing with the application of tools and techniques (e.g. critical path method) for directing the use of diverse resources toward the accomplishment of a unique, complex outcome (a one-time task) within time, cost and quality constraints. This understanding of PM is also expressed in what has become widely known as the "Magic Triangle" of PM [22, 23]: Projects strive for producing a *specific outcome in a defined quality* within a given *cost* and *time* frame.

The development and diffusion of information and communication technology throughout the last decades has made PM pay dedicated attention to IT. Kwak and Anbari [20] estimate that over the last 30 years academic publications on IT projects and their management amount to a share of about ten percent of all publications on PM. Being rooted in

general PM, IT PM still shares its fundamental assumptions. As Atkinson [23] and Sauer and Reich [24] demonstrate, IT PM adopts the general idea of developing a defined outcome, in this case an IT-solution, under time, budget and quality constraints as expressed by the Magic Triangle. This assumption is still prevalent most contemporary textbooks on IT PM [25, 26, 27]. Some of these textbooks explicitly account for the variety of possible IT project outcomes including software products or modules, a packaged software solution customized to specific business needs, the migration of systems, the maintenance and adaptation of existing applications, the setting up of databases, server installations or systems software updates to be rolled out (e.g. [28]). The vast majority of textbooks, though, center on software applications and accordingly deal with software projects in particular (e.g. [25, 26, 27]). Therefore, we stick to the example of software projects to delineate the domain of IT PM from technical development tasks involved in IT projects. In the case of software projects, the latter are associated with the discipline of Software Engineering (SE) as opposed to PM. Hence, though going hand in hand, PM and SE are addressing fundamentally different tasks and challenges in IT projects [29]. The interaction and differences between IT PM and Software Engineering can be illustrated by comparing the respective phase models as depicted in Figure 1.

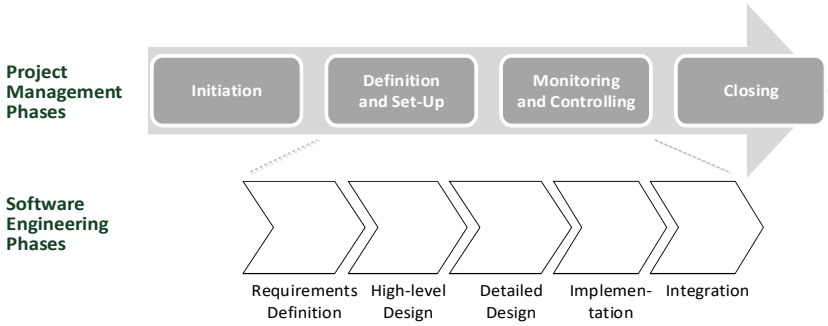

Figure 1. Software Engineering and Project Management

Software development activities are traditionally structured into phase models with phases often named “requirements definition”, “high-level software design”, “detailed software design”, “implementation and unit testing”, and “unit integration and system testing” (e.g. [27, 30]). The operational work in projects is to be carried out by (technical) personnel whose activities need to be coordinated and supervised. Management tasks include project planning, assigning work to project staff, organizing the project as well as leading the team and controlling work progress. In addition to coordinating internal work, management in many projects also includes the synchronization with external partners, the cooperation with users, the communication with stakeholders as well as managing quality and risk. As depicted in Figure 2, these management tasks are “superordinate” to the technical development activities included in the SE phase model. To illustrate the differences in the SE and IT PM tasks, Figure 1 uses a typical IT PM phase model [27] distinguishing four phases: “initiation”, “definition (or planning) and set-up”, “supervision and controlling”, and “closing”. The figure also visualizes that the IT PM phases span across and extend the SE phases. IT PM starts long before the first line of code is written and often even before the demands on the software solution are fully known. Additionally, PM does not end with the delivery of a piece of software as outcome but rather extends the process to the take-over of the deliverable by the project customer and, if necessary, its integration into the target environment [29].

The distinction of management tasks from technical tasks in IT projects is not only a conceptual one but also well supported by empirical research. In fact, studies did not find technical skills to be among the most important qualifications of successful IT project managers. Instead, managerial qualifications including leadership capability, verbal and written communication, scope management, listening, project planning, people skills, motivational skills, negotiation and organizational skills were the top ten qualifications [31, 32].

Our short sketch of PM is necessarily simplified and as such not capable of giving a full account of the latest efforts to address some of the restrictions pointed out [9]. However, such efforts clearly evidence an increasing awareness for the scope limitations of traditional IT PM and its constricted focus on cost, schedule, and functionality [24].

2.2 Program Management

Professional institutions such as the Project Management Institute (PMI), the Association for Project Management (APA), or the UK Office of Governance Commerce (OGC) have clearly realized the limitations of PM. As a response, these institutions have suggested Program Management to complement projects and Project Management. The concept of a program emerged in dealing with the limitations of the more common concept of a project [14]. Projects typically presuppose an outcome that is clearly defined in scope and quality so that PM can focus on accomplishing this outcome within the given resource and time constraints. Programs, in contrast, are perceived as "big" organizational undertakings involving a larger number of projects in support of common, superordinate business goals. More formally, programs can be defined as large-scale initiatives involving a set of interrelated projects and organizational measures that are intended to collectively realize a value. Lycett, Rassau, and Danson [33, p. 289] characterize programs as having a significant impact on the organization and sharing a common intention related to the corporate goals. The projects involved in a program are interdependent in their resources and, even more importantly, in that they share a common intention and contribute to achieving superordinate goals. Therefore, the full value of a program is only realized when the projects included are successfully implemented in combination. The superordinate business goals pursued are often strategic by nature [15]. Consequently, programs typically have a high impact on the entire organization or at least on large parts of it [33].

Program Management (PgM) refers to a set of management tasks and practices essential for successful program planning and execution. Ferns [34, p. 149], in an early definition, summarizes these activities as "the coordinate support, planning, prioritization and monitoring of projects to meet changing business needs". In a similar vein, Lycett, Rassau, and Danson [33, p. 289] define PgM activities as "the integration and management of a group of related projects with the intent of achieving benefits that would not be realized if they were managed independently". Gaddie [35] elaborates in more detail on the challenges involved in PgM as opposed to PM, which include the balancing of scope between projects, the resolution of project conflict, and the prioritization of project resources with respect to the achievement of a superordinate business goal or an overriding (strategic) purpose. Partington, Pellegrinelli, and Young [15, p. 87] specifically emphasize the strategic nature of PgM which they describe as dealing with the "structures and processes that are used to co-ordinate and direct multiple interrelated projects that together constitute an organization's strategy".

Table 1. Programs vs. Projects

Feature	**Project Management**	**Program Management**
Objective	Bring about an outcome of a specified quality within defined time, resource, and cost constraints	Achieve an overarching (strategic) goal by implementing a larger IT-initiative involving a set of related IT/IS projects
Scope	Single investment which is to be implemented	Multiple goal-interdependent investments implemented through projects and accompanying change measures
Duration	Finite, predefined start and end, several months to one year or more	Finite, often several years
Manager's role	Heads the project team and represents the project to its owners and, if applicable, to portfolio and program management	Supervises managers of the projects in the program, heads administrative staff supporting PgM (often organized in an PgM office), reports to top management
Success Measures	Narrowly defined in terms of scope of the project outcome, quality, time, and cost	Broadly defined in terms of benefits delivered to stakeholders or the achievement of an organization's (strategic) goals

Table 1 gives an overview of the distinguishing features of PgM as opposed to PM schematically. It is important to note that it is not sheer size that distinguishes programs from projects as sometimes assumed in the literature [34, 36]. For example, developing a complex software application for the public agencies and rolling it out to a dozen sites or more is surely challenging, but might still be best dealt with in a project setting. Some authors refer to such projects as "mega projects" to highlight specific risks and management challenges associated with such large projects [37]. PgM can also be clearly distinguished from Project Portfolio Management, which has its roots in the management of capital investments. Portfolio Management takes a relatively narrow investment perspective and pursues the ultimate goal of maximizing the risk-returns-ratio across the entirety of an organization's projects [38, 39]. Finally, with its orientation towards specific strategic goals and its association with organizational change, PgM can also be distinguished from multi-project management, which has an operational focus on resource allocations, scheduling and day-to-day co-ordination [40, 41].

2.3 IT Program Management

The "key rationale for organizing work into an IT program is that the intended organizational benefits cannot be achieved by pursuing individual IT projects on their own" [17, p. 58]. Hence, IT programs "typically encompass a coordinated set of interrelated IT projects" [17, p. 58], which is seen as being "structured to meet goals established by top management regarding the use of technology" [18, p. 80]. Table 2 reports the particularities that Gregory et al. [17] associate with IT transformation programs (also see [42]). As basic characteristics, they point out the importance of IT programs for achieving competitiveness in the current dynamic business environments and the role of information technology as a competitive lever and an enabler of change in this situation (Table 2, rows 1 and 2). The other two characteristics refer to the management of IT programs: The authors assume that IT PgM has to deal with high levels of complexity and to ensure IT-business collaboration (Table 2, rows 3 and 4).

Table 2. Characteristics of IT transformation Programs [17]

Characteristic	**Description**
Achieving IT-based competitiveness	IT transformation programs serve the specific purpose of increasing the IT-based competitiveness of a firm and are therefore often observed in competitive and dynamic business environments. Within such competitive and dynamic business contexts, a key mechanism for achieving IT-based competitiveness is building an IT platform that provides stable core operations and the necessary foundation for competing with IT.
Triggering IT-enabled change	IT transformation programs typically involve substantial change. A particular characteristic of IT transformation programs, as opposed to organizational transformation programs in general, is that this change is enabled or triggered by IT. Thus, in IT transformation programs, "IT" is considered a major asset for leveraging organizational transformation, and the changes made to organizational IT itself are considered important for leveraging business change.
Dealing with IT program complexity	Executing IT transformation programs involves the complexity associated with managing a set of highly interrelated IT projects and aligning individual contributions to the strategic objectives at the program level. IT program management can be conceptualized as an integral part of an IT transformation process, i.e., the design, development, and deployment of changes to IT and the organization.
Partnering between IT and business	Of the multiple ways in which IT functions may contribute to business inside an organization, a specific characteristic of IT transformation programs is that they require the IT organization to be an active partner with the business. The IT-business partnering perspective involves the need for IT and the business organization to be mutually accommodating and to adopt the mind-set that IT is an integral element to the business.

At the heart of an IT program is what Gregory et al. [17, p. 57] call an "IT platform". They use the term platform to demarcate IT programs clearly from IT projects with the latter having a piece of software or a single information system as object and outcome. The object of an IT program, in contrast, is what Ciborra [43] has described as the IT-based infrastructure of an organization. Such an infrastructure comprises all the prerequisites for technology-based organizational information and communication. These include hardware components such as computers or network

equipment as well as application systems and stocks of (digital) information to be processed and transmitted via IT [44, 45, 46]. As part of an infrastructure, these components do not provide value independently but only in relation to each other. In other words, application systems, computers, networks, and databases have to be integrated into a coherent whole to have the full value of an IT-based infrastructure materialize. This is what differentiates a single IT component or an arbitrary set of components from an IT-based infrastructure [47, 46, 43].

Given its *heterogeneity*, it is clear why changes to and developments of an IT-based infrastructure cannot easily be dealt with in IT projects alone. While projects focus on single IT components, programs have to assure the implementation of many different (infrastructure) components at the same time and in relation to each other. Implementing single components calls for setting up IT projects, e.g. software development projects, database projects, and hardware rollouts, in combination with training or organizational change measures. These projects – as the components they intend to deliver – are interrelated and thus in need of mutual coordination.

Another important characteristic of IT-based infrastructure is that it is a foundation for conducting business that permeates the organization and often transcends corporate boundaries, thus affecting large parts of the organization's business [48]. Hence, it is not a mere technical artefact, but always related to the organization it supports and the prevailing practices of use. In other terms, IT-based infrastructure is "*socially embedded*" [44, 45, 46]. As such, it cannot be changed or extended successfully without giving due consideration to the business context and use practices. Rather, making modifications to the IT-based infrastructure requires organizational adaptations and often triggers organizational change.

A third important characteristic of an IT-based infrastructure is that it is virtually impossible to build it from scratch. In contrast, such an infrastructure evolves over time in an organizational context. Consequently, any attempt to change an IT-based infrastructure needs to take account of an "*installed base*" as the status quo to be further developed [44, 45, 46]. This challenge is not well addressed by IT PM that has been criticized for following a "start from scratch" approach. As such, it has either "ignored the influential role of pre-existing information systems" and infrastructure [9, p. 3] or at best has dealt with it as a constraint.

Given the heterogeneity of IT-based infrastructures, their embeddedness into the organization, and their evolution over time, we subscribe to the view of Gregory et al. [1] who associate IT programs with levels of complexity that are much higher than those for IT projects. In particular, given the embeddedness of IT-based infrastructures into the business organization, IT programs have to deal with organizational change on a level that is far beyond the levels of participation acknowledged in the IT PM literature. This change, in turn, calls for a strong partnering of IT and business as argued by Gregory et al. [1]. Finally, as endeavors in both technical and organizational change, IT programs have to deal with high levels of uncertainty. IT projects, in contrast, premise well-defined objectives, a tightly defined (tangible) outcome, and clear-cut conditions (e.g. resource and time restrictions as laid out in a project brief).

3. Research Approach

Our study on challenges in IT program management includes five case studies from organizations that ran into trouble with their programs. The following sub-sections introduce our focus in studying PgM challenges as well as the case studies and the method for data collection (for a detailed documentation see [49, 50]).

3.1 Research Focus

Large change initiatives require attention by top management and much control and decision making by senior executives. The strategic role and transformational character of IT programs emphasize IT PgM as an executive function. Consequently, we define management in a focused sense of "to lead, to direct" rather than in the colloquial definition of "to handle skillfully" or "to work upon for a purpose". Management in this definition includes (only those) activities that executives engage in as they direct organizational matters in order to achieve organizational goals. The colloquial definition, in contrast, is unspecific in that it denies the difference between such management tasks on the

one hand and technical development and administrative tasks on the one hand. Our focused understanding of IT PgM hence parallels in some respect the demarcation of IT PM from the more technical discipline of Software Engineering introduced above (Figure 1).

Our definition of PgM also ties our research to Management Studies that informed us with the "classical" POLC structure for differentiating management activities in a narrow sense from the vast set of activities associated with an inclusive definition of management. The POLC structure, which distinguishes management functions into planning, organizing, leading, and controlling activities, can be traced back to Henry Fayol's seminal work on management studies [51]. According to the verdict of Wren and Bedeian [51, p. 415] the POLC structure has stood the test of time in the history of management thought, so that recent work has rather complemented as opposed to replaced it. The relevance of the classification and its clarity and feel led us to adopt it in our research.

3.2 Case Studies

Given that IT PgM is an under-researched field, we pursued an exploratory approach, which is particularly suitable when a researcher wants to explore areas about which he has little or no knowledge [52]. Our exploratory research builds on case studies with data collected by means of document analysis and semi-structured interviews. However, as a single case study always focuses on a particular setting at hand, results are difficult to generalize. One way to address this difficulty is to include more than one case study into research. As Yin [52] suggests, multiple cases enable comparisons to clarify whether an emergent finding is simply idiosyncratic to a single case or consistently replicated in several cases. Comparing different cases can help to generalize results by looking for common or shared experience and controlling for idiosyncrasies. Yin [52, p. 41] calls this kind of reasoning "analytical generalization" as opposed to "statistical generalization", which is used in large-scale quantitative studies.

Table 3. Overview of the Cases

Code	Program motivation, aims, and duration	Role of IT in the program
TLC	Reduce costs and improve time to market by replacing idiosyncratic and ill-documented legacy applications and interfaces. *- 2 ½ years -*	Integration of reporting applications, consolidation, and functional extension of accounting and reporting systems.
TEC	Consolidate financial reporting after merger; fulfill compliance requirements for going public. *- 2 years -*	Integration and standardization of IT-based infrastructure, introduction of standard software for core operations.
LIT	Spin-off of a technology division as an independent subsidiary in preparation of going public. *- 1 ½ year -*	Set-up of an IT-based infrastructure for the new subsidiary including network hardware, applications, and data resources.
SUP	Merging the IT-based infrastructures of two newly acquired businesses in a way that allows for organizationally integrating them into the group. *- 3 years -*	Integration and standardization of IT-based infrastructures while keeping operations alive.
AUT	Set up of an IT-based infrastructure for a new offshore production plant. *- 3 years -*	Set-up of a completely new IT-based infrastructure including network, application systems, and data resources.

For our multiple case study research, we had access to detailed information on six programs, all having the development of IT-based infrastructures at their heart. All programs were also coordinated hierarchically, as assumed in the program management literature [33, 36]. The organizations carrying out the programs are headquartered in Germany, but do business on an international scale. We excluded one program where IT did not play as significant a role as we assumed in our definition of an IT program. This left us with a sample of five cases to analyze and compare. Table 3 provides a

summary of the cases (due to confidentiality requirements we cannot provide detailed information on the organizations involved and their resource inputs here). Cases TLC and TEC were from the information and communication technology industry, cases SUP and AUT from the manufacturing industry, and case LIT from the consumer electronics industry. The choice of our five cases followed a "replication logic" [52, p. 57] in that the case situations are looked upon as being similar in the way they exhibit conformable challenges. The fifth case (AUT), however, differed from the first four in that it was more technologically challenging. The program did not change established organizational practices but was concerned with setting up an infrastructure for a new organizational unit. As such, it is not an IT-based change program in a strict sense. Consequently, we used the AUT case rather for comparing it with the other four programs, following the idea of "theoretical replication" in multiple case study research [52, p. 57].

In the first case, the large telecommunications company "TLC" saw the need to technically consolidate and standardize its infrastructure. Hence, the company initiated the program to revamp the heterogeneous, complex, and largely proprietary network and hardware infrastructure. In the second case, the telecommunications company "TEC", which had undergone a merger just prior to our research, aimed to consolidate its more than 50 reporting systems into one integrated solution. The third company "LIT" was a business unit carved out of a large technology corporation. The program aimed at setting up an IT-based infrastructure for the new subsidiary that was expected to provide the IT services required for business operations from day one, and to facilitate reporting for going public. The fourth organization, the automotive supplier "SUP", had recently acquired two smaller, specialized supplier companies. SUP subsequently initiated a post-merger integration program in which the integration of the IT-based infrastructures played a major role in realizing synergy. In the fifth case, AUT extended its production facilities by building a new plant in China. The program was set up to realize the infrastructure required for plant operations.

3.3 Data Collection and Analysis

We received access to the case data via a management consultancy. In the first two cases, the consultancy had sole auditing mandates. In the latter three cases, the consultancy had auditing mandates and, on top of this, assignments to bring dedicated PgM competence into the running programs. In all five cases, we had access to the complete documentation of the PgM audits conducted as well as to the program brief, the documentation of the program organization and management, as well as to reports on the progress over time. Moreover, in the latter three cases, we also had access to presentations including information on the running programs, problems, and management issues that arose. In addition to studying these documents, we had the opportunity to discuss and verify findings from our document analysis in interviews with one experienced consultant in each case (senior consultant level or higher), who was actively involved and had an intimate knowledge of the program. The interviews also provided us with the opportunity to collect additional information on the cases from the experience our interviewees made with the programs. For this purpose, we conducted the interviews in a narrative manner using a semi-structured interview guideline (see Appendix). The interviews allowed us to verify and complete our understanding of the program issues encountered in the analysis of audit reports and program documents. On top, we received a detailed account of the problems and management issues that our interviewees identified in the assessment of the programs and, in three cases, in their active involvement in managing the program later on. As concerns the measures taken for resolving the issues, we clearly distinguished between the consultancy proposals and the measures approved by the organizations undertaking the programs.

For documentation, the interviewers took notes and summarized the interviews in written protocols right after having conducted them. Afterwards, two different researchers analyzed the protocols independently by highlighting the issues raised, identifying problem causes, and relating issues to measures proposed or taken. We finally summarized the results of our interviews against the background of the program information gained from the document analysis in "case vignettes" of about 10 pages per case.

After analyzing the cases individually, we also compared the results of our analysis across cases in order to identify issues that were somehow "typical" for such programs [49, 42]. From this analysis, we compiled a list that we finally validated in expert interviews. We chose interviewees who had acquired profound knowledge about reoccurring

management issues in IT programs over many years as well as experience in what measures tend to be effective in dealing with these issues. Hence, we could justifiably looked upon them as experts in the field. Three of them were practice leaders from the partner consultancy that already gave us access to the cases, but of course distinct from our interviewees in the case studies. A fourth expert interviewed was also an IT management consultant, yet from another consultancy. The fifth one was the business head of a large IT program in an international logistics company. We structured the expert interviews along the phases of the program management life cycle to facilitate the interviews by giving them an easy to follow logical order and practical orientation.

4. Challenges and Recommendations for Managing IT Programs

In this section, we present core findings from our case studies. To present these findings in an "actionable" way, we again use the program management life cycle as an organizing framework. While designations may differ, the four stages "Identification", "Set-Up", "Execution", and "Closing" are generic to most life cycle models [33] including those proposed by the OGC [10] and the PMI [11]. In the following subsections, we present critical management issues and challenges in the first three phases of the PgM lifecycle. We exclude the closing phase in the following, because the data we collected on what happened after program execution, e.g. evaluation of program success, release and reintegration of program and project staff, or documenting lessons learnt, were only limited.

In the next three subsections, we briefly introduce the first three PgM stages. For each of the stages, we then report on typical issues that managers need to pay heed to in order to avoid severe difficulties and problems we observed in the studied programs. For further insight into our findings, we refer the reader to [50, 49, 42].

4.1 Program Identification

As big moves, programs make high demands on resources that need to be justified by the benefits. Accordingly, it is important to weigh up the motivation and intended benefits of the program against the resource requirements and risks. The identification stage deals with the clarification of the purpose and objectives of a program with regard to the organization's mission, goals and strategies. Justifications for establishing a program include fundamental change pressures to be addressed or significant business level benefits to be achieved by the program. However, repudiating the idea of establishing a program is also a possible outcome of the identification stage.

Formulate and promote a compelling vision for the program

To achieve visibility, awareness, and support, a clear idea of why to conduct a program and what to achieve is important. A clean-cut and compelling vision statement is instrumental for this. The SUP case, for example, suffered from a vision that hinted only vaguely towards a long-term organizational future and failed to give a clear idea of the program's intended business benefits and value. In the cases of TEC and AUT, the program vision was poorly communicated to the larger organization and thus largely unknown outside the program. In effect, these programs experienced a lack of awareness for their importance, arbitrary stakeholder expectations, and limited support by the business.

A tangible vision can also help to keep the motivation alive and maintain speed and sense of purpose. This is of vital importance for programs. As long-term endeavors, they deliver business benefits only with a significant time lag so that they are at risk of experiencing strain and fatigue during execution.

Analyze and clarify the scope of the program in terms of reach and range

IT programs typically reach beyond technology (or say the IT unit) in that they bring about organizational change to the business. Accordingly, it is essential to clarify the business scope of the program (which units or sites are affected?) and the scale of change to be brought about (e.g. supporting the current organization vs. transforming it).

The program in the case of TEC affected different sites in several countries, but PgM did not pay enough attention to the different cultural backgrounds and specific local needs. The AUT program, in particular, neglected the specific

economic and cultural situation in China. Both programs were looked upon as "rollouts" of a "given" infrastructure solution rather than endeavors of IT-based change in specific organizational and cultural environments. This turned out to be mistaken, so that both programs had to make strong provisions for adapting their solution to local needs and national peculiarities later on. PgM in the TEC case, for example, established a standing committee with multinational representatives from the different sites during program execution.

Define the business benefits to be achieved and relate them to stakeholder interest

While the deliverance of the targeted IT-based infrastructure is a necessary prerequisite for program success, a well-functioning infrastructure solution does not guarantee business value per se. Rather, it is the (beneficial) effects that the IT-based infrastructure has on work practices in the business organization that ultimately bring about the intended business value. Hence, it is important to state the intended business benefits from early on and to define how their achievement is to be measured. The business value of an IT program also strongly depends on whether the business welcomes the organizational changes and adaptations necessitated by the new infrastructure or not. Hence, addressing the interests of the business stakeholders and finding support in the business organization is equally important for IT program success. A good way for achieving this is by demonstrating from the outset how a program benefits the different stakeholder groups and how it adds value to the business.

The programs in the SUP and AUT cases were promoted without paying due attention to the specific interests of different stakeholder groups. This resulted in excessive and misled stakeholder expectations that the programs could not live up to. The program in the SUP case, as a result, had to invest extensively in the management of stakeholder expectations during program execution including target group specific communication. In the case of AUT, good personal relationships between program representatives and line executives partly helped to align expectations later on.

Ensure support by key stakeholders and senior executives

Even when the diverse stakeholder groups affected by a program clearly understand the benefits, their interests and expectations can be so diverse that conflicts arise which cannot be mutually resolved. Implementing IT programs across the organization, hence, requires additional top management support beyond that of the CIO. Only with this support, it is possible to resolve conflicts between stakeholders and to overcome resistance. A clear definition of strategic benefits can be instrumental in obtaining the management support required.

The LIT program might serve as a case in point, since it brought about organizational change to a degree that put the formal positions and the authority of line executives in the business organization into question. As our interviewee explained, "Many stakeholders involved (…) were placed high in the business hierarchy. This resulted in major political problems when it came to planning and implementing changes in the future line organization". The resistance provoked by the program could be resolved only in exhausting political proceedings and with strong top-management involvement.

Identify the technological expertise required and look for adequate external partners on the market

IT programs build on particular technologies and related expertise that is rarely (fully) available in-house. In fact, none of the organizations in our study possessed the complete technological expertise required to make decisions on all aspects of the IT-based infrastructure or to oversee solution development completely.

Given the dependency of IT programs on contributions from external experts, the responsible managers paid little attention to selecting suitable service providers and consultancies as partners at the outset of the program. In the TLC and TEC cases, this omission resulted in significant technical drawbacks and failures during execution due to missing expertise, differing perceptions of responsibility, and mutual recriminations between providers.

Assess internal program management competencies, support, and training needs

In the IT programs we studied, many PgM responsibilities were assigned to line executives that did not possess dedicated PgM skills and experience. Key positions were staffed with IT experts who had considerable technological

knowledge but often lacked a strong leadership profile. The lack of PgM skills became particularly apparent in the LIT and AUT cases that finally commissioned an external consultancy to provide PgM training and coaching on the job as well as support and guidance to the internal IT executives.

4.2 Setting up the program

The program identification phase prepares the decision on whether to embark on an IT program or not. This decision is based on the questions of (I) whether there is (the need to conduct) an IT program at all in terms of strategic value to be achieved and change to be brought about and (II) whether the organization is capable of running the program. If the decision is affirmative, the program can be set up formally. Loosely speaking, the set-up phase is concerned with developing high-level plans on how to execute the program. This includes refining the vision and defining the program organization, chartering the projects involved, clarifying project interdependencies, and sequencing projects as well as accompanying organizational change measures.

Substantiate the program vision with an infrastructure blueprint

A tangible program vision can help to maintain speed and a sense of purpose during program execution as already mentioned (section 4.1). In addition, a clear-cut and concrete vision can contribute to a common understanding of the targeted outcomes and of the interplay of the program deliverables.

The vision in the SUP case was too vague to provide orientation and guidance. The other programs, which started with a clearer vision, performed better and had less difficulty to find acceptance for the changes brought about. However, we found that simple vision statements, while providing some sense of purpose, do not automatically provide a common understanding of the IT-based infrastructure to be developed through the program. Additional blueprints, called “target architectures” (TLC) or “target operating models” (TEC) in our cases, can help underpin the vision in terms of the outcomes to be achieved. Such blueprints can also be instrumental in building a common understanding across different stakeholder groups, business departments, units, or sites as concerns what the program is about.

Define major building blocks

Architectural blueprints can also serve as a common reference point for the different parties involved in program execution later on. By highlighting major building blocks of the targeted infrastructure, they can help identify critical deliverables and define projects for developing these deliverables. Moreover, such blueprints facilitate the co-ordination of different projects and the integration of their outcomes into a common infrastructure solution.

PgM in the TLC case defined project assignments and deliverables in broad strokes only so that managers had difficulties in identifying aberrations and in taking timely corrective actions later on. The same program also suffered from third parties working to formal contract only, without being strongly committed to the program objectives, so that they had little interest in committing themselves to building the overall infrastructure solution. We observed a similar situation in the TEC and AUT cases. A clearly defined target architecture could have helped in clarifying the contributions expected from the external partners and in aligning them with those of other external and internal projects.

Devise project plans in an integrated manner and define common planning and reporting standards

An overall program plan is a kind of master plan that gives an overview of the major program positions. These include internal projects, external projects and deliveries, as well as accompanying organizational change measures. As a master plan, the program plan is necessarily aggregated and somewhat abstract. Hence, it is important to relate it to the more detailed project plans, which provide insight into the deliverables, resource requirements, cost estimates, time scales and risks associated with establishing the program positions.

In most of the cases that we studied, we could observe a lack of integration of the program plan with the lower level plans. In the TLC, TEC, and AUT cases, this lack resulted in misguided top-level estimates of cost and effort. In addition, managers in the TLC case had to struggle with duplicate planning efforts, unaligned plans, and unrealistic

project schedules, because the different parties involved in the program built their plans on divergent premises. The problems in all three cases were specifically severe with respect to external providers that used proprietary planning and reporting standards and management tools. Introducing common program and project management tools turned out to be an effective measure to foster better integration of program planning and reporting (TLC).

Organize the program in detail and involve internal actors in key roles

All the programs that we studied suffered more or less from a poorly defined program organization. The organizational plans did not go much beyond rough structure charts printed on slides. Roles and responsibilities lacked clear definitions. When assigning roles to internal managers, it is furthermore important that these have enough capacity and the necessary PgM competencies. In the TEC, LIT, and AUT cases, PgM responsibility was assigned to IT mangers on top of their responsibilities in the line organization. The TEC case where the CIO was expected to take over the program lead may serve as a case in point. The CIO and other IT executives in the TEC case were heavily overstrained with their PgM duties so that they ignored them to an extent to which the program was perceived as devoid of any leadership.

Moreover, we found that assigning key PgM roles to external parties resulted in a loss of oversight and control over the program. In the TLC case, for example, the responsibility for change management was completely laid into the hands of an external consultancy that had only a limited understanding of TLC's business. Consultants also dominated the program management office, which was set up to support program management and controlling. This resulted in the internal program managers having only indirect access to and insight into the program and its progress. Moreover, the consultants saw themselves more in an administrative role. They neglected an active progress monitoring and program controlling. Unlike this negative example, the involvement of external professionals also turned out be helpful in bringing in PgM competence or in assuming unpopular roles in monitoring program progress or evaluating critical deliverables ("bad guy") in our programs.

Establish program-wide management standards

While well-defined program roles and responsibilities are fundamental for a good program organization, there is more to it than that. In addition, common process and working standards are important to facilitate program execution. Programs involve diverse parties and are distributed across different projects. Hence, common planning and reporting procedures (TLC, TEC, LIT, SUP), unified methods for quality and risk management across all program levels (TLC, TEC, LIT), and defined escalation procedures (TLC, TEC) are important for managing them in an integrative manner. Clear rules for conducting meetings and for writing minutes can also improve PgM effectiveness (TLC, LIT, AUT).

Design contractual and relational mechanisms for governing external partners

IT programs are typically very dependent on expertise from third parties. This, in turn, calls for an informed selection of external partners and for carefully designing the mechanisms that govern co-operation. These include modes of co-operation, reporting procedures and co-operative learning mechanisms. Contracts as governance mechanisms should define the contribution of the external actors as precisely as possible to clarify expectations. Beyond specifying every partner's individual contribution to the program, it is also advisable to include shared incentives for the achievement of the overall program success.

Managing external partners was a major challenge in all programs we studied. In the LIT and TLC cases, the PgM executives had even been completely unprepared for dealing with this challenge. They had neither much experience in selecting and contracting external suppliers nor in supervising procurement processes. To counter these deficits, an external consultancy trained them in conducting tender exercises effectively and supported them in contracting suppliers and partners as well as in supervising contract fulfillment and co-operation.

4.3 Program execution

The execution stage is concerned with supervising the implementation of the program. During this stage, the project managers run the individual projects involved, and PgM takes responsibility for monitoring progress, assuring and promoting benefits delivery, assessing risks, representing the program to stakeholders, and aligning it with the target business environment. The execution of a successful program ends with the delivery of the targeted infrastructure and the achievement of the intended (strategic) business benefits.

Deal with scope changes actively and explicitly

Programs always have to adapt to changing demands and conditions. This is even more the case in IT programs since these have to deal with ongoing technological changes and with changing business needs in parallel. However, scope changes might affect program delivery, so that it is critical to document them and have effects on program duration and cost approved.

The cases TLC, SUP, and AUT all had to deal with significant scope changes. The programs started with a business demand that was only defined in broad strokes and hence needed refinement later. The requirements formulated by business representatives during program execution were rather ad-hoc, turned out to be unreliable, and changed over time. In response, measures and standards for defining and approving requirements had to be introduced during execution. These included the installation of a dedicated authority for verifying and approving business requirements as well as the introduction of formal "end-to-end" processes (TLC, SUP) covering all steps from requirements formulation through verification and agreement to fulfillment.

Co-ordinate program activities across work streams

A specific challenge in IT programs is to manage the complex interrelationships between technical projects (e. g. building up a computer network, installing servers, developing software) and more business-oriented projects and organizational change measures. In the cases SUP, TLC, and LIT, the different projects were organized in specialized "work streams", e.g. for building the technical infrastructure, for developing software applications, for changing organizational practices and for dealing with legal and compliance issues. Defining such work streams allows for bundling specific (technical, organizational or legal) competencies. This advantage, however, can be offset by silo thinking within the work streams and by the tendency to act independently of each other. In the LIT case, PgM introduced dedicated mechanisms for coordinating projects and activities across different work streams including regular meetings for work stream leads.

Monitor project delivery closely and approve deliverables formally

Strong leadership requires the conclusion of agreements on what is to be achieved by the projects involved in a program and making clear what good project performance looks like. This in turn calls for tightly monitoring the performance of internal project managers as well as external service providers and suppliers. The project managers in the TLC and AUT programs tended to keep project problems under wraps, which resulted in major delays. TLC also struggled heavily with outsourced projects. These remained black boxes to TLC, so that technical shortcomings did not become visible until completion. Monitoring external partners turned out to be even more challenging, since these tended to narrowly focus on their projects without having a strong interest in the infrastructure solution and the program's success in general. Hence, it was difficult to solve technical deficiencies and incompatibilities due to mutual recriminations between the providers.

From these experiences, we conclude the need to define project deliverables clearly, and evaluate delivery regularly and diligently. This can be done, for example, by having deliverables pass quality gates before approval (LIT, AUT). Given that PgM lacks the technical competencies to do so, it is also possible to assign mandates for the evaluation of key deliverables to external experts as it happened in the cases TLC and LIT.

Keep program on speed

As long-term endeavors, strain and fatigue imperil IT programs. Hence, in the absence of incentives and performance regimes, there is the danger that those charged with program tasks lose their motivation, neglect their duties, or even resign their program roles. A tangible vision can help in keeping a sense of purpose, but we found that continuous monitoring combined with strong performance incentives is required to keep a program on speed on the long run. Incentives may include career opportunities for internal project managers (SUP) as well as success bonuses for external providers (TLC, TEC, AUT). These bonuses, however, should not only narrowly relate to project deliverables but also to their larger contribution to overall program success.

Be aware of and explicitly address cultural differences

A major challenge across all programs we studied was to deal with different organizational cultures. The most fundamental barriers we identified related to the communication between IT representatives and business representatives. These became especially apparent in the requirements definition processes that were characterized by vagueness and misunderstanding (TLC, SUP, AUT). We observed particular problems in the TLC, LIT and SUP programs, which organized IT-related activities into separate work streams.

On top of communication barriers between IT and business, four of the IT programs we studied involved organizations or sites in different countries (TLC, TEC, SUP, AUT). However, PgM did not pay sufficient attention to national differences and cultural peculiarities in the initiation and set-up stage, so that additional adaptation effort was required during program execution. Outsourcing and offshoring of IT brought additional diversity to the spectrum of national and organizational cultures in a program. In the TLC case, for example, the Chinese provider had a service mentality that lead him accept any requirement from TLC without questioning it. The provider also accepted requirements that he did not understand or was even able to fulfill at all.

Promulgate program progress and report benefits on a regular basis

The success of an IT program does not only depend on the successful development of an IT-based infrastructure alone, but equally on the business organization and whether it accepts and welcomes the change brought about by the program or not. In the programs we studied, however, the business often lost interest in the program over time due to its long duration and the time lag until benefits showed up. In the face of problems and delays as well as high costs incurred in the programs, a sense of achievement even gave way to a perception of non-performance. This happened in the TLC and TEC case that failed to keep close contact to the business organization as well as in the SUP case that dealt with stakeholders on an ad-hoc basis only. As a result, the business organizations did not feel a sense of ownership and were largely unprepared to take over the program results later on. In the LIT program, we observed fewer problems in this respect due to a more regular communication with stakeholders and the business organization.

5. Summary

In our research, we set out to provide a fresh and unbiased look at the challenges that managers of IT programs face. Our multiple case study allowed us to uncover a set of common management issues and provided us with some insight into measures that can help address them effectively. We presented our findings in an actionable way following the stages of the PgM life cycle. Table 4 summarizes our findings in tabular form.

Table 4. Recommendations for Managing IT Programs

Recommendation	***Explanation and justification***
Identification phase	
Formulate and promote a compelling vision for the program	The program vision should provide a clear picture of what the program is to achieve and why. If such a vision is missing, programs are in danger of weak support, dissipating efforts, and of experiencing fatigue over time.

Recommendation	***Explanation and justification***
Identification phase	
Analyze and clarify the scope of the program in terms of reach and range	IT programs bring technology-driven organizational change to the business. Hence, it is essential to clarify in advance the business functions, units, and sites affected (scope) as well as the extent of organizational change and transformation expected (scale).
Define the business benefits to achieve and relate them to stakeholder interests	IT programs provide an IT-based infrastructure to support and connect large parts of the business, hence affecting multiple stakeholder groups. In order to avoid resistance and prepare the different groups for the change, it is vital that these groups see (their) benefits in the program. A benefits plan can be instrumental in achieving this.
Ensure support by senior executives and key stakeholders	Showing program benefits to stakeholders is important for receiving their support. However, stakeholder interests are not always homogenous so that conflicts may arise which cannot be mutually resolved. Strong top management backing and support is important for resolving and conflicts and overcoming resistance to change.
Identify technological gaps and check for market availability of the requisite technologies and expertise	The realization of IT programs requires particular technologies and competencies, which are seldom (fully) available in-house. Accordingly, before selecting technology vendors, IT service providers, or IT consultants for a program, organizations should diligently evaluate their ability to bring in the required know-how to the program.
Assess internal program management competencies, provide support and training	Executing PgM positions requires dedicated skills and experiences that are not necessarily available in the standard line organization. More specifically, they reach beyond technology and the expertise of many IT professionals. Hence, training and support are essential to prepare and enable internal managers for taking over PgM roles.
Set-Up phase	
Substantiate the program vision with an infrastructure blueprint	At the heart of any program vision is the IT-based infrastructure to be developed. Documenting this infrastructure in a "blueprint" or "target architectures" helps to make the intended outcome more tangible. Architecture blueprints also help in identifying and demarcating major building blocks and documenting interrelations between them.
Devise project plans in an integrated manner	The building blocks depicted in an architecture blueprint are also a good starting point for project and program planning. They help in identifying and defining the projects necessary to implement the major deliverables, in relating them to each other, and orchestrating them towards the development of the overall infrastructure.
Organize the program in detail and involve internal actors in key roles	A detailed program organization involves defining PgM roles with clearly assigned tasks and responsibilities. Without such role definitions, it is virtually impossible to fill them appropriately with internal staff. Delegating critical roles to external experts is not a viable option, even in cases where internal PgM competencies are limited.
Establish program-wide management standards	Clear role definitions are the foundation of any good program organization. In addition, PgM should lay down common planning and reporting procedures as well as standards for quality and risk management. Such standards later on facilitate the supervision of the program and the coordination of the projects involved.
Design contracts and relational mechanisms for governing external partners	Selecting external technology vendors, IT service providers, and IT consultants is one thing, building an effective partnership with them another. While it is important to design contracts diligently and to verify contract fulfillment, common incentives and additional relational mechanisms can further the reliability and quality of contributions from external partners.
Execution phase	
Manage scope changes actively	IT programs have to deal with ongoing changes in business demand as well as with technological changes and unexpectedly occurring technical problems. Such events can easily affect program delivery. Hence, it is important to formally document them and have their effects on the program duration and costs approved by sponsors and stakeholders affected.

Recommendation	*Explanation and justification*
Identification phase	
Co-ordinate program activities across work streams	To reduce complexity, IT program activities are often organized in work streams, which follow different perspectives on the change to be brought about. Examples are technical development, organizational change, staff training, or legal matters. The activities in different work streams are, however, factually interdependent and in need of close coordination.
Bridge cultural differences	Given their wide organizational reach, IT programs typically affect diverse organizational units, sites, and countries. Particularities of IT professional ethics and a multitude of external partners exacerbate cultural diversity. Hence, PgM should involve high cultural awareness. In addition, many programs necessitate mechanisms for avoiding and overcoming departmental thinking.
Monitor delivery closely	A central challenge in IT program lies in the integration and orchestration of a multitude of partial contributions from internal projects and external providers into a coherent whole. Close monitoring and diligent quality control are essential for seamlessly integrating diverse deliverables and synchronizing their provision across the program.
Keep program on speed	A compelling program vision is a good starting point for creating an initial program motivation. However, in the absence of strong incentives and continuing motivation efforts, programs as long-term endeavors inevitably suffer from strain and fatigue over time. Incentives may include financial ones as well as career opportunities for project managers and program staff.
Promulgate progress	Given the high costs incurred in IT programs and the time lag for benefits to show up, it is not surprising when a sense of achievement gets lost over time. In face of problems and delays, programs are easily perceived as non-performing. Accordingly, it is essential to highlight and communicate achievements actively to both, internal staff as well as sponsors and stakeholders.

The recommendations we give are still tentative and do not assume completeness. We clearly see empirical limitations. First, our focus on IT programs that ran into difficulties is specific. We could have equally studied IT program success stories, if we had access to comparable data. Second, we cannot exclude that our indirect access to the field via a management consultancy has biased our findings in some respect. Third, there is still some residual heterogeneity in the program settings, though we had selected our sample diligently with respect to the "replication logic" we applied in our analysis. Irrespective of these limitations, we found some support for the validity of our findings. A first set of five expert interviews affirmed our belief of having been able to identify important challenges that are at least of more than singular relevance to IT program managers.

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Appendix. Interview Guideline

We conducted narrative interviews with the help of the semi-structured guideline displayed below. As concerns the assessment of management issues in the programs (fourth topic area in our interview guideline) we structured our interview along the auditing dimensions applied by the consultancy to assess programs and to improve program management practice. These dimensions are “Leadership and Vision”, “Organization and Governance”, “Planning and Scope”, “Financial Management”, “Stakeholder and Dependency Management”, “Change Management”, “Human Resource Management”, “Quality Management”, and “Risk Management”. We stuck to these dimensions for the purpose of data collection and interview transliteration (for the case vignettes see [50]). However, to be clear, we did not use this structure for our analysis. The reason for structuring the interviews this way was that the auditing dimensions reflected the consulting practice of our interviewees and thus facilitated the interviews.

Topic Area	Content
Initiation of the interview	▪ Introduction of interviewer and interviewee ▪ Explanation of the research (context, goals, approach) ▪ Expectations, goals, and structure of the interview
Interview partner and her/his experience	▪ Department and position in the company ▪ Experience in the area of PgM, in particular related to managing IT programs
Information about the program and the consulting mandate	▪ Duration of the program, team size and structure, role of the interviewee within the consulting mandate ▪ Customer organization (industry, employees, revenue) and its business situation (market situation, strategy, business challenges) ▪ Program description (duration, goals, structure, measures, technologies) ▪ Focused mission statement: What were the core problems to be addressed by the program and/or the (strategic) business goals to be achieved? ▪ Approach taken to resolve the customer’s problem (methods, approach)
Issues and challenges in managing the program	For each of the nine audit dimensions … ▪ What does good management look like in the light of this dimension? How important is good management in this dimension for achieving program success? ▪ Which of the management issues and challenges did you experience as most pressing with regard to this dimension? Give examples!

Topic Area	Content
Measures recommended, endorsed, or implemented to improve the program situation	▪ Measures and actions to address the challenge(s) in the program implemented or considered for implementation ▪ Success of the measure in the eyes of the customer (approved? applied? effective?) ▪ Interviewee's ex post evaluation of the measures or actions ▪ Are there important challenges and difficulties in managing programs that are beyond the scope or the dimensions we just discussed?
Measures recommended, endorsed, or implemented to improve the program situation	▪ Measures and actions to address the challenge(s) in the program implemented or considered for implementation ▪ Success of the measure in the eyes of the customer (approved? applied? effective?) ▪ Interviewee's ex post evaluation of the measures or actions
Open ending	▪ Are there further important challenges and difficulties in managing programs that have not been touched upon so far? (beyond the scope of the dimensions)

Biographical notes

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R. Alexander Teubner is Akademischer Oberrat (Senior Lecturer/Associate Professor) at the Department for Information Systems, University of Muenster in Germany with a teaching focus on Information Management. He also teaches graduate and executive courses in Information Management. Dr. Teubner heads the Research Group on Strategic Information Management of the European Research Center for Information Systems (ERCIS). A large part of his research is on the concept and contents of IT/IS strategies, IT/IS strategy development as well as in strategy implementation with respect to managing IT/IS investment, portfolios, and programs. Further research is concerned with the future of the IT/IS function in the digital age with an emphasis on sourcing, organizational design, and governance. Dr. Teubner's research has been published in renowned academic journals as well as in applied journals, textbook chapters, and monographs.

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