



A framework for paradoxical tensions of project management

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Viewpoint

Abstract:

Research into organizations has concluded that organizational effectiveness is paradoxical, i.e., effective organizations have attributes that are simultaneously contradictory, even mutually exclusive. Although projects are temporary organizations, the paradox lens has largely been omitted in their context. This paper is an attempt to rectify the situation. It introduces a framework of eleven paradoxical tensions, concerning priority, structure, and execution of projects, wishing that it would encourage future research on paradoxical tensions of project management.

Keywords:

project management; paradox lens; ambidexterity.

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1. Introduction

The paradox lens has aroused considerable interest in organization studies [1]-[6]. Cameron [1] argues that organizational effectiveness is inherently paradoxical: "To be effective, an organization must possess attributes that are simultaneously contradictory, even mutually exclusive" (p. 544-545). Recognizing that projects are temporary organizations [7], [8], one could expect that the paradox lens would be of interest in their context, too.

Despite its potential relevance to project management (PM), the paradox lens has received very little attention in PM research. A literature analysis of paradoxical tensions in PM research (Section 2.3) indicates that the paradox lens has received scant attention therein and has primarily been applied as a research instrument – as theory or meta-theory – for analyzing and making sense of project management: each paper proposes a set of tensions unique to the study.

The purpose of this paper is to provide a framework of more typical paradoxical tensions in the context of (individual) projects. The focus lies in sets ($n > 1$) of co-existing paradoxical tensions rather than in a single tension. The proposed framework originates from the information systems (IS) development and the agile software development (ASD) context - as explained in the accompanying paper [9]. Therefore, the framework is most relevant in the case of design-oriented projects. The term "design-oriented" suggests that interest does not only lie in pure design projects such as media projects [10] or architectural design projects (e.g., [11], [12]), but covers projects in which design – both as the verb and noun – is an essential or core activity and output. Design as an output is abstract and typically is expected to exhibit some innovativeness.

This paper aims at answering the following research question: *What are typical and persistent paradoxical tensions encountered, especially in design-oriented projects?* The idea is that tensions are concrete enough so that project managers can recognize them and persistent so that they are faced constantly [2]. The proposed tensions individually are not necessarily new. Some of them - if not most - have individually been identified in the PM literature. The contribution of this paper lies in the framework and in the whole set of paradoxical tensions.

This paper makes both theoretical and practical contributions. The concrete paradoxical tensions provide new insight into the complexity and difficulty of project management. Even though not claimed to be exhaustive, they also provide avenues for future research.

More generally, the paper is in line with recent proposals to redirect research on project management [13]-[15]. The paradox lens as a theoretical framework illustrates the complexity and ambiguity of project management; the concrete paradoxical tensions of the structure reflect the social nature of projects (in terms of power, communication, rewarding, and participants); the tensions imply a broader conceptualization of projects (multi-disciplinarity, with multiple purposes, contestable, negotiable throughout), and the resolution of the tensions trusts on reflection rather than following the detailed procedures prescribed by PM methods and tools. Compared with [13], the only clear exception is the focus of on "product creation" rather than on "value creation". It will be justified in Section 3.

The next section introduces the "paradox lens" as the theoretical background of this paper and the framework of eleven paradoxical tensions. The following three sections explain the tensions in detail and justify their relevance in the PM context. Section 6 discusses research implications and practical implications of the framework and limitations of the paper. It outlines how future PM research could and should be conducted when focusing on typical paradoxical tensions of project management.

2. Theoretical background and prior research

Drawing on the literature on organizational paradoxes [1]-[3], Section 2.1 introduces the concept of "paradox", "paradoxical tension", and related concepts. After this introduction, Section 2.3 outlines the framework of eleven paradoxical tensions and Section 2.3. summarizes prior research on paradoxical tensions of project management.

2.1 Paradoxical tensions

Modern organizations face increasing complexity due to the higher volatility, uncertainty, and ambiguity of their business environment, pulling organizations in multiple, competing directions [16]. This has stimulated scholars to view them through the paradox lens to understand such competing tensions [2]. Cameron [1] interprets a paradox as “an idea involving two opposing thoughts or propositions which, however contradictory, are equally necessary to convey a more imposing, illuminating, life-related or provocative insight into truth than either factor can muster in its own right”.

Paradoxes are closely related to terms such as dilemmas, dualities, dialectics, contradictions, tensions, and ambidexterity. Cameron [1] notes that the idea of 'paradox' differs in nature from that of 'dilemma', which is often used as a synonym. Smith and Lewis [2] distinguish paradoxes, dilemmas, and dialectics. They suggest that a “paradox” denotes “Contradictory yet interrelated elements (dualities) that exist simultaneously and persist over time; such elements seem logical when considered in isolation, but irrational, inconsistent, and absurd when juxtaposed” (p. 387). A “dilemma” on the other hand comprises “competing choices, each with advantages and disadvantages”, and “dialectics” refers to “contradictory elements (thesis and antithesis) resolved through integration (synthesis), which, over time, will confront new opposition”.

The ambidexterity perspective [17]-[19] is closely related to the paradox perspective. The literature on ambidexterity, however, typically focuses on a single tension between exploitation and exploration [20] or alternatively alignment and adaptability, “ambidexterity” referring to the ability to both exploit and explore.

This paper does not consider terminological choices essential here. However, since the literature on the paradox perspective applies quite a stringent interpretation of “paradox”, I prefer to speak about “paradoxical tensions” rather than “paradoxes”. The tensions to be introduced in this paper are not necessarily counter-intuitive, absurd, and intrinsically unreasonable enough to be considered genuine “paradox”. Contrary to Fairhurst et al. [3], this paper also includes tradeoffs among paradoxical tension. However, the paradox lens implies that dilemmas and tradeoffs are not treated as either-or-choices, but the competing demands of the tension must be addressed simultaneously (both-and) [2].

2.2 The conceptual framework for paradoxical tensions of systems development

A literature analysis to be introduced in Section 2.3 indicated that PM research had paid scant attention to paradoxical tensions of project management. I was able to identify only fourteen relevant papers, each of them proposing its own set of tensions. The aim of this paper is to introduce a framework of more general and typical paradoxical tensions originating from the IS development context [9].

Due to its origin, the framework is most relevant in the case of design-oriented projects, in which design (as a verb) is an essential part of the process and outcome (design as a noun). Design projects in many respects resemble “soft projects” [21]. The design output is abstract by nature, the goals are often ambiguous, there are many alternatives to be considered, the development of alternatives typically requires close participation of a number of stakeholders with different interests and expertise, there is a constant negotiation between stakeholders, and the quality of alternatives is to a large extent a subjective issue. As a consequence, design-oriented projects are characterized by intellectual complexity, ambiguity, equivocality, and learning.

One can distinguish three groups of paradoxical tensions in the project context: those concerning project goals and performance (priority tensions), those concerning project organization or structure (structural tensions), and those concerning the project execution process (execution tensions). Figure 1 depicts the framework.

Priority tensions deal with the importance and attention imposed on alternative or complementary goals of the project. Those identified in Figure 1 form an extension of the traditional project goals or performance dimensions (cost, time, quality) [22], [23]. These extensions will be explained in detail in Section 3.4. The first and third priority tensions are from Hage [24], who suggests them as fundamental problems of organizational effectiveness. The tension between development time and development effort is well-known in software engineering (SE) [25].

The four structural tensions reflect the classical structural characteristics of organizations: centralization of power, formalization of work, stratification of rewards, and organizational complexity [24], respectively. These concepts are introduced at the beginning of Section 4.

The four tensions of execution are inspired by Boehm and Turner's [26] contrast between disciplined and agility in the SE context.

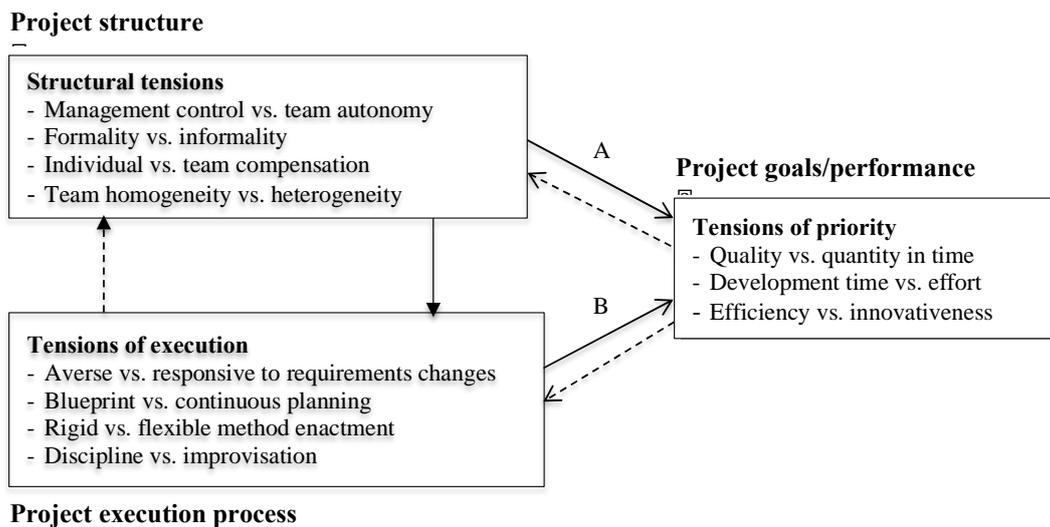


Fig. 1. The conceptual framework of paradoxical tensions in ASD (adapted from [9])

Figure 1 suggests that the project goals/performance, structure, and execution form a mutually interacting system. The solid arrows depict the “real process” of how the project structure affects the execution process, and both of them affect the project performance. The dotted arrows describe the reverse “feedforward and feedback processes” of how the project goals – and later project performance and related discrepancies - guide the project structure and the project execution. In a similar way, the experience from the execution process may lead to deliberate structural changes.

Each of the eleven tensions will be individually argued and explained in detail in Sections 3-5. Arrows A and B will be discussed in Section 6.

2.3 Prior research on paradoxical tensions in project management – literature analyses

The topic of this paper is related to a massive body of literature. I conducted three separate literature analyses of prior research on paradoxical tensions in project management:

1. Analysis of to what extent the paradox lens has been implicitly or explicitly applied in the PM literature.
2. Analysis of to what extent each of the eleven paradoxical tension of Figure 1 has been addressed in the PM literature.
3. Analysis of to what extent the PM literature has empirically investigated the impact of tensions of structure and tensions of execution on project performance (arrows A and B in Figure 1).

The first and third analyses were “semi-systematic” processes with the objective to gain a reasonably convincing understanding of PM research in question. The focus of the first analysis was in sets ($n > 1$) of tensions as indicators of implicit or explicit application of the paradox lens, whereas the third analysis focused on individual paradoxical tensions.

To find out to what extent the paradox lens has been applied in the PM literature, I conducted Google Scholar searches in September 2020. The aim was to conduct a comprehensive search so that it covers various scientific conferences, too. Therefore, I preferred Google Scholar to Scopus and Web of Science. Referring to the terminological confusion discussed above, I used the search formula “paradoxes/tensions/dilemmas/ contradictions/ ambidexterity in/of project”. Since I was interested in the application of the paradox lens (or similar) rather than in individual “paradoxes/tensions/dilemmas/contradictions, I used the plural of the keywords. The analysis process and its results are described in Appendix A.

The first analysis indicates that PM research in question has been very limited and fragmented. I was able to identify only fourteen relevant papers, each of them proposing its unique set of paradoxical tensions.

To find out to what extent the PM literature has empirically investigated the impact of tensions of structure and tensions of execution on project performance, I decided to limit the search to mainstream PM research as represented by *International Journal of Project Management* and *Project Management Journal*. Furthermore, because of the “causality” implied in the question, I focused on explanatory/predictive quantitative studies rather than on qualitative ones. I did a number of searches using the opposite ends of each tension with their “indicators” as keywords, including alternative project performance dimensions in search terms. In order to identify explanatory/predictive quantitative studies, I used typical statistical concepts as additional search terms. The analysis process and its results are described in Appendix B.

The results of this third analysis identified thirteen relevant papers. From the viewpoint of research into paradoxical tensions, all of them had limitations. Ten of the thirteen papers included only one dimension of project performance as the dependent variable, eliminating in that way the chance to investigate possible paradoxical demands imposed by different project priorities. Furthermore, only three of the thirteen papers included as independent variables constructs that can be interpreted as opposite ends of paradoxical tension. None of the papers included the opposite ends of a paradoxical tension as separate constructs and, at the same time, comprising more than one dimension of project performance.

The second literature analysis just attempted to identify prior research relevant to each tension and to refer to it according to the normal academic practice. This analysis mainly focused on the mainstream PM literature but was not strictly confined to it. It also attempted to make use of existing systematic literature reviews as much as possible.

3. Paradoxical tensions of priority

This and the following two sections introduce the eleven paradoxical tensions in more detail and attempt to argue for their relevance in the PM context by identifying justificatory arguments in the PM literature.

3.1 Introduction

There is a massive body of literature on the success criteria of projects [27], [28]. Project success is traditionally evaluated in terms of the “iron or golden triangle”: time (schedule), cost (budget), and quality [22], [23] with trade-offs between them [29]-[31]. Atkinson [22] proposes that the golden triangle should be extended to capture organizational benefits and benefits to the stakeholders. Winter et al. [13] echo his view, proposing a change from product creation to value creation as a primary focus of project management thinking. At the same time, they point out that the value creation often takes place a long time after the project, as a temporary organization, is closed.

To clarify the issue, it has been suggested that one should distinguish “project management success” and “project success” [32], [33] or “project efficiency” and “project success” [34]. Adapting these suggestions, this paper distinguishes “project performance” and “project success”. Terminologically, “project performance” is preferred in this paper, since “project management success” gives an impression that the success in question is just a management issue and because “efficiency” in this paper is used in a more specific meaning than in [34]. “Project performance” assesses how well the project was carried out using criteria that can be evaluated during the project execution or shortly after it. “Project success”, on the contrary, refers to the totality of positive and negative effects (benefits and side effects) of

project outcome, which often accrues over time after the project closing and can just be predicted and *a priori* evaluated during the project execution.

The focus of the tensions of priority lies in “project performance” rather than in “project success”. In the view of Zwikael et al. [35]-[37], it is the project governance (the project owner) rather than project management who is accountable for “benefits realization” or project effectiveness more broadly (including also negative side effects). When considering the tensions of priority, one should note, however, that project governance and project management are highly interdependent. When the project objectives, including project scope, are renegotiable throughout the project [13], there is an obvious need for interaction between the project owner, project manager, and other stakeholders to agree on objectives and expected benefits.

3.2 *The tension between quality and quantity in time (speed)*

Quantity refers to the amount of project output (artifact) completed. Quality refers to the degree to which extent the project output satisfies customers’ needs. As a consequence, one can distinguish two aspects of the quality of product output: quality of customer requirements and quality of (technical) implementation.

The tension between quantity and quality is age-old. Referring to Woodworth (Woodworth, R.S., The accuracy of voluntary movement, *Psychological Review*, 3, 1899), Beersma et al. [38]) write that “complex tasks require some degree of both speed [\approx quantity in time] and accuracy [\approx quality], but there are trade-offs that make meeting both of these task requirements at the same time difficult” (p. 574), and these trade-offs are ubiquitous. Hage [24] sees the dilemma between quality and quantity per unit of time (i.e., average speed, shortly “speed”) as one of the fundamental problems of organizational effectiveness. This tension is prevalent, especially in labor-intensive work such as the first-line service work [39] and scholarly research [40].

Although speed and quality are frequently mentioned as project performance dimensions in the PM literature, it is difficult to find papers that see any tension between them. The IS and SE literature provides some examples, however. It has become an issue in the context of ASD projects when the central priority has been to increase the speed [41], [42] and in particular in the case of startup companies [43], [44]. Note also that the tradeoff between quantity of time (speed) and quality does not contradict with findings that ASD has improved both the speed of software development and the quality of the developed software when compared with the traditional waterfall model [9].

3.3 *The tension between development time and development effort*

In the context of traditional software development, it is generally accepted that, while the technology of software development is given, compressing the development time beyond some point will increase the development effort required [25]. Brooks’ [45] paradoxical law “Adding manpower to a late software project makes it later” (p. 25), on the other hand, implies that beyond some point, additional effort - if it requires additional people - cannot substitute the time but increases the development time required. However, the ASD community does not see the tension between development time and development cost problematic. The reason may be that the software development in ASD progresses in terms of time-boxed sprints rather than phases. Despite that, the choice of sprint length is not necessarily trivial [46]. Furthermore, if an ASD project is governed by the completion date and budget planned at the beginning of a project (as in [47], for example), it obviously encounters similar problems as traditional software projects: risks of schedule and budget overruns.

The PM literature implicitly or explicitly recognizes that there is a trade-off relationship between development time and development effort [48]-[50]. Shr and Chen [48] point out in the context of construction projects that shortening the time increases the construction cost due to multiple shifts and overtime work. Oyedele [50] recognize working long hours and excessive workload due to tight deadlines as constituents of project-induced stress and as a demotivator in design projects.

3.4 The tension between efficiency and innovativeness

Design-oriented projects are usually expected to exhibit some innovativeness, leading to the tension between efficiency and innovativeness. It is close to the tension between efficiency and flexibility extensively discussed in organization theory [51], the need for flexibility often being justified by the need to innovate. Also, the ambidexterity between exploration and exploitation reflects the tension between efficiency and innovativeness/flexibility [20].

As a consequence, there is a huge body of related literature in the case of traditional “permanent” organizations, but not so much in the case of temporary organizations such as projects [52]-[54]. Yet, the tension between efficiency and innovativeness/flexibility is recognized in the PM literature (e.g., [19], [52], [55]-[60]).

Much of the latter research draws on the ambidexterity perspective. There is, however, a fundamental difference between the tension between exploitation and exploration in the ambidexterity literature and the paradoxical tension between efficiency and innovativeness in this paper. Ambidexterity is an organizational capability or competency that affects the performance of an organization after a considerable time-lag [54]. Efficiency and innovativeness in this paper, on the contrary, are introduced as two project performance dimensions. Taking a short time frame, any resource slack – whether financial, time available, or excess personnel – is bad from the viewpoint of efficiency both in the case of permanent and temporary organizations. But this efficiency gain is achieved at the cost of innovativeness since slack resources tend to foster innovation both at the organization level and project level [61].

3.5 Summary

Figure 2 summarizes the above discussion as a “golden triangle” of paradoxical tensions of project performance. It extends the original triangle to comprise quantity, efficiency, and innovativeness and related three tensions. For completeness, it includes risk [42] and satisfaction [62] as additional criteria, the related arrows underlining that performance along the six dimensions affects the satisfaction with the project performance and that delay risk, cost overrun risk, quality risk [63] as well risks of low novelty and inefficient execution [64] affect project performance risk.

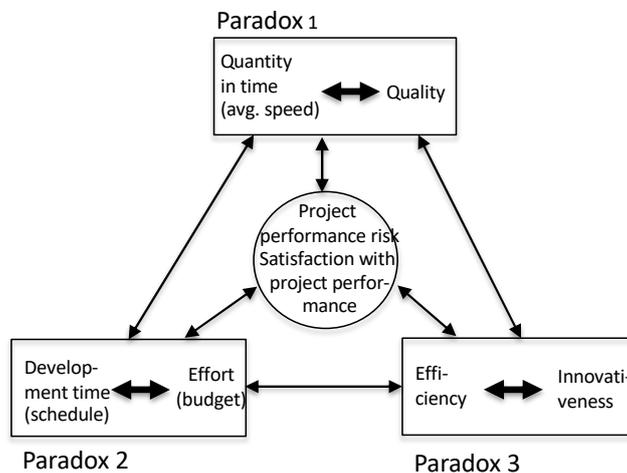


Fig. 2. The “golden triangle” of paradoxical tensions of project performance [9]

4. Paradoxical tensions of structure

4.1 Introduction

Organization studies have identified a number of dimensions to characterize organization structure. Hage [24] focuses on four of them: centralization of power, formalization of work, stratification of rewards, and organizational complexity. *Centralization* is the degree to which power and control are concentrated to relatively few, i.e., how decisions, especially strategic ones, are made only by the elite and how many by the entire personnel; *formalization* refers to the degree to what extent the work is codified into rules, procedures and regulations; *stratification* describes the concentration of rewards and other benefits of groups relative to other groups [24], [65]; and *organizational complexity* refers to the concentration and diversity of different specialists in an organization (determined by specialization, differentiation, and professionalism) [66]).

Reflecting these four structural dimensions, this paper identifies four paradoxical tensions: management control vs. team autonomy, formality vs. informality, individual vs. team-based rewarding, and homogeneity vs. heterogeneity of participants. Differing from the above four structural characteristics (centralization etc.), the tensions are not assumed to continuous dimensions, but opposite ends of each tension entail qualitatively different structural mechanisms to structure the project.

The opposite ends also tend to support different dimensions of project performance (especially efficiency contra innovativeness), accentuating their paradoxical nature. The literature in organization studies (e.g., [24], [67]) and on innovation diffusion [65] largely agrees that low centralization of power (team autonomy), low formalization of organizational work, and high organizational complexity (heterogeneity of members) support organizational innovativeness. Hage [24] also claims that low stratification of rewards (e.g., team-based rewarding) fosters innovation. At the same time, it is believed that more structure (such as higher centralization, formalization, and specialization) promotes efficiency not only under stable environmental conditions [68] but also under changing conditions [69].

4.2 Management control vs. team autonomy

The tension between management control and team autonomy has been extensively discussed at the team level. Magpili and Pazos [70] - in their literature review of factors that affect team performance and successful implementation of self-managing teams - identify as a major challenge how to balance team's autonomy while providing some basic guidance and structure, implying that both are needed. A self-managing team "is a group of individuals with diverse skills and knowledge with the collective autonomy and responsibility to plan, manage, and execute tasks interdependently to attain a common goal" (p. 4). Since Magpili and Pazos do not distinguish different dimensions of team performance, one cannot draw direct conclusions about the influence of the tension between management control and team autonomy on the priority tensions. However, they assess that self-managing teams work best when they execute tasks with high uncertainty, high interdependence, low routineness, high task and technological novelty, and high innovativeness. This is highly compatible with the characteristics of many design-oriented projects and underlines the significance of relative autonomy of self-managing teams for innovativeness.

Even though not explicitly recognizing the tension between managerial control and team autonomy, among *control modes* (e.g., [71]), output control, input control, and behavior control reflect "bureaucratic" managerial control [72], clan control emphasizes team autonomy and self-control reflecting individual autonomy [73]. Furthermore, control styles such as enabling control [71], empowerment [74], and shared leadership [75] increase autonomy within the project team.

Wiener et al. [71] reviewed 57 papers addressing IS project. According to their review of the effects of control modes on project performance, there is wide agreement that all the above control modes have significant positive effects on project performance in the case of internal IS projects, whereas, in the case of outsourced projects, the results are mixed. Studies are also inconclusive as to whether the control modes complement, substitute, or simultaneously do both. At the same time, they note that project performance is usually examined at an aggregate level or as a single performance

dimension and acknowledge that some studies provide initial evidence for partly inverse control effects on project efficiency, quality, and adaptiveness (p. 754).

There is also a considerable number of papers published in PM journals, which analyses control and leadership in projects ([75] for a review). The tension between managerial control and team autonomy has also been recognized therein [76]-[79], the general perception being that team autonomy is needed in projects which prioritize innovation since hierarchical control tends to stifle creativity. Appendix B summarizes empirical findings of explanatory/predictive quantitative PM research related to the relationship between managerial control/team autonomy and project performance.

4.3 Formality vs. informality

As noted above, formality – as the degree to what extent the work is codified into rules, procedures, and regulations – is widely used to characterize organizations. Automation of work – either automation of entire jobs or specific tasks – implies extreme formalization so that a job or task can be executed by computers. Standardization and formalization are also closely related [66] since standards normally must be documented into rules and regulations.

The tension between formality and informality is closely related to the tension between management control and team autonomy as exemplified by the common distinction between formal control and informal control, formal control covering output control, input control and behavior control, and informal control clan control and self-control (e.g., [71]). The focus of the latter tension is, however, in the distribution of power, whereas formality vs. informality describes the degree of formalization.

Formalization does not concern only control but also communication [80], is related, for example, with team spirit and trust [81], knowledge sharing [82], problem-solving [83], and project documentation [84]. Projects typically comprise a mixture of formal and informal communication, depending on the nature of the project (e.g., [85], [86]). Appendix B summarizes empirical findings of explanatory/predictive quantitative PM research related to the relationship between formality/informality and project performance.

4.4 Individual vs. team-based rewarding

This paper views the tension between individual and team-based rewarding at the level of team members in projects rather than at the level of project partners. Motivating team members is an important issue in all work-related teams, and rewards have a significant role in it [87]. Most of the papers on the topic view individual rewards and shared (team-based) rewards as either-or choices. Since both of them have shortcomings, Pearsall et al. [87] propose hybrid rewards, which are based on both individual performance and team performance. In their view, hybrid rewards are beneficial in the case of teams with high task interdependence, where both individual effort and high levels of collective interaction are required. Design work in design-oriented projects is typically highly interdependent.

Pearsall [87] also hypothesizes that teams with hybrid rewards outperform teams with individual rewards due to increased information allocation (meaning that team members can develop deep, discrete areas of expertise and gain access to each other's knowledge when needed) and that teams with hybrid rewards outperform teams with shared rewards due to reduced social loafing (or free-riding).

Although alternative reward mechanisms of team members are recognized in the PM literature [88]-[95], the said literature has paid relatively little attention to the tension between individual and team-based rewarding [96]. Appendix B summarizes empirical findings of explanatory/predictive quantitative PM research related to the relationship between individual/team-based rewarding and project performance.

4.5 Homogeneity vs. heterogeneity of participants

Homogeneity and heterogeneity are the opposite ends of the diversity dimension that has been widely investigated in the context of teams [97], [98]. This paper focuses on the task-related diversity rather than on the bio-demographic one since the former has been found to be a more significant predictor of team performance than the latter one [97].

Horwitz and Horwitz [97] found that task-related diversity has a significant positive relationship with the quality and quantity of team output. Focusing on team innovation in their meta-analysis, Hülshager et al. [98] found support for the positive relationship between job-relevant (task-related) diversity and innovation. They also raise the question, if job-relevant diversity is a predictor of innovation, is the relationship linear or curvilinear? Li et al. [99] partially answer this question. They found that the curvilinear relationship between functional background (job-relevant) diversity and team ambidexterity.

Team diversity has also received some attention in the PM literature [93], [100]-[103] (see Appendix B).

4.6 Summary

Just as the three tensions of priority, the four structural tensions are also internally interrelated (see Figure 3). Walton's [104] meta-analysis provides empirical evidence that the three constituents of organizational complexity (task specialization, vertical differentiation, horizontal differentiation), (de)centralization, standardization, and formalization are highly correlated. Ramesh et al. [53] imply that formalization may intervene in almost all four aspects of the structure.

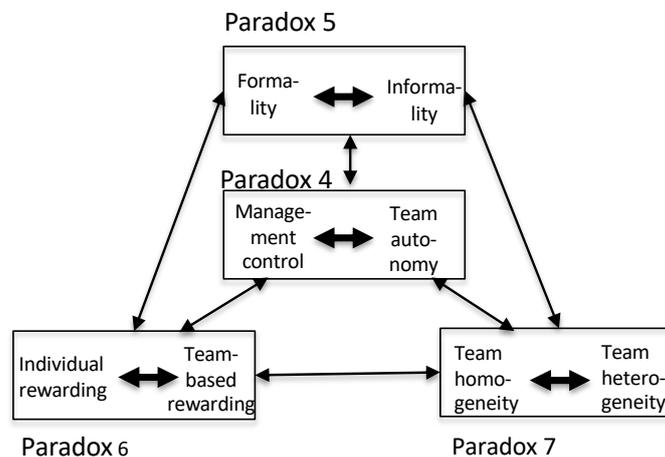


Fig. 3. Paradoxical tensions of structure [9]

5. Paradoxical tensions of execution

Ideas of agile software development (ASD) has received some attention in the PM literature [105]-[111], the ideas being generalized to project management in general under the label “agile project management” (APM) [105].

Boehm and Turner [112] make distinctions between disciplined and agile on the one hand and plan-driven and agile on the other hand to contrast ASD with more traditional systems development approaches. These widely cited distinctions comprise at least four dimensions: 1) Averse vs. responsive towards requirements change; 2) Blueprint planning vs. continuous planning; 3) Rigid vs. flexible method enactment; 4) Discipline vs. improvisation.

5.1 Averse vs. responsive towards requirements change

Requirements refer to the agreed-upon functionality to be provided by the project output (functional requirements) and related quality of the delivered functionality (non-functional requirements). According to Conboy [113], readiness to changes is a key characteristic of agility. Conforto et al. [108] suggest that agility “is the project team's ability to quickly change the project plan as a response to customer or stakeholders needs, market or technology demands in order to achieve better project and product performance in an innovative and dynamic project environment” (p. 667).

Such changes may concern the project scope, functional requirements, and non-functional quality requirements. They may narrow the scope and lower the requirements or widen the scope and raise additional or higher requirements. In the ASD context, the pressure to keep the deadlines may lead to narrowing the scope and making quality concessions [114], [115]. The iterative and incremental nature of ASD, on the other hand, may lead to scope or feature creep [116] due to the marginal analysis when the “value increase” of an additional feature seems to exceed its development cost.

Requirements prioritization in ASD is the gate that determines the extent to which the proposed requirements and related changes are responded to. It is not an objective process. Ramesh et al. [117] note that it may also be prone to conflicts in the case of several customers, and Heikkilä et al. [118] write that “gut-feeling, lobbying, politics, sell-in and strong individuals affect the requirements prioritization in practice” (p. 117). Rolland [119] describes some of his experiences of requirement engineering in large ASD projects caused by the sheer number of user stories (close to 2500 in one project). Some requirements may also be prioritized so low that they effectively are rejected. So, in real life, ASD/APM teams may be more or less ready and/or able to respond quickly to requirements changes.

5.2 *Blueprint vs. continuous planning*

The distinction between plan-driven and agile [112] gives a distorted view of the agile approach as if it were not driven by plans at all. Actually, it is also plan-driven but based on a “philosophy” of planning different from the waterfall model.

The tension between blueprint planning and continuous planning is adapted from Faludi [120]. He makes a distinction between the blueprint mode of planning, “the production of glossy plans and the unswerving execution of proposals they entail”, and the process mode of planning “whereby programs are adapted during their implementation as and when incoming information requires such changes” (pp. 131-132). The blueprint planning in the agile context is usually called “upfront planning” or “front-end planning”.

It is clear that the agile approach primarily follows the process mode of planning (called “continuous planning” in the following), but it is unclear to what extent it is or should be governed by blueprint planning. Serrador and Pinto [107] claim that the agile approach does not totally abandon upfront planning, although it attempts to minimize it. If an agile project is to be governed by an overall project budget and schedule, front-end planning is obviously needed to produce the required budget and schedule. Front-end planning is also recommended for designing the software architecture [121]. Since normally non-functional requirements such as security, maintainability, and usability concern the whole system and cannot be localized into any individual user story or its implementation, the agile team(s) should also have design standards and principles that guide the teams to take these qualities into account in a consistent way. This requires some upfront planning. Related to usability, the book of Cockton et al. [122] includes several articles that argue for front-end planning to make ASD more user-centered.

5.3 *Rigid vs. flexible method enactment*

It has been recognized in the PM literature that “one size does not fit all” in the case of PM methods [110], [123], [124]. As a consequence, PM methods are specialized for different application areas, or general methods are tailored to “fit” the type of project, its application area, characteristics of permanent organizations involved and their contexts, and other project characteristics such as its size and task interdependence [125], [126].

It is less widely recognized that the selected method for a project may be adapted during the project execution. When explaining the Agile Manifesto, Fowler and Higshmisth [127] emphasize that agile methods are not assumed to be followed slavishly. Howell et al. [124] and Lippe and vom Brocke [128] point out that the situational contingency factors may change during the project execution, and therefore there may be a good reason to change or adjust the selected project structure PM approach in use. The tension between rigid vs. flexible describes whether the selected PM method in use is adapted or not.

5.4 Discipline vs. improvisation

Boehm and Turner [26] state at the beginning of their book, “Discipline is the foundation for any successful endeavor” (p. 1). Later they introduce agility as a counterpart of discipline and contend that every successful endeavor in our changing world requires discipline and agility. I agree with them but prefer to consider improvisation rather than agility as a counterpart of discipline.

There has been some interest in improvisation in the PM literature [129]-[131]. Leybourne and Sadler-Smith [129] see improvisation as a combination of intuition, creativity, and bricolage. In the case of bricolage, the use of resources available when improvising mainly draws on tacit knowledge and experience [129], [131]. Therefore, it is difficult to be sure that improvisation is creative and novel in any sense. As a consequence, instead of “novelty” I see “spontaneity” as the key in improvisation.

In line with [26], the point is that all successful projects need both discipline and spontaneous improvisation. Whether traditional PM or agile methods, management control and formality, planning (both blueprint and continuous) as well as PM methods, including techniques, “practices” and tools, make the process more disciplined. On the other hand, no PM method is detailed enough to completely determine the project execution and/or to take all emerging situations into account. Therefore, there is by necessity some space and also a need for improvisation.

5.5 Summary

Figure 4 illustrates the four paradoxical tensions of project execution, emphasizing that they are interrelated and form a totality. It includes the tension between discipline vs. improvisation in the center, emphasizing that the way the other three tensions are addressed affects to what extent the execution is disciplined and to what extent in an improvised (spontaneous) way.

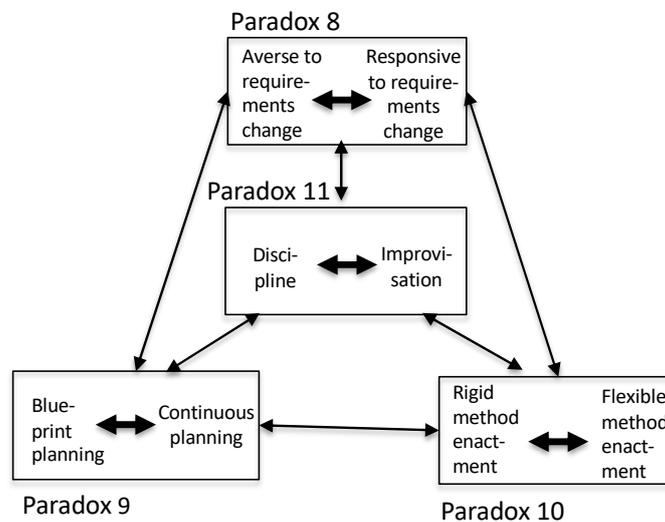


Fig. 4. Paradoxical tensions of execution (adapted from [9])

6. Discussion and final comments

As implied by Figure 1, the paradoxical tensions of priority, structure, and execution are interrelated. Figure 5 illustrates the resultant structure, including project success (value, effectiveness) for completeness.

This section discusses the significance of the framework for PM research and practice.

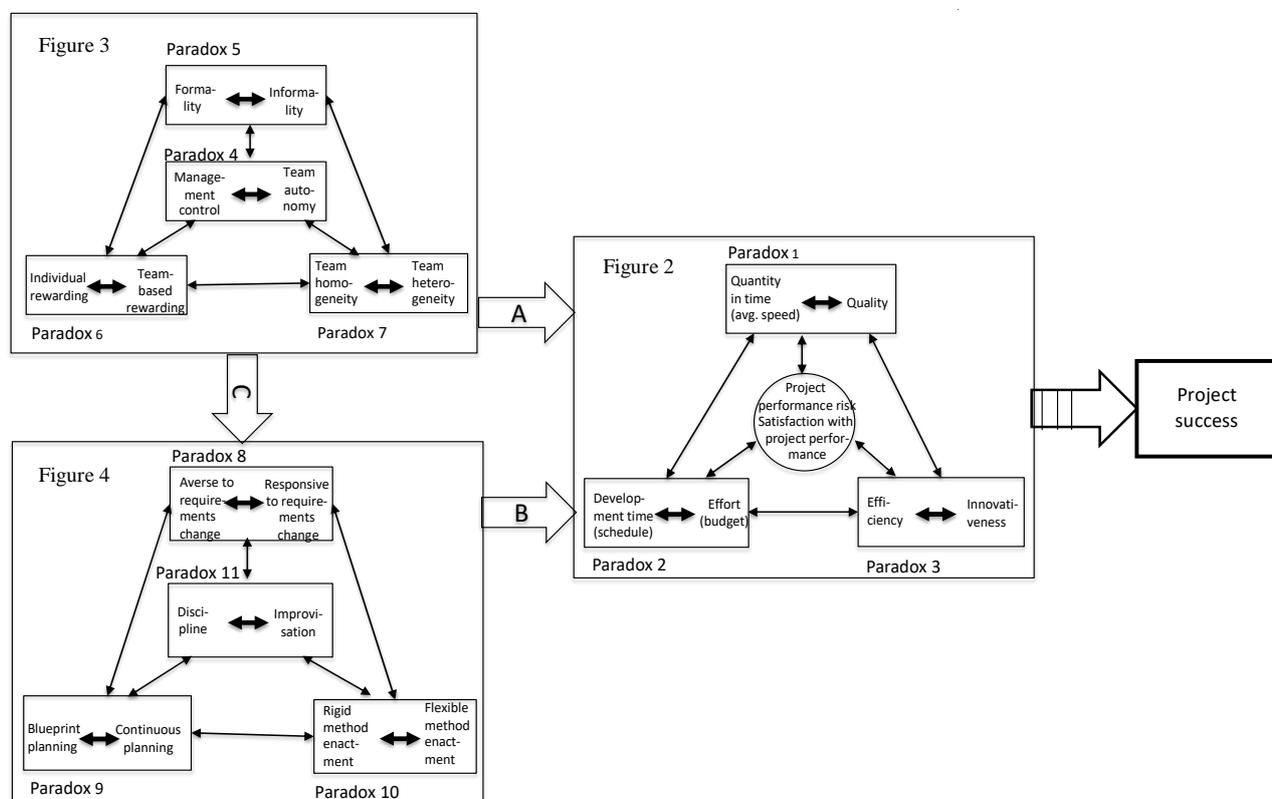


Fig. 5. Summary of the framework

6.1 Research implications

Empirical research informed by the paradox lens has mainly been qualitative, as evidenced by the introduction to the special issue of Organization Studies on paradoxes, tensions, and dualities of innovation and change [4]. Following this path, future qualitative PM research could attempt to validate the existence of the paradoxical tensions in projects, being open to additional ones. Researchers could focus on whether they are able to identify such tensions and whether practitioners participating in the investigated projects are able to recognize them, too.

As for explanatory/predictive quantitative PM research, future PM research could investigate whether the opposite ends of each tension tend to support different dimensions of performance (arrows A and B in Figure 5). To do it systematically explanatory/predictive PM research should:

- 1) include the opposite ends of each tension as separate constructs and
- 2) include a representative set of dimensions of project performance.

In order to find out the current status PM research related to arrows A and B, I conducted a literature review reported in detail in Appendix B. It identifies thirteen PM papers that are related to the arrows A and B.

None of the thirteen papers explicitly addresses any of the paradoxical tensions. Most of them (10) includes a single dependent variable (aggregated or one-dimensional construct of project performance). One of the papers, [129], has two project performance dimensions, and two studies, [93] and [103], include three dimensions.

Liu and Cross [93] distinguish team effectiveness (“as “the extent to which the project outputs achieved the performance expectations of key project stakeholders”), team efficiency (“the ability of the project team to meet its

budget and schedule goals (...) and utilize resources within constraints”) and innovation “the creative accomplishment of teams in generating new ideas, methods, approaches, inventions, or applications” (p. 1152). From the viewpoint of this paper, their most interesting finding is that team’s functional diversity had a significant negative effect on team efficiency but no significant effects on team effectiveness and innovation. The non-significant impact on innovation is quite surprising when compared with the dominant view (see section 4.4) and is against the hypothesis suggested by the authors.

Recker et al. [103] also include three dimensions of project performance – software functionality, process performance, and customer satisfaction – although their main analysis aggregates them into a single construct (IS development success). Their Appendix B reports, however, results when the three dimensions are kept separate. Recker et al. investigate how three ASD practices affect two aspects of responsiveness to requirements changes - “software team response extensiveness” (the extent to the software team actually incorporated various requirement changes) and “software team response efficiency” (i.e., the additional effort required by the software team to incorporate the requirements changes) and further on IS development project performance. They found that “software team response extensiveness” had significant positive effects on software functionality and on customer satisfaction but a negative effect on process performance. “Software team response efficiency”, on the other hand, had significant positive effects on each of the three dimensions of project performance. Interestingly but understandably, these results imply that being aversive to requirements changes is positive from the viewpoint of process performance and being responsive is beneficial from the viewpoint of software functionality and client satisfaction.

The interest of Leybourne and Sadler-Smith [129] lies in the role of intuition and improvisation in project management. They separate two dimensions of project performance: internal (schedule, cost, scope) and external (related to the customer). They did not find improvisation to affect significantly either dimension of project performance but did find faith in intuition to be positively related to the external project performance.

With a few exceptions, the papers do not distinguish the opposite ends of tensions as separate constructs. Liu and Wang [78], however, separate behavior control and outcome control, clan control, and self-control. In principle, behavior, control and outcome control reflect management control, clan control reflecting team autonomy, and self-control reflecting individual autonomy [73], but measurement instruments in [78] seem to confuse the situation.

Wu et al. [80], as another exception, illustrate a potential tension between formality and informality. They report that formal communication and informal communication have statistically significant but opposite effects on three types of conflicts (relational conflicts, process conflicts, task conflicts), which affect project performance. Since they measure project performance using a single construct, one cannot judge whether formality versus informality may have significantly different effects on dimensions of project performance.

Hsu et al. [102] distinguish shared leadership (associated with team autonomy) and vertical leadership (associated with managerial control) in addition to value diversity. Most interestingly, their study found that vertical leadership positively moderates the predominantly negative impact of value diversity on shared leadership and negatively moderates the positive effect of shared leadership on system quality.

It is remarkable that none of the studies include the opposite ends of a paradoxical tension as separate independent variables and, at the same time, comprise more than one dimension of project performance. As a consequence, there is a clear opportunity for future PM research in this respect. Even though projects differ and there are a number of contextual factors involved [125], [126], I believe that such a research programme could provide a cumulative body of knowledge about the paradoxical nature of project management.

6.2 Practical implications

It is also my hope that the eleven tensions provide new insight to PM practitioners - especially of design-oriented projects - but at the same time are concrete enough that they can recognize them in their daily practice. Readers interested in practical implications, please have a quick look at Figures 2-5.

More concretely, the eleven tensions provide a framework for retrospective evaluation of each "sprint" and for planning the next one: what went well in the previous sprint and what could be improved in the next sprint. In the case of each tension, the questions could be: "Is it in balance", "Do we need A more or B more?". For example, "Was quantity (or speed) and quality in balance?", "Do we need better quality or more quantity (or speed)?", when one considers a project in question, its purpose, and the situation at hand.

6.3 Limitations

The list of tensions is by no means assumed to be exhaustive but can be expanded with additional ones, e.g., exploitation vs. exploration, incremental vs. radical change, and others. It is obvious, however, that too many are too many. So, one should be able to identify the most "fundamental" tensions.

A second clear limitation of this paper is that it is solely based on my armchair reasoning, supported and inspired by a vast body of relevant literature.

6.4 Final comment

It is 25 years ago when I introduced the first ideas of this paper [132] without much impact. Since then, I have occasionally returned to the idea of the paradoxical nature of systems development projects [133], [134]. I am not totally sure whether the question has been about my 25-year obsession or about being at least 25 years ahead of my time. Anyway, this paper, together with the accompanying paper [9], will be my last attempts to promote these ideas. My hope still is that they encourage younger researchers to grasp the opportunity to investigate project management in terms of paradoxical tensions.

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Appendix A. To what extent the paradox lens has been applied in the PM literature?

To find out an answer to the above question, I conducted a Google Scholar search in September 2020. The aim was to conduct a comprehensive search so that it covers various scientific conferences, too. Therefore, I preferred Google Scholar to Scopus and Web of Science.

Referring to the terminological confusion discussed Section 2.1, I used the search formula "paradoxes/tensions/dilemmas/contradictions/ambidexterity in/of project". Since I was interested in the application of the paradox lens (or similar) rather than in individual paradoxes/tensions/dilemmas/contradictions, I used the plural of the keywords.

The initial search led to 481 hits. After that, I excluded all citation hits ("[CITATION]") and papers not in English. Publications not published on scientific forums were also excluded. If a paper used a keyword in a totally different meaning (e.g., "contradiction" to refer to inconsistencies of research results), or if it just referred to another paper with one of the keywords in the title of the reference, it was not included. I also excluded papers that discuss "ethical dilemmas", since they typically represent either-or choices rather than both-and ones. Also, papers that addressed tensions of project-based learning/education rather than of project management and tensions of research on project management were excluded.

Finally, I ended up with fourteen papers summarized in Table A.1. It indicates that the paradoxes lens has implicitly or explicitly been applied mainly as a research instrument - theory or meta-theory - for analyzing and making sense of project management, emphasizing uniqueness rather than typicality. They report quite diverse sets of paradoxical tensions. One reason is that they originated from quite different types of projects. The only commonality between the papers is that the last three of them applied the framework for organizational tensions - introduced by Smith and Lewis [2] - distinguishing paradoxes concerning belonging, learning, organizing, and performing.

Table A.1. Prior research on paradoxical tensions of managing projects

Paper	Source/focus	Paradoxes/dilemmas/tensions/contradictions
Lewis et al. 2002 [135]	Quantitative: Product development projects	Emergent vs. planned style of project management reflecting tensions between emergent vs. determined, divergent vs. convergent thinking, freedom vs. structure, and inside vs. outside. The two styles differ in the way they address monitoring, evaluation, and control. The planned style relies on monitoring milestones, evaluation by formal reviews, and directive control, whereas the emergent styles relies on monitoring understandings, evaluation by wider information gathering, and participative control.
Andriopoulos and Lewis 2009 [136]	Qualitative: Project-based organizations proving NPD consultancy	Strategic intent: Profit vs. breakthroughs (\approx efficiency vs. innovativeness) Customer orientation: Tight coupling vs. loose coupling Personal drivers: Discipline vs. passion
DeFillippi 2009 [10]	"Qualitative": Media projects	1. Individualization vs. collective belonging 2. Creative autonomy vs. corporate control 3. Creative exploration vs. commercial exploitation
Aubry and Lievre 2010 [137]	Qualitative: Two projects of polar expedition	Ambidexterity - tension between exploitation and exploration - tension between planning/rationalization and adaptation/learning
Brady and Maylor 2010 [138]	Mixed? A project designing, developing, and eventually manufacturing a new piece of military hardware	The improvement paradox: A project-based organization performing poorly and in need of improvement in its management of projects was not pursuing any improvement activities. The project form of organization is lauded as the one most likely to deliver innovative solutions whilst at the same time being resistant to changes in its own structures and processes The good behaviors and practices that had served the project so well in the construction phase seemed to be abandoned as it moved into operation
Leminen et al. 2015 [139]	Qualitative: Open innovation projects using the living lab approach	1. Living lab creates feasible results not initially targeted. 2. Monetary incentives decrease motivation. 3. Those with resource lack would profit most from living labs, but those with resource slack will reap the benefits. 4. Collision of user-centric and user-driven mindsets. 5. Heterogeneous customer needs require increasing the number of users. 6. Conflicts and collisions speed up innovation development. 7. New inexperienced users speed up the product development.
DeFillippi and Sydow 2016 [140]	Conceptual: Project networks	1. The distance paradox: Tensions between the temporary and permanent organization. 2. The learning paradox: Tensions between knowledge creation and transfer. 3. The identity paradox: Tensions between individual and collective identity. 4. The difference paradox: Tensions between crafting and standardizing practices. 5. The temporal paradox: Tensions between past, present, and future project work
Samset and Volden 2016 [141]	Qualitative: Large public investment projects	1. The success paradox: Success is measured in terms of tactical performance rather than strategic performance 2. The paradox of the significance of front-end management: Fewer resources are used upfront to identify the best conceptual solution (project governance) than to improve tactical performance during implementation (project management) 3. The paradox of early information overflow: Decisions are based on masses of detailed information upfront rather than carefully selected facts and judgmental information relevant to highlight the essential issues 4. The paradox of the opportunity space: The choice of conceptual solution is made without systematically scrutinizing the opportunity space upfront 5. The paradox of strategic alignment: Strategy and alignment of objectives are highlighted as essential concerns, but in most cases, the internal logic of causalities and the probabilities of realization are erroneous 6. The cost estimation paradox: The focus is on the final cost estimate (the budget), while early cost estimates are overlooked 7. The paradox of disregarded analyses of costs and benefits: Detailed estimation of cost and benefits is commonly done upfront but disregarded by decision-makers, who tend to emphasize other aspects 8. The paradox of "predict and provide": The tendency is to choose a "predict-and-provide" strategy rather than explore alternative solutions 9. The paradox of perverse incentives: Public investments with no financial obligations for the target group may cause perverse incentives and result in counterproductive projects 10. The paradox of myopic decisions: Long-term viability is the intention, but the planning

Paper	Source/focus	Paradoxes/dilemmas/tensions/contradictions
		horizon is too short, resulting in sub-optimal choices that one will regret later
Ahuja et al. 2017 [11]	Qualitative: Architects in complex, urban renewal projects	1. Tensions related to design control 2. Tensions related to professional autonomy => Identity paradox
Boonstra et al. [142]	Qualitative: A project developing an electronic health record system	Tensions related to technology: 1. Standardized vs. customized 2. Large scope vs. small scope Tensions related to work organization: 3. High impact vs. low impact 4. Integration vs. differentiation Tensions related to project process: 5. Top-down vs. bottom-up 6. Big bang vs. incremental 7. Differentiated vs. integrated
Manzoni and Caporarello 2017 [12]	Qualitative: Architectural design studio	Performing (goals) – creating a high-level symbolic project that is also profitable Belonging (identity) – projecting the lead architect’s views while incorporating the ideas of clients and other architects Organizing (processes) – making architecture musical, structured and emotional all at the same time Learning (knowledge) – balancing the interplay of innovation and tradition
Maylor and Turner 2017 [143]	Projects: Systematic literature analysis, workshops with managers related to projects	A tension between having to follow a process and a manager having the flexibility to respond in the best way they see fit at the time, whatever the process says. Too little time spent defining the work can lead to longer project duration, but too much time expenditure can lead to diminishing returns
Delisle 2019 [144]	Projects: Content analysis of two books on PM	Learning tension Past-Future Cyclic-Linear Beginnings-Ends Performing tension Short-Long Term Constraints Belonging tension Temporary- Permanent Unicity-Repetition Organizing tension Predictive-Adaptive Flexibility-Control
Labelle et al. 2019 [145]	A complex design project of a biorefinery	Belonging tensions Performance tensions Learning tensions Level tensions (systematic, organizational, individual) Change tensions (radical, incremental, urgency of the situation) Temporal tensions Spatial tensions

Appendix B. To what extent quantitative PM research has investigated the impact of tensions of structure and tensions of execution on project performance?

To find out an answer to the question above (see arrows A and B in Figures 1 and 5 in the main text), I conducted Google Scholar searches in November 2020. I limited the searches to explanatory/predictive quantitative studies because of the focus on the “causality” implied by the arrows A and B.

I did a number of searches using the opposite ends of each tension with their “indicators” as keywords (e.g., “output control”, “input control”, “behavior control” for “managerial control”; “empowerment” and “shared leadership” for “autonomy”), including alternative project performance dimensions (such as “project performance”, “project efficiency”, “project effectiveness”) in search terms. In order to identify explanatory/predictive quantitative studies, I used typical statistical terms (“correlation” and “regression”) as additional search terms.

The searches identified thirteen papers listed in Table B.1 with their findings related to the tensions. It should be noted that Table B.1 does not report all results of the reviewed papers, just those related to the paradoxical tensions identified in this paper.

As general observations, Table B.1 indicates that there are clearly more quantitative studies related to the paradoxical tensions of structure than on those of execution. A possible explanation may be that the latter tensions are related to ASD, even though they have much longer intellectual roots in IS and SE research [9]. As far as ASD and APM are considered, they are easily condensed into a single variable such as “agility-based project management approach” [110] without separating characterizing features of agility and their effect on project performance. Most studies (10 out of 13) include only one dependent variable (project performance dimension), one study ([129]) including two performance dimensions, and two studies ([93] and [103]) three dimensions.

Table B.1: Summary of results of the papers

Relationships	Type of projects	References
A: Structure -> Project performance		
<i>Management control vs. team autonomy:</i>		
Team autonomy ++> Teamwork effectiveness (moderated by team dispersion) Team autonomy o+> Quality of decision-making ++> Teamwork effectiveness (moderated by team dispersion)	Miscellaneous	Bourgault et al. 2008 [146]
Behavior control (≈ managerial control) ++> Project performance (relative to schedule + budget + quality + client satisfaction + goals) Outcome control (≈ managerial control) ++> Project performance Clan control (≈ “client involvement”) ++> Project performance Self-control (≈ team autonomy) oo> Project performance All significant relationships are moderated by organizational environment risk and team risk so that higher risk decreases the positive impact of the control mechanism in question.	Medical IS projects	Liu and Wang 2016 [78]
Outcome control (OC) (≈ managerial control) ++> Project performance Behavior control (BC) (≈ managerial control) ++> Project performance	Dwelling fit-out projects	Ning et al. 2017 [147]
Value diversity -o> Shared leadership (≈ team autonomy) (positively moderated by vertical leadership (≈ managerial control) Shared leadership ++> System quality (negatively moderated by vertical leadership) Value diversity --> System quality	IS development projects	Hsu et al. 2017 [102]
<i>Formality vs. informality:</i>		
Formalization of decision processes o+> Team effectiveness (moderated by team dispersion) Formalization of decision processes ++> Quality of decision-making ++> Team effectiveness (moderated by team dispersion)	Miscellaneous	Bourgault et al. 2008 [146]
Formal communication ++> Relationship conflict Informal communication --> Relationship conflict Formal communication --> Process conflict Informal communication ++> Process conflict	Miscellaneous	Wu et al. 2017 [80]

Relationships	Type of projects	References
Formal communication --> Task conflict Informal communication ++> Task conflict Relationship conflict --> Project success Process conflict --> Project success Task conflict ++> Project success		
<i>Individual rewarding vs. team-based rewarding:</i>		
Team-based financial incentive ++> Knowledge management performance of NPD teams (positively moderated by knowledge codifiability and teachability) Non-financial incentive ++> Knowledge management performance of NPD teams	New high-tech product development projects	Zhang and Zhang 2014 [92]
Reward interdependence (\approx team-based rewarding) ++> NPD team collaboration (negatively moderated by team size and functional team heterogeneity) Nonfinancial incentives ++> NPD team collaboration (negatively moderated by team size).	New product development projects	Zhang et al. 2019 [95]
<i>Team homogeneity vs. team heterogeneity:</i>		
Value diversity ++> Task conflict Value diversity ++> Relationship conflict Information diversity ++> Task conflict Demographic diversity ++> Relationship conflict Task conflict ++> Communication Task conflict ++> Balance of contributions Relationship conflict oo> Communication Relationship conflict --> Balance of contribution Communication ++> Project performance (goals met + quality of work completed + schedule + efficiency + morale) Balance of contribution ++> Project performance	IS development projects	Liang et al. 2012 [100]
Team's functional diversity oo> Team effectiveness (\approx quality + satisfaction + success) Team's functional diversity --> Team efficiency (cost-efficiency + time-efficiency + schedule + budget) Team's functional diversity oo> Innovation	Miscellaneous	Liu and Cross 2016 [93]
Knowledge heterogeneity ++> Team performance Knowledge heterogeneity ++> Knowledge reuse ++> Team performance Knowledge heterogeneity ++> Employee relationships ++> Team performance	Engineering design teams	Zhang and Li 2016 [101]
Value diversity --> System quality Shared leadership ++> System quality	IS development projects	Hsu et al. 2017 [102]
Reward interdependence (\approx team-based rewarding) ++> NPD team collaboration (negatively moderated by team size and functional team heterogeneity)	New product development projects	Zhang et al. 2019 [95]
C: Execution -> Project performance		
<i>Averse vs. responsive to changes:</i>		
Software team response extensiveness ++> Software functionality Software team response extensiveness ++> Customer satisfaction (satisfaction with the developed system) Software team response extensiveness --> Software team response efficiency Software team response efficiency ++> Software functionality Software team response efficiency ++> Process performance (budget, schedule) Software team response efficiency ++> Customer satisfaction	Agile IS development projects in one organization	Recker et al. 2017 [103]
<i>Blueprint vs. continuous planning:</i>		
Planning (= the proportion of total development time spent defining product requirements prior to the start coding) oo> Development time Build frequency --> Development time	Software development projects	Callahan and Moretton 2001 [148]
<i>Rigid vs. flexible method enactment</i>		
<i>Discipline vs. improvisation:</i>		

Relationships	Type of projects	References
Faith in intuition oo> Internal project performance (schedule, budget, scope) Faith in intuition ++> External project performance Improvisation oo> Internal project performance Improvisation oo> External project performance	Miscellaneous	Leybourne and Sadler-Smith 2006 [129]

Legends: ++> significant positive relationship, --> significant negative relationship, oo> non-significant relationship, +o> moderated relationship in which the relationship turns into insignificant when the moderator has a high value, o+> moderated relationship in which the relationship is insignificant when the moderator has low value and insignificant when the moderator has high value.

B.1. Managerial control vs. team autonomy

Bourgault et al. [146] investigated the effect of team autonomy and formalization of the decision-making process on the quality of decision-making and further on teamwork effectiveness. Teamwork effectiveness in their study referred to “the perceived performance by team members on items such as task completion, goal achievement, sharing information, conflict resolution, problem-solving, and the team’s ability to create and sustain a good working environment” (p. S102). They found team autonomy to have a significant positive direct effect on teamwork effectiveness, moderated by team dispersion so that in the case of moderate project dispersion, the effect was almost significant ($p \leq 0.10$), and in the case of high dispersion, it was significant (the authors use “moderate” and “high” to characterize the opposites of dispersion). Furthermore, formalization had a positive indirect effect on teamwork effectiveness via quality of decision-making, the effect of team autonomy on quality of decision-making being insignificant when teams were moderately dispersed and almost significant when they were highly dispersed.

Liu and Wang [78] investigated the impact of behavior control, outcome control, clan control, and self-control on project performance (the degree to which the project goals were achieved, the project was within budget and schedule, and was of high quality). They found all the forms of control, except self-control, to have a significant positive direct effect on project performance, whereas the effect of self-control was insignificant. In principle, behavior control and outcome control reflect management control, clan control reflecting team autonomy, and self-control reflecting individual autonomy [73]. Liu and Wang [78], however, measure behavior control and outcome control exercised by the client rather than by management. More confusingly, the items of self-control seem to reflect team autonomy rather than individual autonomy, and the items of clan control seem to measure something like the client’s “involvement” with the development team. The insignificant effect of self-control (\approx team autonomy) on project performance is against the authors’ initial hypothesis.

Ning et al. [147] focused on the effects of outcome control, behavior control, trust in contractor’s competence, and trust in contractor’s good intentions on project performance, reporting all of them to have a significant positive effect.

Hsu et al. [102] investigated the effects of value diversity, shared leadership, and vertical leadership on system quality. They found that value diversity generally has a negative effect on shared leadership, moderated by vertical leadership so that when vertical leadership is very high, the effect is positive but weak. Shared leadership has a positive impact on system quality, moderated by vertical leadership so that when vertical leadership is high, the positive effect is lower than in the case of low vertical leadership. Value diversity was also found to have an almost significant ($p \leq 0.10$) direct effect on system quality. The results of [102] describe how diversity (homogeneity vs. heterogeneity) and shared leadership (autonomy), and vertical leadership (managerial control) may be interrelated.

B.2. Formality vs. informality

In the above-mentioned study of Bourgault et al. [147], formalization was found to have an almost significant direct effect on teamwork effectiveness ($p \leq 0.10$) moderated so that the effect was insignificant when teams were moderately dispersed and significant when teams were highly dispersed. Furthermore, formalization had a positive indirect effect on teamwork effectiveness via quality of decision-making,

Wu et al. [80] analyze formal communication, informal communication, and communication willingness as determinants of three types of conflict - relational conflicts, process conflicts, task conflicts. Each of the types of conflict is assumed to affect project success. They report that formal communication and informal communication have

significant but opposite effects on the three types of conflict. Since they measure project success using a single construct, one cannot judge whether formality versus informality may have significantly different effects on dimensions of project success.

B.3. Individual vs. team-based rewarding

Zhang and Zhang [92] and Zhang et al. [95] investigate the impact of team-based rewarding and non-financial incentives in the new product development (NPD) context, using knowledge management performance of NPD teams and NPD team collaboration as the dependent variables, respectively. Both studies find that team-based rewarding has a positive impact on the dependent variable in question. The former study suggests that the relationship is positively moderated by knowledge codifiability and teachability, and the latter study that the relationship in question is negatively moderated by team size and team heterogeneity.

B.4. Team homogeneity vs. team heterogeneity

As introduced above, Hsu et al. [102] and Zhang et al. [95] include diversity or heterogeneity in their models and will not be discussed in more detail here.

Liang et al. [100] investigate the impact of value diversity on project performance (goals met, amount of work completed, within schedule, efficiency, morale), including information diversity and demographic diversity as controls. Their results imply that both information diversity and value diversity have a positive indirect effect on project performance via their positive effects on task conflict, which affects communication and balance of contribution positively, the latter two influencing project performance positively. At the same time, value conflict and demographic diversity have negative indirect effects on project performance via their positive effects on relationship conflict, which negatively affects the balance of contribution and communication (even though insignificantly the latter) and therefore negatively on project performance.

Liu and Cross [93] study twelve determinants of project performance, among them team diversity. They distinguish three dimensions of performance: team effectiveness (“the extent to which the project outputs achieved the performance expectations of key project stakeholders”), team efficiency (“the ability of the project team to meet its budget and schedule goals (...) and utilize resources within constraints”) and innovation (the creative accomplishment of teams in generating new ideas, methods, approaches, inventions, or applications”) (p. 1152). They found that the only significant relationship between the team’s functional diversity and the three dimensions of project performance is the negative relationship between the team’s functional diversity and efficiency. Opposite to their hypothesis that there is a positive relationship between team’s functional diversity and innovation, they did not find the relationship significant.

Zhang and Li [101] investigate the direct effect of knowledge heterogeneity on engineering design team performance and indirect effects through employee relationship and knowledge reuse. Despite their *a priori* assumption of negative effects of knowledge heterogeneity, they found it to have only positive direct effects on employee relationships, knowledge reuse, and engineering design team performance.

B.5. Tensions of execution

The interest of Recker et al. [103] lies in how three ASD practices – stand-up meetings, collective code ownership, pair programming – affect responsiveness to requirements changes and further on IS development project performance. They include three project performance dimensions - software functionality, process performance, and customer satisfaction. Although their main analysis aggregates them into a single construct (IS development success), their Appendix B reports results when the three dimensions are kept separate. They found that “software team response extensiveness” (the extent the software team actually incorporated various requirement changes) had a significant positive direct impact on software functionality and customer satisfaction and a significant negative direct effect on “software team response efficiency” (i.e., on the additional effort required by the software team to incorporate the requirements changes). “Software team response efficiency”, on the other hand, had significant positive direct effects on each of the three dimensions of project performance. A detailed analysis of their regression coefficients suggests that

direct effects of “software team response extensiveness” outperform the indirect effects. Since process performance was affected by “software team response efficiency” only, the total effect of “software team response extensiveness” on process performance is negative.

Callahan and Moreton [148] investigate determinants of software development time. They found planning (all upfront analysis, design, and planning before starting coding) to be insignificant as a determinant of project duration, whereas build frequency significantly decreased the duration. Although they refer to the iterative nature of software development in the sense of the spiral model [149], it is likely that their sample of software development projects is biased towards traditional waterfall-type development. It would be interesting to see to what extent their findings are valid in a more agile way of developing software.

The interest of Leybourne and Sadler-Smith [129] lies in the role of intuition and improvisation in project management. They separate two dimensions of project performance: internal (schedule, cost, scope) and external (related to the customer). They did not find improvisation to affect either dimension of project performance significantly but did find faith in intuition to be positively related to the external project performance.

Biographical notes



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Juhani Iivari is a professor emeritus in the Department of Information Processing Science, University of Oulu, Finland. During his career he has served as a professor at the University of Jyväskylä and at the University of Oulu. Before his retirement, he also worked for ten years as a part-time scientific head of INFWEST/INFORTE programs, which are joint efforts of a number of Finnish universities to support doctoral studies in IT. Juhani has also served in various editorial positions for IS journals including *Communications of the Association for Information Systems*, *European Journal of Information Systems*, *Information Systems Journal*, *Information Systems and e-Business Management*, *Information Technology and People*, *Journal of the Association for Information Systems*, *MIS Quarterly*, and *Scandinavian Journal of Information Systems*. His research has broadly focused on the theoretical foundations of information systems, IS development methods and approaches, organizational analysis, implementation and acceptance of information systems, and design science research in IS.