

# Collaboration of Solution Architects and Project Managers

Christof Gellweiler, WHU - Otto Beisheim School of Management, Vallendar, Germany

## ABSTRACT

If IT projects are to be successful, they must meet business requirements, and they must be efficiently managed. IT projects need methodological skills to manage resources as well as technical capabilities for architectural planning and solution design. Project managers and solution architects represent two highly-qualified leadership roles in IT projects, both of which analyze requirements and both of which are responsible for supplying IT solutions. In predictive IT infrastructure projects, solution architects' technology skills complement project managers' organizational competencies. The combination of those skills improves requirements elicitation that is the key for IT project achievement. Project managers and solution architects closely collect and evaluate requirements and specify the scope in the planning phase. The relationship between these roles is examined by the IT management literature and established practitioner frameworks. Finally, suggestions for collaboration are derived and presented in the IT solution life cycle model.

## KEYWORDS

Enterprise Architect, IT Solution Life Cycle, Project Manager, Requirements, Solution Architect

## INTRODUCTION

Information technology (IT) solutions facilitate the attainment of enterprise goals by offering information services to human resources, partners, and customers and by automating business processes. IT solutions should not be viewed as isolated “technology” outcomes (Information Systems Audit and Control Association (ISACA), 2012, p. 76); instead, they must align with the business (Buckl, 2011, p. 152; Luftman, 2003). IT architecture and project management enable a structured supply of IT solutions that effectively meet business requirements (Office of Management and Budget, 2013, p. 149). Both IT architecture and project management are understood as crucial management disciplines for IT project success.

The notion of architecture is poorly understood outside the civil engineering field (Josyula, Orr, & Page, 2012, p. 35). In the IT realm, architecture is an immature, evolving management direction that is establishing its place among diverse IT methodologies. The role of the IT architect is vague in the literature and in practice (Ameller et al., 2012, p. 11; Olsen, 2017, p. 641; Thönssen & von Dewitz, 2018, p. 409). Architecture in IT is wide-ranging; it is multi-dimensional and comprises various levels of detail. Enterprise architecture comprises strategy, organization, processes, assets, resources, etc. (Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE), 2018, p. 644), striving to align IT with business (Baets, 1992; Buckl, 2011, p. 152). Architecture may also focus on solutions, systems, and components from technology segments such as security or networks (The Open Group, 2018, p. 474) or on software applications. Architecture is synonymous with the structural design of components, their features, and integration in present and future conditions (International

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Institute for Business Analysis (IIBA), 2015, p. 441). Architectural works must be planned, developed, implemented, and maintained, which extends to include governance (The Open Group, 2018, p. 23). Purposeful organizational implementation of IT architecture vastly enhances efficient planning and effective design of IT structures.

In contrast to IT architecture, project management is a matured methodology and with established and accepted frameworks. For example, the guide to the *Project Management Body of Knowledge* (PMBOK) includes the standard approved by the American National Standards Institute (Project Management Institute (PMI), 2017, pp. 539–635). Project management is applied in almost all industries, especially for significant IT endeavors. IT projects convert business objectives into project objectives (Kendrick, 2018) and are linked to enterprise strategy either directly or via portfolios and programs (PMI, 2013).

Both IT architecture and project management are associated with strategy, processes, and delivering results (i.e., IT solutions). People, processes, technology, and data are interconnected (Institute of Electrical and Electronics Engineers Computer Society and Association for Computing Machinery (IEEE & ACM), 2018). However, there is no clarity how managing projects and IT architecture relate to each other in practice. The linkages between both management areas and the collaboration between the relevant roles remain undiscovered. There is currently a gap in both the IT management theory and practical business contexts.

The purpose of this article is to gain a better understanding of IT architecture and project management and to better comprehend the linkages between corresponding roles. This article explicates IT architecture and project interrelatedness and illuminates the key players in predictive IT projects from two management practices: the project manager and the solution architect. The skills and tasks of these roles are investigated, comparing and discussing their attributes regarding skill complementation and work organization. Technology skills from solution architect complement planning and organizational skills from project managers for accurate requirements and scope definitions. In addition, this paper enters into features of software projects to distinguish agile from predictive approaches and their impacts on roles.

This conceptual paper broadens the scope of thinking by bridging theories on fundamental IT management disciplines into an integrated model for collaboration over an IT solution life cycle (Gilson & Goldberg, 2015, pp. 127–128). Finally, further research directions are suggested and key points are summarized.

## RELATIONS BETWEEN PROJECT MANAGEMENT AND IT ARCHITECTURE

Early influential scientific works about architecture did not find connections between project managers and architects (Feeny & Willcocks, 1998; Mentzas, 1997). Mentzas (1997) missed out the role of the architect. He described an approach for implementing strategies for information systems by emphasizing their link with a business and the participation of the business' management and team. He proposed planning actions to implement IT architectures (e.g., budgeting, scheduling, human resources, migration), but he did not identify the role of the architect in this scenario. Technical teams coordinated by a project manager plan logical architectures (functional and organizational needs) and technical architectures (detailed specifications of physical hardware, software, and development efforts). In Mentzas' proposal, even the business architecture (the processes and models of logical and technical architectures) was not the dedicated responsibility of an architect. In contrast, Feeny and Willcocks (1998) underrated the role of the project manager. They excluded project managers from architecture planning and characterized architectural planners by their high technical skills and low-to-medium business skills. These authors saw project management not as a core IT capability, but as an organizational capability related to the business.

The linkage between architects and project managers is more apparent in practitioner frameworks and standards dealing with IT management. Frameworks enable standardized views and help to

develop architectural descriptions by using methods and models or more informal means such as pictures or tables (BKCASE, 2018, p. 636). Frameworks deal with practices, precepts, and rules describing architectures with specific purposes (International Organization for Standardization/International Electrotechnical Commission/Institute of Electrical and Electronics Engineers (ISO, IEC, & IEEE), 2011a, p. 2).

The *Enterprise IT Body of Knowledge* (EITBOK) (IEEE & ACM, 2018) depicts architecture and project management frameworks as the roots of an organization, among other standards that are foundational for furnishing enterprise IT. It shows architectural planning and projects on two different sides of the organizational tree impacting IT operations. A requirement analysis connects project portfolio management and enterprise architecture. Alignment with enterprise architectures and adherence to portfolio management priorities are used as success metrics for requirements. The requirements analysis examines four main categories that require various skills and include project management and solution architecture: business, stakeholders, solution, and transition. Outputs are defined as requirements documents and solution design documents, both of which must contain sufficient information to enable the project team to build the solution.

According to ISO, IEC, and IEEE (2015), architecting is carried out within organizations and/or by temporary projects that supply products and services as per specified resources and requirements. The project/organization must provide detailed information about the architecture (ISO, IEC, & IEEE, 2011a, p. 12); then, architecture frameworks can be used for processes, communication, and interworking over various projects and/or organizations (ISO, IEC, & IEEE, 2011, p. 10). Thus, ISO, IEC, and IEEE display two links between architecture and project management—one refers to contributions on a project basis, and one is strategic regarding framework application.

The *Open Group Architecture Framework* (TOGAF) (The Open Group, 2018) describes itself as a generic framework for defining architectural deliverables and the relevant methods. TOGAF's (The Open Group, 2018, p. 20) methods may be tailored and combined with methods from other IT frameworks such as *Control Objectives for Information and related Technology* (COBIT) (ISACA, 2012), the *IT Infrastructure Library* (Axelos, 2011), and the *PMBOK Guide* (PMI, 2017). Architecture professionals participate in projects, portfolios, and in the entities that govern them (The Open Group, 2018, p. 18). Project management frameworks are used to plan and build deliverables in structured ways. Enterprise architects and project portfolio managers commonly govern solution developments, which plan, create, and supply IT components as part of the projects and in accordance with IT architecture. Project management methods define how changes are managed within an enterprise (The Open Group, 2018, pp. 61–63). TOGAF points out the enterprise architect's responsibility for the design and hand-over of projects for implementation. TOGAF also stresses decision-making with project managers, which requires the architect's experience through all phases of the project (The Open Group, 2018, p. 475).

The *Federal Enterprise Architecture Framework* (Office of Management and Budget, 2013) presents five reference models. One of them, the business reference model, is meant to find opportunities for cost reduction and new capabilities to facilitate strategic goals. Strategic planning is supported by enterprise architecture as well as portfolio and project managers, the former of whom facilitate the alignment of IT projects to enterprises' business needs. Project managers examine existing business capabilities and verify their fit to IT projects. Their responsibility includes aligning the project with the business architecture.

COBIT denotes itself as an integrator of management frameworks for overarching governance (ISACA, 2012, p. 31). Among others, COBIT takes architecture and project management frameworks into account. TOGAF (The Open Group, 2018) and the *PMBOK Guide* (PMI, 2017) are depicted side-by-side as supplements without intersections in the context of four management domains (ISACA, 2012, pp. 79–81). The core of TOGAF is allocated to the management domain “align, plan, and organize,” along with portfolio management, whereas program and project management processes belong to the domain “build, acquire, and implement.”

The *Business Analysis Body of Knowledge* describes business architecture as a discipline of the entire enterprise used to identify stakeholder concerns and support transformation. Results from business architecture deliver inputs to requirements analysis, project planning, and high-level solution design. Project managers, solution architects, and other stakeholders collectively use business architecture models to govern changes within the enterprises they oversee (IIBA, 2015, pp. 408–413).

As reflected in several frameworks and industry standards, IT architecture and project management are connected. Both roles are concerned with strategic alignment, governance, frameworks, planning, and stakeholder communication. A content analysis of job advertisements for IT architects (Gellweiler, 2020) empirically confirmed relatedness to project management. Fifty-eight percent of examined job postings included relation to project management in skill or task descriptions.

In the succeeding sections, the roles and tasks of IT architects are examined in view of complementation with project management tasks. Prior to that, the two fields' cohesiveness is elaborated by considering the technology skills within IT projects.

## TECHNOLOGY SKILLS WITHIN IT PROJECTS

IT projects need profound technology knowledge and related experience. There are controversial standpoints in the literature regarding whether project managers or other project team members should provide technological skills. The different views are displayed below.

Ramazani and Jergeas (2015, p. 46) explored directions in project management education and emphasized the need for project managers to possess both technical and leadership competencies, especially in IT and engineering projects. Ahsan, Ho, and Khan (2013) found that technical expertise was the third most cited competency in the project management literature and the second most frequent code in their analysis of project management job advertisements. However, their study did not reveal the depth of the technical knowledge that was demanded.

In contrast, the list of 18 IT project manager skills created by Jiang, Klein, and Margulis (1998) did not contain any items referring to technology—instead, they concentrated on behavioral skills. According to El-Sabaa (2001), project managers' human skills, followed by conceptual and organizational skills, mattered most for project effectiveness, whereas technical skills were the least influential. Liikamaa et al. (2015) investigated businesses' reasons for replacing IT project managers and found that poor social skills and personal skills were the second most common cause for substitutions—lack of technology skills was not listed.

Napier, Keil, and Tan (2009, p. 266) found the top five skill categories for project managers to be the following: planning and control, general management, leadership, communication, and team development. The top five skills for IT projects that Keil, Lee, and Deng (2013, p. 403) recognized also do not surprise: leadership, verbal communication, scope management, listening, and project planning. What was astonishing in their study was that technical skills for IT system development did not even appear in a table consisting of 19 various skills. The researchers followed up on this issue by interviewing the participating project managers, who argued that they concentrated on management and leadership activities and employed technically skilled people within their team; these experts were critical to project success and needed to be available. Further, Harison and Bonstra (2009, p. 287) reasoned that IT project managers did not need to study technology in depth because technical tasks were delegated to technical specialists who found appropriate solutions. However, an IT project manager must possess a basic technical understanding in order to communicate with experts (Keil, Lee, & Deng, 2013). In the same sense, Napier, Keil, and Tan (2009) defined a project manager skill category of “systems development” to refer to understanding and managing technical complexity for quality control and for the sake of planning; eight of the 19 research subjects fulfilled this category.

Napier, Keil, and Tan (2009, p. 274) also presented four archetypes of IT project managers that differed in the extent to which they possessed the nine skill categories essential to successfully managing IT projects. A combination of all four archetypes (i.e., general manager, problem solver,

client representative, and balanced) made for an ideal IT project manager. The problem-solver archetype added competencies in systems development and planning and offered technical expertise. Thus, this archetype corresponded to IT architects that complemented a project manager's skill set by adding technology and system development skills.

TOGAF's skills framework (The Open Group, 2018, pp. 467–471) reflected lower technology skill demands for project managers and indicated the complementation of architect and project management skills. TOGAF defined 76 different skills allocated to seven groups. Per skill and per role, TOGAF assigned proficiency levels on a four-point integer scale (1 = background, 2 = awareness, 3 = detailed knowledge, 4 = expert). Table 1 depicts the calculated mean proficiency values of the skills per TOGAF's skill categories for enterprise architect technology vis-à-vis the project management role. The dark grey cells in Table 1 mark joint skill areas; both roles must provide high levels of general management skills. Light grey values show the expert categories of each role. In these skill sets, project managers and enterprise architects supplement one other.

The literature is disunited regarding IT skills of project managers. However, the comparison of mean proficiency levels from according TOGAF roles shows complementation of skills. This leads to the proposition: the project manager specializes on planning and managing the work to change the business, while the IT architect possesses deep and broad technological knowledge for solution development. IT architects' technology skills complement project managers' methodological skills. The project manager does not need to study IT in depth.

Skills should correspond to tasks. Next, the tasks of project managers and IT architects are regarded separately. Then, their complementation is discussed in dependence from agile and predictive approaches.

## TASKS OF PROJECT MANAGERS

Major change initiatives in enterprise IT, such as the implementation of new services, equipment installations, or upgrades, require project management (IEEE & ACM, 2018). Project managers have to achieve the objectives of a temporary undertaking in order to establish a unique outcome by means of applying skills, techniques, and tools to meet project requirements (Pinto, 2016, p. 550). Roughly speaking, they manage the work through every phase, from initiating, planning, and execution to closing. Thereby, they plan, monitor, and control the constraints (scope, cost, time, quality, resources, and risks) (IIBA, 2015, p. 18; PMI, 2017). Their tasks also include stakeholder management, communication, and identification of project requirements (PMI, 2013). Beyond this, IIBA (2015, p. 18) denoted a project manager's responsibility to provide solutions according to

**Table 1. Mean proficiency levels per skill category from the TOGAF skill framework**

Categories of skills	Enterprise Architect Technology	Project Manager	Examples
General	3.63	3.75	Leadership, teamwork, communication
Business	3.27	3.27	Strategic planning, business processes/cases
Program/project management	3.00	3.60	Methods and tools, business change management
Legal environment	2.40	3.00	Contract law, data protection law
Technical IT	3.92	2.00	Engineering, data management, security
IT general knowledge	3.59	2.06	System knowledge, service levels, migration planning
Enterprise architecture	3.53	2.35	Modeling, building block design, process design

Proficiency levels: 1 - Background, 2 - Awareness, 3 - Detailed knowledge, 4 - Expert

Source: Author (derived from The Open Group, 2018).

business requirements. IEEE and ACM (2018) considered project management in the context of enterprise IT and stress project managers' responsibilities for planning, acquiring, and coordinating resources, especially people. Human resources are central since they have the greatest impact on costs and schedule (IEEE & ACM, 2018). Project managers are also responsible for implementing technological strategies (PMI, 2017, pp. 8-9); they produce future architecture and must therefore collaborate with architects.

## **TASKS OF IT ARCHITECTS**

Tasks and responsibilities of IT architects depend on their role. There are various types of IT architects that contribute differently to IT projects. Using the enterprise architecture tool selection guide (Schekkerman, 2011, pp. 6-7) and content analysis of job advertisements (Gellweiler, 2019), three types of architects are found with specific objectives and who render tasks accordingly.

First, enterprise architects align IT solutions with businesses and act strategically. They model IT architectures along with business architectures and draw product roadmaps to meet long-term business strategies. They also govern all issues related to IT architectures within an enterprise, take the lead over other subordinated architects, and they advise stakeholders from both the IT and the business side on technology matters. Architecture governance comprises approaches, techniques, methodologies, processes, patterns, etc. to create and sustain the organizational "platform" for architectures and define "re-usables" such as blueprints, references, functional blocks, and generic hardware. It provides the toolbox, the workbench, the frame, and the rules for solution architects to work efficiently and consistently. It may also propose logical and physical solution designs that are central outcomes for solution architects.

Second, solution architects, also referred to as system architects, focus on functional sections within the overall architecture and require more detailed technological knowledge such as data storage, networks, workplaces, and security to design solutions. These architects must collect and analyze the functional and non-functional requirements for detailed solution designs, which include specifications for hardware, operations systems, interfaces, software versions, protocols, flow charts, use cases, etc. to integrate solutions into the overall architecture. Solution architects support projects not only in the planning phase, but also during the execution phase when the solution is deployed and tested.

Third, software architects' needs are different from the previous two types (Schekkerman, 2011, p. 6). Software development generally applies adaptive life cycles (PMI, 2017, p. 19, p. 666). The agile approach was invented for software development (Beck et al., 2001); it defines its own role concept. The characteristics of agile software projects are explicated as follows.

## **AGILE SOFTWARE PROJECTS**

Software projects may select various methods that are fundamentally different from IT infrastructure projects and that may include or exclude project managers and architects. On the one hand, software projects can be managed as other endeavors; on the other hand, there are aspects specific to software engineering that must be taken into account. These relate to software development life cycles (SDLCs) and to their effective and efficient hand-over to stakeholders (Bourque & Fairley, 2014). The SDLC includes processes for specifying requirements and facilitating their transformation into software product delivery (Bourque & Fairley, 2014). Depending on the fitness of a project life cycle, four diverse approaches are available that differ in view of requirements (fixed vs. dynamic), activities (once vs. repeated), delivery (single vs. frequent), and goals (cost, quality, time, customer value). On the one end is the predictive approach with fixed requirements, little changes, and single delivery, and on the other end is the agile approach that allows for flexibility in view of requirements changes via multiple corrections and frequent small productions. In agile software developments requirements may change dynamically in "short iterative planning and execution cycles" (PMI, 2017, p. 666).

Requirements and scope are defined and reworked through all project phases, resulting in a greater number of release versions (PMI, 2017, p. 133).

The roles of project managers and architects are unclear in agile developments. Scrum, a framework for implementing agile methods (Scrum Alliance; 2018) and presumably the best-known method for agile developments (IEEE & ACM, 2018), mentioned neither project managers nor architects in its guide (Schwaber & Sutherland, 2016). The role of the “scrum master” is sometimes compared to the project manager (Bourque & Fairley, 2014; Sutling et al., 2015). However, from the agile alliance perspective, scrum masters are process experts and coaches (Agile Alliance, 2017).

PMI admits that the role of project managers is not known in agile settings, and that due to self-organizing teams, the need for project managers is not recognized (Agile Alliance & PMI, p. 37). In contrast, Pinto (2016, p. 390) portrayed scrum as agile project management. Regarding architecture, TOGAF, one of the most popular architecture frameworks, is not clear in how it positions itself and its roles within agile environments. There is no explicit reference to agile approaches and their relation to architects, not even in the latest edition (9.2 from 2018). Instead, a blog entry on the Open Groups website interpreted some generic parts of TOGAF as adaptations for agility (Lambert, 2018).

Since the project management role in agile software developments is not clear, the software architect type is not followed up in this paper but suggested for future research. In contrast to the agile approach with high requirement flexibility, the predictive approach with solid requirements need intensive planning supported by solution architects.

## REQUIREMENTS ELICITATION IN PREDICTIVE IT PROJECTS

The predictive approach, also referred to as linear development (Bourque & Fairley, 2014) or a waterfall approach (IEEE & ACM, 2018), corresponds to traditional project management phases and frameworks. It can be applied to IT infrastructure projects that can include physical equipment, virtualizations, services, applications, and combinations of these (Josyula, Orr, & Page, 2012, p. 135). In predictive projects, all requirements are collected, analyzed, and then fixed as a basis for the scope baseline, the cost plan, and the project schedule (PMI, 2017).

Requirements express needs and are defined as the “usable representation of a need” (IIBA, 2015, p. 15) or as the “condition or capability that is necessary to be present in a product, service, [or] result to satisfy a business need” (PMI, 2017, p. 719). Future IT solutions are developed based on technical requirements that are derived from business requirements, as-is analysis, and other inputs (e.g., organizational constraints and legal frame conditions).

Requirements are central to IT projects, relevant to all stakeholders, and decisive for the success of predictive projects. A major cause of project failure is inaccurate requirement gathering (PMI, 2018, p. 25). Both solution architects and project managers must understand and manage requirements. Solution architects create IT solutions that meet explicit business requirements and translate these into requirements for IT engineering (Josyula, Orr, & Page, 2012, p. 37). Determination of actual requirements is the key capability for an IT architect (Teare & Paquet, 2005, p. 6). Requirement management is the nucleus of TOGAF’s architecture development method, and it is processed throughout all nine TOGAF phases. Project managers bear the responsibility for requirement collections (i.e., “the process of determining, documenting, and managing stakeholder need[s] and requirements to meet project objectives”) (PMI, 2017, p. 129). So, project managers must closely align themselves with solution architects in order to collect detailed technical requirements.

Requirements are diverse and can be classified in many ways. ISO, IEC, and IEEE (2011b) 29148, section 9.4.2.3 presented the following requirement types: service or functional, operational, interface, environmental, human factors, logistical, maintenance, design, production, verification requirements, validation, deployment, training, certification, retirement, legal, regulatory, environmental, reliability, availability, maintainability, design, usability, quality, safety, and security requirements. Pataki, Dillon, and McCormack (2003) distinguished between the functional requirements impacting business

processes, the technical requirements affecting the system infrastructure, the operational requirements impacting support and operations, and the transitional requirements needed for implementation. PMI (2017, p. 148; 2016, p. 27) suggested the categories exhibited in Table 2. The first four classes can also be found in IIBA (2015, p. 16).

Cisco architects create designs after analyzing business requirements and transform them into technical requirements (Cisco Systems, 2018). Business requirements answer the “what” and “why” questions from a business point of view and concern, for example, use cases or legal/regulatory constraints. Technical requirements are based on business requirements and answer “how” questions. They describe attributes of the solution to support the use cases. Technical requirements are inputs to the design that specify the components (the question of “with what”).

Howsoever requirements are classified, they must be complete, and stakeholders must be able to understand them. Solution architects and project managers must work together to identify and realize all the different types of requirements. Thus, the project manager is dependent on the technical contributions from the solution architect and other stakeholders. Translations from business and stakeholder requirements into functional requirements need technical core competencies on the part of the solution architect, who must collaborate with subject matter experts to realize these. Solution architects’ technological skills are also imperative for working out non-functional requirements, including availability, compatibility, functionality, maintainability, performance efficiency, portability, reliability, scalability, security, usability, certification, compliance, localization, service level agreements, and extensibility (IIBA, 2015, p. 302). Consequently, the responsibility for solution requirements lies with the solution architect. His or her expertise is also needed for transition requirements (e.g., describing detailed migration steps or specifying test requirements). Table 2 exhibits the allocation of responsibilities to requirement types for the discussed roles. The collection and analysis of business requirements are the responsibilities of the enterprise architects and the portfolio managers, with the support of solution architects and project managers. Other roles, e.g., IT executives and system engineers, should also contribute to gathering requirements. Finally, dedicated business analysts may also bear the responsibility for business requirements (IIBA, 2015).

**Table 2. Responsibility matrix for requirements**

Type of Requirements	Short Description	Project Manager	Solution Architect
Business	Strategic needs of the enterprise	C*	C*
Stakeholder	Needs of individuals, groups, and organizations affected by the project	R	C
Solution	Functional req. (e.g., features, user functions) Non-functional req. (e.g., environmental conditions)	C	R
Transition and Readiness	Integration and migration capabilities from as-is to target state	R	C
Program / Project	Planning, controlling, monitoring, assumptions, constraints	R	C
Quality	Validation and verification of solution, results, and services by tests, proof of concept, and/or pilot	R	C

Legend: R - Responsibility, C - Contribution      \* responsibility of portfolio manager / enterprise architect

Source: Author.



## SCOPE SPECIFICATION IN PREDICTIVE IT PROJECTS

Specification of scope is the planning step that follows requirement collection; it describes all the project deliverables and is mainly based on the project goals and detailed requirements it must meet. The total scope of a project may be subdivided into product scope and project scope (PMI, 2017, p. 131).

The product scope contains deliverables that are operationalized at the end of a project to benefit the enterprise. It describes characteristics of physical resources, services, results, or a combination of these as a target state, referred to as “to-be” conditions. In IT projects, the product scope is the solution design that satisfies functional and non-functional requirements. In practice, the term design is often confounded with architecture (BKCASE, 2018, p. 344; Rivera, 2007). In connection with IT, the notion of design is reserved for the technical solution design performed by solution architects and developers (IIBA, 2015, p. 394). It includes technologies and detailed specifications for quantifiable hardware models, commercial off-the-shelf software, techniques necessary for developing software, middleware, platforms (e.g., hypervisors and databases), resource-abstracted virtualizations, interfaces, protocols, supporting tools, controls, operational processes, standards, system configurations, vendor services as well as statements of compatibility, compliance, constraints, preconditions, assumptions, and risks. Furthermore, solution design should comprehend functional descriptions such as flow charts, context diagrams, logical and physical topology graphics, and use cases. The components of product scope are verifiable and handed over to operations. The end result is the capability to perform services (e.g., a function that supports a business domain or an e-commerce function for customers). Deep technical and architectural competencies are needed for valid solutions designs. Requirements teams frequently consist of people with various skills, including solutions architecture, project management, and business analysis (IEEE & ACM, 2018). The solution architect is the technical leader in charge of solution design and any underlying solution requirements.

The project scope describes the ways and the work to be performed to provide the solution—that is, transition from the current condition (“as-is”) to the target state (“to-be”). It must meet transitional requirements and comprise all the tasks necessary to furnish the solution, particularly in terms of project management and system implementation tasks. Examples of project managers’ tasks include planning, stakeholder communication (meetings, minutes, status reporting, etc.), change management, leadership, work coordination, and progress monitoring. The work that architects and system engineers undertake is also part of the project scope (e.g., consultancy, system setup, programming, testing, deployment, and rollout). Coordination of the project scope is the project manager’s core function; however, he or she is highly dependent on contributions from solution architects’ work quality in view of the product scope definition and their support for integration, migration, and quality assurance.

In essence, solution architects concentrate on the product scope—that is, the solution design to meet functional and non-functional requirements; project managers plan and manage the project scope—that is, the work and the resources to accomplish business outcomes (The Open Group, 2018, p. 144). Both scope parts must join together to form a cohesive whole. The variety of tasks in context with architectural complexity and organizational dependencies requires intensive communication and close cooperation between solution architects and project managers.

## COOPERATION OVER AN IT SOLUTION’S LIFE CYCLE

The cooperation between project managers and solutions architects goes beyond specification of requirements and scope. IT services and their associated solutions underlie life cycles (ISACA, 2012, p. 108). IT architecture encompasses the whole life cycle of an IT solution (ISO, IEC, & IEEE, 2011a, p. 8) and is a continuous function that guides its evolution (Buckl, 2011, p. 152). Beyond planning, the architecture process comprises implementation, maintenance, and continuous improvement (ISO, IEC, & IEEE, 2011a, p. 1). IEEE and ACM (2018) depicted enterprise architecture core functions

(i.e., change initiatives, interoperability, security, quality, disaster/recovery, and operations/support) over all the life cycle phases.

Figure 1 illustrates a model with project managers' and solution architects' key activities over a generic IT solution life cycle. It comprises the emergence of the solution as a project, its use in production, and its controlled end of life (i.e., the phase-out). Prior to project initiation, projects must be selected. Project success is incumbent upon selecting the right project, which must be aligned to business/IT strategy and add value to the enterprise. Project prioritization among stakeholders is based on the business architecture (IIBA, 2015, p. 413) and a criterion for IT-business alignment (Luftman, 2003, p. 12). In this early stage, near cooperation between project managers and IT architects is already vital. Enterprise architects, solution architects, portfolio managers, and project managers should collectively agree on priorities and selection based on enterprise strategy, business cases, technical feasibility, and risks. Analysis and decision-making call for various competencies from all these roles (Hanschke, 2012, p. 153; PMI, 2013, p. 7).

Once a project has been selected, the project manager must create a project charter and present it for the management's approval. The project charter formulates the objectives and presents its requirements and scope along with rough costs, a milestone schedule, overall risks, and key stakeholders (PMI, 2017, p. 155). Creating a project charter is the project manager's responsibility; contributions from the solution architect are mandatory. He or she provides technical expertise on high-level requirements, rough design, as well as judgment of risks. In the subsequent planning phase, these items will be further broken down and result in detailed specifications, which remain one of the solution architect's responsibilities.

Expertise from the solution architect is also central in the project execution phase. Based on the scope statement, services and products from IT vendors need to be sourced and implemented. This includes deep technical discussions with IT architects and system engineers from vendors and from the project's organization. Configurations might be changed, added, or refined due to unknown or unexpected system behaviors. The more a project progresses, the more experience is gained on the target solution and its environment. Technical clarifications go on, issues must be solved or decided, design documents must be updated, etc. System engineers need technical leadership from solution architects. Beyond this, architects help to ensure quality via control tests in the lab or in the field. Testing means the evaluation of the IT solution regarding conformance to the requirements specification (PMI, 2017, p. 303). As a result, deliverables are verified and the IT solution is validated for official acceptance (PMI, 2017, p. 305).

After successful acceptance and project completion, the solution architect will enter the operation phase and control minor changes (e.g., software upgrades) until the end of an IT solution's life. The phase-out of an IT solution is part of the subsequent project, which drives the enterprise to the next level of evolution.

Figure 1. IT solution life cycle model with complementing activities of project managers and solution architects. Source: Author.

		IT solution life cycle					
IT Strategy	Project selection	Project life cycle				Production	New project ...
		Initiation	Planning	Execution	Closure	Operations	Phase-out
<b>Project Manager</b>	Business case  Strategy compliance	Project charter	Project plan (costs, time, scope, resources, risks,...)	Monitoring, controlling, management of team and suppliers, deployment, etc.		Not applicable	
<b>Solution Architect</b>	Feasibility study	Consultation	Requirements specification, IT solution design	Implementation and test support		Change management	

## CONCLUSION

Past research on IT architecture and project management is extensive, but their interaction has been underestimated. In this paper, the connection between these crucial IT management disciplines was explored to augment the value of their collaboration. Relations between IT architects and project managers were discovered in IT management frameworks and standards that academic research has overlooked.

IT architecture and project interrelatedness were highlighted by analyzing solution architects' and project managers' tasks and skills. IT architects' tasks depend on their role. Architecture emphasis may be placed on the enterprise level, or the solution level, or during software development. Collaboration with project managers depends on which development approach is being used. Software projects mainly apply agile approaches that define dedicated roles. The structured interworking of architects and project managers is notably rich in waterfall projects for IT infrastructures that achieve their goals in predictive ways. While enterprise architects focus on business needs, strategy, and methodological governance, solution architects conspicuously complement project managers in predictive projects. They provide skills for technology and architecting that are essential when specifying solution requirements and creating corresponding designs, whereas project managers are skilled in and focused on organizing the work and managing personnel. Beyond technical planning, solution architects are involved in project execution by advising personnel on implementation, integration, and testing—that is, requirement verification. Solution architects also help project managers in the early stages when projects are being evaluated, selected, and defined to ensure feasibility and strategy compliance. Close and structured collaborations between project managers and solution architects enhance IT-business alignment and increase IT projects' efficiency and effectiveness.

This essay contributes to the literature by indicating the coherence of IT architecture and project management and by demonstrating the complementarity of skills from key roles. Furthermore, a model for cooperation between solution architects and project managers over an IT solution life cycle was derived.

For practitioners, this article suggests adaption of role descriptions for solution architects to focus on collaboration with project managers. Solution architects must be clear about their responsibilities for the solution requirements/design and support activities embedded in the project plan. Solution architects must understand themselves as technical leaders on par with project managers. Resource plans should allow for solution architect engagement from project selection to the cut-over of the target solution to production. Even better, a solution architect should remain technically responsible over an IT solution's lifetime, including decommissioning at the end of an IT solution's life.

This article raised several questions that are in need of further examination. The strategic relationship between enterprise architects and project managers has not been addressed so far. Also, the roles of software architects and project managers in adaptive initiatives are of interest, not only the architect–project manager connection, but also the links to other roles from agile frameworks, such as scrum master or product owner. Business analysis, another discipline dealing with requirements analysis and design definition (IIBA, 2015, pp. 1-2), seems to overlap with architecture and project management in certain parts—contradictions, coherence, and intersections among these areas and roles might be subjects for further investigations. Foremost, the propositions for collaboration as per the IT solution life cycle model and the requirements responsibility matrix are suggested to be tested. These tests can be carried out via structured interviews or surveys with solution architects, project managers, and near stakeholders such as chief information officers, portfolio/program managers, enterprise architects, and system engineers.

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*Christof Gellweiler is IT project management consultant with more than 25 years of professional experience in the financial services industry and the IT infrastructure business in Germany. He holds a diploma in telecommunication engineering from TH Bingen University of Applied Sciences and earned an Executive-MBA from Northwestern University / Kellogg-WHU. As doctoral student at BI Norwegian Business School, ISM Vilnius, and Aarhus University, Christof's research focused on IT architecture and strategic IT planning. He is certified by PMI and Cisco Systems and teaches project management and digitalization at various universities in Germany and Lithuania.*