

A CHALLENGE-DRIVEN APPROACH TO IMPROVE
SOFTWARE SYSTEM RESEARCH AND DEVELOPMENT PROJECT
PROCESSES

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RESEARCH AND DEVELOPMENT PROJECT PROCESSES**

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ABSTRACT

A CHALLENGE-DRIVEN APPROACH TO IMPROVE SOFTWARE SYSTEM RESEARCH AND DEVELOPMENT PROJECT PROCESSES

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Research and Development (R&D) projects are conducted across various sectors, particularly in automotive, energy, medical/pharmaceutical, and software industries. These projects present significant challenges due to the inherent complexity and uncertainty of the R&D lifecycle. This study focuses on software systems R&D projects, which play a critical role across nearly all industries today. The objectives of this study are to identify the challenges faced in software system R&D projects, make these challenges visible at the process level, and provide a guideline for improving project processes and addressing the challenges based on the Disciplined Agile Delivery framework.

To achieve this, interviews were conducted with 12 individuals representing nine distinct roles across five different organizations. A total of 93 challenge instances were identified. Each challenge was thoroughly analyzed and mapped to the relevant processes defined in the ISO/IEC/IEEE 12207 Systems and Software Engineering – Software Lifecycle Processes standard. The challenges were then categorized into 27 unique first-level themes and 88 unique second-level categories. The process mapping results revealed that most challenges are associated with the Project Planning Process (20%), followed by the Acquisition Process (16%), the Stakeholder Needs and Requirements Identification Process (9%), and the Supply Process (8%). Finally, an improvement approach for software system R&D project processes was proposed, based on alternative solutions provided within the Disciplined Agile Delivery framework.

Keywords: Software System, R&D Project Challenges, ISO/IEC/IEEE 12207, Mapping Study, Disciplined Agile Delivery

ÖZ

YAZILIM SİSTEMİ ARAŞTIRMA VE GELİŞTİRME PROJE SÜREÇLERİNİ İYİLEŞTİRMEYE YÖNELİK ZORLUK ODAKLI BİR YAKLAŞIM

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Araştırma ve Geliştirme (Ar-Ge) projeleri, özellikle otomotiv, enerji, tıp/ilaç ve yazılım endüstrileri olmak üzere çeşitli sektörlerde yürütülmektedir. Bu projeler, Ar-Ge yaşam döngüsünün doğasında bulunan karmaşıklık ve belirsizlik nedeniyle önemli zorluklar ortaya koymaktadır. Bu çalışma, günümüzde neredeyse tüm sektörlerde kritik bir rol oynayan yazılım sistemi Ar-Ge projelerine odaklanmaktadır. Bu çalışmanın amacı, yazılım sistemi Ar-Ge projelerinde karşılaşılan zorlukları belirlemek, bu zorlukları süreç düzeyinde görünür kılmak ve bu projelerin zorluklarını önleyerek/çözerek yazılım sistemi Ar-Ge proje süreçlerini iyileştirmek için bir kılavuz sağlamaktır.

Belirtilen amaçlara ulaşmak için, beş farklı kuruluşta dokuz farklı rolü temsil eden 12 kişiyle görüşmeler yapılmıştır. Toplam 93 zorluk örneği belirlenmiştir. Her zorluk ayrıntılı olarak analiz edilmiş ve ISO/IEC/IEEE 12207 Sistem ve Yazılım Mühendisliği - Yazılım Yaşam Döngüsü Süreçleri standardında tanımlanan süreçlerle eşleştirilmiştir. Zorluklar daha sonra 27 benzersiz birinci seviye temaya ve 88 benzersiz ikinci seviye kategoriye ayrılmıştır. Zorlukların süreçlere haritalanması sonucunda, zorlukların çoğunun Proje Planlama Süreci ile ilişkili olduğunu (%20), ardından Satınalma Süreci (%16), Paydaş İhtiyaç ve Gereksinimlerinin Belirlenmesi Süreci (%9) ve Tedarik Süreci (%8) ile ilişkili olduğu ortaya konulmuştur. Son olarak, Disiplinli Çevik Teslimat metodu kapsamında sunulan alternatif çözümlere dayalı olarak, yazılım sistemi Ar-Ge proje süreçleri için bir iyileştirme yaklaşımı önerilmiştir.

Anahtar Kelimeler: Yazılım Sistemi, Ar-Ge Projesi Zorlukları, ISO/IEC/IEEE 12207, Haritalama Çalışması, Disiplinli Çevik Teslimat

Dedicated to the version of myself who showed up every
single day, even when it was the hardest - and to my beloved
family.

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LIST OF ABBREVIATIONS

CHL	Challenge
DAD	Disciplined Agile Delivery
DSRM	Design Science Research Methodology
E-ID	Expert Identity
ID	Identity
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
LLM	Large Language Models
OECD	Organisation for Economic Co-operation and Development
O-ID	Organization Identity
P-ID	Participant Identity
R&D	Research and Development
RQ	Research Question
SLR	Systematic Literature Review
YoE	Years of Experience

CHAPTER 1

INTRODUCTION

Research and Development (R&D) projects can be defined as projects that are implemented to develop new technology, offer an innovative product/service, or improve an existing product/service to gain new capability [1]. Projects are not considered R&D if they do not introduce a new product, service, or technology. For example, projects that enhance an existing product without using new technology or materials, and projects that produce known products using existing technologies through technology transfer are not specified as R&D projects. Moreover, projects that only include the research phase and do not produce any product/service as a result of the research are not considered within the scope of R&D projects [2–4].

On the other hand, software system R&D projects represent a category of R&D projects where software serves as the primary component of the final product. While these projects may include hardware and data components, and therefore the overall system necessary for the software operation, the focus remains on the software development [5].

R&D projects conducted across nearly every sector are driven by rapid technological advancements, particularly software-based innovations such as artificial intelligence (AI), machine learning, and deep learning [2]. Consequently, companies are increasing their investments in these fields, further emphasizing the importance of R&D projects [2][3]. An analysis of the total R&D expenditures of Organisation for Economic Co-operation and Development (OECD) member countries between 2017 and 2022 reveals a significant increase. Total R&D expenditure rose to around 1,700,000 million USD in 2022, reflecting a 25% increase over just five years [4][5]. As investments in R&D projects and their significance continue to grow, companies and governments have increasingly undertaken more R&D-based initiatives while seeking ways to manage them more effectively [6][7]. When conducting R&D projects, numerous challenges may arise because of their unknown and complex nature. Some of these challenges include the following:

- R&D projects inherently have ambiguous customer requirements. Furthermore, the lack of timely feedback from customers can adversely affect the project's delivery schedule and budget [8].
- Addressing priorities in R&D projects may be challenging due to limited resources and rapid pace of technological changes [1, 8–10].

- Transforming customer needs into system and software requirements can be challenging in R&D projects, especially when there are technical and financial limitations. In such a context, it may be inevitable to encounter conflicts between the stakeholder requests and possible technological solutions [8]. For example, customers may request to use augmented reality glasses in an outdoor environment; even though such a technology platform may not be suitable for outdoor usage.
- The fast evolution of tools and techniques, combined with shifting customer expectations, makes it challenging to forecast requirements in the long term and adapt to changes effectively [8, 11].
- R&D projects often require various stakeholders working in different environments, which can lead to communication challenges in these distributed settings. Geographical distribution among teams may cause delays and misunderstandings in exchanging critical information. This issue complicates coordination, making it challenging to maintain a unified vision for projects and delaying timely decision-making, ultimately impacting the project's effectiveness [11, 12].

One of the key factors in achieving more efficient R&D projects' management is understanding and addressing the challenges encountered throughout these projects. Therefore, the motivation of this study is to identify and analyze challenges in software system R&D projects to provide flexible and adaptable solutions. Although certain standards/methods/approaches are available in literature and in practice, there is a need for an approach with guidance capability that supports the selection of appropriate practices to be implemented.

This thesis explores the challenges of software system R&D projects along with their detailed analysis and reveals with an international standard ISO/IEC/IEEE 12207 Systems and Software Engineering – Software Life Cycle Processes, and a challenge-driven Disciplined Agile Delivery approach to prevent/overcome the challenges in software system R&D projects.

This chapter outlines the problem statement, the purpose of the study, and its significance in the following subsections. Moreover, the research method employed in this study is explained. Finally, the structure of the thesis is presented.

1.1. Statement of the Problem

In literature, studies addressing problematic issues in R&D projects have been conducted across various domains. Dybek and Glodzinski [13] state that bureaucracy in decision-making processes, budget management issues, and planning deficiencies are significant problems in military R&D projects. Similarly, cooperation management problems in large-scale collaborative projects have been reported to impact project success negatively [14]. More broadly, issues related to the effective management of

human resources, change management, customer orientation, and process efficiency have been reported related to R&D projects [6, 15]. Additionally, studies in literature have pointed out challenges based on a lack of customer focus [15, 16] in R&D projects. Technical process-related problems such as deficiencies in requirements gathering, architectural design, and interoperability have also been identified [17]. Furthermore, inadequate stakeholder management [18, 19] project management failures [20], and supply chain-related risks [21] have also been identified in R&D projects. Although referred studies have addressed challenges in various R&D projects in a limited manner, focusing on specific domains and processes, there remains a need to examine challenges within the context of the software system R&D projects to prevent/overcome these challenges.

1.2. Purpose of the Study

The purpose of this study is to provide solutions to the challenges encountered in software system R&D projects. To achieve this, the study first identifies and systematically examines the challenges in software system R&D projects, analyzes their distribution within a process-oriented framework, and identifies the specific processes to which they are most strongly related. These efforts aim to highlight critical problem areas at the process level and proposes approaches for preventing or overcoming these challenges.

This research aims to answer the research questions presented in Table 1, using the specified research methods.

Table 1: Research Questions and Methods

ID	Research Question (RQ)	Methods to Answer RQ	Related Chapter in Study
RQ1:	What are the existing process models developed for/adapted to R&D projects?	<ul style="list-style-type: none"> Systematic Literature Review 	CHAPTER 3
RQ2:	How suitable are existing process models for software system R&D projects? What are their strengths and weaknesses?	<ul style="list-style-type: none"> Criteria-Based Evaluation using 5-Point Likert Scale 	CHAPTER 3
RQ3:	What are the challenges faced by stakeholders in varying roles in software system R&D projects?	<ul style="list-style-type: none"> Semi-Structured Interviews Thematic Analysis 	CHAPTER 4
RQ4:	Which processes are associated with the challenges encountered in software system R&D projects?	<ul style="list-style-type: none"> Process Mapping based on ISO/IEC/IEEE 12207 	CHAPTER 4

Table 1 (cont.)

ID	Research Question (RQ)	Methods to Answer RQ	Related Chapter in Study
RQ5:	What is the perceived suitability of the Disciplined Agile Delivery (DAD) framework for preventing/resolving challenges in software system R&D projects?	<ul style="list-style-type: none"> • Expert Review • Criteria-Based Evaluation using 5-Point Likert Scale 	CHAPTER 5 CHAPTER 6

1.3. Significance of the Study

R&D projects, due to their inherent uncertainty and complexity, are challenging to manage from both administrative and technical perspectives. However, the literature lacks a study that clearly identifies the challenges encountered in software system R&D projects and proposes solutions that are both generalizable and adaptable across diverse contexts. This thesis addresses this gap by comprehensively identifying and articulating these challenges through interviews conducted with participants from various roles serve on software system R&D. Furthermore, through the thematic analysis of challenges and the detailed mapping of these challenges to processes in the ISO/IEC/IEEE 12207 standard, this thesis provides to filling the gap in the literature regarding the challenge–process relationship and data enabling researchers and professionals to identify and relate similar problems to their own work.

In addition, the literature lacks a challenge-focused methodology that is applicable to diverse project, team, and organizational contexts, and existing process models have been observed to fall short in providing the necessary flexibility. The challenge-driven approach developed in this thesis offers a flexible, adaptable methodology suitable for varying conditions, while maintaining a clear focus on addressing identified challenges. This methodology benefits both academic literature and industry practice by providing researchers and practitioners with a structured means to identify problems and generate effective solutions.

1.4. Research Methodology

Design Science Research Methodology (DSRM) offers an approach for generating and evaluating artifacts to solve organizational problems [22]. Thus, the DSR methodology is applied since this approach aligns with the objectives of our study which are identifying real-world problems and developing approaches for their solutions [22]. DSRM consists of six steps, which are problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication [23]. The conducted studies for each step are shown in Figure 1.

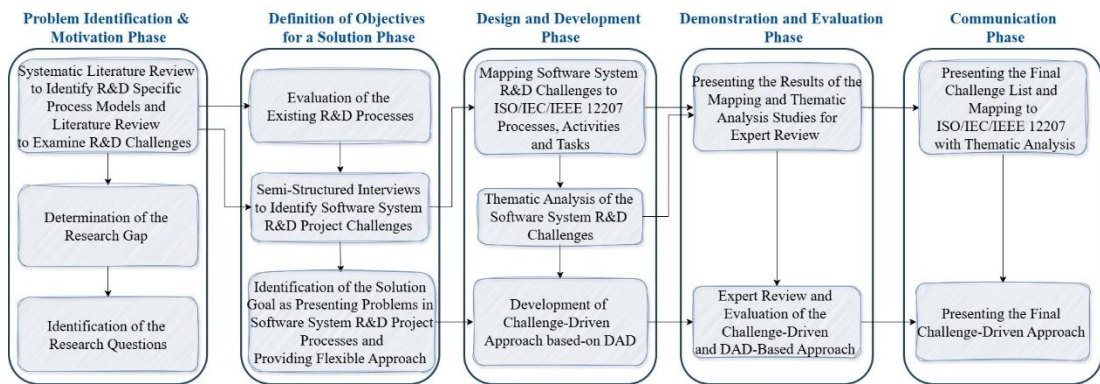


Figure 1 Phases of Design Science Research Methodology

In **problem identification and motivation phase**, literature reviews were conducted to identify the R&D specific process models and software system R&D project challenges. Accordingly, the need for process improvement in software system R&D projects was recognized. Finally, the research questions were discussed and determined.

In **definition of objectives for a solution phase**, after the identification of the problem, existing process models were analyzed in detail and evaluated to explore their limitations. In addition, semi-structured interviews were conducted to understand problems in software system R&D processes. Thus, the objectives for the solution was identified as:

O1: Presenting challenges in software system R&D projects clearly,

O2: Providing flexible approach to prevent/resolve the identified challenging issues.

In **design and development phase**, to develop a flexible approach for software system R&D projects processes, the determined challenges were analyzed and mapped to ISO/IEC/IEEE 12207 process-activity-tasks. Then, the challenge data were analyzed and categorized thematically according to the guideline of Braun and Clarke [24]. Following the mapping and thematic analysis, resources related to the Disciplined Agile Delivery (DAD) methodology were examined, its practices and implementation framework reviewed, and its overall comprehensiveness analyzed. Based on the analysis, it was determined that the DAD framework offers a flexible, Agile-based hybrid structure that can be applied both at the organizational and team levels (i.e., on a broad scale). Consequently, a challenge-driven, DAD-based approach was developed within the scope of this study.

In **demonstration and evaluation phases**, existing processes, challenge mappings to ISO/IEC/IEEE 12207, and categorizations were evaluated by an expert. Also, the challenge-driven approach was reviewed and evaluated by four experts who were the participants of the challenge identification part. In the evaluation phase, meetings were conducted with four professionals to evaluate the approach provided as an output of the design and development phase. These review and evaluation processes were

conducted as one-to-one meetings, and eight criteria with a 5-point Likert Scale were used for assessment. The criteria were selected based on the study providing criteria for DSR artifacts [25]. The assessment criteria used are *Effectiveness, Fidelity with Real World Cases, Correctness, Ease of Use, Understandability, Intention to Use, Completeness*, and *Adaptability*.

In **communication phase**, as the last phase of the DSRM, the findings of the systematic literature review conducted as part of this study were presented at the 3rd International Congress of Electrical and Computer Engineering, held from 27 to 30 November 2024, and are scheduled for publication in September 2025 in Springer. Furthermore, the challenges identified in software system R&D projects, along with the challenge-driven approach, are presented in this thesis. Additionally, expert evaluations of the approach are provided in the relevant sections of the thesis.

1.5. Organization of the Thesis

The rest of the thesis is structured as follows:

Chapter 2 provides an overview of the “ISO/IEC/IEEE 12207 Systems and Software Engineering - Software Life Cycle Processes” standard used in the mapping study and the Disciplined Agile Delivery (DAD) framework employed in the proposed approach. Chapter 3 provides information on the Systematic Literature Review that was conducted, including the keywords used, the results obtained, and the R&D models identified through the SLR. Chapter 4 presents the challenges identified through semi-structured interviews and mapping of the identified challenges with their thematic analysis. Chapter 5 describes the approach developed to adapt the proposed DAD framework to software system R&D challenges to avoid/overcome software system R&D challenges. It also demonstrates the application of the developed approach on a selected sample of identified challenges. Chapter 6 explains the evaluation of the proposed approach by DAD-based options. The chapter discusses how the proposed approach and its structured approach were evaluated based on multiple criteria and the results of the assessments. Chapter 7 discusses R&D project challenges and process models in light of both the existing literature and the findings of this study. Chapter 8 explains the theoretical and practical implications of the study and offers recommendations for future work.

CHAPTER 2

BACKGROUND

This chapter gives background on the main components of this research: ISO/IEC/IEEE 12207 Systems and Software Engineering – Software Life Cycle Processes Standard and Disciplined Agile Delivery Framework.

2.1. ISO/IEC/IEEE 12207 Systems and Software Engineering – Software Life Cycle Processes

As an international standard, ISO/IEC/IEEE 12207 is designed to establish a common framework for software life cycle processes. The standard defines activities for fundamental software life cycle processes such as acquisition, development, supply, operation, and maintenance, etc., in software system projects, along with the detailed tasks required to successfully execute these activities [5].

The standard organizes the processes into four main process groups: Agreement Processes (e.g., Acquisition Process), Organizational Project-Enabling Processes (e.g., Human Resources Management Process), Technical Management Processes (e.g., Project Planning Process), and Technical Processes (e.g., Design Process), comprising a total of 30 processes, which were detailed in Table 2.

Table 2: ISO/IEC/IEEE 12207 Process Groups and Processes

Process Groups	Processes
6.1 Agreement Processes	6.1.1 Acquisition Process
	6.1.2 Supply Process
6.2 Organizational Project-Enabling Processes	6.2.1 Life Cycle Model Management Process
	6.2.2 Infrastructure Management Process
	6.2.3 Portfolio Management Process
	6.2.4 Human Resource Management Process
	6.2.5 Quality Management Process
	6.2.6 Knowledge Management Process
6.3 Technical Management Processes	6.3.1 Project Planning Process
	6.3.2 Project Assessment and Control Process
	6.3.3 Decision Management Process
	6.3.4 Risk Management Process

Table 2 (cont.)

Process Groups	Processes
6.3 Technical Management Processes	6.3.5 Configuration Management Process
	6.3.6 Information Management Process
	6.3.7 Measurement Process
	6.3.8 Quality Assurance Process
6.4 Technical Processes	6.4.1 Business or Mission Analysis Process
	6.4.2 Stakeholder Needs and Requirements Definition Process
	6.4.3 System/Software Requirements Definition Process
	6.4.4 Architecture Definition Process
	6.4.5 Design Definition Process
	6.4.6 System Analysis Process
	6.4.7 Implementation Process
	6.4.8 Integration Process
	6.4.9 Verification Process
	6.4.10 Transition Process
	6.4.11 Validation Process
	6.4.12 Operation Process
	6.4.13 Maintenance Process
	6.4.14 Disposal Process
Annex A	Tailoring Process

For each process, the standard defines the purpose and expected outcomes of the related process, and the activities and tasks that need to be implemented to achieve the outcomes of a process [5]. This structured process organization ensures a comprehensive understanding of the software lifecycle and offers a foundation for systematically mapping identified challenges to specific processes within software system R&D projects.

2.2. Disciplined Agile Delivery (DAD)

The Disciplined Agile Delivery (DAD) framework emerged in the early 2000s, by Ambler of IBM Rational and Lines at various organizations worked on implementing and promoting Agile practices, observing certain shortcomings and incompatibilities. Among the challenges they encountered were the inability to scale practices beyond a pilot team, difficulties faced by some organizations in applying Agile methods in their original form, and the added complexity of Agile when combined with the controlled progress structure of traditional methodologies. A key reason behind these issues was the limited scope of Agile methods, which often failed to address many stages of the Information Technology (IT) delivery cycle and focused primarily on deliverable products [26].

After realizing these issues, Ambler has developed the Disciplined Agile Delivery process framework, and he has been developing the framework with Lines nowadays [26]. Thus, Disciplined Agile Delivery was defined as a process framework built on hybrid, goal-driven, and Agile practices, which individuals, teams, and organizations can tailor to fit their specific needs [27, 28].

2.2.1. Structure of the DAD

Disciplined Agile Delivery offers a decision framework based on a Phase-Goal-Decision Point-Options structure [28–31]. The structure and its components are explained below.

DAD Phase: In the context of DAD Phases, the stages of the project were identified in a lean way, and these phases were defined as Inception, Construction, and Transition by DAD [29].

DAD Process Goal: As one of DAD’s primary purposes is to provide a goal-driven approach for making process-related decisions, the defined process goals of DAD aim to guide users in identifying and setting their improvement goals. DAD defines 24 process goals [32].

DAD Decision Point: Defined under each Process Goal, these elements represent specific intents that require decision-making. They were previously referred to as process factors/issues [29].

DAD Option: These are the practice/strategy choices that can be applied and are shown to the right of the decision point [29].

- **Default Option:** The recommended outset option defined by DAD. Default options were marked bold in DA Knowledge Base [33] in DA tool kit. If the option is not suitable for your team/situation, you can choose among the other options [29].
- **Ordered Option List:** While the project team is expected to select the option that best fits their context, the approach is designed to support teams that need guidance or prefer to make decisions based on the level of recommendation for each option. These are presented as option lists marked with an upward-pointing arrow. The option at the top is the most aligned with lean and Agile principles, whereas the one at the bottom is the least compatible [29].
- **Unordered Option List:** The options are presented in no particular order, as each has its own advantages and disadvantages [29].

DAD offers a structure called DA Knowledge Base [33], which includes all of these components and is accessible over the Internet. This study primarily focuses on developing approach based on this structure.

CHAPTER 3

SYSTEMATIC LITERATURE REVIEW

This chapter represents the systematic literature review (SLR) process that was carried out to identify process models that were developed or adapted specifically for R&D projects and already exist in the literature, as referred to in RQ1. Moreover, the identified process models are evaluated and their strengths and weaknesses are examined in this chapter, as referred to in RQ2.

This chapter was presented at the 3rd International Congress of Electrical and Computer Engineering, held from 27 to 30 November 2024, and scheduled to be published in September 2025 in Springer.

In system/software development projects, process models define the various stages of a project and specify the processes associated with each stage, as utilized by companies involved in these projects. Conversely, process reference methods offer detailed guidance on executing a series of processes, detailing the specific steps involved in each process, including roles and necessary activities. In this study, our focus is specifically on process models, aiming to explore their role in guiding the implementation and management of processes, thereby distinguishing our approach from those that prioritize broader process reference methods.

In their research, Pavia et al. [34] evaluate various existing R&D process models, focusing on the R&D Standard Processes [35], the Higher Degree Process Model (HDG) [36], the Framework for Web-based Research Support System (WRSS) [37], and eXtreme Researching (XR) [9]. Their study identifies nine key requirements, particularly in fields like applied computing. These key requirements include aspects such as preparation for development, life cycle, management, quality assurance, collaborative and distributed development, research development activities, and academy-industry collaborations [34]. As a result of this study, they determined that the approach best suited to meet the nine identified requirements is XR.

Considering the identified need and context, the purpose of our research is to explore and evaluate existing process models developed/tailored specifically for R&D projects. The objectives of this study are:

1. Identify the existing process models that have been developed or adapted for R&D projects.
2. Assess the applicability of these models, considering the specific challenges associated with system/software R&D projects.
3. Analyze the strengths and weaknesses of the current R&D process models to understand their effectiveness.

To achieve these objectives, we first applied a systematic literature review (SLR) and specified six process models developed/tailored for system and software R&D projects. Following this, a critical examination of these models was carried out using specific evaluation criteria.

3.1. Research Approach

In this study, we applied qualitative research and first conducted an SLR to achieve the 1st objective, which is about identifying process models/processes developed or tailored for R&D projects in the literature. Then, to achieve the 2nd and 3rd objectives given above, we evaluated identified process models based on the predefined criteria using a 5-Point Likert Scale. These criteria include *Level of Detail*, *Completeness*, *Correctness*, and *Adaptability*. They were defined considering the characteristics of R&D process models and similar studies [38]. Below, we explain each research step in detail.

3.2. Systematic Literature Review (SLR) on Existing R&D Process Models

SLR was conducted to comprehensively identify the process models developed for R&D projects. While conducting the SLR, the Kitchenham's guideline for performing SLRs in Software Engineering [39] was followed. In line with this guideline, the keywords listed in Table 3 were identified and proceeded with the SLR accordingly.

For the SLR, keywords given in Table 3 were searched in the IEEE Xplore (I), ACM (A) digital libraries and Google Scholar (S). The total number of studies found, and the elimination results are also provided in the table below.

Table 3: SLR Keywords and Evaluation Results

Literature Review Finding Results									
Keyword	Initial Search ^a			1 st Evaluation Results ^b			2 nd Evaluation Results ^c		
	I	A	S	I	A	S	I	A	S
"research and development" laboratory AND "software system" OR "research based software project"	2894	1486	21850	1	0	2	0	0	1
"software research and development" laboratory OR "software research and development laboratory workflows"	13	46	1811	0	0	4	0	0	0
"research and software development" laboratory AND workflows	131	1347	33400	2	0	3	0	0	0

Table 3 (cont.)

Literature Review Finding Results									
Keyword	Initial Search ^a			1 st Evaluation Results ^b			2 nd Evaluation Results ^c		
	I	A	S	I	A	S	I	A	S
"research life cycle" OR "R&D lifecycle" OR "R&D life cycle"	26	50	3859	0	0	3	0	0	2
scrum based r&d	11	838	15651	0	0	3	0	0	2
Snowballing		-				13			3
						Total			
							31		8

^{a.} Total number of studies found without any elimination

^{b.} Studies that were evaluated as appropriate by examining the title and abstract

^{c.} Studies that were examined in detail with inclusion/exclusion criteria

During the SLR process, a two-stage elimination process was applied to the identified articles, as outlined in the table above. In the first stage, the title and abstract of the identified articles were reviewed, and they were selected based on the following inclusion criteria:

- Article published either in English or Turkish.
- Article demonstrates quality and academic validity, such as publication in peer-reviewed journals or conference proceedings.
- Article mentions R&D projects and the process models developed/adapted for these projects in its title/abstract.

In the second stage of the elimination process, the following inclusion criteria were used:

- Studies that involve the development or application of process models specifically for system/software R&D projects.
- Studies that are based on models used in software/system projects or that provide practices that can be applied in software/system R&D projects.

Only studies that met this criterion, after a thorough evaluation of their content, were included.

In addition, the articles were excluded if:

- The study was specific to certain industries such as medical, pharmaceutical, automotive or others that do not include the part of the system/software R&D.

- They did not directly address the development/application of processes/process models for R&D projects.

This process ensured that only relevant articles that met these criteria were included in the evaluation.

It is emphasized that this literature review revealed a notably low number of models specifically developed or adapted for R&D projects. Additionally, it is observed that many studies that provide process model for R&D projects focus on R&D projects in the medical-pharmaceutical sector or projects that only include the research phase [40–44]. These studies were excluded from the evaluation based on the inclusion/exclusion criteria defined above.

According to the results of elimination with the 2nd evaluation stage, six process models/life cycle models have been detected. These models are R&D Standard Processes [35], Framework for WRSS [37], Extreme Researching (XR) [9, 45], 6-Phases Project Life Cycle [1], Scrum Together with UML Models [12], and Agile Methodology for txtUML [46]. Thus, the final focused models are explained below.

3.3. R&D Standard Processes

The R&D Standard Processes [35] model outlines four main processes and their sub-categories. Processes defined in R&D Standard Processes model are shown in Table 4.

Table 4: R&D Standard Processes

Processes	Sub-Categories
R&D Life Cycle Processes	System / Software
	Devices
	Basic Technology
	Standardization
	Policy and Strategy
Supporting Processes	No sub-categories.
Project Management Processes	No sub-categories.
Organizational Processes	No sub-categories.

3.4. Framework for Web-based Research Support System (WRSS)

WRSS [37] was developed to draw a framework with explaining research processes and methods for web-based research support systems. This model defines seven different phases as shown in Table 5.

Table 5: Phases of Framework for WRSS

Phases	Phase Naming
Phase 1	Idea-generating phase
Phase 2	Problem-definition phase
Phase 3	Procedure-design/planning phase
Phase 4	Observation/experimentation phase
Phase 5	Data-analysis phase
Phase 6	Results-interpretation phase
Phase 7	Communication phase

3.5. Extreme Researching (XR)

XR [9, 45] is a model developed by a team at Ericsson company focusing on applied research. The foundation of the model is based on eXtreme Programming (XP), a methodology from Agile methods. The practices included in XR are shown in Table 6.

Table 6: XR Activities

Activities	Activity Naming
Activity 1	Frequent integration
Activity 2	Remote pair programming
Activity 3	On-site customer
Activity 4	Collective knowledge
Activity 5	Planning game
Activity 6	Metaphor
Activity 7	40h week on average
Activity 8	Coding standards
Activity 9	Controlled software spikes
Activity 10	Testing
Activity 11	Refactoring
Activity 12	Object-oriented component-based modelling

3.6. 6-Phases Project Life Cycle

The 6-Phases Project Life Cycle [1] is a model that primarily outlines the six main phases that R&D projects should have. These phases are as shown in Table 7.

Table 7: 6-Phases Project Life Cycle

Phases	Phase Naming
Phase 1	Initial Scoping
Phase 2	Project Specification
Phase 3	Detailed Planning
Phase 4	Implementation via Actions and Review
Phase 5	Completion with Delivery
Phase 6	Post-Project Evaluation

3.7. Scrum Together with UML Models

The model described with Scrum Together with UML Models [12] is actually hybrid (Waterfall, Scrum, Rational Unified Process (RUP), and XP) life cycle model adapted to an R&D project. In this model, the authors described three main phases and activities related to these phases and these are as shown in Table 8.

Table 8: Phases of Scrum Together with UML Models

Phases	Processes of Phases
Initialization	Business Modeling
	Requirements
	Analysis and Design
Implementation	Implementation
Deployment	Deploy
	Test

3.8. Agile Methodology for txtUML

The Agile Methodology for txtUML model [46] is an adapted version of Scrum, tailored for an R&D team developing txtUML software. The events tailored from Scrum events are as shown in Table 9.

Table 9: Events of Agile Methodology for txtUML

Events	Event Naming
Event 1	Preparation
Event 2	Weekly Routine
Event 3	Retrospective
Event 4	Demonstration

3.9. Evaluation of Existing Process Models

In this section, the determined models were evaluated by their suitability for R&D projects using the criteria of Level of Detail, Completeness, Correctness, and Adaptability.

As mentioned earlier, these criteria were defined based on a similar study [38]. These criteria are adapted to fit the context of the research. The definitions of the criteria are provided below and detailed meanings of each criterion for the 5-point Likert Scale are provided in Table 10.

- **Level of Detail:** This criterion aims to evaluate the level of detail at which the model specifies its phases, processes, activities, inputs, and outputs. It is assessed that how thoroughly the models define their processes, phases, practices, and activities. This includes evaluating how well they specify the practices and activities required within their scope.
- **Completeness:** This criterion aims to assess how effectively the model incorporates both the "research" and "development" aspects of R&D projects.
- **Correctness:** This criterion aims to evaluate how accurately the model describes de facto practices/methods. Thus, it is assessed that how well the defined models adhere to established practices, methodologies, and activities.
- **Adaptability:** This criterion aims to assess how well the model can be adapted to Software Research and Development Project(s).

Table 10: Criteria for Evaluation of R&D Process Models

Likert Scale		Criteria		
Score	Level of Detail	Completeness	Correctness	Adaptability
1- Very Poor	Details of defined processes/practices/activities are minimal or absent.	"Research" or "software development" processes/practices/activities are not addressed or are minimally covered, lacking comprehensiveness in evaluating both aspects.	Accuracy of defined practices/processes/activities are uncertain or mostly incorrect.	The processes/practices/activities show minimal or no potential for adaptation to software R&D projects.

Table 10 (cont.)

Likert Scale		Criteria		
Score	Level of Detail	Completeness	Correctness	Adaptability
2- Poor	Phases/processes/activities are defined in a low level of detail.	Both "research" and "software development" processes/practices/activities are inadequately or unclearly addressed, lacking comprehensive evaluation of both aspects.	Accuracy of defined practices/processes/activities is inadequate or unclear.	The processes/practices/activities have limited potential for adaptation to software R&D projects and may require significant modifications.
3- Neutral	Details of phases/processes/activities are moderately specified.	Both "research" and "software development" processes/practices/activities are moderately addressed, but there may be gaps or inconsistencies in evaluating both aspects comprehensively.	Accuracy of defined practices/processes/activities is moderate.	The processes/practices/activities show moderate potential for adaptation to software R&D projects, with some adjustments needed.
4- Good	Details of phases/processes/activities are mostly specified.	Both "research" and "software development" processes/practices/activities are mostly addressed, demonstrating a comprehensive evaluation of both aspects.	Accuracy of defined practices/processes/activities is mostly correct.	The processes/practices/activities demonstrate considerable potential for adaptation to software R&D projects with minor adjustments.
5- Excellent	Details of phases/processes/activities, work products, inputs and outputs are well defined.	Both "research" and "software development" processes/practices/activities are addressed thoroughly and comprehensively, ensuring a comprehensive evaluation of both aspects.	Accuracy of defined practices/processes/activities is highly correct and reliable.	The processes/practices/activities exhibit exceptional potential for adaptation to software R&D projects with minimal modifications required.

3.10. Detailed Review of Evaluation Results of Identified R&D Process Models via Determined Criteria

In accordance with the criteria and the 5-point Likert Scale outlined in Table 11, R&D Standard Processes, Framework for WRSS, XR, 6-Phases Project Life Cycle, Scrum Together with UML Models, and Agile Methodology for txtUML determined by the Literature Review were evaluated by the author. The results of this evaluation and explanation regarding the scores assigned to each criterion for each process model is given in Table 11. This evaluation study was reviewed by the expert who has over 20 years of academic experience in software technologies.

Table 11: Detailed Review and Evaluation Results of R&D Process Models

R&D Process Models	Criteria							
	<i>Level of Detail</i>		<i>Completeness</i>		<i>Correctness</i>		<i>Adaptability</i>	
	S	Explanation	S	Explanation	S	Explanation	S	Explanation
<i>R&D Standard Processes</i>	3	- Comprehensive coverage of processes and sub-categories - Lacks detailed explanations of activities. -Difficult to map specifically to research or development activities	3	- Applicable processes can be inferred for both research and development - Lacks explicit internal mapping between research and development processes and sub-categories	3	-Adheres to established practices and methodologies -Moderate alignment with standard project management processes	3	- Moderate adaptability to R&D projects with necessary adjustments - Covers different process types, making it useful for diverse contexts
<i>Framework for WRSS</i>	1	- High-level phases that indicate activities but lack detailed descriptions - Insufficient detail on practices and steps required within each phase	1	- Only focuses on research activities and neglects software development aspects - Lacks comprehensiveness for a full R&D process	3	- Moderate alignment with standard research phases and methodologies	2	- Mainly focused on research activities, which limits broader applicability

Table 11 (cont.)

R&D Process Models	Criteria							
	<i>Level of Detail</i>		<i>Completeness</i>		<i>Correctness</i>		<i>Adaptability</i>	
	S	Explanation	S	Explanation	S	Explanation	S	Explanation
<i>Extreme Researching (XR)</i>	2	- Activities are defined at a low level of detail, providing flexibility but lacking depth	4	- Primarily focuses on research but includes elements adapted from a software development methodology	4	- Derived from a recognized software development methodology, adapted for research	4	- Based on an Agile software development methodology, making it easy to implement in suitable contexts
<i>6-Phases Project Life Cycle</i>	1	- Phases presented in a generic way - Lacks detailed practices and activities, making the phases high-level without sufficient resolution	1	- Limited focus on research and development practices - Overlooks specific software development activities	3	- Aligns with widely accepted management processes but lacks specificity in research and development activities	2	- Significant modifications are required for adaptation to R&D contexts, especially those involving development aspects
<i>Scrum Together with UML Models</i>	4	-High level of detail for phases -Explains when to use which life cycle model	4	-Covers both research and development perspective mostly	3	- Difficulty in assessing completeness due to its complex structure - Mostly designed in accordance with general practices	3	-Adaptability of events and phases varies depending on the project
<i>Agile Methodology for txtUML</i>	3	-Not sufficient to explain research activities and their outputs	3	-Limited focus on research activities	2	-Determined events are a bit far from the original purpose	2	-Determined events and roles are highly project specific

3.11. Strengths and Weaknesses of Existing Process Models

Based on the evaluation results, the strengths and weaknesses of the process models are described below.

3.11.1. *R&D Standard Processes*

Strengths: Since it is designed considering various process groups, it includes almost every process necessary for implementation throughout a project. In this aspect, it comprehensively presents processes and sub-categories ranging from project management processes to organizational processes, and even support processes. For these reasons, it is designed as an adaptable model for both R&D projects and other types of projects.

Weaknesses: Due to its inclusion of many different processes, it is designed as a highly comprehensive model, and the resolution of the mentioned sub-categories in the model is quite low. Since specific practices and activities to be implemented within each sub-category are not defined, the model has some deficiencies in its guiding aspects. Furthermore, apart from well-known traditional processes, the model does not include any specific processes, practices, or activities unique to R&D projects. Therefore, it lacks distinguishing features that set it apart from processes applied to any project. *Framework for WRSS*

Strengths: The names of the phases in the model are designed to describe the activities to be carried out during each phase. The phases specified in this model cover the majority of the stages generally required in an R&D project.

Weaknesses: While the model comprehensively addresses and divides the stages of an R&D project into phases, the level of detail within these phases is insufficient. This means that the phases defined in this model are very high-level. While each phase's purpose is superficially explained, the steps required to achieve this purpose, as well as the practices and activities to be implemented, are not addressed. Additionally, inputs and outputs are not defined. Moreover, a clear framework is not outlined. Although the phase names do not explicitly suggest a sole focus on research, the lack of discussion on the activities to be carried out in each phase makes it challenging to assess the model's comprehensiveness for both research and development activities. Some phases, like Phase 3, are broadly named. While combining design and planning in one phase is feasible, it can further complicate the already complex structure of R&D projects.

3.11.3. *Extreme Researching (XR)*

Strengths: In the scope of the study [9], a software development methodology, specifically XP, was utilized and adapted to fit research activities. This adaptation aims to enhance the applicability of the methodology in both the research and development activities of R&D projects.

Weaknesses: Since the model was developed using Agile methodology, it is primarily applicable to projects where an Agile lifecycle can be implemented.

3.11.4. 6-Phases Project Life Cycle

Strengths: The 6-Phases Project Life Cycle model is suitable for outlining a general framework for the phases to be applied in R&D projects. Since the phases are considered in a generic manner, they can serve as a basis for constructing the lifecycle of any R&D project. The phases listed here can be further elaborated and tailored to the specific characteristics of each project.

Weaknesses: The phases are presented in a generic manner. Since specific practices and activities for each phase are not defined, the identified phases remain high-level. The model does not include a phase specific to R&D projects but provides a general framework that can be applied and adapted to any project.

3.11.5. Scrum Together with UML Models

Strengths: One of the strengths of this model is that it tailors universally recognized lifecycle models to the specific dynamics of R&D projects. Additionally, the adaptation is illustrated through a case study of a sample project, which further contributes to the clarity and understanding of the applied lifecycle model.

Weaknesses: It has been evaluated that designing a hybrid model by drawing inspiration from several lifecycle models (i.e., Waterfall, Scrum, RUP, XP) has led to a complex structure. Selecting only the practices suited to their projects from each model and applying them after modification has been assessed as creating a standardization issue. This, in turn, makes the adapted model more difficult to apply to other projects. Additionally, it has been evaluated that carrying out the majority of research activities during the initialization phase (and thus within a waterfall cycle) would provide a limited response to the ongoing research needs inherent to R&D projects. This approach may not fully align with the continuous exploration required throughout the project lifecycle.

3.11.6. Agile Methodology for txtUML

Strengths: The flexibility of the methodology, derived from its adaptation of the Scrum methodology, is a key strength. This flexibility enhances its adaptability to other projects, allowing it to be customized for different project requirements.

Weaknesses: Despite being adapted from Scrum, significant deviations in the implementation of core Scrum events are considered weaknesses. For instance, the daily Scrum is conducted weekly, the frequency of sprints is not clearly defined, and the sprint review is not implemented. These deviations diminish one of Scrum's primary advantages-continuous feedback. As a result, the adapted methodology fails to provide sufficient feedback frequency for an R&D project.

3.12. Results of the Study

The primary outcomes of the study are as follows:

- It has been identified that there is no consistency in terminology within R&D process models. While some refer to it as a "framework," others use the term "life cycle." This lack of uniformity in naming has been found to cause confusion and indicates that the terminology used is not always aligned with the content of the models.
- Most of the R&D models do not clearly define the types of R&D projects they are suitable for, nor do they specify the project challenges they are designed to address. Moreover, most of them do not provide clear guidance on when and which practices should be used. These gaps limit the applicability of these models across different R&D project types.
- It has been determined that R&D processes should be differentiated from standard software/system development life cycle processes due to the unique, complex, and exploratory nature of R&D projects. In this context, considering the deficiencies in the processes specific to R&D projects outlined in the literature, it is recommended either to design a separate process or to adapt standard process models for these projects.

These outcomes have provided us a comprehensive understanding of the current landscape of R&D methodologies, with highlighting areas for improvement. This process has enabled us to draw conclusions on what to focus on when developing and evaluating the effectiveness of our R&D approach. It has also emphasized the importance of defining the characteristics of the R&D projects our approach will target, setting clear boundaries, and developing practical solutions to address specific challenges encountered in these projects. Therefore, it is crucial to ensure that our approach addresses these gaps by providing clear, actionable guidance tailored to different types of R&D projects and their specific challenges.

In conclusion, we determined that the following aspects should be considered when developing an approach for an R&D project:

- Identification of Core Challenges and Determine Practical Solutions: Designing a model by understanding the primary challenges encountered in R&D projects and determining effective practices to address them.
- Applicability to Project Types: Determining which types of R&D projects (system/software/medical, constructed/in-house) the methodology can be applied to or adapted for.

CHAPTER 4

SOFTWARE SYSTEM R&D PROJECT CHALLENGES

This section provides details on research methodology, data collection process, and approach used to uncover the software system R&D project's challenges, map the identified challenges through the analysis of the collected data, and categorization of these challenges.

The purpose of this section is to address the following RQs:

RQ3: What are the challenges faced by stakeholders in varying roles in software system R&D projects?

RQ4: Which processes are associated with the challenges encountered in software system R&D projects?

To answer these questions, a qualitative research method was applied. Firstly, semi-structured interviews were conducted to identify the challenges experienced in software system R&D projects and to uncover these challenges through expert insight, addresses RQ3. Following this, a mapping study was performed using the ISO/IEC/IEEE 12207 standard. This mapping was performed to analyze the frequency of the identified challenges across different processes. As a result, the processes most associated with challenges in software system R&D projects were identified, addresses RQ4. Finally, thematic analysis was conducted to present challenges in an aggregate and precise way.

4.1. Interview Design and Conduct

The semi-structured interview method was chosen as it allows challenges through pre-prepared questions while providing the flexibility to ask additional questions based on participants' responses. Participants for the interview study were selected through purposive sampling to ensure relevance and depth. They were required to have at least three years of experience and work in various roles in software system R&D projects. Furthermore, to ensure diverse and comprehensive contributions to the research, participants were selected from various roles.

Interviews were conducted with 12 individuals from five different organizations, representing nine different job titles. The participant profiles are provided in Table 12. In the table, each interview participant is assigned a participant ID (P-ID). The stakeholder role column indicates the participant's role within the R&D project. Also, participants' job titles and their years of experience (YoE) in these job titles are also

provided in Table 12. The organizations where participants work are identified using letter codes (i.e. A, B, C, D, E) and are listed in the organization ID (O-ID) column.

Table 12: Interview Participants' Profiles

P-ID	Stakeholder Role	Job Title	YoE	O-ID
P1	Project Team Member	Quality Engineer	13	A
P2	Project Team Member	Quality Engineer	17	A
P3	Project Team Member	Test Engineer & Team Leader	5	A
P4	Project Manager	Project Manager	16	A
P5	Project Team Member	R&D Team Leader, Product Manager	11	A
P6	Regulatory Body	R&D and Incentive Group Leader	17	A
P7	Project Team Member	Project Engineer	5	A
P8	Support Function Team Member	Business Process Engineer	4	A
P9	Project Team Member	Software Developer & Team Leader	6	B
P10	Project Team Member	Project Engineer	9	C
P11	User	R&D Project Coordinator	13	D
P12	Governmental Customer	Quality and Test Specialist	20	E

The participants were asked pre-determined questions related to Life Cycle Management, Project Management, Quality Assurance, Requirement Analysis, Design, Software Development, Verification and Validation, Subcontractor Management, Procurement, and Communication Management processes. The interviews were conducted face-to-face with nine participants and online with three participants, each session lasting approximately 50-60 minutes. The data collected from the participants' responses were manually documented during the interviews, and at the end of each session, the participants verified the accuracy of the documented responses.

Participants had experience in both self-funded and contracted software system R&D projects, which allowed the study to capture challenges applicable across different project funding types. The characteristics of the participating organizations are described below, and their types and relationships are illustrated in Figure 2.

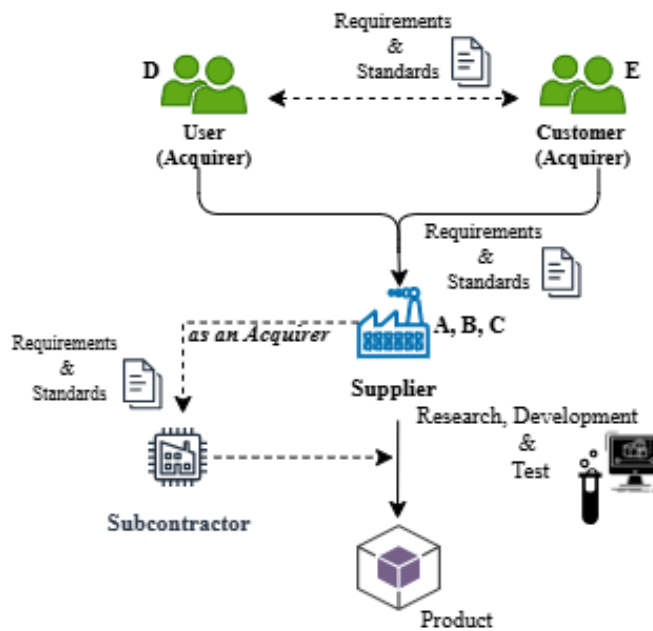


Figure 2 Relationship Between Participating Organizations

There are two types of projects that shape the relationships between participating organizations: government-funded R&D projects and self-funded R&D projects. In government-funded R&D projects, **Organizations A, B, and C** serve as *suppliers*, responsible for developing, testing, and delivering the final product or service to the customer/user. These organizations may also serve as acquirers by subcontracting certain activities of a project. The supplier organizations selected for the interview are large, well-established institutions, each employing between 3,000 and 15,000 people, and all certified at CMMI Level 3. **Organization D**, which is a governmental institute, represents the *user*, the party requiring the product or service. It provides directions such as on the technical requirements and quality standards expected of the final product or service. **Organization E**, which is a *governmental institute*, functions as the *customer*, responsible for procuring the product or service needed by Organization D and plays a regulatory role by defining the scope, standards, and constraints of all project outputs. Additionally, organization E ensures that user expectations and needs are thoroughly analyzed and communicated to the supplier through technical requirements, contracts, and other documentation. It acts as a bridge between the user (D) and the supplier organizations (A, B, and C).

In self-funded R&D projects, organizations A, B, and C act as both users/customers/acquirers and suppliers, meaning they standardize, finance and develop the product using their own internal resources. If the product developed in this way is intended to be offered to external entities, organizations D and E may enter the picture solely as users/customers, not as acquirers.

4.2. Analysis of Interview Data

Participant statements recorded during the interviews were refined to clearly express the challenge, the source of the difficulty, and the root cause of the problem, without introducing any additional information. As a result, a total of 93 challenge instances were identified. All challenges along with their mappings are presented in APPENDIX A.

4.3. Mapping Process and Verification of the Mapping

To systematically map the challenges identified through interviews, the ISO/IEC/IEEE 12207 standard was examined in detail, including its structure, objectives, outputs, activities, and task definitions. Afterwards, each challenge was individually analyzed and matched to relevant process(es) within the ISO/IEC/IEEE 12207 standard using keywords extracted from the challenges. If the initially mapped processes pointed to additional related processes, those connections were also investigated, and further mappings were carried out as needed. Beyond process-level mappings, the root causes reported by participants were considered, and specific activities or tasks potentially contributing to these challenges were identified. In this way, a structured mapping was established not only at the process level but also at the activity and task levels. Finally, all challenges were categorized into first-level themes and second-level categories, enabling a clearer understanding of the relationships between challenges and processes and helping to identify recurring issues and common patterns across different process areas.

For example, an examination of Challenge 29 (CHL 29) in Table 13 shows that the issue arose during the definition of user needs and technical requirements. Accordingly, this challenge was linked to both the Acquisition Process where technical specifications forming the project scope are defined and the Stakeholder Needs and Requirements Definition Process where user needs are clarified. Based on the challenge description, activities and tasks from the ISO/IEC/IEEE 12207 standard related to requirements preparation and consideration of technological constraints were mapped.

Table 13: Example from the Mapped Challenges

CHL ID	Challenge Definition	First-Level Theme	Second-Level Category	Related Process(es)	Related Activity(ies) and Task(s)	Detail of the Task(s)	P-ID
29	<i>“While preparing the technical specifications, the needs are defined without</i>	Technical Management	Inadequate Consideration of Technical Readiness	Acquisition	6.1.1.3.a Prepare for the Acquisition (2)	(2) Prepare a request for the supply of a product or service	P5

Table 13 (cont.)

<i>considering the current technology readiness level, meaning the limitations and capabilities of existing technology are not taken into account.”</i>	Stakeholder	6.4.2.3.d	(1)	that includes the requirements.
	Needs and Requirements Definition	Transform Stakeholder Needs into Stakeholder Requirements (1)	Identify the constraints on a system solution.	

The corresponding first-level theme was finalized as “Technical Management”, and the second-level category was finalized as “Inadequate Consideration of Technical Readiness”. As illustrated in this example, a complete list of all identified challenges, their corresponding process-activity-task mappings, and the finalized first-level themes and second-level categorizations are provided in APPENDIX B.

Following the initial mapping by the author of the thesis, all challenge-process-practice mappings, first-level themes and second-level categories were reviewed, revised where necessary, and validated by an expert, who has over 20 years of academic experience on software technologies. During this review, inappropriate second-level categories were revised, new categories were introduced, and additional process mappings were added where applicable. These updates were discussed in two review meetings involving author of the thesis and expert. The full mapping and category assignments were finalized based on these discussions. As a result of this comprehensive review process, initially there were 45 unique second-level categories and 38 of them were revised to clarify and standardize, and 43 new unique categories were introduced along with 20 new challenge-process mappings. In total, 88 unique second-level categories were identified. Moreover, there were 23 unique first-level themes and 21 of them were revised to clarify and standardize, and 4 new unique categories were introduced. In total, 27 unique first-level themes were identified.

4.4. Analysis of the Challenges

The mapping study results are illustrated in Figure 3 as the number of the challenges associated with each process frequency, and the percentage of all challenges that each process accounts for. Since only one challenge is associated with each of the Configuration Management, Integration, Quality Assurance, Operation, and Tailoring Processes, these are collectively presented as “Other Processes” in the Figure 3.

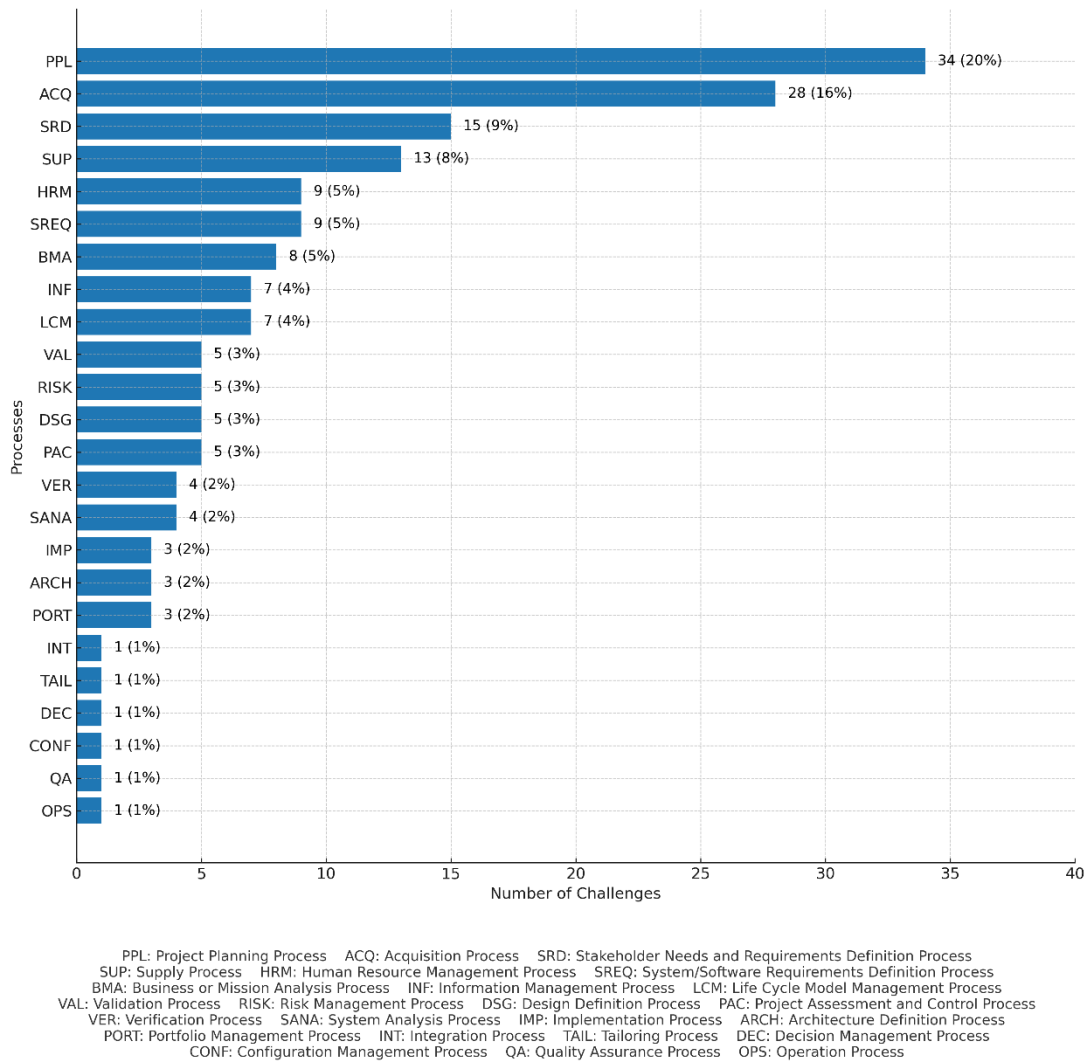


Figure 3 Process-Based Frequency of the Challenges

According to the mapping study, the most challenge associated processes were identified as **Project Planning (20%)**, **Acquisition (16%)**, **Stakeholder Needs and Requirements Definition (9%)**, and **Supply (8%)** processes which means **53%** of the encountered problems occur in these processes. The analysis focuses on these four key processes identified through the mapping study.

4.4.1. Project Planning Process-Related Challenges

Project Planning process ensures the project management and technical activities are effectively planned in terms of scope, time, and resources [5]. Based on the interview results, 34 challenge instances indicated by 11 participants encountered in R&D projects were found to be related to the Project Planning process, and this process was the process with the most challenges (20%). The challenges mapped to the Project Planning Process, along with their first-level themes and second-level categories, are presented in Table 14.

Table 14: First-Level Themes and Second-Level Categorizations of the Challenges Related to the Project Planning Process

	First-Level Theme	Second-Level Category	CHL ID
Project Planning Process	Planning and Scheduling	Insufficient Project Duration	10, 20, 24
		Delay in Testing	4, 16
		Insufficient Project Planning	12, 53
		Lack of Integrated Timeline Management Among Contractors	38, 41
		Design Definition Delay	2
		Inaccurate Project Planning	7
		Inefficient and Contract-Driven Project Planning	1
		Insufficient Roadmap Planning	57
		Lack of Dry Run Tests Before Formal Tests	91
		Lack of Subcontractor Schedule Adherence	41
		Requirements Definition Delay	2
	Estimation and Feasibility	Insufficient Budget	21, 23, 54
		Insufficient Project Duration	10, 20, 24
Insufficient Feasibility Analysis		23	
Limited R&D due to Budget Constraints			
Overestimation of Work		28	
Poor Budget Estimation in Early Stages of a Project		21	
Poor Feasibility Analysis		60	
Poor Timeline Estimation		82	
Scope Management	Poor Scope and Needs Analysis	3, 50, 63	
	Technical Management	Inadequate Consideration of Technical Readiness	34
		Poor Development Planning	64

Table 14 (cont.)

First-Level Theme	Second-Level Category	CHL ID
Technical Management	Inefficient Technical Management	74
Communication and Coordination Management	Inefficient Communication Among Internal and External Stakeholders	36, 43
	Lack of Secure Communication Protocols	36
Conflict Management	Insufficient Conflict Management	52
Information Sharing Management	Insufficient Information Sharing Mechanisms	70
Management Practices	Lack of Standardized Management Frameworks and Governance	86
Process Flexibility	Rigidity of the Waterfall Model for R&D Projects	85
Review and Feedback	Insufficient Review Mechanisms	8
	Insufficient Stakeholder Feedback	
Stakeholder Management	Excessive Stakeholder Intervention Limiting Technical Autonomy	67

The results show that budget and time constraints significantly affect planning activities throughout the project life cycle. These constraints are considered to lead to insufficient allocation of time and resources for both comprehensive planning and effective project execution. This is often attributed to the reliance on high-level plans instead of detailed and actionable ones, as well as to the inadequate execution of feasibility studies and estimation activities.

Considering the intensity of the challenges, it has been observed that the Project Planning process plays a key role in determining the success of a project. The difficulties encountered in this process indicate that planning should be conducted with sufficient time and attention at the outset and should be continuously updated throughout the project lifecycle.

4.4.2. Acquisition Process-Related Challenges

The Acquisition process ensures the procurement and delivery of products and services required by the acquirer within the project scope [5]. Based on the interview results, 28 challenge instances indicated by 9 participants encountered in R&D projects were found to be related to the Acquisition process (16%) and this positions the Acquisition Process as the second most challenging process. All of the challenges mapped to the Acquisition Process, along with their first-level themes and second-level categories, are presented in Table 15.

Table 15: First-Level Themes and Second-Level Categorizations of the Challenges Related to the Acquisition Process

	First-Level Theme	Second-Level Category	CHL ID
Acquisition Process	Estimation and Feasibility	Insufficient Budget	21, 23, 54
		Insufficient Project Duration	10, 20, 24
		Insufficient Feasibility Analysis	23
		Lack of Systematic Approach in Determining Project Duration	14
		Limited R&D due to Budget Constraints	23
		Poor Budget Estimation in Early Stages of a Project	21
		Poor Timeline Estimation	82
	Contract Management	Rigidity of Contract Rules	19, 20, 44, 47, 48, 92, 93
		Lack of Supplier Involvement in Contract Negotiation	93
		Insufficient Tailoring of Regulatory Standards to R&D Context	46
	Subcontractor Management	Lack of Expert Support	26
		Weak Collaboration with Academic Institutions	
		Poor Subcontractor Selection Strategy	37, 63
		Lack of Evaluation Criteria for Subcontractor Selection	37
		Lack of Subcontractor Schedule Adherence	41
	Planning and Scheduling	Lack of Integrated Timeline Management Among Contractors	38, 41
		Insufficient Project Duration	20
		Insufficient Project Planning	12
	Process Flexibility	Rigidity of the Waterfall Model for R&D Projects	44, 48, 84
		Inefficient Life Cycle Model Choice by Customer	47
Technical Management	Inadequate Consideration of Technical Readiness	29, 34	
Communication and Coordination Management	Insufficient Communication and Coordination Among Internal and External Stakeholders	36	
	Lack of Secure Communication Protocols		
Requirements Management	Inadequate Need Definition and Analysis in Early Stages of a Project	89	
Scope Management	Poor Project Constraint Analysis	82	
Stakeholder Engagement and Continuity	Insufficient End-User Involvement in Requirements Definition	78	

Table 15 (cont.)

First-Level Theme	Second-Level Category	CHL ID
User Resistance and Organizational Mindset	Bias Against Prototypes Limiting R&D Continuity	80

The most frequently encountered challenge in the Acquisition Process was identified as the lack of flexibility in contract structures suitable for the dynamic nature of R&D projects (i.e., *Rigidity of Contract Rules*). This was followed by insufficiencies in project budget and time, which were the most common challenges in the Project Planning process which is the most challenging one. These findings suggest that contracts which is an output of the Acquisition Process, impose rigid constraints as fixed timelines and budgets, which in turn contribute significantly to other frequently encountered challenges.

One issue we would like to emphasize here is that Acquisition and Supply Processes should be addressed together. The key factor in this determination is the significant overlap observed in Acquisition and Supply processes' main challenge categories. We observed that ten categories are shared between these two processes, with the top three being identical. This finding highlights that the role of suppliers must not be overlooked during the execution of Acquisition Process activities. Early interaction between users/customers and suppliers is essential to eliminate biases, align expectations, and enable a more informed and collaborative acquisition process. Such an approach is expected to contribute significantly to the successful execution of R&D projects.

4.4.3. Stakeholder Needs and Requirements Definition Process-Related Challenges

This process involves identifying user/acquirer expectations, defining project constraints, and establishing requirements accordingly [5]. The main output of the process is the defined/documented system/software requirements. Based on the interview results, 15 of the identified challenge instances indicated by 6 participants, representing 9% of all challenges are related to the Stakeholder Needs and Requirements Definition Process. The challenges mapped to the Stakeholder Needs and Requirements Definition Process, along with their first-level themes and second-level categories are presented in Table 16.

Table 16: First-Level Themes and Second-Level Categorizations of the Challenges Related to the Stakeholder Needs and Requirements Definition Process

	First-Level Theme	Second-Level Category	CHL ID
Stakeholder Needs and Requirements Definition Process	Requirements Management	Insufficient Requirements Specification and Analysis	6, 30, 75, 76
		Poor Requirements Definition	64, 88, 89
		Inadequate Need Definition and Analysis in Early Stages of a Project	88, 89
		Overloading Product Scope with Excessive Requirements	77
		Poor Demand Management	64

Table 16 (cont.)

Requirements Management	Poor Scope and Needs Analysis	3
Stakeholder Engagement and Continuity	Insufficient End-User Involvement in Requirements Definition	78, 79
	Insufficient Early-Stage User Engagement	83
Stakeholder Management	Lack of Technical Awareness among Stakeholders	32, 75
	Insufficient Stakeholder Alignment	64
Technical Management	Inadequate Consideration of Technical Readiness	29, 34
	Inadequacy in Exploring Alternative Solutions	30
User Resistance and Organizational Mindset	Lack of R&D Mindset among Users	79
	Bias Against Prototypes Limiting R&D Continuity	80

The interview findings revealed that the most common challenges within the Stakeholder Needs and Requirements Definition process stemmed from insufficient analysis of the actual need and the expected outcomes of the project. Another major issue was the limited involvement of users and other stakeholders in this process, which made it difficult for them to grasp the complex technical structure inherent in R&D projects, thus complicating the requirements definition phase. Additionally, *the incomplete identification of user/customer needs and the emergence of unplanned, inconsistent, and untimely requests led to conflicting expectations among stakeholders (CHL 64)*, creating difficulties in both technical and administrative project management. It was also observed that the challenges in this process often extended into the System/Software Requirements Definition Process. For instance, challenges like *CHL 3*, *CHL 6*, and *CHL 30*, were also associated with the System/Software Requirements Definition Process. We would like to highlight that challenges in the Stakeholder Needs and Requirements Definition Process account for almost 50% of the issues in the System/Software Requirements Definition Process and the significant impact of the challenges encountered here on other processes.

4.4.4. Supply Process-Related Challenges

Supply process that aims to provide the product/service needed by the acquirer by the supplier [5]. The main output of the process is the Contract/Purchase Order signed between the acquirer and the supplier. According to the interview results, 13 of the identified challenge instances indicated by 8 participants, accounting for 8% of all challenges. The challenges mapped to the Supply Process, along with their first-level themes and second-level categories are presented in Table 17.

Table 17: First-Level Themes and Second-Level Categorizations of the Challenges Related to the Supply Process

	First-Level Theme	Second-Level Category	CHL ID
Supply Process	Estimation and Feasibility	Insufficient Budget	21, 23, 54
		Insufficient Project Duration	10, 20, 24
		Insufficient Feasibility Analysis	23

Table 17 (cont.)

First-Level Theme	Second-Level Category	CHL ID
Estimation and Feasibility	Lack of Systematic Approach in Determining Project Duration	14
	Limited R&D due to Budget Constraints	23
	Poor Budget Estimation in Early Stages of a Project	21
	Poor Feasibility Analysis	60
	Poor Timeline Estimation	82
Contract Management	Rigidity of Contract Rules	20, 47
Technical Management	Inadequate Consideration of Technical Readiness	34
	Inadequacy in Exploring Alternative Solutions at Initial Stages of a Project	39
Planning and Scheduling	Insufficient Project Planning	12
Process Flexibility	Inefficient Life Cycle Model Choice by Customer	47
Scope Management	Poor Project Constraint Analysis	82

It has been observed that over 50% of the challenges related to the Supply Process stem from time and budget constraints. As also highlighted in the analysis of the Acquisition Process, another key issue is the lack of coordination between these two processes, particularly the limited involvement of the supplier, and the inability to make joint, feasible decisions. Notably, 11 of the challenges mapped to the Supply process also appear under the Acquisition process, indicating a strong interdependency between these two processes.

The challenges identified through the interviews and associated with other processes are detailed in the following subheading.

4.4.5. Remaining Processes and Related Challenges

The first-level themes and second-level categories for the remaining processes are presented in descending order based on the number of associated challenges in Table 18. Detailed mapping results and thematic analysis for all challenges are provided in APPENDIX A and APPENDIX B.

Table 18: First-Level Themes and Second-Level Categorizations of the Challenges Related to the Remaining Processes

Process	First-Level Theme	Second-Level Category	CHL ID
Human Resource Management	Workforce Capacity and Capability	Lack of Domain-Specific Expertise	15, 40, 58

Table 18 (cont.)

Process	First-Level Theme	Second-Level Category	CHL ID
Human Resource Management	Workforce Capacity and Capability	Inadequate Staffing for Quality Assurance	9, 87
		Inadequate Staffing for Software Development	25
		Inadequate Staffing for Test	18
	Technical Management	Lack of Centralized Project Management	73
		Lack of Technical Management Perspective	72
System / Software Requirements Definition	Requirements Management	Insufficient Requirements Specification and Analysis	6, 30, 65
		Poor Scope and Needs Analysis	3, 50, 51
		Poor Requirements Definition	2, 64
	Review and Feedback	Insufficient Review Mechanisms	8
		Insufficient Stakeholder Feedback	
Business or Mission Analysis	Market Orientation	Poor R&D-to-Market Translation	35, 49, 55
		Poor R&D-to-Market Alignment	61, 62
		Insufficient Trend Analysis	56
	Strategic Planning	Inadequate Future-State Projection	31
		Inadequate Intellectual Property Strategy Integration	59
		Poor Business Model	55
		Short-Term ROI Focus	59
Information Management	Communication and Coordination Management	Inefficient Communication Among Internal and External Stakeholders	11, 36, 43, 68, 71
		Lack of Intercultural Training and Support	69
		Lack of Secure Communication Protocols	36
		Lack of Shared Communication Norms	69
	Information Sharing Management	Insufficient Information Sharing Mechanisms	69, 70
	Conflict Management	Insufficient Conflict Management	68
	Life Cycle Model Management	Process Flexibility	Rigidity of the Waterfall Model for R&D Projects
Inefficiency of Sequential Mandatory Testing Structures			85
Inefficient Life Cycle Model Choice by Customer			47
Communication and Coordination Management		Inefficient Communication Among Internal and External Stakeholders	66

Table 18 (cont.)

Process	First-Level Theme	Second-Level Category	CHL ID
Validation	Test Management	Insufficient Testing	4, 16, 91
		Inefficiency of Sequential Mandatory Testing Structures	85
	Review and Feedback	Insufficient Review Mechanisms	8
		Insufficient Stakeholder Feedback	
		Lack of Dry Run Tests Before Formal Tests	91
Risk Management	Planning and Scheduling	Lack of Integrated Timeline Management Among Contractors	38, 41
	Stakeholder Engagement and Continuity	Frequent Turnover among External Stakeholders	81, 90
	Risk Assessment	Lack of Risk Assessment	53
	Subcontractor Management	Lack of Subcontractor Schedule Adherence	41
Design Definition	Design and Architecture	Lack of Reusability in System Architecture/Design	5
	Reusability	Poor Reusability	27
	Design and Architecture Management	Insufficient Design Alternatives Development	12
		Overloading Product Scope with Excessive Requirements	77
		Poor Design Definition	2
Project Assessment and Control	Workforce Capacity and Capability	Lack of Domain-Specific Expertise	40, 58
	Planning and Scheduling	Design Definition Delay	2
		Requirements Definition Delay	
	Review and Feedback	Lack of Dry Run Tests Before Formal Tests	91
	Scope Management	Lack of Adherence to Initial Project Objectives	50
Verification	Test Management	Insufficient Testing	4, 16, 91
		Insufficient Test Automation	17
		Lack of Dry Run Tests Before Formal Tests	91
System Analysis	Scope Management	Poor Scope and Needs Analysis	3, 22, 51
		Poor Requirements Analysis	22
	Estimation and Feasibility	Poor Feasibility Analysis	6
Implementation	Review and Feedback	Insufficient Review Mechanisms	8
		Insufficient Stakeholder Feedback	
	Scope Management	Lack of Adherence to Initial Project Objectives	50
	Test Management	Insufficient Test Automation	17
Architecture Definition	Design and Architecture	Lack of Reusability in System Architecture/Design	5
	Reusability	Poor Reusability	27
	Design and Architecture Management	Overloading Product Scope with Excessive Requirements	77

Table 18 (cont.)

Process	First-Level Theme	Second-Level Category	CHL ID
Portfolio Management	Decision Management	Lack of Timely Decision-Making	73
	Market Orientation	Poor R&D-to-Market Translation	35
	Portfolio Management	Poor Portfolio Management	53
	Technical Management	Lack of Centralized Project Management	73
Configuration Management	Contract Management	Rigidity of Contract Rules	48
Decision Management	Stakeholder Management	Excessive Stakeholder Intervention Limiting Technical Autonomy	67
Integration	Communication and Coordination	Insufficient Coordination Among Subcontractors	42
	System Integration Management	Insufficient System Integration Management	
Operation	User Resistance and Organizational Mindset	User Resistance to New Technology	45
Quality Assurance	Review and Feedback	Insufficient Review Mechanisms Insufficient Stakeholder Feedback	8
Tailoring	Contract Management	Insufficient Tailoring of Regulatory Standards to R&D Context	46

Although each of these processes has a relatively low number of associated challenges, recurring and significant problems were observed. Notable issues include inadequate staffing, communication gaps, rigidity of waterfall life cycle model, deficiencies in testing activities etc. were found to impact multiple processes. This highlights the importance of inter-process dependencies in the software system development life cycle. This comprehensive mapping supports the identification of important but less emphasized processes that also require improvement.

CHAPTER 5

THE CHALLENGE-DRIVEN AND FLEXIBLE IMPROVEMENT APPROACH

This chapter presents a challenge-driven and flexible approach that integrates the Disciplined Agile Delivery (DAD) framework, which is a hybrid process framework designed to support process-based improvement in software system R&D projects, as part of the RQ5.

The approach was developed by analyzing the challenges identified in this study and mapping them to the relevant phases, process goals, and decision points within the DAD framework.

Although the approach specifically targets the challenges identified in this study and the context of software system R&D projects, the flexible and adaptable nature of DAD also offers a valuable foundation for addressing challenges in other types of software system projects.

Rather than replacing existing standards or methods, this approach is intended to complement them, especially rigid approaches such as waterfall, by providing flexible, challenge-driven, and customizable alternatives. In this context, the approach aims to offer a flexible and adaptable approach to prevent or overcome the challenges of software system R&D projects.

The approach provides;

- Guidance on identifying project characteristics and associated challenges,
- A structured approach for mapping identified challenges to relevant DAD phases, process goals, and decision points,
- Practical examples demonstrating the application of the approach through 10 selected challenges from software system R&D projects.

5.1. Why Disciplined Agile Delivery (DAD)?

As the identified challenges reveal, software system R&D projects face not only difficulties based on the continuous research and development cycle but also constraints imposed by standardized contracts and rigid processes. Consequently, it has been observed that the currently implemented universal processes and practices are insufficient to address these challenges or to prevent situations previously identified as risky.

Disciplined Agile Delivery (DAD), however, goes beyond simply promoting agility since it enables the practical implementation of Agile principles across project, team, and organizational levels. This flexibility allows even safety-critical projects, which typically rely on strict and waterfall-based structures, to adopt a gradual transition toward agility (whether fully Agile or fully traditional, as needed). The other reasons to choose DAD are:

- It enables improvement at individual, team, and organizational levels by allowing each to define its own Way of Working (WoW) [26].
- It offers context-sensitive solutions, facilitating the tailoring of practices to specific challenges and supporting step-by-step improvement [26].
- It provides a hybrid structure, accommodating both Agile and traditional approaches [26].
- It supports improvement not only in the software development lifecycle but also in a wide range of enterprise-level processes [26].
- It is both decision- and goal-oriented, guiding teams in making deliberate, context-aware choices [26].

5.2. A Structured Approach for Mapping Challenges to DAD-Based Solutions

This subsection outlines guidance for applying the Disciplined Agile Delivery (DAD) framework through a challenge-driven approach. The steps of the challenge-driven approach are *Identifying the General Characteristics of a Project, Identifying the Challenges Encountered in a Project, Determining the Focus, Examining the Provided Challenges in the Approach, and Implementing the Recommended Solutions or Creating Your Own Solutions*.

Figure 4 illustrates the workflow you should follow during this process.

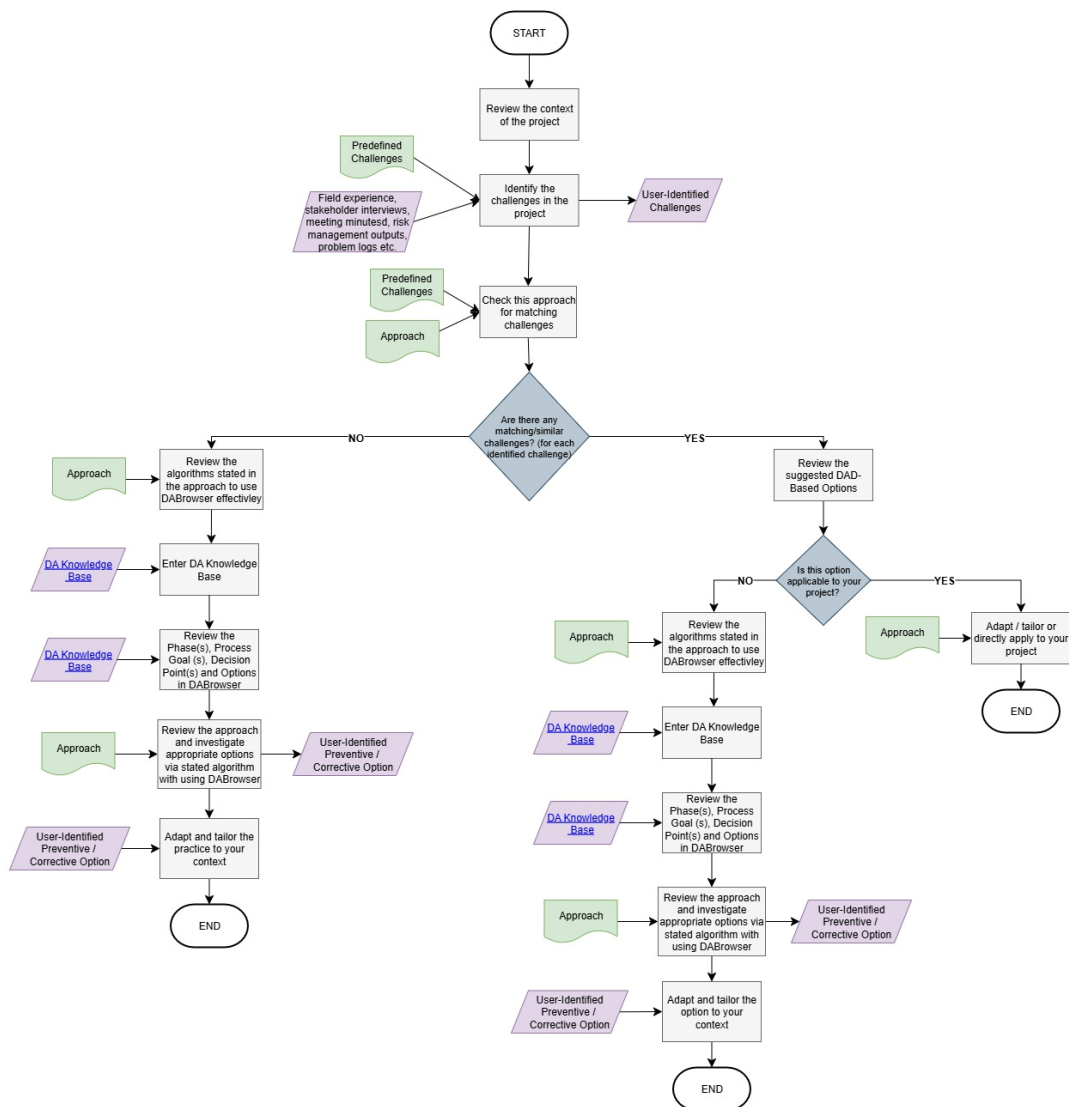


Figure 4 Illustration of Steps of the Challenge-Driven Approach

5.2.1. Algorithms to Apply the Challenge-Driven Approach

In this subsection, the steps of the approach are presented using structured algorithms that encompass both preventive and corrective approaches. These algorithm structures are designed to enhance the understandability of the approach and standardize its application. Both algorithms present the steps in a systematic, traceable, and repeatable manner, beginning with the definition of a challenge and articulation of the practitioner's focus, followed by the identification of the relevant DAD phase and process goal as outlined in the approach, the evaluation of decision points, and the final selection of context-appropriate options. This provides the practitioner with a structured sentence format that not only guides navigation through the DA Knowledge Base [33], but also offers a justified explanation of the decisions made within the team

or organization and the rationale behind the chosen option. This enables users to understand not only what actions need to be taken, but also why a particular solution was selected in response to a given challenge, allowing them to develop a customized solution tailored to their specific context.

The algorithms are divided into two types, based on how the challenge is intended to be addressed:

Preventive Approach Algorithm: It is applied to difficulties that have not yet occurred but are anticipated as potential risks.

In order to prevent the “[Bx: Challenges]” challenge, see the [Cx: DAD Phase] phase of DAD, targeting the process goal [Dx: DAD Process Goal]. As part of this goal, you should decide on the [Ex: DAD Decision Point(s)] decision point that enables [Gx: Preventive Impact of the Option] and choose among the DAD-based options that suits you the best {if Fx is not empty → “ such as [Fx: Sample of DAD-Based Options]}”. (ALGORITHM-1)

Corrective Approach Algorithm: It is applied to address challenges that have already been experienced and have affected the course of the project.

In order to resolve the “[Bx: Challenges]” challenge, see the [Cx: DAD Phase] phase of DAD, targeting the process goal [Dx: DAD Process Goal]. As part of this goal, you should decide on the [Ex: DAD Decision Point(s)] decision point that enables [Hx: Corrective Impact of the Option] and choose among the DAD-based options that suits you the best {if Fx is not empty → “ such as [Fx: Sample of DAD-Based Options]}”. (ALGORITHM-2)

The components of the algorithms are provided in Table 19.

Table 19: Explanation of the Symbols in Algorithms

Symbol	Explanation
Bx	Description of the identified challenge
Cx	The DAD Phase associated with the challenge (e.g., Inception, Construction, Transition etc.)
Dx	The relevant Process Goal within the selected DAD phase (e.g., Explore Scope, Coordinate Activities etc.)

Table 19 (cont.)

Symbol	Explanation
Ex	The Decision Point under the Process Goal (e.g., Choose Modeling Strategy, Align Measurement Strategy etc.)
Fx	The Options (DAD practices) that can be applied to address the related challenge
Gx	The expected Preventive Impact of the selected decision (stated in the EQUATION-1)
Hx	The expected Corrective Impact of the selected decision (stated in the EQUATION-2)

5.2.2. *Identify the General Characteristics of Your Project*

To support the selection of suitable DAD-based options, an initial analysis of the project should be conducted to clarify its key characteristics. The following elements can be taken into account during this analysis and considered when selecting appropriate practices in subsequent stages.

- Project Type (e.g., contract/internal R&D, contract/internal development project)
- Current Phase of the Project (e.g., planning, development, testing)
- Stakeholder Structure (e.g., subcontractor, customer, user relationships)
- Regulatory or Institutional/Governmental Constraints (if applicable)

5.2.3. *Identify the Challenges Encountered in Your Project*

To identify the challenges encountered in your project, firstly review the list provided in APPENDIX A. From this list, identify the challenges that are similar to those you have encountered in your own project.

Moreover, you can conduct interviews with stakeholders, review meeting notes, and examine outputs from risk management activities, as well as problem logs to list the challenges in your project and then compare with the challenges listed in APPENDIX A to achieve the final challenge list for your project.

5.2.4. *Determine Your Focus*

You need to define how you intend to approach the challenges you have identified. To do so, begin by answering the following questions for each challenge:

- Has the challenge already occurred in the project?
- Or is it a potential risk that has not yet realised?

If the challenge has already occurred, a corrective approach should be applied. If it has not yet occurred but is anticipated based on current indicators, a preventive approach should be adopted to mitigate it in advance.

Based on this distinction, you should choose practices from DAD by using the structured algorithms defined for preventive or corrective approaches, as outlined in subsection 5.2.1.

5.2.5. *Examine the Provided Challenges in the Approach*

By reviewing the example challenge-driven approach applications presented in subsection 5.3, you can find preventive or corrective approach practices as examples for the 10 challenges identified in context of software system R&D projects.

Based on these examples, if you identify challenges that align with your case:

- You should review the associated preventive or corrective approaches and related DAD-based practices provided in the example. If these solutions are suitable for your context, you can adapt or tailor them accordingly and proceed with implementation.
- If the solutions are not sufficiently relevant, or if a similar challenge is not included in the example, you should develop your own preventive or corrective solution by following the steps outlined in subsection 5.2.6.

5.2.6. *Implement the Recommended Solutions or Create Your Own Solutions*

If the challenge you have identified is similar to those included in the application example of the approach given in subsection 5.3, you can implement the recommended solutions directly. Alternatively, you may create your own solutions using the steps of the challenge-driven approach by following the steps below:

1. Open the **DA Browser** [33].
2. From the panel on the left, identify the relevant **Phases** (e.g., *Inception*, *Construction*, etc.) associated with your challenge.
3. Click on the **Process Goals** within each phase. In the pop-up window on the right, review their descriptions and determine which goals are most relevant for resolving or preventing your challenge.
4. For each selected Process Goal, identify the **Decision Point(s)** listed under that goal. These represent specific questions or choices that must be made to fulfill the process goal. For each Decision Point, review its content and purpose to evaluate the **Impact** that making the right decision in this area would have on your challenge.

5. Then, examine the **Options and Trade-Offs** shown in the right-hand pop-up window associated with that Decision Point. Choose and implement the practices that are best suited to your team or organization. Note that some practices are presented in a ranked order, progressing in the direction of the arrow from least to most recommended.
6. If you encounter difficulty identifying a suitable option, you may use the **search** function in the DA Browser. Enter keywords related to the theme of your challenge to explore additional relevant options.

5.3. Application Examples

Selected examples demonstrating the use of the challenge-driven and DAD-based approach are presented in the following subsections for both preventive and corrective approaches. These examples show the comprehensive application of the step-by-step guidance outlined in the preceding subsections.

5.3.1. Examples for Preventive Approach

[Bx]: CHL 2: “Requirements and design documents are either not prepared at all or are not prepared in a timely manner.”

Table 20: Examples for Preventive Approach

DAD Phase [Cx]	DAD Process Goal [Dx]	DAD Decision Point [Ex]	Sample of DAD Option [Fx]	Preventive Impact [Gx]
Inception	Explore Scope	Explore General Requirements	Shall Statement	early exploration of the requirements and clarification of the scope at the beginning of the project
<p>Preventive Approach: In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Explore General Requirements decision point that enables early exploration of the requirements and clarification of the scope at the beginning of the project and choose among the DAD-based options that suits you the best such as Shall Statement.</p>				
DAD Phase [Cx]	DAD Process Goal [Dx]	DAD Decision Point [Ex]	Sample of DAD Option [Fx]	Preventive Impact [Gx]
Inception	Plan the Release	Capture Plan		the plan to be visualized, made concrete, clearly communicated, and effectively followed
<p>Preventive Approach: In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Capture Plan decision point that enables the plan to be visualized, made concrete, clearly communicated, and effectively followed and choose among the DAD-based options that suits you the best.</p>				

Table 20 (cont.)

DAD Phase [Cx]	DAD Process Goal [Dx]	DAD Decision Point [Ex]	Sample of DAD Option [Fx]	Preventive Impact [Gx]
Ongoing	Coordinate Activities	Facilitate a Working Session	a Joint Application Requirements (JAR) Sessions	conducting sessions and ease of exploration of stakeholder needs in a collaborative and timely manner

Preventive Approach: In order to prevent "*Requirements and design documents are either not prepared at all or are not prepared in a timely manner.*" challenge, see the **Ongoing** phase of DAD, targeting the process goal **Coordinate Activities**. As part of this goal, you should decide on the **Facilitate a Working Session** decision point that enables **conducting sessions and ease of exploration of stakeholder needs in a collaborative and timely manner** and choose among the DAD-based options that suits you the best such as **Joint Application Requirements (JAR) Sessions**.

5.3.2. Examples for Corrective Approach

[Bx]: CHL 14: "The absence of a systematic approach in determining project durations."

Table 21: Examples for Corrective Approach

DAD Phase [Cx]	DAD Process Goal [Dx]	DAD Decision Point [Ex]	Sample of DAD Option [Fx]	Corrective Impact [Hx]
Inception	Plan the Release	Choose Schedule Cadences		bringing discipline to the process by setting regular and sustainable cadences when there is poor planning, uncertainty, or continuous deviation, replacing ad hoc practices with structured intervals or cycles

Corrective Approach: In order to resolve "*The absence of a systematic approach in determining project durations.*" challenge, see the **Inception** phase of DAD, targeting the process goal **Plan the Release**. As part of this goal, you should decide on the **Choose Schedule Cadences** decision point that enables **bringing discipline to the process by setting regular and sustainable cadences when there is poor planning, uncertainty, or continuous deviation, replacing ad hoc practices with structured intervals or cycles** and choose among the DAD-based options that suits you the best.

DAD Phase [Cx]	DAD Process Goal [Dx]	DAD Decision Point [Ex]	Sample of DAD Option [Fx]	Corrective Impact [Hx]
Inception	Plan the Release	Estimation Strategy		reduction of deviations after unsuccessful forecasts by switching to a more appropriate/data-driven strategy

Table 21 (cont.)

<p>Corrective Approach: In order to resolve "<i>The absence of a systematic approach in determining project durations.</i>" challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Estimation Strategy decision point that enables reduction of deviations after unsuccessful forecasts by switching to a more appropriate/data-driven strategy and choose among the DAD-based options that suits you the best.</p>				
DAD Phase [Cx]	DAD Process Goal [Dx]	DAD Decision Point [Ex]	Sample of DAD Option [Fx]	Corrective Impact [Hx]
Ongoing	Measure Outcomes	Forecast Schedule		the definition of a new forecasting process based on historical data in cases of unrealistic or incomplete estimates, thereby improving the accuracy of planning
<p>Corrective Approach: In order to resolve "<i>The absence of a systematic approach in determining project durations.</i>" challenge, see the Ongoing phase of DAD, targeting the process goal Measure Outcomes. As part of this goal, you should decide on the Forecast Schedule decision point that enables the definition of a new forecasting process based on historical data in cases of unrealistic or incomplete estimates, thereby improving the accuracy of planning and choose among the DAD-based options that suits you the best.</p>				

CHAPTER 6

EVALUATION OF THE APPROACH BY EXPERTS

This section presents the details of the verification process of the challenge-driven approach presented in Chapter 5.

6.1. Verification Approach

To verify the DAD-based approach presented in Chapter 5, four experts who had previously participated in the interviews during the challenge identification phase of this study were invited to review and evaluate the 10 challenges presented in APPENDIX C and APPENDIX D.

During the evaluation process, the details of the approach under review were first explained and presented to each expert. The evaluation criteria established for verification and the methodology for conducting the evaluation were also described. Subsequently, the application of the approach was demonstrated and reviewed individually for the 10 challenges, after which the experts were asked to assess the criteria both for each challenge individually and for the approach overall.

6.2. Verification Design and Conduct

Experts for the review and validation studies were selected from individuals previously interviewed during the challenge identification stage of software system R&D projects. This selection ensured that the experts could evaluate and provide feedback on solutions developed for the challenges they had previously shared, drawing directly from their own experiences. The validation studies were conducted with two Quality Engineers (E1 and E2), an R&D Team Leader/Product Manager (E5), and a Project Engineer (E7), ensuring that the approach was assessed from multiple perspectives, including quality management, administrative, and technical viewpoints. Moreover, the experts who were coded as P1, P2, P5, and P7 in subsection 4.1 are referred to here as E1, E2, E5, and E7, respectively, to indicate their role in the evaluation. The review and evaluation meetings were conducted face-to-face with all experts, and each session lasted approximately 100-120 minutes.

Application examples about challenge-driven approach, given in APPENDIX C and APPENDIX D, were presented to the participants with predefined two-stage criteria. Each of the experts evaluated five challenges out of 10. Thus, each of the 10 challenges was reviewed by at least two different experts.

Eight criteria were used to conduct the assessments. The first three criteria (*Effectiveness, Fidelity with Real World Cases, Correctness*) [25] were used for challenge-specific evaluation, and the remaining five criteria (*Ease of Use, Understandability, Intention to Use, Completeness, Adaptability*) [25] were employed to evaluate the challenge-driven improvement options and approach as a whole. Details of these criteria are explained in Table 22.

Table 22: Details of the Evaluation Criteria

Criterion	Description	Evaluation Scope
Effectiveness	The approach provides a meaningful contribution to preventing/overcoming the challenge.	Challenge-Specific
Fidelity with Real World Cases	The approach aligns with real-world applications and is suitable for practical situations.	Challenge-Specific
Correctness	The approach is both technically and conceptually correct.	Challenge-Specific
Ease of Use	The approach is easy to apply and can be used to prevent/overcome challenges encountered in safety-critical projects.	General
Understandability	The approach is easy to understand and interpret.	General
Intention to Use	There is a willingness to adopt the approach; it shows potential for acceptance and adoption in practice.	General
Completeness	The approach provides a comprehensive approach to challenges. The challenge or method is closely related.	General
Adaptability	The approach is flexible and can be adapted to different project conditions, organizational structures, or needs, making it applicable across various contexts.	General

6.3. Data Collection and Analysis

The evaluation of the challenge-driven approach was conducted using a 5-point Likert Scale (*1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree*). During the interviews, each of the experts was asked to provide any suggestions related to the challenge-based practices or the approach in general. All suggestions were noted and analyzed. Where relevant, the suggested modifications (i.e. adding DAD practices) were integrated into the improvement practices.

6.4. Results of the Evaluation

The proposed challenge-driven approach was evaluated by four experts (E1, E2, E5, E7) based on both challenge and general criteria. The evaluation results are presented under this heading.

The challenge-by-challenge assessment results are given in Table 23.

Table 23: Challenge-Based Evaluation Results

CHL ID	E-ID	Effectiveness	Average	Fidelity with Real World Cases	Average	Correctness	Average
2	E1	5	4.5	5	4.5	4	4.5
	E7	4		4		5	
11	E2	4	4.5	5	5	5	5
	E7	5		5		5	
14	E2	5	5	5	5	5	5
	E7	5		5		5	
15	E1	5	4	3	3	4	4
	E5	3		3		4	
19	E2	4	4.5	5	5	5	5
	E5	5		5		5	
33	E1	5	5	4	4.5	5	5
	E5	5		5		5	
42	E2	5	4.5	5	4.5	5	4.5
	E5	4		4		4	
49	E5	5	5	5	5	5	5
	E7	5		5		5	
79	E1	5	5	5	5	5	5
	E7	5		5		5	
91	E1	5	5	4	4	5	5
	E2	5		4		5	

6.4.1. Effectiveness

This criterion evaluates how effectively the proposed approach overcomes or prevents the relevant challenge.

All experts rated CHL-14, CHL-49, CHL-79, and CHL-91 with the highest score of 5, indicating that the recommendations developed for these challenges were perceived as highly effective. For CHL-15, the average score was 4, with P5 assigning a lower rating of 3. This suggests that the recommendation for CHL-15 was perceived as less effective compared to others. The remaining challenges received average scores of 4.5 or higher, demonstrating a generally strong performance across the board. Overall, the proposed practices were considered to be effective for the majority of the challenges. The only notable weakness was observed in CHL-15. In response to E5's feedback, an additional practice from DAD, *Construction – Produce a Potentially Consumable Solution – Explore Solution Design – Proof of Concept (PoC)*, was integrated to strengthen the effectiveness of the solution for CHL-15.

6.4.2. *Fidelity with Real World Cases*

This criterion assesses the extent to which the proposed approach aligns with real-world applications.

CHL-14, CHL-19, CHL-49, CHL-79, and CHL-91 each received the highest score of 5, indicating strong alignment with real-world practices. CHL-2, CHL-11, and CHL-42 followed with average scores of 4.5.

In contrast, CHL-15 received an average score of 3. Expert feedback indicated that while most practices aligned with real-world applications, the practices recommended for CHL-15 only partially matched real-world cases. Full alignment could be achieved by incorporating additional practices. Accordingly, the recommendations from the Effectiveness criterion assessment were added to the practices proposed for CHL-15.

6.4.3. *Correctness*

This criterion measures whether the proposed approach is technically and conceptually consistent and correct.

Several challenges including CHL-11, CHL-14, CHL-19, CHL-33, CHL-49, CHL-79, and CHL-91 received the 5 point from all experts, indicating a strong consensus on the technical and conceptual soundness of the corresponding recommendations.

Overall, the evaluation results show that the proposed solutions are largely correct and consistent in both technical and conceptual perspective. However, CHL-15 received a comparatively lower score, indicating that the technical validity of the proposed solution in this specific case was questioned by experts and may require further refinement. Consequently, based on the experts' suggestions, the relevant practices were incorporated into the scope of CHL-15.

The average scores for all three criteria which are effectiveness, real-world alignment, and correctness are 4.5 or higher, indicating that the proposed solutions are generally effective, practical, and conceptually sound. However, CHL-15 scored at or above

average in all three dimensions, and additions were made based on expert feedback to further enhance the validity and applicability of the solution.

The consistently high and balanced scores for the remaining challenges demonstrate that the proposed approach offers a practical and comprehensive tool for addressing a wide range of challenges encountered in software system R&D projects.

As a result of the evaluations conducted by four experts (E1, E2, E5, E7), the evaluation outcomes of the proposed approach based on five general criteria are presented in Table 24.

Table 24: Overall Evaluation of the Approach and DAD-Based Alternatives

E-ID	Ease of Use	Understandability	Intention to Use	Completeness	Adaptability
E1	4	5	5	4	5
E2	4	4	4	5	5
E5	5	5	5	4	5
E7	4	5	4	5	5
Average	4.25	4.75	4.5	4.5	5

6.4.4. Ease of Use

This criterion evaluates how easy and practical the approach is to use.

While E1, E2, and E7 each gave a score of 4, E5 rated it a 5, resulting in an average score of 4.25 for this criterion. This distribution indicates that the approach is generally perceived as easy to implement, although it may present some practical challenges for most users during application. Interview feedback suggested that organization-wide adoption may require a period of familiarization. Moreover, E1 also stated that *“in some cases, it is difficult to persuade the customer to comply with our choices.”*

Consequently, evaluations based on this criterion demonstrate that, while the approach is practical and applicable, its challenge-focused nature requires users to perform contextual analysis, a skill that develops with experience. Furthermore, while it is easy to use, it can be difficult for customers to comply with in some cases.

6.4.5. Understandability

This criterion evaluates how easy the approach is to comprehend.

All experts, except E2, gave a score of 5, resulting in an average score of 4.75 for this criterion. This result indicates that the approach has a clear, systematic, and easily

understandable structure. Expert E2 noted, “*The approach is understandable, but the structure and use of the DA Knowledge Base require time to become familiar.*”

6.4.6. *Intention to Use*

This criterion assesses the approach’s potential for use.

Experts E1 and E5 expressed a strong willingness to adopt the approach and each assigned a score of 5. Experts E2 and E7 also indicated individual willingness to use the approach but anticipated challenges in implementing it at the organizational level; both assigned a score of 4. The result shows that the average score is 4.5 for this criterion. The results show a generally high level of confidence in the approach’s practical applicability.

Overall, the findings indicate that the approach is likely to gain acceptance among potential users. However, it is believed that organizing collaborative activities, such as a workshop involving the use of the DA Knowledge Base [33] and the developed guidance, could further enhance willingness to use by enabling hands-on experience with the approach.

6.4.7. *Completeness*

This criterion evaluates whether the approach provides a holistic solution to the challenges.

Experts E1 and E5 gave a score of 4, while E2 and E7 assigned a score of 5. Overall, the approach was considered to demonstrate a high level of completeness.

E1 and E5 also contributed to the evaluation by suggesting additional DAD options that could be applied to certain challenges. In response, the participants collaborated using the DA Knowledge Base to identify and select the relevant Phase, Process Goal, Decision Point, and Option, which were then added to the final recommendations.

Specifically, E1 suggested that incorporating feedback mechanisms within the scope of CHL 15 would be beneficial. As a result, the following recommendation was added: *Ongoing – Grow Team Members – Provide Feedback – Continuous/Regular Feedback and/or Team Lead Review*. Additionally, E5 proposed including the following DAD element to address potential technical aspects of CHL 15: *Construction – Produce a Potentially Consumable Solution – Explore Solution Design – Proof of Concept (PoC)*.

6.4.8. *Adaptability*

This criterion evaluates the extent to which the solution can be adapted to different project conditions, organizational structures, or needs, as well as its flexibility and ability to be integrated into various contexts.

All experts scored 5 for this criterion, indicating the approach's strong applicability across various contexts (e.g., different sectors, project structures, and organizational cultures).

This result suggests that the approach is not limited to a specific situation but can be flexibly integrated into diverse R&D environments. Experts emphasized that the challenge-driven, DAD-based improvements are highly adaptable due to their inherent flexibility and sensitivity to contextual factors.

The results indicate that the proposed challenge-driven approach provides a solution that is both structurally robust and practically applicable. Average scores of 4.0 and above across all evaluation criteria confirm that the approach is fundamentally effective, applicable, understandable, and extensible. In particular, the high scores for Adaptability (5.00) and Understandability (4.75) highlight that the approach has been developed with a strong emphasis on both broad applicability and clarity.

CHAPTER 7

DISCUSSION

7.1. Software System R&D Project Process Challenges

The existing studies in literature were reviewed in a manner aligned with the purpose of this study. Few studies were found to address R&D challenges from a process-oriented perspective. Most existing research focuses on sector-specific contexts (e.g., software, medical, pharmaceutical, automotive) or specific domains such as IoT, AI, or military product R&D [2-18].

As indicated in the interview results conducted to determine software system R&D challenges, most challenges (20%) are encountered in the **Project Planning** process which is the process that triggers and manages the whole activities of a project. Moreover, the results of the thematic analysis conducted after the challenge identification phase revealed that the **greatest challenges were associated with the Planning and Scheduling theme**, accounting for 11% of the challenges. The study by Ghorbani and Khanachah [20] states key outputs of the Project Planning process like management of project's cost, time, human resources, budget allocation, procurement activities and feasibility, each contribute significantly (with an impact rate of 75–84%) to the failure of R&D projects. The authors also emphasize the importance of accurate time estimation based on available resources and the creation of a realistic project schedule, which aligns with the challenges identified in our study. These insights underline the critical need for effective and well-grounded planning in managing R&D efforts. In line with this finding, our study highlights that particular attention must be paid to the feasibility of decisions made within the scope of the both Project Planning, **Acquisition and Supply** processes, especially regarding time and budget constraints, as well as the inclusion of a comprehensive range of stakeholders to the Acquisition Process activities. As an example of this context, it was observed that time and budget constraints set in contracts (CHL 1: "*Planning activities are inadequate and lack effectiveness due to contract-driven and top-down planning approaches.*" (P1)) led to insufficient allocation of time and resources for both comprehensive planning and effective project execution. Moreover, the thematic analysis of the challenges identified in this study revealed that the **category with the highest occurrence of challenges** was the **Rigidity of Contract Rules**, further indicating the presence of significant issues in this area. This often resulted in the creation of high-level plans dictated by contractual limitations rather than detailed and actionable plans, and feasibility studies were either inadequately conducted or entirely neglected.

In our study, the challenges mapped to the **Stakeholder Needs and Requirements Definition** process include the failure to determine stakeholder needs accurately, completely, and in a timely manner, as well as the emergence of conflicting expectations among stakeholders. This aligns with the findings of Callahan and Lasry [16], who emphasize that the input of all stakeholders, particularly customers and end

users, is critical for R&D projects, especially during the initiation and completion phases. Supporting this perspective, the studies of Elias, Cavana and Jackson [18] and Elias [19] highlight the dynamic nature of stakeholders, noting that their expectations can evolve and conflict over time. This observation is consistent with the challenges encountered in software system R&D projects as identified in our research. The study by Majava, Nuotila, Haapasalo and Law [8] also highlighted challenges such as difficulty in prioritizing customer needs, delays in receiving feedback, mismatches between customer expectations and development outputs, and the loss or alteration of customer expectations during internal communication. In addition to these, our study found that *insufficient involvement of end users in the requirements definition process (CHL 78)* blocks the development of products aligned with user expectations, especially when *users lack familiarity with the technology (CHL 75)*. This leads to difficulties in accurately identifying real needs and results in *issues that can later necessitate changes in requirements and design (CHL 88)*.

Moreover, in Shapley's study [47], the challenges encountered in military R&D projects are specifically examined and the study highlights issues of bureaucratic delays in decision-making, regardless of the scale of the decision, budget constraints, and difficulties in technical and administrative planning and prioritization. These findings align with the challenges identified in our study, particularly within the Acquisition, Project Planning and Stakeholder Needs and Requirements Definition processes. In the study by Simões, Rodrigues, and Soares [14], the challenges encountered in large-scale collaborative R&D projects are examined from the perspective of collaboration management. When comparing these challenges with the ISO/IEC/IEEE 12207 processes, it was evaluated that the challenges could be associated with the Stakeholder Needs and Requirements Definition Process. Additionally, their study highlights the importance of stakeholder participation in the Acquisition process, which aligns with the findings of our research.

When Forozandeh's study [21] is examined in the context of the Supply process, it is observed that it focuses on delays occurring within the supply chain. In our study, it was found that the supply process should largely be considered together with the acquisition process, as the inputs and outputs of these two processes are interdependent. Furthermore, our findings highlight that incorporating the supplier's input into decisions made during the acquisition phase is crucial for establishing an appropriate and effective project structure. Additionally, some challenges identified during the Stakeholder Needs and Requirements Definition process were also found to be related to the **System Analysis** and **System/Software Requirements Definition** processes. In particular, challenges concerning product functionality and limitations were observed (*i.e. CHL3, CHL 6*) to be relevant to all three processes. However, studies about R&D challenges in literature does not place any particular emphasis on this point.

In addition, the study by Seo, Han, Shin, and Na [48] focused on challenges specific to AI R&D projects, particularly emphasizing the shortage of trained human resources in the field. In our study, similar challenges were identified in software system R&D projects, including both a *lack of human resources in terms of quantity and a shortage of personnel with the necessary domain expertise for domain-specific projects (e.g., CHL 9, CHL 15 etc.)*. These challenges were associated with the **Human Resources**

Management process in our research. Another relevant study by Dybek and Głodzinski [13] discussed knowledge management issues in military manufacturing R&D projects. The study fundamentally highlighted the absence of effective project management practices. It emphasized the need for a dedicated project management unit responsible for creating, storing, and distributing knowledge among stakeholders in accordance with established standards. In our study, similar challenges, such as *lack of information sharing between internal units (CHL 11) and unwillingness to share details with external units due to confidentiality issues (CHL 36)*, were identified in software system R&D projects. When analyzed through the lens of ISO/IEC/IEEE 12207, the challenges defined by Dybek and Głodzinski [13] were associated with the **Information Management** and Project Planning processes.

While Chien's study [49] addresses issues encountered in selecting R&D projects for portfolio creation, our study additionally maps some issues directly to the **Portfolio Management** process including *failures to ensure market alignment of R&D projects (CHL 35)*, *initiating projects without sufficient analysis (CHL 53)*, and *administrative problems in projects involving multiple departments (CHL 73)*. However, Chien's study [49] does not explicitly associate the identified problems with the Portfolio Management process.

According to the findings of our study, the processes with the fewest identified challenges were **Quality Assurance, Integration, Operation, Tailoring, Configuration Management, and Decision Management**. For each of these processes, a single corresponding challenge was mapped. The challenges identified include: *insufficient feedback from stakeholders and inadequate review practices (CHL 8)*, *integration problems caused by the involvement of multiple subcontractors (CHL 42)*, *user resistance to adopting the delivered system (CHL 45)*, *user or customer expectations for compliance with military standards (CHL 46)*, *the inability of the change management mechanism to operate flexibly within the R&D structure (CHL 48)*, and *excessive stakeholder interference that prevents the project team from making independent decisions (CHL 67)*. Furthermore, Tang, Cheng, Xie, and Tao [50] examined Configuration Management challenges in R&D projects involving the production of complex equipment systems. They observed that integration and testing difficulties arise due to the large number of subsystems and interfaces, and that design and product development processes are prolonged for the same reason. While their primary focus was on configuration management challenges, such as configuring numerous subsystems, managing changes, and preparing complex technical documentation containing configuration data, it can also be inferred that challenges occur in the **Integration, Verification, and Design Definition** processes according to our mapping study.

Wang, Lin, and Huang [51] examined **Risk Management** challenges in R&D projects, focusing on issues in the risk identification and prioritization stages that result in time and cost losses. In our study, challenges such as *subcontractor schedule management (CHL 38, CHL 41)* and *frequent changes of users combined with the lack of dedicated personnel (CHL 81, CHL 90)* were associated with the Risk Management process.

Although in our study, challenges related to Quality Assurance, Operation, Tailoring, Decision Management, **Business or Mission Analysis, Life Cycle Model Management, Validation, and Project Assessment and Control** processes were identified and relevant mappings were made, it was observed that there were no studies in literature mentioning challenges specifically point to these processes.

Although the literature discusses challenges encountered in R&D projects, their relationship to specific processes has generally not been explicitly established and can be mostly inferred indirectly. The findings of our study demonstrate that examining challenges in software system R&D projects on a process-by-process basis is essential for understanding the root causes of problems and identifying areas requiring targeted solutions. By clearly identifying and systematically classifying these challenges, this thesis contributes to the literature by providing a structured foundation for linking challenges to the processes in which they arise.

7.2. Process Models for R&D vs Challenge-Driven Approach Based on DAD

In the first phase of this study, a systematic literature review was conducted on methods developed or adapted for R&D projects. While several methods were identified as suitable for R&D contexts and were presented accordingly, evaluations conducted within the scope of this study revealed that existing process models offer limited problem-solving capacity. These models tend to be presented at a general, high level, often lacking detailed guidance on practical implementation.

This thesis clearly defines the challenges encountered in software system R&D projects and explicitly maps them to relevant processes. This contributes to a clearer understanding of the problems and supports the development of appropriate preventive or corrective approaches.

Moreover, although some existing models have been developed or adapted specifically for R&D projects, many are based on static, standardized process flows. Among the few that offer flexibility are Extreme Programming (XP) [9], Scrum Together with UML Models [12], and the Agile Methodology for txtUML [46]. However, these approaches are either highly project and context-specific or lack sufficient detail, limiting their broader applicability.

In contrast, the approach proposed in this study is supported by the Disciplined Agile Delivery (DAD) framework, which provides a high degree of flexibility even within the constraints of rigidly structured R&D projects. For example, DAD's *Develop Common Vision* process goal enables stakeholders to align on shared objectives and resolve contractual tensions, thereby fostering more flexible and collaborative project management. Thus, the approach enables more tailored, challenge-specific implementation across different project/team/organizational contexts.

A key strength of the developed approach is its foundation in real-world challenges, enabling process improvement efforts that are grounded in actual project needs. Unlike

many other models, this approach is not intended to be used in isolation; rather, it can be integrated with existing process models or applied to enhance them by offering specific, targeted solutions. This study also presents a step-by-step implementation path, facilitating the practical application of the proposed approach.

7.3. Validity Threats

In qualitative research, depending on the conditions under which the study is conducted, threats to the reliability and validity of the outputs may arise at various stages, including study design, data collection, and data analysis [52]. This subsection describes these potential threats, explains their possible impact on the study, and outlines the mitigation strategies implemented.

7.3.1. Internal Validity

During the challenge identification stage of the study, a potential threat to the consistency of participant responses was identified. To address this, all participants were asked a common set of semi-structured questions, ensuring that their responses aligned with core themes and thereby maintaining consistency. However, individual differences in perception and interpretation could not be entirely eliminated. Additionally, participants were selected from diverse roles and organizations to reduce the risk of challenges being addressed solely from an administrative, technical, customer, or supplier perspective.

In the thematic analysis and mapping stage, there was a risk that the researcher's own experiences and expectations could influence the analysis. To mitigate this, the thematic analysis process was conducted in line with established studies in the literature and subsequently reviewed and validated by an expert who is experienced in software technologies. Similarly, the mapping process was carried out through a detailed review of the processes outlined in the ISO/IEC/IEEE 12207 standard, and this mapping was also reviewed and validated by an expert with academic experience in software technologies. In both cases, multiple review meetings were held to facilitate mutual evaluation of the thematic analysis and mapping results, thereby minimizing subjective bias.

During the validation phase of the Challenge-Driven Approach, a potential threat arose that participants might evaluate the proposed recommendations solely within the context of their own institution or role, overlooking broader applicability. To address this, evaluation criteria were designed to cover both challenge-specific and general assessments. Evaluation meetings were conducted in two stages: first at the challenge-specific level, then at the general level. Each criterion and the evaluation method were explained in detail to the experts at the outset and reiterated during the relevant sessions, enabling them to evaluate across multiple contexts. Furthermore, the evaluation involved experts from various roles in quality, project management, and technical domains, ensuring that the approach was not considered solely from an administrative or solely technical perspective.

7.3.2. *External Validity*

During the challenge identification phase of the study, there was a risk of sector-specific bias, as 10 of the 12 interviewees were involved in safety-critical projects. To mitigate this, the interviews were designed to capture a broad range of perspectives by avoiding sector-specific questions. The findings indicated that the identified challenges were not unique to military or software system R&D projects but represented common issues across various R&D contexts.. Still, some sector-based differences may persist.

7.3.3. *Construct Validity*

During the challenge identification stage, open-ended and non-leading questions were employed to elicit insights from both technical and managerial perspectives, thereby reducing the risk of purely administrative or purely technical bias. Still, certain perspectives may have been more strongly represented due to the participants' individual areas of expertise.

In the evaluation stage of the challenge-driven approach, there was a risk that participants might not fully understand the approach or the DAD framework. To mitigate this, each expert was provided with a detailed explanation of the DAD framework, its structure, and relevant terminology, supported by a flowchart. Examples illustrating the application of the approach were presented, including 10 sample challenges, each explained individually to ensure familiarity with the concepts.

A further risk concerned incomplete or inaccurate understanding of the evaluation criteria. This was mitigated by providing detailed definitions and scope descriptions for each criterion prior to the evaluation sessions.

Despite these measures, experts may still have based their evaluations on their own domain expertise and individual levels of familiarity with the DAD framework.

7.4. **Limitations**

This study was conducted in Türkiye and the findings might have been influenced by country-specific factors such as national legal frameworks and culture. Thus, the findings might not be valid for other countries. Moreover, most of the participants (8 out of 12) are from organization A, thus this might have led a bias in the sense that challenges were predominantly reported from the same organization.

Solutions to challenges developed using the preventive and corrective approaches outlined in this study may vary according to the practitioner's perspective. For instance, a software developer may prioritize technically oriented solutions, whereas professionals in quality assurance or project management may focus more on managerial aspects. As a result, the identification and perceived feasibility of solutions can differ among practitioners with varying roles and experience levels. Moreover,

having the solutions identified through the challenge-driven approach evaluated by individuals familiar with and trained in the DAD framework could facilitate a quicker, more accurate, and more comprehensive understanding of the approach.

CHAPTER 8

CONCLUSION

The purpose of this study is to clearly identify the challenges encountered in software system R&D projects and to propose an approach for preventing or resolving these challenges. This study identified **93 challenge instances** in software system R&D projects through semi-structured interviews, along with their **88 different challenge categories** and **27 unique themes** through the analysis of the identified challenges. By mapping these challenges to ISO/IEC/IEEE 12207 processes, the most challenging processes were determined. In total, the identified challenges were associated with 24 processes. The analysis showed that challenges were predominantly **(53%) concentrated in the Project Planning (20%), Acquisition (16%), Stakeholder Needs and Requirements Definition (9%), and Supply (8%)** processes. According to the results of the thematic analysis, the **three categories with the highest frequency** of challenges were **Rigidity of Contract Rules, Rigidity of the Waterfall Model for R&D Projects, and Inefficient Communication Among Internal and External Stakeholders**. Similarly, the **three themes with the highest frequency** of problems were **Planning and Scheduling, Requirements Management, and Estimation and Feasibility**.

Unlike previous studies in literature, our study provides a process-based view of the challenges in software system R&D projects. By doing so, the study not only validates existing knowledge but also adds value by offering categorization and detailed process-based insights through the ISO/IEC/IEEE 12207 standard. This approach enables a comprehensive and detailed examination of software system R&D project challenges, making the challenges visible at the process, activity, and task levels. The findings highlight areas needing improvement.

Moreover, this study introduces a **challenge-driven flexible approach by applying the Disciplined Agile Delivery (DAD) framework** to software system R&D projects. Unlike existing models, which often rely on generic workflows or assume ideal project conditions, the proposed approach is better aligned with the dynamic and uncertain nature of R&D projects and contributes flexibility.

In addition, the study enhances existing literature by offering structured approach for addressing challenges or context-specific issues not only in software system R&D projects, but potentially across a wider range of software and system development contexts. This is achieved through the approach's clear formulation aimed at preventing and resolving challenges.

Finally, a multi-criteria expert evaluation of the model supports the verification of its theoretical soundness and demonstrates its validity, comprehensiveness, and practical applicability from the perspective of industry practitioners.

8.1. Theoretical Implications

This study's challenge-driven, flexible, and structured approach enables practitioners and researchers to develop tailored challenge-driven examples for their own projects. Moreover, the approach allows practitioners to adapt the process structure within their organizations and integrate DAD practices into their workflows, taking into account the specific challenges they encounter.

8.2. Practical Implications

This study offers practical and adaptable approach for professionals engaged in software system R&D projects. By mapping selected challenges to DAD-based phases, process goals, decision points, and options, the proposed approach enables organizations to communicate more effectively about areas requiring improvement and the actions taken, while also supporting the enhancement of existing processes. Moreover, the approach promotes a mindset of continuous improvement by providing not only a solution-oriented approach but also a preventive one, facilitating the early identification and mitigation of process-related risks in R&D environments.

Thus, the proposed approach offers an insight into Agile practices applied in a hybrid context and enables both organizations and individuals to make decisions using a structured, challenge-driven approach.

8.3. Future Work

In future studies, applicability of the proposed approach across different sectors, encompassing both R&D-focused and standard projects could be examined through case studies. In addition, all challenges identified in this study could be systematically integrated into the DAD framework. Additionally, future studies could incorporate thematic analysis supported by Large Language Models (LLMs) and conduct the generation of different challenge themes and categories identified in this study. Finally, future research could explore how the proposed approach might be adapted to alternative frameworks or methodologies beyond the DAD framework.

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APPENDICES

APPENDIX A

SOFTWARE SYSTEM R&D PROJECT CHALLENGES ALONG WITH MAPPINGS TO ISO/IEC/IEEE 12207

This appendix provides a detailed list of all challenges identified in the study, along with their corresponding mappings to the relevant processes, activities, and tasks defined in the ISO/IEC/IEEE 12207 standard. Mappings highlighted in green indicate additions made following expert review.

Table 25: Software System R&D Project Challenges and Mappings to ISO/IEC/IEEE 12207

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
1	Planning activities are inadequate and lack effectiveness due to contract-driven and top-down planning approaches.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1) (7)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates. (7) Generate and communicate a plan for project and technical management and execution, including reviews.	P1
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	System/Software Requirements Definition Process	6.4.3.3.b Define System/Software Requirements (5)	(5) Define system/software requirements and requirements attributes, including the following	P1
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Project Assessment and Control Process	6.3.2.3.b Assess the Project (3)	(3) Assess project and technical status against appropriate plans to determine actual and projected cost, schedule, and performance variances.	
		Design Definition Process	6.4.5.3.b Establish Designs Related to Each Software System Element (5)	(5) Establish the design artifacts.	
3	The functional capabilities and limitations of the product to be developed are not clearly defined, and its boundaries are not explicitly established.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.d Transform Stakeholder Needs into Stakeholder Requirements (3)	(3) Define stakeholder requirements, consistent with life cycle concepts, scenarios, interactions, constraints, and critical quality characteristics.	P1
		System Analysis Process	6.4.6.3.b Perform System Analysis	6.4.6.3.b Perform System Analysis	
		Project Planning Process	6.3.1.3.a Define the Project (2)	(2) Define the project scope as established in the agreement.	
		System/Software Requirements Definition Process	6.4.3.3.b Define System/Software Requirements (3)	(3) Define necessary implementation constraints.	
4	Intermediate tests are not conducted adequately due to time constraints, and testing activities are mostly postponed until the final stage of the product.	Verification Process	6.4.9.3.a Prepare for Verification (1)	(1) Define the verification strategy, which includes the following:	P1
		Validation Process	6.4.11.3.a Prepare for Validation (1)	(1) Define the validation strategy, which includes the following:	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1) (7) 6.3.1.3.c Activate the Project (3)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates. (7) Generate and communicate a plan for project and technical management and execution, including reviews. ----- (3) Implement project plans.	
5	System/software architecture is not reusable by design.	Architecture Definition Process	6.4.4.3.a Prepare for Architecture Definition (2)	(2) Identify stakeholder concerns.	P1
		Design Definition Process	6.4.5.3.a Prepare for Software System Design Definition (2)	(2) Select and prioritize design principles and design characteristics.	
6	Insufficient analysis to accurately determine needs and evaluate whether these needs can be realistically met.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.b Define Stakeholder Needs (2) (4) 6.4.2.3.c Develop the Operational Concept and Other Life Cycle Concepts (1) 6.4.2.3.d Transform Stakeholder Needs into Stakeholder Requirements (1) 6.4.2.3.e Analyze Stakeholder Requirements (1) (2) (3) (4)	(2) Identify stakeholder needs. (4) Define the stakeholder needs and rationale. ----- (1) Define a representative set of scenarios to identify the required capabilities that correspond to anticipated operational and other life cycle concepts. ----- (1) Identify the constraints on a system solution. ----- (1) Analyze the	P2

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				complete set of stakeholder requirements. (2) Define critical performance measures that enable the assessment of technical achievement. (3) Feed back the analyzed requirements to applicable stakeholders to validate that their needs and expectations have been adequately captured and expressed. (4) Resolve stakeholder requirements issues.	
		System Analysis Process	6.4.6.3.b Perform System Analysis (1) (2) (3) (4)	(1) Identify and validate contexts and assumptions. (2) Apply the selected analysis methods to perform the required analysis. (3) Review the analysis results for quality and validity. (4) Establish conclusions and recommendations	
		System/Software Requirements Definition Process	6.4.3.3.c Analyze System/Software Requirements (1)	(1) Analyze the complete set of system/software requirements.	
7	Inability to create accurate and comprehensive future scheduling plans.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical	P2

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				objectives and work estimates.	
8	Insufficient feedback and quality assurance due to the infrequent review of system/software requirements, design, and implementation outputs by both internal and external stakeholders.	Quality Assurance Process	6.3.8.3.a Prepare for Quality Assurance (1.iv) (1.v)	(1) Define a Quality Assurance strategy. The strategy is consistent with the organizational Quality Management policies and objectives and includes: (1.iv) Activities appropriate to each supplier (including subcontractors); (1.v) Required verification, validation, monitoring, measurement, review, inspection, audit, and test activities specific to the products or services	P2
		System/Software Requirements Definition Process	6.4.3.3.c Analyze System/Software Requirements (3)	(3) Feed back the analyzed requirements to applicable stakeholders for review.	
		Validation Process	6.4.11.3.b Perform Validation (2)	(2) Perform the validation procedures in the defined environment.	
		Implementation Process	6.4.7.3.b Perform Implementation (6)	(6) Record objective evidence that the software system element meets requirements.	
		Project Planning Process	6.3.1.3.b Plan Project and Technical	(7) Generate and communicate a plan for project and technical	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
			Management (7)	management and execution, including reviews.	
9	Insufficient number of personnel assigned to Quality Engineering activities.	Human Resource Management Process	6.2.4.3.c Acquire and Provide Skills (1) (2) (3)	(1) Obtain qualified personnel when skill deficits are identified. (2) Maintain and manage the pool of skilled personnel necessary to staff ongoing projects. (3) Make project assignments based on project and staff-development needs.	P2
10	Insufficient project duration to accommodate required activities and processes.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) 6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Define a strategy for how the acquisition will be conducted. ----- (1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.	P2
		Project Planning Process	6.3.1.3.b Plan Project and Technical	(1) Define and maintain a project schedule based on management and technical	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
			Management (1)	objectives and work estimates.	
		Supply Process	6.1.2.3.b Respond to a Request for Supply of Product or Services (1) (2) 6.1.2.3.c Establish and Maintain an Agreement (1)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond. (2) Prepare a response that satisfies the solicitation. ----- (1) Negotiate an agreement with the acquirer that includes acceptance criteria.	
11	Lack of information sharing between internal units and unwillingness to share details.	Information Management Process	6.3.6.3.b Perform Information Management (1) (3)	(1) Obtain, develop, or transform the identified items of information. (3) Publish, distribute or provide access to information and information items to designated stakeholders.	P2
		Supply Process	6.1.2.3.b Respond to a Request of Products or Services (1)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond.	
12	Insufficient attention is given to the technical solution, schedule, and cost during contract negotiations.	Acquisition Process	6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Develop an agreement with the supplier that includes acceptance criteria (2) Identify necessary changes to the agreement. (3) Evaluate	P2

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				<p>impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.</p>	
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1) (3)	<p>(1) Define and maintain a project schedule based on management and technical objectives and work estimates. (3) Define the costs and plan a budget.</p>	
		Design Definition Process	6.4.5.2.b Establish Design Related to Each Software System Element	<p>(3) Examine design alternatives and feasibility of implementation.</p>	
13	Lack of flexibility in project activities due to the rigid structure of the waterfall life cycle.	Life Cycle Model Management Process	6.2.1.3.a Establish the Process (1) (2)	<p>(1) Establish policies and procedures for process management and deployment that are consistent with organizational strategies. (2) Establish the processes that implement the requirements of this document and that are consistent with organizational strategies.</p>	P3
14	The absence of a systematic approach in determining project durations.	Acquisition Process	6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	<p>(1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify</p>	P3

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.	
				(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond. -----	
		Supply Process	6.1.2.3.b Respond to a Request of Products or Services (1) 6.1.2.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Negotiate an agreement with the acquirer that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the acquirer, as necessary. (5) Update the agreement with the acquirer, as necessary.	
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Human Resource Management Process	6.2.4.3.b Develop Skills (1) (2) 6.2.4.3.c Acquire and Provide Skills (1) (2) (3)	(1) Establish skills development strategy. (2) Obtain or develop training, education or mentoring	P3

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
16	Insufficient time allocated for testing activities in contracted R&D projects.			resources. ----- (1) Obtain qualified personnel when skill deficits are identified. (2) Maintain and manage the pool of skilled personnel necessary to staff ongoing projects. (3) Make project assignments based on project and staff-development needs.	
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (2) (7) 6.3.1.3.c Activate the Project (3)	(2) Define achievement criteria for the life cycle stage decision gates, delivery dates and major dependencies on external inputs or outputs. (7) Generate and communicate a plan for project and technical management and execution, including reviews. ----- (3) Implement project plans.	P3
		Verification Process	6.4.9.3.a Prepare for Verification (1)	(1) Define the verification strategy, which includes the following:	
		Validation Process	6.4.11.3.a Prepare for Validation (1)	(1) Define the validation strategy, which includes the following:	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
17	Insufficient test automation results in increased dependence on manual testing, causing inefficiencies.	Verification Process	6.4.9.3.a Prepare for Verification (5) (6)	(5) Identify and plan for the necessary enabling systems or services needed to support verification. (6) Obtain or acquire access to the enabling systems or services to be used to support verification.	P3
		Implementation Process	6.4.7.3.a Prepare for Implementation (1)	(1) Define an implementation strategy, with consideration of the following: vii. creation of manual or automated test procedures to verify that a software unit meets its requirements before creation of the software unit (test-driven development);	
18	Absence of dedicated testing personnel in R&D projects, leading to dependence on staff allocated from contracted projects.	Human Resource Management Process	6.2.4.3.c Acquire and Provide Skills (2) (3) (5) 6.4.9.3.a Prepare for Verification (5)	(2) Maintain and manage the pool of skilled personnel necessary to staff ongoing projects. (3) Make project assignments based on project and staff-development needs. (5) Control multi-project management interfaces to resolve personnel conflicts. ----- (5) Identify and plan for the necessary	P3

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				enabling systems or services needed to support verification.	
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (2)	(2) Prepare a request for the supply of a product or service that includes the requirements.	P4
20	Insufficient contract schedule limiting flexibility and project activities.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) 6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Define a strategy for how the acquisition will be conducted. ----- (1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.	P4

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	
		Supply Process	6.1.2.3.b Respond to a Request for Supply of Product or Services (1) (2) 6.1.2.3.c Establish and Maintain an Agreement (1)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond. (2) Prepare a response that satisfies the solicitation. ----- (1) Negotiate an agreement with the acquirer that includes acceptance criteria.	
21	Although R&D projects typically require high costs, they are often carried out with limited budgets.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) 6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Define a strategy for how the acquisition will be conducted. ----- (1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with	P4

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				the supplier, as necessary.	
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (3)	(3) Define the costs and plan a budget.	
		Supply Process	6.1.2.3.b Respond to a Request for Supply of Product or Services (1) (2) 6.1.2.3.c Establish and Maintain an Agreement (1)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond. (2) Prepare a response that satisfies the solicitation. ----- (1) Negotiate an agreement with the acquirer that includes acceptance criteria.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
22	Failure to identify R&D-critical areas within the project. Failure to define the R&D scope.	System Analysis Process	6.4.6.3.a Define the System Analysis Strategy and Prepare for System Analysis (1) (3)	(1) Identify the problem or question that requires analysis. (3) Define the scope, objectives, and level of fidelity of the analysis.	P5
23	Accelerated R&D due to budget constraints leads to focusing only on delivering a working product, limiting proper research efforts and adversely impacting project outputs.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) 6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Define a strategy for how the acquisition will be conducted. ----- (1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.	P5
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (3)	(3) Define the costs and plan a budget.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Supply Process	6.1.2.3.b Respond to a Request for Supply of Product or Services (1) (2) 6.1.2.3.c Establish and Maintain an Agreement (1)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond. (2) Prepare a response that satisfies the solicitation. ----- (1) Negotiate an agreement with the acquirer that includes acceptance criteria.	
24	Lack of sufficient time in the project schedule to effectively carry out required activities.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) 6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Define a strategy for how the acquisition will be conducted. ----- (1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.	P5
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Supply Process	6.1.2.3.b Respond to a Request for Supply of Product or Services (1) (2) 6.1.2.3.c Establish and Maintain an Agreement (1)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond. (2) Prepare a response that satisfies the solicitation. ----- (1) Negotiate an agreement with the acquirer that includes acceptance criteria.	
25	Insufficient number of software development personnel.	Human Resource Management Process	6.2.4.3.c Acquire and Provide Skills (1) (2) (3)	(1) Obtain qualified personnel when skill deficits are identified. (2) Maintain and manage the pool of skilled personnel necessary to staff ongoing projects. (3) Make project assignments based on project and staff-development needs.	P5
26	Failure to take necessary initiatives to engage with academic institutions resulted in insufficient expert support.	Acquisition Process	6.1.1.3.b Advertise the Acquisition and Select the Supplier (1)	(1) Communicate the request for the supply of a product or service to potential suppliers;	P5
27	Low reusability of case-specific solutions prevented meeting the need in	Architecture Definition Process	6.4.4.3.a Prepare for Architecture Definition (5)	(5) Identify and plan for the necessary enabling systems or services	P5

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
	a very similar project.			needed to support the Architecture Definition process.	
		Design Definition Process	6.4.5.3.a Prepare for Software System Design Definition (3)	----- (3) Identify and plan for the necessary enabling systems or services needed to support design definition.	
28	Due to the nature of the "research" component in R&D projects, the actual process of conducting research is frequently skipped. Instead of repeatedly attempting to solve problems through systematic investigation, teams often rely on assumptions, leading to frequent underestimation or overestimation of the work involved.	Life Cycle Model Management Process	6.2.1.3.a Establish the Process (1) (2)	(1) Establish policies and procedures for process management and deployment that are consistent with organizational strategies. (2) Establish the processes that implement the requirements of this document and that are consistent with organizational strategies.	P5
		Project Planning Process	6.3.1.3.a Define the Project (3)	(3) Define and maintain a life cycle model that is comprised of stages using the defined life cycle models of the organization.	
29	While preparing the technical specifications document of agreement, the needs are defined without considering the current technology readiness level, meaning the limitations and capabilities of existing technology	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (2)	(2) Prepare a request for the supply of a product or service that includes the requirements.	P5
		Stakeholder Needs and Requirements Definition Process	6.4.2.3.d Transform Stakeholder Needs into Stakeholder	(1) Identify the constraints on a system solution.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
	are not taken into account.		Requirements (1)		
30	Failure to clearly define needs drives solution diversity, causing excessive resource and budget requirements.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.b Define Stakeholder Needs (1) (2) (3) (4) 6.4.2.3.e Analyze Stakeholder Requirements (3) (4)	(1) Define context of use within the concept of operations and the preliminary life cycle concepts. (2) Identify stakeholder needs. (3) Prioritize and down-select needs. (4) Define the stakeholder needs and rationale. ----- (3) Feed back the analyzed requirements to applicable stakeholders to validate that their needs and expectations have been adequately captured and expressed. (4) Resolve stakeholder requirements issues.	P5
		System/Software Requirements Definition Process	6.4.3.3.b Define System/Software Requirements (5)	(5) Define system/software requirements and requirements attributes, including the following:	
31	Failure to make an accurate and comprehensive projection of the output to be generated from the R&D project, resulting in the project being carried out without addressing the	Business or Mission Analysis Process	6.4.1.b Define the Problem or Opportunity Space (2)	(2) Define the mission, business, or operational problem or opportunity.	P5

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
	question of where this work will stand in 10 years.				
32	The developed technology is ready for use, but users are not yet prepared to adopt and use it due to gaps in habits, knowledge, or infrastructure. Thus, users may struggle to articulate appropriate or realistic expectations aligned with the technological capabilities.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.d Transform Stakeholder Needs into Stakeholder Requirements (1)	(1) Identify the constraints on a system solution.	P5
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Life Cycle Model Management Process	6.2.1.3.a Establish the Process (1) (2)	(1) Establish policies and procedures for process management and deployment that are consistent with organizational strategies. (2) Establish the processes that implement the requirements of this document and that are consistent with organizational strategies.	P5
34	Misalignment in the starting point of R&D activities — although technology readiness levels 1-3 are ideally handled by universities before transitioning to industry, companies undertake these early-stage activities themselves.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) (2) 6.1.1.3.b Advertise the Acquisition and Select the Supplier (1)	(1) Define a strategy for how the acquisition will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements.	P6
		Supply Process	6.1.2.3.a Prepare for the	(2) Define a supply strategy.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
			Supply (2)		
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (6)	(6) Plan the acquisition of materials and enabling systems and services supplied from outside the project.	
35	Failure to transform R&D outcomes into marketable products and sales, leading to insufficient return on investment.	Business or Mission Analysis Process	6.4.1.3.a Prepare for Business or Mission Analysis (3) (4) 6.4.1.3.b Define the Problem or Opportunity Space (1)	(3) Identify and plan for the necessary enabling systems or services needed to support business or mission analysis. (4) Obtain or acquire access to the enabling systems or services to be used. ----- (1) Analyze customer complaints, problems and opportunities in the context of relevant trade-space factors.	P6
		Portfolio Management Process	6.2.3.3.a Define and Authorize Projects (1)	(1) Identify potential new or modified capabilities or missions.	
36	Confidentiality concerns prevent the company from sharing its work or data with third parties like academia.	Information Management Process	6.3.6.3.a Prepare for Information Management (1) 6.3.6.3.b Perform Information Management (3)	(1) Define the strategy for information management. ----- (3) Publish, distribute or provide access to information and information items to designated stakeholders.	P6

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Project Planning Process	6.3.1.3.a Define the Project (1) 6.3.1.3.b Plan Project and Technical Management (6)	(1) Identify the project objectives and constraints. ----- (6) Plan the acquisition of materials and enabling systems and services supplied from outside the project.	
		Acquisition Process	6.1.1.3.d Monitor the Agreement (2)	(2) Provide data needed by the supplier and resolve issues in a timely manner.	
37	Subcontractor selection is not based on predefined evaluation criteria.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1)	(1) Define a strategy for how the acquisition will be conducted.	P7
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	
38	Aligning the subcontractor's schedule with the main contractor's schedule causes project delays when the subcontractor fails to meet deadlines.	Risk Management Process	6.3.4.3.b Manage the Risk Profile (1)	(1) Define and record the risk thresholds and conditions under which a level of risk may be accepted.	P7
		Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) (2)	(1) Define a strategy for how the acquisition will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements.	
39	Lack of in-depth analysis and	Supply Process	6.1.2.3.b Respond to a	(1) Evaluate a request for the	P7

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
	detailing of the technical solution during the contract negotiation phase.		Request for Supply of Product or Services (1)	supply of a product or service) to determine feasibility and how to respond.	
40	Lack of personnel with sufficient expertise in areas requiring domain-specific knowledge.	Human Resource Management Process	6.2.4.3.b Develop Skills (1) (2) 6.2.4.3.c Acquire and Provide Skills (1) (2) (3)	(1) Establish skills development strategy. (2) Obtain or develop training, education or mentoring resources. ----- (1) Obtain qualified personnel when skill deficits are identified. (2) Maintain and manage the pool of skilled personnel necessary to staff (3) Make project assignments based on project and staff-development needs.	P7
		Project Assessment and Control Process	6.3.2.3.b Assess the Project (4)	4) Assess the adequacy of roles, responsibilities, accountabilities, and authorities.	
41	Subcontractor's failure to comply with the agreed delivery schedule.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	P7

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Risk Management Process	6.3.4.3.b Manage the Risk Profile (1)	(1) Define and record the risk thresholds and conditions under which a level of risk may be accepted.	
		Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) (2)	(1) Define a strategy for how the acquisition will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements.	
42	Involvement of multiple subcontractors causing integration problems.	Integration Process	6.4.8.3.a Prepare for Integration (1) (2) 6.4.8.3.b Perform Integration (1) (2)	(1) Define the integration strategy. (2) Identify and define criteria for integration and points at which the correct operation and integrity of the interfaces and the selected software system functions will be verified. ----- (1) Obtain implemented software system elements in accordance with agreed schedules. (2) Integrate the implemented elements.	P7
43	Insufficient communication and coordination between different departments and within individual teams.	Information Management Process	6.3.6.3.a Prepare for Information Management (4) 6.3.6.3.b Perform Information	(4) Define the content, formats and structure of information items. ----- (3) Publish, distribute or provide access to information and	P7

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
			Management (3)	information items to designated stakeholders.	
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (6)	(6) Plan the acquisition of materials and enabling systems and services supplied from outside the project.	
44	The user/customer manages the project as a standard contracted project rather than an R&D project, leading to excessive documentation, strict schedules, and budget constraints.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) (2)	(1) Define a strategy for how the acquisition will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements.	P7
45	Users resist adapting to use the delivered product, and are often hesitant or unwilling to engage with it once deployed.	Operation Process	6.4.12.3.d Support the Customer (1)	(1) Provide assistance and consultation to the customers and users to resolve complaints, incidents, problems, and service requests.	P7
		Acquisition Process	6.1.1.3.a Prepare for the Acquisition (2)	(2) Prepare a request for the supply of a product or service that includes the requirements.	
46	Military standard compliance is expected by the user/customer even in R&D projects, resulting in technical requirements that impose additional constraints.	Tailoring Process	A.2.3.a Tailoring Process Activities and Tasks	Identify and record the circumstances that influence tailoring. These influences include, but are not limited to: (10) the need to conform to other standards.	P7

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
47	The life cycle specified by the customer in the contract is required to follow the waterfall model.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) (2)	(1) Define a strategy for how the acquisition will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements.	P7
		Supply Process	6.1.2.3.b Respond to a Request for Supply of Product or Services (1)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond.	
		Life Cycle Model Management Process	6.2.1.3.a Establish the Process (1) (2)	(1) Establish policies and procedures for process management and deployment that are consistent with organizational strategies. (2) Establish the processes that implement the requirements of this document and that are consistent with organizational strategies.	
48	In contracted R&D projects, the dynamic nature of R&D requires managing changes through standard contract procedures, leading to time-consuming processes like contract and engineering change	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) (2)	(1) Define a strategy for how the acquisition will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements.	P7

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
	requests. As a result, procedural efforts often outweigh R&D efforts.	Configuration Management Process	6.3.5.3.a Plan Configuration Management (1.ix)	(1) Define a configuration management strategy, including approaches for the following: (1.ix) Change management, including preparing stakeholders and especially users for changes in operational software systems and services.	
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.	Business or Mission Analysis Process	6.4.1.b Define the Problem or Opportunity Space (1) (2)	(1) Analyze customer complaints, problems and opportunities in the context of relevant trade-space factors. (2) Define the mission, business, or operational problem or opportunity.	P8
50	Failure to execute the R&D project in line with the initial objectives defined at the beginning of the project.	System/Software Requirements Definition Process	6.4.3.3.a Prepare for System/Software Requirements Definition (1)	(1) Define the functional boundary of the software system or element in terms of the behavior and properties provided.	P8
		Project Assessment and Control Process	6.3.2.3.b Assess the Project (7) (9)	(7) Conduct required management and technical reviews, audits and inspections. (9) Analyze measurement results and make recommendations.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Project Planning Process	6.3.1.3.a Define the Project (2)	(2) Define the project scope as established in the agreement.	
		Implementation Process	6.4.7.3.b Perform Implementation (1)	(1) Realize or adapt software elements, according to the strategy, constraints, and defined implementation procedures.	
51	Inadequate analysis of the project's scope and intended purpose.	System Analysis Process	6.4.6.3.b Perform System Analysis (1) (2) (3) (4)	(1) Identify and validate contexts and assumptions. (2) Apply the selected analysis methods to perform the required analysis. (3) Review the analysis results for quality and validity. (4) Establish conclusions and recommendations.	P8
		System/Software Requirements Definition Process	6.4.3.3.c Analyze System/Software Requirements (1)	(1) Analyze the complete set of system/software requirements.	
52	Disagreements within the team during roadmap determination, leading to extended time required to reach a consensus.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	P8
53	Starting projects without adequate planning as a result of pressure or demands from senior management.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	P8

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
54	Limited budget availability.	Portfolio Management Process	6.2.3.3.a Define and Authorize Projects (2) (5)	(2) Prioritize, select and establish new business opportunities, ventures or undertakings. --- (5) Identify and allocate resources for the achievement of project goals and objectives.	P9
		Risk Management Process	6.3.4.3.c Analyze Risks (2)	(2) Estimate the likelihood of occurrence and consequences of each identified risk.	
		Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) 6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Define a strategy for how the acquisition will be conducted. ----- (1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.	
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (3)	(3) Define the costs and plan a budget.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Supply Process	(3) (5)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond. (2) Prepare a response that satisfies the solicitation. ----- (1) Negotiate an agreement with the acquirer that includes acceptance criteria.	
55	Inability to transform R&D outputs into a marketable product, primarily due to an underdeveloped or inadequate business model.	Business or Mission Analysis Process	6.4.1.b Define the Problem or Opportunity Space (1)	(1) Analyze customer complaints, problems and opportunities in the context of relevant trade-space factors.	P9
56	Initiating studies based on popularity rather than real needs or global trends.	Business or Mission Analysis Process	6.4.1.b Define the Problem or Opportunity Space (1) (2)	(1) Analyze customer complaints, problems and opportunities in the context of relevant trade-space factors. (2) Define the mission, business, or operational problem or opportunity.	P9
57	Inadequate and incorrect roadmap creation, leading to uncertainty in project direction.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	P9

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
58	Insufficient domain experts and reliance on interns/juniors negatively impact product quality.	Human Resource Management Process	6.2.4.3.b Develop Skills (1) (2) 6.2.4.3.c Acquire and Provide Skills (1) (2) (3)	(1) Establish skills development strategy. (2) Obtain or develop training, education or mentoring resources. ----- (1) Obtain qualified personnel when skill deficits are identified. (2) Maintain and manage the pool of skilled personnel necessary to staff ongoing projects. (3) Make project assignments based on project and staff-development needs.	p9
		Project Assessment and Control Process	6.3.2.3.b Assess the Project (4)	4) Assess the adequacy of roles, responsibilities, accountabilities, and authorities.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
59	R&D is expected to always result in a product, causing patent-oriented R&D opportunities to be overlooked and underutilized.	Business or Mission Analysis Process	6.4.1.a Prepare for Business or Mission Analysis (1) (2) 6.4.1.b Define the Problem or Opportunity Space (1) (2)	(1) Review identified problems and opportunities in the organization strategy with respect to desired organization goals or objectives. (2) Define the business or mission analysis strategy. ----- (1) Analyze customer complaints, problems and opportunities in the context of relevant trade-space factors. (2) Define the mission, business, or operational problem or opportunity.	P9
60	Failure to assess the suitability of the R&D project in relation to the available budget and resources.	Supply Process	6.1.2.3.b Respond to a Request for Supply of Products or Services (1)	(1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond.	P9
		Project Planning Process	6.3.1.3.a Define the Project (3)	(3) Define the costs and plan a budget.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
61	Mismatch between the product developed using internal resources and the marketing strategy applied during sales, resulting in the misdirection of customer expectations.	Business or Mission Analysis Process	6.4.1.b Define the Problem or Opportunity Space (1) 6.4.1.c Characterize the Solution Space (2)	(1) Analyze customer complaints, problems and opportunities in the context of relevant trade-space factors. ----- (2) Identify candidate alternative solution classes that span the potential solution space.	P9
62	Not accurately projecting the product scope at the initial stage, resulting in the expectation that a product developed for a specific customer can later serve a broad, general market.	Business or Mission Analysis Process	6.4.1.b Define the Problem or Opportunity Space (1) 6.4.1.c Characterize the Solution Space (2)	(1) Analyze customer complaints, problems and opportunities in the context of relevant trade-space factors. ----- (2) Identify candidate alternative solution classes that span the potential solution space.	P9
		Project Planning Process	6.3.1.3.a Define the Project (1) (2)	(1) Identify the project objectives and constraints. (2) Define the project scope as established in the agreement.	
63	Subcontractors are selected without technical team involvement, limiting the ability to choose the right subcontractor.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1)	(1) Define a strategy for how the acquisition will be conducted.	P9

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
64	Development is carried out based on instant demands, mostly from top management, without a defined list of needs or requirements and without a development plan. As a result, the final product often fails to meet customer expectations.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (4) (7)	(4) Define roles, responsibilities, accountabilities, and authorities. (7) Generate and communicate a plan for project and technical management and execution, including reviews.	P9
		Stakeholder Needs and Requirements Definition Process	6.4.2.3.e Analyze Stakeholder Requirements (3) (4)	(3) Feed back the analyzed requirements to applicable stakeholders to validate that their needs and expectations have been adequately captured and expressed. (4) Resolve stakeholder requirements issues.	
		System/Software Requirements Definition Process	6.4.3.3.b Define System/Software Requirements (1)	(1) Define each function that the software system or element is required to perform.	
65	Undefined or unspecified requirements set.	System/Software Requirements Definition Process	6.4.3.3.b Define System/Software Requirements (1)	(1) Define each function that the software system or element is required to perform.	P9
66	Communication gaps due to lack of direct interaction between the end-user and developers.	Life Cycle Model Management Process	6.2.1.3.a Establish the Process (3)	(3) Define the roles, responsibilities, accountabilities, and authorities to facilitate implementation of processes and the strategic management of life cycles.	P9

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
67	End-user intervention in the design process beyond expected boundaries, accompanied by a proposed solution, restricts the technical team's ability to explore alternative solutions and make independent decisions.	Decision Management Process	6.3.3.3.a Prepare for Decision (1)	(1) Define a decision management strategy. ----- (4) Define roles, responsibilities, accountabilities, and authorities.	P9
68	The involvement of many stakeholders leads to communication breakdowns and challenges in effective information sharing	Information Management Process	6.3.6.3.a Prepare for Information Management (4) 6.3.6.3.b Perform Information Management (3)	(4) Define the content, formats and structure of information items. ----- (3) Publish, distribute or provide access to information and information items to designated stakeholders.	P10
69	Cultural differences between companies from different countries lead to communication challenges, difficulties in collaboration, and obstacles in effective information sharing.	Information Management Process	6.3.6.3.a Prepare for Information Management (4) 6.3.6.3.b Perform Information Management (3)	(4) Define the content, formats and structure of information items. ----- (3) Publish, distribute or provide access to information and information items to designated stakeholders.	P10
70	Insufficient information sharing with incentive institution staff causes difficulties in accessing domain-specific information and project details.	Information Management Process	6.3.6.3.a Prepare for Information Management (1) (2) (4) 6.3.6.3.b Perform Information Management (3)	(1) Define the strategy for information management. (2) Define the items of information that will be managed. (4) Define the content, formats and structure of information	P10

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				items. ----- (3) Publish, distribute or provide access to information and information items to designated stakeholders.	
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (7)	(7) Generate and communicate a plan for project and technical management and execution, including reviews.	
71	Lack of effective communication and insufficient information sharing between teams.	Information Management Process	6.3.6.3.a Prepare for Information Management (4) 6.3.6.3.b Perform Information Management (3)	(4) Define the content, formats and structure of information items. ----- (3) Publish, distribute or provide access to information and information items to designated stakeholders.	P10
72	The absence of technical management by the project manager leads to the emergence of multiple decision-makers within the project.	Human Resource Management Process	6.2.4.3.a Identify Skills (1) 6.3.6.3.c Acquire and Provide Skills (3)	(1) Identify skill needs based on current and expected projects. ----- (3) Make project assignments based on project and staff-development needs.	P10
73	Administrative challenges caused by multiple departments/teams working together, limiting centralized management by a	Human Resource Management Process	6.2.4.3.a Identify Skills (1) 6.3.6.3.c Acquire and Provide Skills (3)	(1) Identify skill needs based on current and expected projects. ----- (3) Make project assignments based on project and staff-	P10

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
	single authority (e.g., PM).			development needs.	
		Portfolio Management Process	6.2.3.3.a Define and Authorize Projects (5)	(5) Identify and allocate resources for the achievement of project goals and objectives.	
74	Ineffective and non-solution-oriented technical management.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (7)	(7) Generate and communicate a plan for project and technical management and execution, including reviews.	P10
75	Due to limited technological knowledge, the end-user is unaware of technical limitations, which creates challenges in accurately identifying and defining needs.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.d Transform Stakeholder Needs into Stakeholder Requirements (1)	(1) Identify the constraints on a system solution.	P11
76	Defining all user deficiencies as needs within a single project, causing difficulties in identifying the real need.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.b Define Stakeholder Needs (1) (2) (3) (4) 6.4.2.3.e Analyze Stakeholder Requirements (3) (4)	(1) Define context of use within the concept of operations and the preliminary life cycle concepts. (2) Identify stakeholder needs. (3) Prioritize and down-select needs. (4) Define the stakeholder needs and rationale. ----- (3) Feed back the analyzed requirements to applicable stakeholders to validate that their	P11

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				needs and expectations have been adequately captured and expressed. (4) Resolve stakeholder requirements issues.	
77	Overloading a single product or project with excessive feature expectations limits its functionality and negatively impacts usability.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.b Define Stakeholder Needs (1) (2) (3) (4) 6.4.2.3.e Analyze Stakeholder Requirements (3) (4)	(1) Define context of use within the concept of operations and the preliminary life cycle concepts. (2) Identify stakeholder needs. (3) Prioritize and down-select needs. (4) Define the stakeholder needs and rationale. ----- (3) Feed back the analyzed requirements to applicable stakeholders to validate that their needs and expectations have been adequately captured and expressed. (4) Resolve stakeholder requirements issues.	P11
		Architecture Definition Process	6.4.4.3.a Prepare for Architecture Definition (1)	(1) Review pertinent information and identify key drivers of the architecture.	
		Design Definition Process	6.4.5.3.a Prepare for Software System Design	(2) Select and prioritize design principles and	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
78	Minimal or no involvement of the end user in the needs definition process.	Stakeholder Needs and Requirements Definition Process	Definition (2) 6.4.2.3.a Prepare for Stakeholder Needs and Requirements Definition (1) (2)	design characteristics. (1) Identify the stakeholders who have an interest in the software system throughout its life cycle. (2) Define the stakeholder needs and requirements definition strategy.	
		Acquisition Process	6.1.1.3.a Prepare for the Acquisition (2)	(1) Define a strategy for how the acquisition will be conducted.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.b Define Stakeholder Needs (1) (2) (4) 6.4.2.3.c Develop the Operational Concept and Other Life Cycle Concepts (1) 6.4.2.3.d Transform Stakeholder Needs into Stakeholder Requirements (1) 6.4.2.3.e Analyze Stakeholder Requirements (3) (4) 6.4.2.3.f Manage the Stakeholder Needs and Requirements Definition (1)	(1) Define context of use within the concept of operations and the preliminary life cycle concepts. (2) Identify stakeholder needs. (4) Define the stakeholder needs and rationale. ----- (1) Define a representative set of scenarios to identify the required capabilities that correspond to anticipated operational and other life cycle concepts. ----- (1) Identify the constraints on a system solution. ----- (3) Feed back the analyzed requirements to applicable stakeholders to validate that their needs and expectations have been adequately captured and expressed. (4) Resolve stakeholder requirements issues. ----- (1) Obtain explicit agreement with designated stakeholders on the stakeholder requirements.	P11

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1)	(1) Define a strategy for how the acquisition will be conducted.	
80	Prematurely stopping R&D projects intended to produce a prototype product, driven by the prejudice that the prototype will not fulfill expectations, thereby blocking further R&D efforts.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.b Define Stakeholder Needs (1) (2) (4) 6.4.2.3.c Develop the Operational Concept and Other Life Cycle Concepts (1) 6.4.2.3.d Transform Stakeholder Needs into Stakeholder Requirements (1) 6.4.2.3.e Analyze Stakeholder Requirements (3) (4) 6.4.2.3.f Manage the Stakeholder Needs and Requirements Definition (1)	(1) Define context of use within the concept of operations and the preliminary life cycle concepts. (2) Identify stakeholder needs. (4) Define the stakeholder needs and rationale. ----- (1) Define a representative set of scenarios to identify the required capabilities that correspond to anticipated operational and other life cycle concepts. ----- (1) Identify the constraints on a system solution. ----- (3) Feed back the analyzed requirements to applicable stakeholders to validate that their needs and expectations have been adequately captured and expressed. (4) Resolve stakeholder requirements issues. ----- (1) Obtain explicit	P11

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				agreement with designated stakeholders on the stakeholder requirements.	
81	Frequent turnover in user staff prevents continuity in R&D projects, as newly assigned personnel need time to gain an R&D perspective and adapt to project dynamics.	Risk Management Process	6.3.4.3.b Manage the Risk Profile (1) (2) (3) 6.3.4.3.c Analyze Risks (2) (3) 6.3.4.3.d Treat Risks (2) 6.3.4.3.e Monitor Risks (1) (3)	(1) Define and record the risk thresholds and conditions under which a level of risk may be accepted. (2) Establish and maintain a risk profile. (3) Periodically provide the relevant risk profile to stakeholders based upon their needs. ----- (2) Estimate the likelihood of occurrence and consequences of each identified risk. (3) Evaluate each risk against its risk thresholds. ----- (2) Implement risk treatment alternatives for which the stakeholders determine that actions should be taken to make a risk acceptable. ----- (1) Continually monitor risks and the risk management context for changes and evaluate the risks when their state has changed. (3) Continually monitor for the	P11

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
82	R&D projects are typically limited to 2-3 years without clear criteria for setting this duration, leading to very few projects being completed successfully and on time.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) 6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	<p>emergence of new risks and sources throughout the life cycle.</p> <p>(1) Define a strategy for how the acquisition will be conducted. ----- (1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.</p>	P11
		Supply Process	6.1.2.3.b Respond to a Request for Supply of Product or Services (1) (2) 6.1.2.3.c Establish and Maintain an Agreement (1)	<p>1) Evaluate a request for the supply of a product or service) to determine feasibility and how to respond. (2) Prepare a response that satisfies the solicitation. ----- (1) Negotiate an agreement with the acquirer that includes acceptance criteria.</p>	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1)	(1) Define and maintain a project schedule based on management and technical objectives and work estimates.	
83	Resistance to R&D projects creates a prejudice that the resulting product will be incomplete and not suitable for use.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.e Analyze Stakeholder Requirements (3) (4) 6.4.2.3.f Manage the Stakeholder Needs and Requirements Definition (1)	(3) Feed back the analyzed requirements to applicable stakeholders to validate that their needs and expectations have been adequately captured and expressed. (4) Resolve stakeholder requirements issues. ----- (1) Obtain explicit agreement with designated stakeholders on the stakeholder requirements.	P11
84	The flexible and evolving nature of R&D projects conflicts with the rigid structure of waterfall-based models, which are often embedded in both contractual agreements and implementation practices. This misalignment leads to difficulties in adapting to change and negatively affects project schedules.	Life Cycle Model Management Process	6.2.1.3.a Establish the Process (1) (2)	(1) Establish policies and procedures for process management and deployment that are consistent with organizational strategies. (2) Establish the processes that implement the requirements of this document and that are consistent with organizational strategies.	P12
		Acquisition Process	6.1.1.3.a Prepare for the	(1) Define a strategy for how the acquisition	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
			Acquisition (1) (2)	will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements.	
85	Although projects are divided into phases for management purposes, requiring formal acceptance tests at the end of each phase creates bureaucratic obstacles and prolongs the process, causing serious delays in the project schedule.	Life Cycle Model Management Process	6.2.1.3.a Establish the Process (1) (2)	(1) Establish policies and procedures for process management and deployment that are consistent with organizational strategies. (2) Establish the processes that implement the requirements of this document and that are consistent with organizational strategies.	P12
		Validation Process	6.4.11.3.a Prepare for Validation (1)	(1) Define the validation strategy.	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (1) (2) (7)	1) Define and maintain a project schedule based on management and technical objectives and work estimates. 2) Define achievement criteria for the life cycle stage decision gates, delivery dates and major dependencies on external inputs or outputs. 7) Generate and communicate a plan for project and technical management and execution, including reviews.	
86	Rushed contracts and unclear frameworks lead to inconsistent management practices across individuals, departments, and institutions.	Project Planning Process	6.3.1.3.b Plan Project and Technical Management (4)	(4) Define roles, responsibilities, accountabilities, and authorities.	P12
87	Insufficient allocation of personnel to quality-related roles negatively affects the effectiveness of quality control and testing activities. In some cases, the customer-side quality representative is responsible for multiple projects and companies, limiting their focus and productivity.	Human Resource Management Process	6.2.4.3.c Acquire and Provide Skills (1) (2) (3)	(1) Obtain qualified personnel when skill deficits are identified. (2) Maintain and manage the pool of skilled personnel necessary to staff ongoing projects. (3) Make project assignments based on project and staff-development needs.	P12

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
88	Inadequate need definition and analysis results in poor requirements, and late-added requirements often lead to major design changes and wasted effort.	Stakeholder Needs and Requirements Definition Process	6.4.2.3.b Define Stakeholder Needs (2) 6.4.2.3.d Transform Stakeholder Needs into Stakeholder Requirements (3)	(2) Identify stakeholder needs. —— (3) Define stakeholder requirements, consistent with life cycle concepts, scenarios, interactions, constraints, and critical quality characteristics.	P12
89	In some projects, the Statement of Work (SOW), which is intended to outline business-level expectations, is directly embedded into the technical specifications part of the agreement. This leads to non-technical items being treated as technical requirements. For example, a SOW statement like ‘the supplier shall ensure effective knowledge transfer to the customer’ is included in the technical specification section, resulting in ambiguity during verification since such expectations cannot be technically tested or measured like functional requirements.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (2) 6.4.2.3.b Define Stakeholder Needs (2) 6.4.2.3.d Transform Stakeholder Needs into Stakeholder Requirements (3)	(2) Prepare a request for the supply of a product or service that includes the requirements. (2) Identify stakeholder needs. —— (3) Define stakeholder requirements, consistent with life cycle concepts, scenarios, interactions, constraints, and critical quality characteristics.	P12

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
90	Without dedicated user personnel, decisions based on subjective opinions risk being challenged when user representatives change, leading to inconsistencies and project disruptions.	Risk Management Process	6.3.4.3.b Manage the Risk Profile (1) (2) (3) 6.3.4.3.c Analyze Risks (2) (3) 6.3.4.3.d Treat Risks (2) 6.3.4.3.e Monitor Risks (1) (3)	(1) Define and record the risk thresholds and conditions under which a level of risk may be accepted. (2) Establish and maintain a risk profile. (3) Periodically provide the relevant risk profile to stakeholders based upon their needs. ----- (2) Estimate the likelihood of occurrence and consequences of each identified risk. (3) Evaluate each risk against its risk thresholds. ----- (2) Implement risk treatment alternatives for which the stakeholders determine that actions should be taken to make a risk acceptable. ----- (1) Continually monitor risks and the risk management context for changes and evaluate the risks when their state has changed. (3) Continually monitor for the emergence of new risks and sources throughout the life cycle.	P12

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Verification Process	6.4.9.3.a Prepare for Verification (1) 6.4.9.3.b Perform Verification (2) 6.4.9.3.c Manage Results of Verification (1) (2)	(1) Define the verification strategy, which includes the following: —— (2) Perform the verification procedures. —— (1) Review verification results and anomalies encountered and identify follow-up actions. (2) Record incidents and problems during verification and track their resolution.	P12
		Validation Process	6.4.11.3.a Prepare for Validation (1)	(1) Record incidents and problems during verification and track their resolution.	
		Project Assessment and Control Process	6.3.2.2.b Assess the Project (7)	(7) Conduct required management and technical reviews, audits and inspections.	
		Project Planning Process	6.3.1.3.b Plan Project and Technical Management (2) (7) 6.3.1.3.c Activate the Project (3)	(2) Define achievement criteria for the life cycle stage decision gates, delivery dates and major dependencies on external inputs or outputs. (7) Generate and communicate a plan for project and technical management and execution, including	

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
				reviews. ----- (3) Implement project plans.	
92	Using standard contract structures, which are suitable for predictable projects, in R&D projects creates incompatibility with the dynamic and uncertain nature of R&D work.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) (2)	(1) Define a strategy for how the acquisition will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements.	P12

Table 25 (cont.)

CHL ID	Challenges of Software System R&D Projects	IEEE 12207 Process Category	IEEE 12207 Activities & Tasks Numbers	IEEE 12207 Details of Tasks	P-ID
93	Lack of supplier involvement in contract preparation leads to unrealistic and hard-to-implement R&D project contracts.	Acquisition Process	6.1.1.3.a Prepare for the Acquisition (1) (2) 6.1.1.3.b Advertise the Acquisition and Select the Supplier (1) (2) 6.1.1.3.c Establish and Maintain an Agreement (1) (2) (3) (4) (5)	(1) Define a strategy for how the acquisition will be conducted. (2) Prepare a request for the supply of a product or service that includes the requirements. ---- (1) Communicate the request for the supply of a product or service to potential suppliers; and (2) Select one or more suppliers. ---- (1) Develop an agreement with the supplier that includes acceptance criteria. (2) Identify necessary changes to the agreement. (3) Evaluate impact of changes on the agreement. (4) Negotiate the agreement with the supplier. (5) Update the agreement with the supplier, as necessary.	P12

APPENDIX B

SOFTWARE SYSTEM R&D PROJECT CHALLENGES CATEGORIZATION

This appendix presents the challenges identified in software system R&D projects, along with their finalized first-level themes and second-level categories.

Table 26: Categorization of the Software System R&D Project Challenges

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
1	Planning activities are inadequate and lack effectiveness due to contract-driven and top-down planning approaches.	Inefficient and Contract-Driven Project Planning	Planning and Scheduling
		Poor Requirements Definition	Requirements Management
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Requirements Definition Delay	Planning and Scheduling
		Design Definition Delay	
		Poor Design Definition	Design and Architecture Management
3	The functional capabilities and limitations of the product to be developed are not clearly defined, and its boundaries are not explicitly established.		Scope Management
		Poor Scope and Needs Analysis	Requirements Management
4	Intermediate tests are not conducted adequately due to time constraints, and testing activities are mostly postponed until the final stage of the product.	Insufficient Testing	Test Management
		Delay in Testing	Planning and Scheduling
5	System/software architecture is not reusable by design.	Lack of Reusability in System Architecture/Design	Design and Architecture Reusability
6	Insufficient analysis to accurately determine needs and evaluate whether these needs can be realistically met.	Insufficient Requirements Specification and Analysis	Requirements Management
		Poor Feasibility Analysis	Estimation and Feasibility
7	Inability to create accurate and comprehensive future scheduling plans.	Inaccurate Project Planning	Planning and Scheduling

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
8	Insufficient feedback and quality assurance due to the infrequent review of system/software requirements, design, and implementation outputs by both internal and external stakeholders.	Insufficient Stakeholder Feedback <hr/> Insufficient Review Mechanisms	Review and Feedback
9	Insufficient number of personnel assigned to Quality Engineering activities.	Inadequate Staffing for Quality Assurance	Workforce Capacity and Capability
10	Insufficient project duration to accommodate required activities and processes.	Insufficient Project Duration	Estimation and Feasibility <hr/> Planning and Scheduling
11	Lack of information sharing between internal units and unwillingness to share details.	Inefficient Communication Among Internal and External Stakeholders	Communication and Coordination Management
12	Insufficient attention is given to the technical solution, schedule, and cost during contract negotiations.	Insufficient Project Planning <hr/> Insufficient Design Alternatives Development	Planning and Scheduling <hr/> Design and Architecture Management
13	Lack of flexibility in project activities due to the rigid structure of the waterfall life cycle.	Rigidity of the Waterfall Model for R&D Projects	Process Flexibility
14	The absence of a systematic approach in determining project durations.	Lack of Systematic Approach in Determining Project Duration	Estimation and Feasibility
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Lack of Domain-Specific Expertise	Workforce Capacity and Capability
16	Insufficient time allocated for testing activities in contracted R&D projects.	Delay in Testing <hr/> Insufficient Testing	Planning and Scheduling <hr/> Test Management
17	Insufficient test automation results in increased dependence on manual testing, causing inefficiencies.	Insufficient Test Automation	Test Management

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
18	Absence of dedicated testing personnel in R&D projects, leading to dependence on staff allocated from contracted projects.	Inadequate Staffing for Test	Workforce Capacity and Capability
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.	Rigidity of Contract Rules	Contract Management
20	Insufficient contract schedule limiting flexibility and project activities.	Insufficient Project Duration	Estimation and Feasibility
			Planning and Scheduling
21	Although R&D projects typically require high costs, they are often carried out with limited budgets.	Poor Budget Estimation in Early Stages of a Project	Estimation and Feasibility
		Insufficient Budget	
22	Failure to identify R&D-critical areas within the project. Failure to define the R&D scope.	Poor Scope and Needs Analysis	Scope Management
		Poor Requirements Analysis	Requirements Management
23	Accelerated R&D due to budget constraints leads to focusing only on delivering a working product, limiting proper research efforts and adversely impacting project outputs.	Insufficient Budget	Estimation and Feasibility
		Limited R&D due to Budget Constraints	
		Insufficient Feasibility Analysis	
24	Lack of sufficient time in the project schedule to effectively carry out required activities.	Insufficient Project Duration	Estimation and Feasibility
			Planning and Scheduling
25	Insufficient number of software development personnel.	Inadequate Staffing for Software Development	Workforce Capacity and Capability
26	Failure to take necessary initiatives to engage with academic institutions resulted in insufficient expert support.	Weak Collaboration with Academic Institutions	Subcontractor Management

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
		Lack of Expert Support	
27	Low reusability of case-specific solutions prevented meeting the need in a very similar project.	Poor Reusability	Design and Architecture Reusability
28	Due to the nature of the "research" component in R&D projects, the actual process of conducting research is frequently skipped. Instead of repeatedly attempting to solve problems through systematic investigation, teams often rely on assumptions, leading to frequent underestimation or overestimation of the work involved.	Rigidity of the Waterfall Model for R&D Projects	Process Flexibility
		Overestimation of Work	Estimation and Feasibility
		Underestimation of Work	
29	While preparing the technical specifications document of agreement, the needs are defined without considering the current technology readiness level, meaning the limitations and capabilities of existing technology are not taken into account.	Inadequate Consideration of Technical Readiness	Technical Management
30	Failure to clearly define needs drives solution diversity, causing excessive resource and budget requirements.	Inadequacy in Exploring Alternative Solutions	Technical Management
		Insufficient Requirements Specification and Analysis	Requirements Management
31	Failure to make an accurate and comprehensive projection of the output to be generated from the R&D project, resulting in the project being carried out without addressing the question of where this work will stand in 10 years.	Inadequate Future-State Projection	Strategic Planning
32	The developed technology is ready for use, but users are not yet prepared to adopt and use it due to gaps in habits, knowledge, or infrastructure. Thus, users may struggle to articulate appropriate or realistic expectations aligned with the technological capabilities.	Lack of Technical Awareness among Stakeholders	Stakeholder Management
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Rigidity of the Waterfall Model for R&D Projects	Process Flexibility
34	Misalignment in the starting point of R&D activities — although technology readiness levels 1-3 are ideally handled by universities before transitioning to	Inadequate Consideration of Technical Readiness	Technical Management

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
	industry, companies undertake these early-stage activities themselves.		
35	Failure to transform R&D outcomes into marketable products and sales, leading to insufficient return on investment.	Poor R&D-to-Market Translation	Market Orientation
36	Confidentiality concerns prevent the company from sharing its work or data with third parties like academia.	Inefficient Communication Among Internal and External Stakeholders Lack of Secure Communication Protocols	Communication and Coordination Management
37	Subcontractor selection is not based on predefined evaluation criteria.	Poor Subcontractor Selection Strategy Lack of Evaluation Criteria for Subcontractor Selection	Subcontractor Management
38	Aligning the subcontractor's schedule with the main contractor's schedule causes project delays when the subcontractor fails to meet deadlines.	Lack of Integrated Timeline Management Among Contractors	Planning and Scheduling
39	Lack of in-depth analysis and detailing of the technical solution during the contract negotiation phase.	Inadequacy in Exploring Alternative Solutions	Technical Management
40	Lack of personnel with sufficient expertise in areas requiring domain-specific knowledge.	Lack of Domain-Specific Expertise	Workforce Capacity and Capability
41	Subcontractor's failure to comply with the agreed delivery schedule.	Lack of Subcontractor Schedule Adherence Lack of Integrated Timeline Management Among Contractors	Subcontractor Management Planning and Scheduling
42	Involvement of multiple subcontractors causing integration problems.	Insufficient Coordination Among Subcontractors Insufficient System Integration Management	Communication and Coordination Management System Integration Management

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
43	Insufficient communication and coordination between different departments and within individual teams.	Inefficient Communication Among Internal and External Stakeholders	Communication and Coordination Management
44	The user/customer manages the project as a standard contracted project rather than an R&D project, leading to excessive documentation, strict schedules, and budget constraints.	Rigidity of the Waterfall Model for R&D Projects	Process Flexibility
		Rigidity of Contract Rules	Contract Management
45	Users resist adapting to use the delivered product, and are often hesitant or unwilling to engage with it once deployed.	User Resistance to New Technology	User Resistance and Organizational Mindset
46	Military standard compliance is expected by the user/customer even in R&D projects, resulting in technical requirements that impose additional constraints.	Insufficient Tailoring of Regulatory Standards to R&D Context	Contract Management
		Rigidity of Contract Rules	Contract Management
47	The life cycle specified by the customer in the contract is required to follow the waterfall model.	Inefficient Life Cycle Model Choice by Customer	Process Flexibility
		Rigidity of Contract Rules	Contract Management
48	In contracted R&D projects, the dynamic nature of R&D requires managing changes through standard contract procedures, leading to time-consuming processes like contract and engineering change requests. As a result, procedural efforts often outweigh R&D efforts.	Rigidity of Contract Rules	Contract Management
		Rigidity of the Waterfall Model for R&D Projects	Process Flexibility
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.	Poor R&D-to-Market Translation	Market Orientation
50	Failure to execute the R&D project in line with the initial objectives defined at the beginning of the project.	Lack of Adherence to Initial Project Objectives	Scope Management
		Poor Scope and Needs Analysis	Requirements Management
51	Inadequate analysis of the project's scope and intended purpose.	Poor Scope and Needs Analysis	Scope Management

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
52	Disagreements within the team during roadmap determination, leading to extended time required to reach a consensus.	Insufficient Conflict Management	Conflict Management
53	Starting projects without adequate planning as a result of pressure or demands from senior management.	Insufficient Project Planning	Planning and Scheduling
		Poor Portfolio Management	Portfolio Management
		Lack of Risk Assessment	Risk Assessment
54	Limited budget availability.	Insufficient Budget	Estimation and Feasibility
55	Inability to transform R&D outputs into a marketable product, primarily due to an underdeveloped or inadequate business model.	Poor R&D-to-Market Translation	Market Orientation
		Poor Business Model	Strategic Planning
56	Initiating studies based on popularity rather than real needs or global trends.	Insufficient Trend Analysis	Market Orientation
57	Inadequate and incorrect roadmap creation, leading to uncertainty in project direction.	Insufficient Roadmap Planning	Planning and Scheduling
58	Insufficient domain experts and reliance on interns/juniors negatively impact product quality.	Lack of Domain-Specific Expertise	Workforce Capacity and Capability
59	R&D is expected to always result in a product, causing patent-oriented R&D opportunities to be overlooked and underutilized.	Short-Term ROI Focus	Strategic Planning
		Inadequate Intellectual Property Strategy Integration	
60	Failure to assess the suitability of the R&D project in relation to the available budget and resources.	Poor Feasibility Analysis	Estimation and Feasibility
		Inadequate Resource Allocation	Resource Management
61	Mismatch between the product developed using internal resources and the marketing strategy applied during sales, resulting in the misdirection of customer expectations.	Poor R&D-to-Market Alignment	Market Orientation
		Lack of Feedback Loops Among Stakeholders	Review and Feedback
62	Not accurately projecting the product scope at the initial stage, resulting in the expectation that a product developed for a specific customer can later serve a broad, general market.	Poor R&D-to-Market Alignment	Market Orientation
		Poor Scope and Needs Analysis	Scope Management

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
63	Subcontractors are selected without technical team involvement, limiting the ability to choose the right subcontractor.	Poor Subcontractor Selection Strategy	Subcontractor Management
64	Development is carried out based on instant demands, mostly from top management, without a defined list of needs or requirements and without a development plan. As a result, the final product often fails to meet customer expectations.	Poor Demand Management	Requirements Management
		Insufficient Stakeholder Alignment	Stakeholder Management
		Poor Development Planning	Technical Management
		Poor Requirements Definition	
65	Undefined or unspecified requirements set.	Insufficient Requirements Specification and Analysis	Requirements Management
66	Communication gaps due to lack of direct interaction between the end-user and developers.	Inefficient Communication Among Internal and External Stakeholders	Communication and Coordination Management
67	End-user intervention in the design process beyond expected boundaries, accompanied by a proposed solution, restricts the technical team's ability to explore alternative solutions and make independent decisions.	Excessive Stakeholder Intervention Limiting Technical Autonomy	Stakeholder Management
68	The involvement of many stakeholders leads to communication breakdowns and challenges in effective information sharing	Inefficient Communication Among Internal and External Stakeholders	Communication and Coordination Management
		Insufficient Conflict Management	
69	Cultural differences between companies from different countries lead to communication challenges, difficulties in collaboration, and obstacles in effective information sharing.	Lack of Shared Communication Norms	Communication and Coordination Management
		Insufficient Information Sharing Mechanisms	
		Lack of Intercultural Training and Support	

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
70	Insufficient information sharing with incentive institution staff causes difficulties in accessing domain-specific information and project details.	Insufficient Information Sharing Mechanisms	Information Sharing Management
		Lack of Domain-Specific Expertise	Workforce Capacity and Capability
71	Lack of effective communication and insufficient information sharing between teams.	Inefficient Communication Among Internal and External Stakeholders	Communication and Coordination Management
72	The absence of technical management by the project manager leads to the emergence of multiple decision-makers within the project.	Lack of Technical Management Perspective	Technical Management
		Inefficient Conflict Resolution	Conflict Management
73	Administrative challenges caused by multiple departments/teams working together, limiting centralized management by a single authority (e.g., PM).	Lack of Centralized Project Management	Technical Management
		Lack of Timely Decision-Making	Decision Management
74	Ineffective and non-solution-oriented technical management.	Inefficient Technical Management	Technical Management
75	Due to limited technological knowledge, the end-user is unaware of technical limitations, which creates challenges in accurately identifying and defining needs.	Lack of Technical Awareness among Stakeholders	Stakeholder Management
		Insufficient Requirements Specification and Analysis	Requirements Management
76	Defining all user deficiencies as needs within a single project, causing difficulties in identifying the real need.	Insufficient Requirements Specification and Analysis	Requirements Management
77	Overloading a single product or project with excessive feature expectations limits its functionality and negatively impacts usability.	Overloading Product Scope with Excessive Requirements	Scope Management
			Requirements Management
			Design and Architecture Management
78	Minimal or no involvement of the end user in the needs definition process.	Insufficient End-User Involvement in Requirements Definition	Stakeholder Engagement and Continuity

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.	Lack of R&D Mindset among Users	User Resistance and Organizational Mindset
		Insufficient End-User Involvement in Requirements Definition	Stakeholder Engagement and Continuity
80	Prematurely stopping R&D projects intended to produce a prototype product, driven by the prejudice that the prototype will not fulfill expectations, thereby blocking further R&D efforts.	Bias Against Prototypes Limiting R&D Continuity	User Resistance and Organizational Mindset
81	Frequent turnover in user staff prevents continuity in R&D projects, as newly assigned personnel need time to gain an R&D perspective and adapt to project dynamics.	Frequent Turnover among External Stakeholders	Stakeholder Engagement and Continuity
82	R&D projects are typically limited to 2-3 years without clear criteria for setting this duration, leading to very few projects being completed successfully and on time.	Poor Project Constraint Analysis	Scope Management
		Poor Timeline Estimation	Estimation and Feasibility
83	Resistance to R&D projects creates a prejudice that the resulting product will be incomplete and not suitable for use.	Insufficient Early-Stage User Engagement	Stakeholder Engagement and Continuity
84	The flexible and evolving nature of R&D projects conflicts with the rigid structure of waterfall-based models, which are often embedded in both contractual agreements and implementation practices. This misalignment leads to difficulties in adapting to change and negatively affects project schedules.	Rigidity of the Waterfall Model for R&D Projects	Process Flexibility
85	Although projects are divided into phases for management purposes, requiring formal acceptance tests at the end of each phase creates bureaucratic obstacles and prolongs the process, causing serious delays in the project schedule.	Rigidity of the Waterfall Model for R&D Projects	Process Flexibility
		Inefficiency of Sequential Mandatory Testing Structures	Test Management
86	Rushed contracts and unclear frameworks lead to inconsistent management practices across individuals, departments, and institutions.	Lack of Standardized Management Frameworks and Governance	Management Practices

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
87	In insufficient allocation of personnel to quality-related roles negatively affects the effectiveness of quality control and testing activities. In some cases, the customer-side quality representative is responsible for multiple projects and companies, limiting their focus and productivity.	Inadequate Staffing for Quality Assurance	Workforce Capacity and Capability
88	Inadequate need definition and analysis results in poor requirements, and late-added requirements often lead to major design changes and wasted effort.	Inadequate Need Definition and Analysis in Early Stages of a Project Poor Requirements Definition	Requirements Management
89	In some projects, the Statement of Work (SOW), which is intended to outline business-level expectations, is directly embedded into the technical specifications part of the agreement. This leads to non-technical items being treated as technical requirements. For example, a SOW statement like 'the supplier shall ensure effective knowledge transfer to the customer' is included in the technical specification section, resulting in ambiguity during verification since such expectations cannot be technically tested or measured like functional requirements.	Inadequate Need Definition and Analysis in Early Stages of a Project Poor Requirements Definition	Requirements Management
90	Without dedicated user personnel, decisions based on subjective opinions risk being challenged when user representatives change, leading to inconsistencies and project disruptions.	Frequent Turnover among External Stakeholders Lack of Expert Support	Stakeholder Engagement and Continuity Workforce Capacity and Capability
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Insufficient Testing Lack of Dry Run Tests Before Formal Tests	Test Management Planning and Scheduling Review and Feedback
92	Using standard contract structures, which are suitable for predictable projects, in R&D projects creates incompatibility with the dynamic and uncertain nature of R&D work.	Rigidity of Contract Rules	Contract Management
93	Lack of supplier involvement in contract preparation leads to unrealistic and hard-to-implement R&D project contracts.	Lack of Supplier Involvement in Contract Negotiation	Contract Management

Table 26 (cont.)

CHL ID	Challenges of Software System R&D Projects	Second-Level Category	First-Level Theme
		Rigidity of Contract Rules	

APPENDIX C

APPLICATION EXAMPLES OF PREVENTIVE APPROACH

In this appendix, preventive approaches proposed in line with the guidance of the approach to avoid the challenges identified within the scope of the study are presented. Additions made based on the suggestions of interview participants are highlighted in orange.

Table 27: Preventive Approach Examples with Software System R&D Challenges

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Explore Scope	Explore General Requirements	Shall Statement	early exploration of the requirements and clarification of the scope at the beginning of the project	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Explore General Requirements decision point that enables early exploration of the requirements and clarification of the scope at the beginning of the project and choose among the DAD-based options that suits you the best such as Shall Statement.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Explore Scope	Explore Quality Requirements		early exploration of the quality requirements	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Explore Quality Requirements decision point that enables early exploration of the quality requirements and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Explore Scope	Level of Detail of the Scope Document	Requirements Envisioning (light specification)	quick and high-level requirements documentation in early phase	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Level of Detail of the Scope Document decision point that enables quick and high-level requirements documentation in early phase and choose among the DAD-based options that suits you

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							the best such as Requirements Envisioning (light specification).
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Explore Scope	Explore Usage	Design (User Experience (UX))	early exploration of the usage scenarios and providing user-friendly design	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Explore Usage decision point that enables early exploration of the usage scenarios and providing user-friendly design and choose among the DAD-based options that suits you the best such as Design Sprint (User Experience (UX)).
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Identify Architecture Strategy	Explore the Architecture		early exploration of the design decisions	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Identify Architecture Strategy. As part of this goal, you should decide on the Explore the Architecture decision point that enables early exploration of the

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							design decisions and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Identify Architecture Strategy	Level of Detail of Architecture Document	High-Level Overview	prevention of overdesign through quick and high-level architectural/design documentation in early phase	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Identify Architecture Strategy. As part of this goal, you should decide on the Level of Detail of Architecture Document decision point that enables prevention of overdesign through quick and high-level architectural/design documentation in early phase and choose among the DAD-based options that suits you the best such as High-Level Overview.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Plan the Release	Level of Detail of the Plan	Rolling Wave	planning of preparation of the documents with continuous planning and updating the plans according to changing situations	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Level of Detail of the Plan

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
						from the beginning to avoid ambiguity	decision point that enables planning of preparation of the documents with continuous planning and updating the plans according to changing situations from the beginning to avoid ambiguity and choose among the DAD-based options that suits you the best such as Rolling Wave.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Plan Release	the Estimation Strategy		ease of estimation and planning of preparation of these documents with quick, experience-based estimations	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Estimation Strategy decision point that enables ease of estimation and planning of preparation of these documents with quick, experience-based estimations and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all	Inception	Plan Release	the Capture Plan		the plan to be visualized, made concrete, clearly communicated, and effectively followed	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	or are not prepared in a timely manner.						of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Capture Plan decision point that enables the plan to be visualized, made concrete, clearly communicated, and effectively followed and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Address Changing Stakeholder Needs	Stakeholder Interaction With Team	Active Stakeholder Participation, Indirectly via Product Owner	ease of exploration of stakeholder needs with stakeholder interaction or via product owner in timely manner	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Address Changing Stakeholder Needs. As part of this goal, you should decide on the Stakeholder Interaction With Team decision point that enables ease of exploration of stakeholder needs with stakeholder interaction or via product owner in timely manner and choose among the DAD-based options that suits you the best such as Active Stakeholder Participation, Indirectly via Product Owner.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Address Changing Stakeholder Needs	Elicit Requirements		stakeholder needs to be elicited in a timely manner using demos, interviews, or collaborative sessions such as model storming and backlog refinement.	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Address Changing Stakeholder Needs. As part of this goal, you should decide on the Elicit Requirements decision point that enables stakeholder needs to be elicited in a timely manner using demos, interviews, or collaborative sessions such as model storming and backlog refinement. and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Address Changing Stakeholder Needs	Explore Stakeholder Needs		ease of exploration of design and stakeholder needs in timely manner	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Address Changing Stakeholder Needs. As part of this goal, you should decide on the Explore Stakeholder Needs decision point that enables ease of exploration of design and

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							stakeholder needs in timely manner and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Produce a Potentially Consumable Solution	Organize the Work		the planned work to be discussed within the team at regular intervals and allows for ongoing evaluation of progress	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Produce a Potentially Consumable Solution. As part of this goal, you should decide on the Organize the Work decision point that enables the planned work to be discussed within the team at regular intervals and allows for ongoing evaluation of progress and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Produce a Potentially Consumable Solution	Explore Solution Design		making design decisions at an early stage helps prevent confusion and ensures alignment between requirements and design, enabling the project to progress	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Produce a Potentially Consumable Solution. As part of this goal, you should decide on the

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
						in a more coordinated and consistent manner	Explore Solution Design decision point that enables making design decisions at an early stage helps prevent confusion and ensures alignment between requirements and design, enabling the project to progress in a more coordinated and consistent manner and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Produce a Potentially Consumable Solution	Write Deliverable Documentation		the creation of brief, focused, and easily consumable documentation tailored to specific needs	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Produce a Potentially Consumable Solution. As part of this goal, you should decide on the Write Deliverable Documentation decision point that enables the creation of brief, focused, and easily consumable documentation tailored to specific needs and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are	Ongoing	Coordinate Activities	Facilitate Working Session	Joint Application Requirements (JAR) Sessions	conducting sessions and ease of exploration of	In order to prevent "Requirements and design documents are either not prepared at all or are not

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	either not prepared at all or are not prepared in a timely manner.					stakeholder needs in a collaborative and timely manner	prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Facilitate a Working Session decision point that enables conducting sessions and ease of exploration of stakeholder needs in a collaborative and timely manner and choose among the DAD-based options that suits you the best such as Joint Application Requirements (JAR) Sessions.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Coordinate Activities	Facilitate Working Session ^a	Joint Application Design Sessions (JAD)	conducting exploration of design in a collaborative manner and timely manner	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Facilitate a Working Session decision point that enables conducting exploration of design in a collaborative manner and timely manner and choose among the DAD-based options that suits you the best such as Joint

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							Application Design (JAD) Sessions.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Organize Metrics	Choose Measurement Focus	Measure Outcomes	identification of measurement focus after identification of probable problematic issues, conducting and reporting related measurements to increase awareness of the team	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Organize Metrics. As part of this goal, you should decide on the Choose Measurement Focus decision point that enables identification of measurement focus after identification of probable problematic issues, conducting and reporting related measurements to increase awareness of the team and choose among the DAD-based options that suits you the best such as Measure Outcomes.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Organize Metrics	Choose Measurement Strategy		identification of measurement focus after identification of probable problematic issues, conducting and reporting related measurements to	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Organize Metrics. As part of this goal, you should decide on the

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
						increase awareness of the team	Choose Measurement Strategy decision point that enables identification of measurement focus after identification of probable problematic issues, conducting and reporting related measurements to increase awareness of the team and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Organize Metrics	Report Metrics	Automated Dashboards	identification of measurement focus after identification of probable problematic issues, conducting and reporting related measurements to increase awareness of the team	In order to prevent "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Organize Metrics. As part of this goal, you should decide on the Report Metrics decision point that enables identification of measurement focus after identification of probable problematic issues, conducting and reporting related measurements to increase awareness of the team and choose among the DAD-based options that suits you the best such as Automated Dashboards.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Share Information		the establishment of an open and flexible information-sharing environment, the regular exchange of information, and the creation of a culture that encourages these practices	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Share Information decision point that enables the establishment of an open and flexible information-sharing environment, the regular exchange of information, and the creation of a culture that encourages these practices and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Artifact Ownership		the prevention of bottlenecks caused by information being controlled by only a limited number of individuals	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Artifact Ownership decision point that enables the prevention of bottlenecks caused by information being controlled by only a limited number of individuals and choose

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Coordinate Within Team		coordination and communication within the team	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Coordinate Within Team decision point that enables coordination and communication within the team and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Facilitate a Working Session		the organization of sessions where the team can share information, such as planning, requirements determination, design, etc., that require specific information sharing	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Facilitate a Working Session decision point that enables the organization of sessions where the team can share information, such as planning, requirements determination,

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							design, etc., that require specific information sharing and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Coordinate Across Program		coordination and communication within the program	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Coordinate Across Program decision point that enables coordination and communication within the program and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Coordinate Across the Organization		coordination and communication within the organization	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Coordinate Across the Organization decision point that enables coordination and

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							communication within the organization and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Cross Team Coordination		coordination and information sharing between different teams	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Cross Team Coordination decision point that enables coordination and information sharing between different teams and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Evolve Way of Working (WoW)	Physical Environment		teams working on the same project to be placed in areas close to each other before the project starts	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Physical Environment decision point that enables teams working on the same project to be placed in

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							areas close to each other before the project starts and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Evolve Way of Working (WoW)	Choose Communication Styles		the prevention of misunderstandings, loss of information and disconnections by choosing the right communication environment	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Choose Communication Styles decision point that enables the prevention of misunderstandings, loss of information and disconnections by choosing the right communication environment and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Evolve Way of Working (WoW)	Choose Collaboration Styles		the prevention of information loss, misunderstandings and disconnections by creating a collaborative working environment between teams	In order to prevent "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Choose Collaboration Styles

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							decision point that enables the prevention of information loss, misunderstandings and disconnections by creating a collaborative working environment between teams and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan Release	the Source of Plan		the determination of who will create the plan and the determination of more realistic and applicable timeframes with the identified stakeholders	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Source of Plan decision point that enables the determination of who will create the plan and the determination of more realistic and applicable timeframes with the identified stakeholders and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan Release	the Scope of Plan		planning of all deliverables in the project	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							goal, you should decide on the Scope of Plan decision point that enables planning of all deliverables in the project and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan Release	the Scheduling Strategy		a clear scheduling strategy to be determined at the beginning of the project and a realistic and applicable time plan to be made	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Scheduling Strategy decision point that enables a clear scheduling strategy to be determined at the beginning of the project and a realistic and applicable time plan to be made and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan Release	the Level of Detail of the Plan	Rolling Wave	the planning to be continuously updated and the project duration to be estimated more accurately accordingly	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Level of Detail of the Plan

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							decision point that enables the planning to be continuously updated and the project duration to be estimated more accurately accordingly and choose among the DAD-based options that suits you the best such as Rolling Wave.
14	The absence of a systematic approach in determining project durations.	Inception	Plan Release	the	Choose Schedule Cadences	clear cadences to be defined at the beginning and duration estimates to be made more controlled accordingly and planning to be done systematically	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Choose Schedule Cadences decision point that enables clear cadences to be defined at the beginning and duration estimates to be made more controlled accordingly and planning to be done systematically and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan Release	the	Estimation Strategy	the initial selection of the forecasting strategy and the systematic determination of durations	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							goal, you should decide on the Estimation Strategy decision point that enables the initial selection of the forecasting strategy and the systematic determination of durations and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan Release	the	Choose Estimation Unit	a fixed unit of measurement to be determined before the estimation process begins, making the estimates more consistent and meaningful within the team	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Choose Estimation Unit decision point that enables a fixed unit of measurement to be determined before the estimation process begins, making the estimates more consistent and meaningful within the team and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining	Inception	Plan Release	the	Capture Plan	the plan to be recorded in a simple manner in terms of value, output, time and	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	project durations.					resource dimensions, and enables more balanced and systematic planning	Plan the Release. As part of this goal, you should decide on the Capture Plan decision point that enables the plan to be recorded in a simple manner in terms of value, output, time and resource dimensions, and enables more balanced and systematic planning and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Ongoing	Measure Outcomes	Forecast Schedule		planned and data-based calendar estimates, more realistic project duration determination and harmony between teams	In order to prevent "The absence of a systematic approach in determining project durations." challenge, see the Ongoing phase of DAD, targeting the process goal Measure Outcomes. As part of this goal, you should decide on the Forecast Schedule decision point that enables planned and data-based calendar estimates, more realistic project duration determination and harmony between teams and choose among the DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in	Inception	Form Team	Team Completeness		the assignment of resources with domain knowledge to ensure that the	In order to prevent "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	areas requiring domain-specific expertise.					team is complete not only numerically but also competently at the beginning of the project	Inception phase of DAD, targeting the process goal Form Team. As part of this goal, you should decide on the Team Completeness decision point that enables the assignment of resources with domain knowledge to ensure that the team is complete not only numerically but also competently at the beginning of the project and choose among the DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Inception	Plan Release	the Capture Plan	Staffing Plan	the pre-definition of roles requiring domain knowledge and the assignment of team members with this expertise	In order to prevent "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Capture Plan decision point that enables the pre-definition of roles requiring domain knowledge and the assignment of team members with this expertise and choose among the DAD-based options that suits you the best such as Staffing Plan.
15	Insufficient know-how of	Ongoing	Grow Team Members	Improve Skills and Knowledge		the early acquisition of necessary	In order to prevent "Insufficient know-how of the staff, particularly

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	the staff, particularly in areas requiring domain-specific expertise.					domain knowledge by providing the team with continuous learning opportunities at the beginning of the project, thereby preventing knowledge gaps in critical areas	in areas requiring domain-specific expertise." challenge, see the Ongoing phase of DAD, targeting the process goal Grow Team Members. As part of this goal, you should decide on the Improve Skills and Knowledge decision point that enables the early acquisition of necessary domain knowledge by providing the team with continuous learning opportunities at the beginning of the project, thereby preventing knowledge gaps in critical areas and choose among the DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Ongoing	Grow Team Members	Sustain Team		opportunities for defining the team structure or supporting team development to prevent the emergence of knowledge gaps	In order to prevent "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Ongoing phase of DAD, targeting the process goal Grow Team Members. As part of this goal, you should decide on the Sustain Team decision point that enables opportunities for defining the team structure or supporting team development to prevent the emergence of knowledge gaps and

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							choose among the DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Ongoing	Grow Team Members	Provide Feedback	Continuous/Regular Feedback, Team Lead Review	team members' knowledge gaps to be identified in advance through regular feedback loops and reviews by the team leader, and opportunities such as training are provided to close the knowledge gap before the project starts/early in the project	In order to prevent "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Ongoing phase of DAD, targeting the process goal Grow Team Members. As part of this goal, you should decide on the Provide Feedback decision point that enables team members' knowledge gaps to be identified in advance through regular feedback loops and reviews by the team leader, and opportunities such as training are provided to close the knowledge gap before the project starts/early in the project and choose among the DAD-based options that suits you the best such as Continuous/Regular Feedback, Team Lead Review.
15	Insufficient know-how of the staff, particularly in areas requiring domain-	Construction	Produce a Potentially Consumable Solution	Explore Solution Design	Proof of Concept (PoC)	the testing of technical suitability and knowledge adequacy at an early stage by conducting small-	In order to prevent "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Construction phase of DAD, targeting the process goal Produce

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	specific expertise.					scale PoCs before developing solutions for issues requiring domain expertise	a Potentially Consumable Solution. As part of this goal, you should decide on the Explore Solution Design decision point that enables the testing of technical suitability and knowledge adequacy at an early stage by conducting small-scale PoCs before developing solutions for issues requiring domain expertise and choose among the DAD-based options that suits you the best such as Proof of Concept (PoC).
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Enterprise	People Management	Guide Careers		the identification of areas that require specialization according to the organization's vision, the support of team members with domain-focused development opportunities, the initiation of specialization before there is a lack of knowledge, and the selection of	In order to prevent "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Enterprise phase of DAD, targeting the process goal People Management. As part of this goal, you should decide on the Guide Careers decision point that enables the identification of areas that require specialization according to the organization's vision, the support of team members with domain-focused development opportunities, the initiation of specialization before there is a

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach	
						coaches and mentors from these teams	lack of knowledge, and the selection of coaches and mentors from these teams and choose among the DAD-based options that suits you the best.	
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Enterprise	People Management	Ensure Diversity		team building with people from different experiences, skills and backgrounds	In order to prevent "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Enterprise phase of DAD, targeting the process goal People Management. As part of this goal, you should decide on the Ensure Diversity decision point that enables team building with people from different experiences, skills and backgrounds and choose among the DAD-based options that suits you the best.	
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Enterprise	People Management	Staff Groups	Forecast Needs	Staffing	foreseeing when specific knowledge will be needed and taking appropriate measures accordingly	In order to prevent "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Enterprise phase of DAD, targeting the process goal People Management. As part of this goal, you should decide on the Staff Groups decision point that enables foreseeing when specific

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							knowledge will be needed and taking appropriate measures accordingly and choose among the DAD-based options that suits you the best such as Forecast Staffing Needs.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.	Ongoing	Evolve Way of Working (WoW)	Select Life Cycle		both contractual compliance and the flexibility required for R&D by adopting a hybrid lifecycle from the beginning of the project (e.g., using a waterfall approach for the overall project and agile approaches for exploratory phases)	In order to prevent "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Select Life Cycle decision point that enables both contractual compliance and the flexibility required for R&D by adopting a hybrid lifecycle from the beginning of the project (e.g., using a waterfall approach for the overall project and agile approaches for exploratory phases)

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.	Ongoing	Evolve Way of Working (WoW)	Visualize Existing Process		the early visualization of activities currently planned to be implemented to reveal which phases are discovery-oriented and to increase awareness	In order to prevent "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Visualize Existing Process decision point that enables the early visualization of activities currently planned to be implemented to reveal which phases are discovery-oriented and to increase awareness and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual	Ongoing	Evolve Way of Working (WoW)	Tailor Process	Initial	WoW to be tailored at the beginning of the project,	In order to prevent "Although the project and its contractual structure follow a standard format,

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	<p>structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.</p>					<p>enabling the phases requiring research to be defined more flexibly and iteratively, and simplifying documentation, approval mechanisms and decision-making processes for these phases</p>	<p>certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Tailor Initial Process decision point that enables WoW to be tailored at the beginning of the project, enabling the phases requiring research to be defined more flexibly and iteratively, and simplifying documentation, approval mechanisms and decision-making processes for these phases and choose among the DAD-based options that suits you the best.</p>
19	<p>Although the project and its contractual structure follow a standard format, certain</p>	<p>Ongoing</p>	<p>Evolve Way of Working (WoW)</p>	<p>Identify Potential Improvements</p>		<p>reviewing the existing WoW before the project begins, identifying areas where rigid contract processes</p>	<p>In order to prevent "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch</p>

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	<p>phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.</p>					<p>may be incompatible with research, and allowing contract terms to be reinterpreted or flexibility proposals to be developed for research-specific phases</p>	<p>between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Identify Potential Improvements decision point that enables reviewing the existing WoW before the project begins, identifying areas where rigid contract processes may be incompatible with research, and allowing contract terms to be reinterpreted or flexibility proposals to be developed for research-specific phases and choose among the DAD-based options that suits you the best.</p>
19	<p>Although the project and its contractual structure follow a standard format, certain phases within the project</p>	<p>Ongoing</p>	<p>Evolve Way of Working (WoW)</p>	<p>Reuse Known Strategies</p>		<p>the evaluation of flexible process strategies that have been applied in similar R&D projects before, or if there are practices that are</p>	<p>In order to prevent "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible,</p>

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.					considered applicable in DAD, these practices should be evaluated before the contract and the project process should be shaped more harmoniously from the beginning	uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Reuse Known Strategies decision point that enables the evaluation of flexible process strategies that have been applied in similar R&D projects before, or if there are practices that are considered applicable in DAD, these practices should be evaluated before the contract and the project process should be shaped more harmoniously from the beginning and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require	Ongoing	Evolve Way of Working (WoW)	Implement Potential Improvements		continuous monitoring of potential strategies for process improvement and testing them through short-term controlled experiments,	In order to prevent "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.					enabling the determination of which approaches are suitable for the nature of R&D before the project begins, and enabling more flexible and realistic planning and guidance of the contract before the contract is created	project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Implement Potential Improvements decision point that enables continuous monitoring of potential strategies for process improvement and testing them through short-term controlled experiments, enabling the determination of which approaches are suitable for the nature of R&D before the project begins, and enabling more flexible and realistic planning and guidance of the contract before the contract is created and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain phases within the project	Ongoing	Evolve Way of Working (WoW)	Capture WoW		teams to clarify their WoW at the beginning of the project and document it if necessary, thus reducing potential conflicts with	In order to prevent "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible,

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.					contractual expectations by defining in advance where flexibility in R&D processes will be applied	uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Capture WoW decision point that enables teams to clarify their WoW at the beginning of the project and document it if necessary, thus reducing potential conflicts with contractual expectations by defining in advance where flexibility in R&D processes will be applied and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a	Ongoing	Evolve Way of Working (WoW)	Share Improvements With Others		teams to share their experiences and learnings within the corporate knowledge pool, contributing to more realistic planning and contracting of other projects with similar R&D processes, thus	In order to prevent "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD,

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.					making future contracts more flexible and adaptable	targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Share Improvements With Others decision point that enables teams to share their experiences and learnings within the corporate knowledge pool, contributing to more realistic planning and contracting of other projects with similar R&D processes, thus making future contracts more flexible and adaptable and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid	Ongoing	Leverage and Enhance Existing Infrastructure	Work With Process Assets		reviewing existing process assets before starting the project and defining flexible process templates that will be compatible with the activities within the scope of the contract	In order to prevent "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Leverage and Enhance Existing Infrastructure. As part of this goal,

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.						you should decide on the Work With Process Assets decision point that enables reviewing existing process assets before starting the project and defining flexible process templates that will be compatible with the activities within the scope of the contract and choose among the DAD-based options that suits you the best.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Select Life Cycle	Hybrid	the implementation of both the steps brought by the waterfall life cycle and deemed important by the team, and the implementation of DAD-based practices, enabling the project to be shaped by meeting at the midpoint	In order to prevent "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Select Life Cycle decision point that enables the implementation of both the steps brought by the waterfall life cycle and deemed important by the team, and the implementation of DAD-based practices, enabling the project to be shaped by meeting at the midpoint and choose among the DAD-based options that suits you the best such as Hybrid.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Visualize Existing Process		the team to analyze the process they are implementing, raise awareness and choose their WoW accordingly	In order to prevent "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Visualize Existing Process decision point that enables the team to analyze the process they are implementing, raise awareness and choose their WoW accordingly and choose among the DAD-based options that suits you the best.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Tailor Initial Process		the team to tailor processes from the very beginning to suit WoW	In order to prevent "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Tailor Initial Process decision point that enables the team to tailor processes from the very beginning to suit WoW and choose among the DAD-based options that suits you the best.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Reuse Known Strategies	Idea from Disciplined Agile (DA) Tool Kit	the team to choose appropriate practices, or at least get an idea, with the help of the DA Tool Kit when determining their own WoW	In order to prevent "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Reuse Known Strategies decision point that enables the team to choose appropriate practices, or at least get an idea, with the help of the DA Tool Kit when determining their own WoW and choose among the DAD-based options that suits you the best such as Idea from Disciplined Agile (DA) Tool Kit.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Capture WoW		the WoW determined by the team to be documented and recorded, and if necessary, to share best practices with other teams within the organization, etc., or to inform new members of the team	In order to prevent "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Capture WoW decision point that enables the WoW determined by the team to be documented and recorded, and if necessary, to

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							share best practices with other teams within the organization, etc., or to inform new members of the team and choose among the DAD-based options that suits you the best.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Share Improvements With Others	the improvements to be shared within the company/between teams, setting an example for other teams, increasing the awareness of teams that are considering making changes to their working style, and enabling early intervention rather than starting projects with a working style that is not suitable for them		In order to prevent "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Share Improvements With Others decision point that enables the improvements to be shared within the company/between teams, setting an example for other teams, increasing the awareness of teams that are considering making changes to their working style, and enabling early intervention rather than starting projects with a working style that is not suitable for them and choose among the DAD-based options that suits you the best.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
42	Involvement of multiple subcontractors causing integration problems.	DevOps	Release Management	Plan Release Schedule		all internal and external stakeholders to plan in which timeframes they will release the relevant part and to prevent irregular release and integration confusion	In order to prevent "Involvement of multiple subcontractors causing integration problems." challenge, see the DevOps phase of DAD, targeting the process goal Release Management. As part of this goal, you should decide on the Plan Release Schedule decision point that enables all internal and external stakeholders to plan in which timeframes they will release the relevant part and to prevent irregular release and integration confusion and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	DevOps	Release Management	Schedule Solution Release		all internal and external stakeholders to plan the timeframes in which they will release the parts they developed for a specific solution and to prevent irregular release and integration confusion	In order to prevent "Involvement of multiple subcontractors causing integration problems." challenge, see the DevOps phase of DAD, targeting the process goal Release Management. As part of this goal, you should decide on the Schedule Solution Release decision point that enables all internal and external stakeholders to plan the timeframes in which they will release the parts they developed for a specific solution and to prevent irregular release and

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							integration confusion and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	DevOps	Release Management	Manage Infrastructure Configuration		the definition of dependencies of components before release and integration and their control accordingly, preventing integration errors by preventing information disconnections, preventing errors based on incorrect configuration and detecting risky deployments in advance	In order to prevent "Involvement of multiple subcontractors causing integration problems." challenge, see the DevOps phase of DAD, targeting the process goal Release Management. As part of this goal, you should decide on the Manage Infrastructure Configuration decision point that enables the definition of dependencies of components before release and integration and their control accordingly, preventing integration errors by preventing information disconnections, preventing errors based on incorrect configuration and detecting risky deployments in advance and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing	DevOps	Release Management	Determine Production Readiness		the prevention of incorrect/incomplete output being transferred to the integration	In order to prevent "Involvement of multiple subcontractors causing integration problems." challenge, see the DevOps phase of DAD, targeting the process goal Release

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	integration problems.					environment, checking whether the stakeholders are ready for the release, completing pre-release testing/approval processes, and preventing chaos caused by lack of communication	Management. As part of this goal, you should decide on the Determine Production Readiness decision point that enables the prevention of incorrect/incomplete output being transferred to the integration environment, checking whether the stakeholders are ready for the release, completing pre-release testing/approval processes, and preventing chaos caused by lack of communication and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	DevOps	Release Management	Govern Releases		the decisions taken for release and integration to be documented at a basic level, such as guidance, to create metrics, to measure and monitor activities, and thus to reduce risk	In order to prevent "Involvement of multiple subcontractors causing integration problems." challenge, see the DevOps phase of DAD, targeting the process goal Release Management. As part of this goal, you should decide on the Govern Releases decision point that enables the decisions taken for release and integration to be documented at a basic level, such as guidance, to create metrics, to measure and monitor activities, and thus to reduce risk and choose among the DAD-based options that suits you the best.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
42	Involvement of multiple subcontractors causing integration problems.	Transition	Deploy the Solution	the Release Strategy		stakeholders to answer the questions "which features are we deploying, to what extent (full/partial), at what availability level?", to coordinate in advance, and to make release plans and manage integrations accordingly	In order to prevent "Involvement of multiple subcontractors causing integration problems." challenge, see the Transition phase of DAD, targeting the process goal Deploy the Solution. As part of this goal, you should decide on the Release Strategy decision point that enables stakeholders to answer the questions "which features are we deploying, to what extent (full/partial), at what availability level?", to coordinate in advance, and to make release plans and manage integrations accordingly and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	Transition	Deploy the Solution	the Release Into Production		stakeholders to successfully receive releases and identify appropriate method(s) to communicate/integrate these releases	In order to prevent "Involvement of multiple subcontractors causing integration problems." challenge, see the Transition phase of DAD, targeting the process goal Deploy the Solution. As part of this goal, you should decide on the Release Into Production decision point that enables stakeholders to successfully receive releases and identify appropriate method(s) to communicate/integrate these releases and choose among the

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.	Value Stream	Portfolio Management	Identify Potential Value		the pre-analysis of similar products, competitors and alternative solutions in the current market and the clear definition of the differentiating value proposition	In order to prevent "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Portfolio Management. As part of this goal, you should decide on the Identify Potential Value decision point that enables the pre-analysis of similar products, competitors and alternative solutions in the current market and the clear definition of the differentiating value proposition and choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research	Value Stream	Product Management	Monitor Market	the	the initiation of a needs-oriented R&D process by systematically monitoring market	In order to prevent "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.					trends, user needs and similar products before the project	research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Monitor the Market decision point that enables the initiation of a needs-oriented R&D process by systematically monitoring market trends, user needs and similar products before the project and choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the	Value Stream	Product Management	Market Offering(s)	Create Marketing Plan, Identify Potential Customers	the creation of a marketing plan by clarifying the target audience, needs and differentiating features of the product to be offered to the market in advance	In order to prevent "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Market Offering(s) decision point that

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	development activities after the product development has already begun.						enables the creation of a marketing plan by clarifying the target audience, needs and differentiating features of the product to be offered to the market in advance and choose among the DAD-based options that suits you the best such as Create Marketing Plan, Identify Potential Customers.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.	Value Stream	Product Management	Evolve Vision		the product vision to be concretized, market needs to be better understood and the right direction to be determined by interacting with the user and other stakeholders at an early stage	In order to prevent "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Evolve Vision decision point that enables the product vision to be concretized, market needs to be better understood and the right direction to be determined by interacting with the user and other stakeholders at an early stage and

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.	Value Stream	Product Management	Explore Potential Functionality		the potential functionality of the product to be evaluated in advance, together with user needs and market data, and to prevent unnecessary development	In order to prevent "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Explore Potential Functionality decision point that enables the potential functionality of the product to be evaluated in advance, together with user needs and market data, and to prevent unnecessary development and choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research	Value Stream	Product Management	Capture Roadmap		the vision created in line with market needs to be announced with a roadmap explaining	In order to prevent "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.					what will be developed over time and why, and to prevent false expectations by clearly sharing it	research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Capture Roadmap decision point that enables the vision created in line with market needs to be announced with a roadmap explaining what will be developed over time and why, and to prevent false expectations by clearly sharing it and choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research	Value Stream	Product Management	Evolve Roadmap	Rolling Wave	the roadmap to be updated regularly, reflecting market changes or late-noticed needs in a timely manner	In order to prevent "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal,

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	in parallel with the development activities after the product development has already begun.						you should decide on the Evolve Roadmap decision point that enables the roadmap to be updated regularly, reflecting market changes or late-noticed needs in a timely manner and choose among the DAD-based options that suits you the best such as Rolling Wave.
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for	Inception	Develop Common Vision	Vision Strategy	Collaborative	the development of a common vision through user participation, the shaping of expectations within the correct framework, and the correct foundation of the prototype perception at an early stage	In order to prevent "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Inception phase of DAD, targeting the process goal Develop Common Vision. As part of this goal, you should decide on the Vision Strategy decision point that enables the development of a common vision through user participation, the shaping of expectations within the correct framework, and the correct

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	prototype or initial use.						foundation of the prototype perception at an early stage and choose among the DAD-based options that suits you the best such as Collaborative.
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.	Inception	Develop Common Vision	Capture Vision	the Expected Outcomes	the user to avoid the perception of a "missing/defective product" by providing high-level information about the targeted outputs at the early stage of the project	In order to prevent "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Inception phase of DAD, targeting the process goal Develop Common Vision. As part of this goal, you should decide on the Capture the Vision decision point that enables the user to avoid the perception of a "missing/defective product" by providing high-level information about the targeted outputs at the early stage of the project and choose among the DAD-based options that suits you the best such as Expected Outcomes.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.	Inception	Develop Common Vision	Level of Detail of the Vision	Lightweight	the information to be conveyed to the user regarding the project's vision to be sufficiently detailed and explained, the creation of a vision statement that creates awareness about the nature of R&D, and the sharing of this vision with relevant stakeholders when necessary	In order to prevent "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Inception phase of DAD, targeting the process goal Develop Common Vision. As part of this goal, you should decide on the Level of Detail of the Vision decision point that enables the information to be conveyed to the user regarding the project's vision to be sufficiently detailed and explained, the creation of a vision statement that creates awareness about the nature of R&D, and the sharing of this vision with relevant stakeholders when necessary and choose among the DAD-based options that suits you the best such as Lightweight.
79	Resistance to R&D projects on the user	Transition	Ensure Production Readiness	Ensure Stakeholder Readiness	Train/Educate Stakeholders	providing training to the user about the project output	In order to prevent "Resistance to R&D projects on the user side, perceiving the prototype product

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	<p>side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.</p>					<p>before deployment, which not only improves system usability and familiarity but also helps reduce user resistance</p>	<p>as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Transition phase of DAD, targeting the process goal Ensure Production Readiness. As part of this goal, you should decide on the Ensure Stakeholder Readiness decision point that enables providing training to the user about the project output before deployment, which not only improves system usability and familiarity but also helps reduce user resistance and choose among the DAD-based options that suits you the best such as Train/Educate Stakeholders.</p>
79	<p>Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final</p>	Value Stream	Product Management	Evolve Vision		<p>iterative vision development and prototyping sessions to be held with stakeholders, especially with the user, to better understand the</p>	<p>In order to prevent "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an</p>

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.					purpose of the product and the development process of the users, to apply early and interactive prototyping approaches when necessary and to prevent perception differences	unawareness that the product is intended for prototype or initial use." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Evolve Vision decision point that enables iterative vision development and prototyping sessions to be held with stakeholders, especially with the user, to better understand the purpose of the product and the development process of the users, to apply early and interactive prototyping approaches when necessary and to prevent perception differences and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan the Release	the Source of Plan		the release plan to be prepared together with the technical roles and the dry run scope and requirements to be included in the plan	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Source of Plan decision point that enables the release plan to be

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							prepared together with the technical roles and the dry run scope and requirements to be included in the plan and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan Release	the Scope of Plan		the inclusion of all critical test types (dry run etc.) in the planning	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Scope of Plan decision point that enables the inclusion of all critical test types (dry run etc.) in the planning and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan Release	the Scheduling Strategy		the planning to allocate time for all testing activities, including dry runs, and to choose hybrid approaches that take risks into account, not just fixed dates	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Scheduling Strategy decision point

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							that enables the planning to allocate time for all testing activities, including dry runs, and to choose hybrid approaches that take risks into account, not just fixed dates and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan Release	the Level of Detail of the Plan		critical steps such as dry run tests to be adequately defined in the plan document and the planning to be continuously updated	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Level of Detail of the Plan decision point that enables critical steps such as dry run tests to be adequately defined in the plan document and the planning to be continuously updated and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to	Inception	Plan Release	the Choose Schedule Cadences	Production Releases	clear cadences to be defined at the beginning and duration estimates to be made more	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	surface during acceptance tests.					controlled accordingly and critical activities such as dry runs to be included in the plan	of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Choose Schedule Cadences decision point that enables clear cadences to be defined at the beginning and duration estimates to be made more controlled accordingly and critical activities such as dry runs to be included in the plan and choose among the DAD-based options that suits you the best such as Production Releases.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan Release	the Capture Plan		dry run tests to be visible and tracked in plan outputs	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Capture Plan decision point that enables dry run tests to be visible and tracked in plan outputs and choose among the DAD-based options that suits you the best.
91	Skipping or poorly	Inception	Develop Test Strategy	Test Automation Strategy		early error detection and reduction of	In order to prevent "Skipping or poorly executing dry run tests

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
	executing dry run tests causes critical errors to surface during acceptance tests.					dry run load by automating functional and integration tests of critical modules, especially before dry run tests	causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Develop Test Strategy. As part of this goal, you should decide on the Test Automation Strategy decision point that enables early error detection and reduction of dry run load by automating functional and integration tests of critical modules, especially before dry run tests and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Develop Test Strategy	Test Automation Coverage		identification of parts that can be included in automation	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Develop Test Strategy. As part of this goal, you should decide on the Test Automation Coverage decision point that enables identification of parts that can be included in automation and choose among the DAD-based options that suits you the best.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Develop Test Strategy	Development Strategy		the development process to be conducted in a test-oriented manner and to produce high quality products	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Develop Test Strategy. As part of this goal, you should decide on the Development Strategy decision point that enables the development process to be conducted in a test-oriented manner and to produce high quality products and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Construction	Accelerate Value Delivery	Choose Testing Strategies		correct and complete execution of dry run tests	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Construction phase of DAD, targeting the process goal Accelerate Value Delivery. As part of this goal, you should decide on the Choose Testing Strategies decision point that enables correct and complete execution of dry run tests and choose among the DAD-based options that suits you the best.

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Transition	Deploy the Solution	the Release Strategy		early evaluation of risky components, minimizes user impact, and enables granular, controlled, and safe release	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Transition phase of DAD, targeting the process goal Deploy the Solution. As part of this goal, you should decide on the Release Strategy decision point that enables early evaluation of risky components, minimizes user impact, and enables granular, controlled, and safe release and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Transition	Deploy the Solution	the Release Into Production		the piecemeal deployment of pre-release components, and the prevention of errors that may occur before critical tests with measures such as backup and logging	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Transition phase of DAD, targeting the process goal Deploy the Solution. As part of this goal, you should decide on the Release Into Production decision point that enables the piecemeal deployment of pre-release components, and the prevention of errors that may occur before critical tests with measures such as backup and logging and choose

Table 27 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Preventive Impact of the Option	Preventive Approach
							among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Ongoing	Coordinate Activities	Coordinate Release Schedule		the release schedules of teams working in parallel to be planned in a compatible way from the beginning and critical tests to be executed in the same time period without conflict	In order to prevent "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Coordinate Release Schedule decision point that enables the release schedules of teams working in parallel to be planned in a compatible way from the beginning and critical tests to be executed in the same time period without conflict and choose among the DAD-based options that suits you the best.

APPENDIX D

APPLICATION EXAMPLES OF CORRECTIVE APPROACH

In this appendix, corrective approaches proposed in line with the guidance of the approach to overcome the challenges identified within the scope of the study are presented. Additions made based on the suggestions of interview participants are highlighted in orange.

Table 28: Corrective Approach Examples with Software System R&D Challenges

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Corrective Impact of the Option	Corrective Approach
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Explore Scope	Explore General Requirements	Shall Statement	exploration of the requirements that are missing or misunderstood	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Explore General Requirements decision point that enables exploration of the requirements that are missing or misunderstood and choose among the DAD-based options that suits you the best such as Shall Statement.
2	Requirements and design documents are either not prepared at all or are not	Inception	Explore Scope	Explore Quality Requirements		exploration of the quality requirements that are missing or misunderstood	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Explore Quality

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	prepared in a timely manner.						Requirements decision point that enables exploration of the quality requirements that are missing or misunderstood and choose among the DAD-based options that suits you the best.
200	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Explore Scope	Level of Detail of the Scope Document	Requirements Envisioning (light specification)	the preparation of documents that are delayed /not prepared at all, at a lower level of detail and in a guiding manner by drawing the basic framework	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Level of Detail of the Scope Document decision point that enables the preparation of documents that are delayed /not prepared at all, at a lower level of detail and in a guiding manner by drawing the basic framework and choose among the DAD-based options that suits you the best such as Requirements Envisioning (light specification).
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Explore Scope	Explore Usage	Design Sprint (User Experience (UX))	exploration of the missing use cases through user feedback and including to the both documentation and system	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Explore Scope. As part of this goal, you should decide on the Explore Usage decision point that enables exploration of the missing use cases through user

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach	
							feedback and including to the both documentation and system and choose among the DAD-based options that suits you the best such as Design Sprint (User Experience (UX)).	
201	2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Identify Architecture Strategy	Explore the Architecture	exploration of the missing design decisions	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Identify Architecture Strategy. As part of this goal, you should decide on the Explore the Architecture decision point that enables exploration of the missing design decisions and choose among the DAD-based options that suits you the best.	
	2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Identify Architecture Strategy	Level of Detail of Architecture Document	High-Level Overview	the quick and high-level preparation of documents which are often delayed or not prepared at all, by providing a lower level of detail in a guiding manner that outlines the basic framework	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Identify Architecture Strategy. As part of this goal, you should decide on the Level of Detail of Architecture Document decision point that enables the quick and high-level preparation of documents which are often delayed or not prepared at all, by providing a lower level of detail in

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
							a guiding manner that outlines the basic framework and choose among the DAD-based options that suits you the best such as High-Level Overview.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Plan the Release	Level of Detail of the Plan	Rolling Wave	revising or re-detailing of a plan when issues arise due to insufficient initial detail	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Level of Detail of the Plan decision point that enables revising or re-detailing of a plan when issues arise due to insufficient initial detail and choose among the DAD-based options that suits you the best such as Rolling Wave.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Plan the Release	Estimation Strategy		ease of estimation and planning of preparation of these documents with quick, experience-based estimations if there is a need to update the estimations	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Estimation Strategy decision point that enables ease of estimation and planning of preparation of these documents with quick, experience-based estimations if there is a need to update the estimations and choose among

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
							the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Inception	Plan the Release	Capture Plan		the updated plan to be visualized, made concrete, clearly communicated, and effectively followed	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Capture Plan decision point that enables the updated plan to be visualized, made concrete, clearly communicated, and effectively followed and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Address Changing Stakeholder Needs	Stakeholder Interaction With Team	Active Stakeholder Participation, Indirectly via Product Owner	ease of exploration of changing stakeholder needs with stakeholder interaction or via product owner as long as needed	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Address Changing Stakeholder Needs. As part of this goal, you should decide on the Stakeholder Interaction With Team decision point that enables ease of exploration of changing stakeholder needs with stakeholder interaction or via product owner as long as needed and choose among the DAD-based options that suits you the best such as Active Stakeholder

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
							Participation, Indirectly via Product Owner.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Address Changing Stakeholder Needs	Elicit Requirements	the identification of previously missing or misinterpreted requirements with interviews or model storming/backlog refinement sessions		In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Address Changing Stakeholder Needs. As part of this goal, you should decide on the Elicit Requirements decision point that enables the identification of previously missing or misinterpreted requirements with interviews or model storming/backlog refinement sessions and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Address Changing Stakeholder Needs	Explore Stakeholder Needs	ease of exploration of design and changing stakeholder needs as long as needed		In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Address Changing Stakeholder Needs. As part of this goal, you should decide on the Explore Stakeholder Needs decision point that enables ease of exploration of design and changing stakeholder needs as long as needed and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Produce a Potentially Consumable Solution	Organize the Work		the planned work to be discussed within the team at regular intervals and allows for ongoing evaluation of progress	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Produce a Potentially Consumable Solution. As part of this goal, you should decide on the Organize the Work decision point that enables the planned work to be discussed within the team at regular intervals and allows for ongoing evaluation of progress and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Produce a Potentially Consumable Solution	Explore Solution Design		making of delayed or previously overlooked design decisions, as well as updating the design to better align with project needs	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Produce a Potentially Consumable Solution. As part of this goal, you should decide on the Explore Solution Design decision point that enables making of delayed or previously overlooked design decisions, as well as updating the design to better align with project needs and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	of	Corrective Impact of the Option	Corrective Approach
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Construction	Produce a Potentially Consumable Solution	Write Deliverable Documentation			the creation of brief, focused, and easily consumable documentation tailored to specific needs	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Construction phase of DAD, targeting the process goal Produce a Potentially Consumable Solution. As part of this goal, you should decide on the Write Deliverable Documentation decision point that enables the creation of brief, focused, and easily consumable documentation tailored to specific needs and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Coordinate Activities	Facilitate a Working Session	Joint Application Requirements (JAR) Sessions		conducting sessions and so ease of exploration of stakeholder needs in a collaborative manner	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Facilitate a Working Session decision point that enables conducting sessions and so ease of exploration of stakeholder needs in a collaborative manner and choose among the DAD-based options that suits you the best such as Joint Application Requirements (JAR) Sessions.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Coordinate Activities	Facilitate a Working Session	Joint Application Design (JAD) Sessions	conducting sessions and so ease of exploration of design in a collaborative manner	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Facilitate a Working Session decision point that enables conducting sessions and so ease of exploration of design in a collaborative manner and choose among the DAD-based options that suits you the best such as Joint Application Design (JAD) Sessions.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Organize Metrics	Choose Measurement Focus	Measure Outcomes	revision of measurement focus after identification of problematic issues, conducting and reporting related measurements to increase awareness of the team	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Organize Metrics. As part of this goal, you should decide on the Choose Measurement Focus decision point that enables revision of measurement focus after identification of problematic issues, conducting and reporting related measurements to increase awareness of the team and choose among the DAD-based options that suits you the best such as Measure Outcomes.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Organize Metrics	Choose Measurement Strategy		revision of measurement focus after identification of problematic issues, conducting and reporting related measurements to increase awareness of the team	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Organize Metrics. As part of this goal, you should decide on the Choose Measurement Strategy decision point that enables revision of measurement focus after identification of problematic issues, conducting and reporting related measurements to increase awareness of the team and choose among the DAD-based options that suits you the best.
2	Requirements and design documents are either not prepared at all or are not prepared in a timely manner.	Ongoing	Organize Metrics	Report Metrics	Automated Dashboards	uncovering and highlighting problems that were overlooked or ignored in the past.	In order to resolve "Requirements and design documents are either not prepared at all or are not prepared in a timely manner." challenge, see the Ongoing phase of DAD, targeting the process goal Organize Metrics. As part of this goal, you should decide on the Report Metrics decision point that enables uncovering and highlighting problems that were overlooked or ignored in the past. and choose among the DAD-based options that suits you the best such as Automated Dashboards.
11	Lack of information	Ongoing	Coordinate Activities	Artifact Ownership		identification of the problem areas	In order to resolve "Lack of information sharing between internal units and

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	sharing between internal units and unwillingness to share details.					and provides flexibility to address them in case where information sharing is limited	unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Artifact Ownership decision point that enables identification of the problem areas and provides flexibility to address them in case where information sharing is limited and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Coordinate Within Team		intra-team coordination to address identified communication and information sharing deficiencies	In order to resolve "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Coordinate Within Team decision point that enables intra-team coordination to address identified communication and information sharing deficiencies and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Facilitate a Working Session		the organization of sessions where the team can share information on issues where there is a lack of information	In order to resolve "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Facilitate a Working Session decision

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
						sharing and causing disruptions, and to close the gap	point that enables the organization of sessions where the team can share information on issues where there is a lack of information sharing and causing disruptions, and to close the gap and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Coordinate Across Program		coordination within the program to address identified communication and information sharing deficiencies	In order to resolve "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Coordinate Across Program decision point that enables coordination within the program to address identified communication and information sharing deficiencies and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Coordinate Across the Organization		intra-organizational coordination to address identified communication and information sharing deficiencies	In order to resolve "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Coordinate Across the Organization decision point that enables intra-organizational coordination to address identified communication and information

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
							sharing deficiencies and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Coordinate Activities	Cross Team Coordination		teams to ensure coordination and information flow in case of a lack of communication/information sharing between different teams	In order to resolve "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Cross Team Coordination decision point that enables teams to ensure coordination and information flow in case of a lack of communication/information sharing between different teams and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Evolve Way of Working (WoW)	Physical Environment		the creation of environments where teams with identified information sharing deficiencies can come together	In order to resolve "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Physical Environment decision point that enables the creation of environments where teams with identified information sharing deficiencies can come together and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	of Corrective Impact of the Option	Corrective Approach
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Evolve Way of Working (WoW)	Choose Communication Styles		corrective intervention by selecting a more effective communication channel if there are wrong decisions or conflicts as a result of faulty communication	In order to resolve "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Choose Communication Styles decision point that enables corrective intervention by selecting a more effective communication channel if there are wrong decisions or conflicts as a result of faulty communication and choose among the DAD-based options that suits you the best.
11	Lack of information sharing between internal units and unwillingness to share details.	Ongoing	Evolve Way of Working (WoW)	Choose Collaboration Styles		the resolution/improvement of existing problems arising from the lack of information sharing by recognizing the isolated/individual work culture and transitioning to more collaborative models	In order to resolve "Lack of information sharing between internal units and unwillingness to share details." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Choose Collaboration Styles decision point that enables the resolution/improvement of existing problems arising from the lack of information sharing by recognizing the isolated/individual work culture and transitioning to more collaborative models and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
14	The absence of a systematic approach in determining project durations.	Inception	Plan the Release	Source of Plan		the planning process to be restructured for the remaining activities to the extent possible and run with the participation of the team if the plan was made unilaterally and failed	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Source of Plan decision point that enables the planning process to be restructured for the remaining activities to the extent possible and run with the participation of the team if the plan was made unilaterally and failed and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan the Release	Scope of Plan		planning from the current stage of the project to eliminate problems arising from the lack of a systematic approach and a timeframe	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Scope of Plan decision point that enables planning from the current stage of the project to eliminate problems arising from the lack of a systematic approach and a timeframe and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining	Inception	Plan the Release	Scheduling Strategy		if the project is under pressure in terms of time, scope and cost	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	project durations.					and the plan has failed, the strategy can be reconsidered and a relaxation of the constraint can be considered	process goal Plan the Release. As part of this goal, you should decide on the Scheduling Strategy decision point that enables if the project is under pressure in terms of time, scope and cost and the plan has failed, the strategy can be reconsidered and a relaxation of the constraint can be considered and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan the Release	Level of Detail of the Plan	Rolling Wave	continuous planning in case the current plan is too superficial or too detailed and the deadlines need to be re-planned	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Level of Detail of the Plan decision point that enables continuous planning in case the current plan is too superficial or too detailed and the deadlines need to be re-planned and choose among the DAD-based options that suits you the best such as Rolling Wave.
14	The absence of a systematic approach in determining project durations.	Inception	Plan the Release	Choose Schedule Cadences		bringing discipline to the process by setting regular and sustainable cadences when	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
						there is poor planning, uncertainty, or continuous deviation, replacing ad hoc practices with structured intervals or cycles	Choose Schedule Cadences decision point that enables bringing discipline to the process by setting regular and sustainable cadences when there is poor planning, uncertainty, or continuous deviation, replacing ad hoc practices with structured intervals or cycles and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan the Release	Estimation Strategy		reduction of deviations after unsuccessful forecasts by switching to a more appropriate/data-driven strategy	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Estimation Strategy decision point that enables reduction of deviations after unsuccessful forecasts by switching to a more appropriate/data-driven strategy and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan the Release	Choose Estimation Unit		the planning to be revised by selecting a clear unit when inconsistent or uncertain forecast units are detected after planning	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Choose Estimation Unit decision point that enables the planning to be revised by

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
							selecting a clear unit when inconsistent or uncertain forecast units are detected after planning and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Inception	Plan the Release	Capture Plan		the simplification of processes and documentation by shifting from cost- or schedule-driven, heavily documented plans to an outcome- and value-oriented strategy with minimal documentation	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Capture Plan decision point that enables the simplification of processes and documentation by shifting from cost- or schedule-driven, heavily documented plans to an outcome- and value-oriented strategy with minimal documentation and choose among the DAD-based options that suits you the best.
14	The absence of a systematic approach in determining project durations.	Ongoing	Measure Outcomes	Forecast Schedule		the definition of a new forecasting process based on historical data in cases of unrealistic or incomplete estimates, thereby improving the accuracy of planning	In order to resolve "The absence of a systematic approach in determining project durations." challenge, see the Ongoing phase of DAD, targeting the process goal Measure Outcomes. As part of this goal, you should decide on the Forecast Schedule decision point that enables the definition of a new forecasting process based on historical data in cases of unrealistic or incomplete estimates, thereby improving the accuracy of

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
							planning and choose among the DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Inception	Form Team	Team Completeness		the formation of specialized teams by bringing in external resources, seeking consultancy, or reorganizing internal resources when knowledge gaps within the team are identified as the project progresses	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Inception phase of DAD, targeting the process goal Form Team. As part of this goal, you should decide on the Team Completeness decision point that enables the formation of specialized teams by bringing in external resources, seeking consultancy, or reorganizing internal resources when knowledge gaps within the team are identified as the project progresses and choose among the DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Inception	Plan the Release	Capture Plan	Staffing Plan	expert assignment, consultant engagement, or internal rotation through updates to the staffing plan when knowledge gaps within the team are identified	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Capture Plan decision point that enables expert assignment, consultant engagement, or internal rotation through updates to the staffing plan when knowledge gaps within the team are identified and choose among the DAD-

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
							based options that suits you the best such as Staffing Plan.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Ongoing	Grow Team Members	Improve Skills and Knowledge		closing the knowledge gap through mentorship or short-term expert support when a lack of domain knowledge has begun to affect the project	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Ongoing phase of DAD, targeting the process goal Grow Team Members. As part of this goal, you should decide on the Improve Skills and Knowledge decision point that enables closing the knowledge gap through mentorship or short-term expert support when a lack of domain knowledge has begun to affect the project and choose among the DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Ongoing	Grow Team Members	Sustain Team		practical ways to close existing knowledge gaps when they are noticed	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Ongoing phase of DAD, targeting the process goal Grow Team Members. As part of this goal, you should decide on the Sustain Team decision point that enables practical ways to close existing knowledge gaps when they are noticed and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Ongoing	Grow Team Members	Provide Feedback	Continuous/Regular Feedback, Team Lead Review	the team leader to identify problems related to lack of knowledge, redistribute tasks, and provide supportive resources/coaching for tasks requiring expertise	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Ongoing phase of DAD, targeting the process goal Grow Team Members. As part of this goal, you should decide on the Provide Feedback decision point that enables the team leader to identify problems related to lack of knowledge, redistribute tasks, and provide supportive resources/coaching for tasks requiring expertise and choose among the DAD-based options that suits you the best such as Continuous/Regular Feedback, Team Lead Review.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Construction	Produce a Potentially Consumable Solution	Explore Solution Design	Proof of Concept (PoC)	in cases where problems arise due to knowledge gaps during the development process, the use of a Proof of Concept (PoC) to test different variants of the technical solution, allowing the team to proceed with the option that	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Construction phase of DAD, targeting the process goal Produce a Potentially Consumable Solution. As part of this goal, you should decide on the Explore Solution Design decision point that enables in cases where problems arise due to knowledge gaps during the development process, the use of a Proof of Concept (PoC) to test different variants of the technical solution, allowing the team to proceed with the option that best fits their capabilities and choose among the

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
						best fits their capabilities	DAD-based options that suits you the best such as Proof of Concept (PoC).
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Enterprise	People Management	Guide Careers		aligning identified knowledge gaps during the project with individual career goals, thereby supporting the development of team members	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Enterprise phase of DAD, targeting the process goal People Management. As part of this goal, you should decide on the Guide Careers decision point that enables aligning identified knowledge gaps during the project with individual career goals, thereby supporting the development of team members and choose among the DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Enterprise	People Management	Ensure Diversity		addressing skill gaps by reinforcing the team with additional members who have different areas of expertise when the existing team is insufficient	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Enterprise phase of DAD, targeting the process goal People Management. As part of this goal, you should decide on the Ensure Diversity decision point that enables addressing skill gaps by reinforcing the team with additional members who have different areas of expertise when the existing team is insufficient and choose among the

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
							DAD-based options that suits you the best.
15	Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise.	Enterprise	People Management	Staff Groups	Forecast Staffing Needs	the need for expertise to be recognized and the staffing plan to be revised as the project progresses	In order to resolve "Insufficient know-how of the staff, particularly in areas requiring domain-specific expertise." challenge, see the Enterprise phase of DAD, targeting the process goal People Management. As part of this goal, you should decide on the Staff Groups decision point that enables the need for expertise to be recognized and the staffing plan to be revised as the project progresses and choose among the DAD-based options that suits you the best such as Forecast Staffing Needs.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the	Ongoing	Evolve Way of Working (WoW)	Select Life Cycle		the reconsideration of the lifecycle and the application of agile approaches locally (e.g. timeboxed iterations) to the relevant phases as the project progresses, when the areas requiring	In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Select Life Cycle decision point that enables the reconsideration of

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.					discovery become clear	the lifecycle and the application of agile approaches locally (e.g. timeboxed iterations) to the relevant phases as the project progresses, when the areas requiring discovery become clear and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D,	Ongoing	Evolve Way of Working (WoW)	Visualize Existing Process		re-evaluation of existing activities for phases that require exploration after the project has begun	In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Visualize Existing Process decision point that enables re-evaluation of existing activities for phases that require exploration after the project has begun and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	of	Corrective Impact of the Option	Corrective Approach
	making project execution more difficult during those phases.							
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.	Ongoing	Evolve Way of Working (WoW)	Tailor Initial Process			the existing process to be re-tailored to address the difficulties encountered in the exploration phases after the project has started, and a separate approach to these phases can be developed, thus achieving a structure that allows for both contractual compliance and exploration.	In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Tailor Initial Process decision point that enables the existing process to be re-tailored to address the difficulties encountered in the exploration phases after the project has started, and a separate approach to these phases can be developed, thus achieving a structure that allows for both contractual compliance and exploration. and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.	Ongoing	Evolve Way of Working (WoW)	Identify Potential Improvements		the restructuring of processes during project execution by identifying where flexibility is needed—through retrospectives or internal team evaluations—if it becomes evident during the research phase that existing processes are hindering progress, and by making process improvements in short cycles	In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Identify Potential Improvements decision point that enables the restructuring of processes during project execution by identifying where flexibility is needed—through retrospectives or internal team evaluations—if it becomes evident during the research phase that existing processes are hindering progress, and by making process improvements in short cycles and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain	Ongoing	Evolve Way of Working (WoW)	Reuse Known Strategies		after the project has started, in cases where the nature of R&D conflicts with the existing structure,	In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	<p>phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.</p>					<p>strategies that have worked in similar situations in the past can be reconsidered and adapted to the current process</p>	<p>contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Reuse Known Strategies decision point that enables after the project has started, in cases where the nature of R&D conflicts with the existing structure, strategies that have worked in similar situations in the past can be reconsidered and adapted to the current process and choose among the DAD-based options that suits you the best.</p>
19	<p>Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a</p>	<p>Ongoing</p>	<p>Evolve Way of Working (WoW)</p>	<p>Implement Potential Improvements</p>	<p>methods such as gradually introducing more flexible applications for points that show incompatibility with the R&D structure after the project has started and partially relaxing the</p>	<p>In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should</p>	

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	of	Corrective Impact of the Option	Corrective Approach
	mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.						effects of the rigid form contract	decide on the Implement Potential Improvements decision point that enables methods such as gradually introducing more flexible applications for points that show incompatibility with the R&D structure after the project has started and partially relaxing the effects of the rigid form contract and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible,	Ongoing	Evolve Way of Working (WoW)	Capture WoW			the team to review and document their WoW when the need for flexibility is identified throughout the project, clarifying their expectations for the current process and enabling them to manage it in a more cohesive way within the contract boundaries	In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Capture WoW decision point that enables the team to review and document their WoW when the need for flexibility is identified throughout the project, clarifying their expectations for the current process and enabling them to

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	uncertain nature of R&D, making project execution more difficult during those phases.						manage it in a more cohesive way within the contract boundaries and choose among the DAD-based options that suits you the best.
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.	Ongoing	Evolve Way of Working (WoW)	Share Improvements With Others		the use of improvements shared by other teams	In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Share Improvements With Others decision point that enables the use of improvements shared by other teams and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Corrective Impact of the Option	Corrective Approach
19	Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases.	Ongoing	Leverage and Enhance Existing Infrastructure	Work With Process Assets		updating existing process assets, taking into account the difficulties experienced, transferring the lessons learned to the corporate knowledge pool and preventing similar conflicts in subsequent projects when the need for flexibility in the R&D process cannot be met	In order to resolve "Although the project and its contractual structure follow a standard format, certain phases within the project require exploratory R&D activities. This creates a mismatch between the rigid expectations of the contract and the flexible, uncertain nature of R&D, making project execution more difficult during those phases." challenge, see the Ongoing phase of DAD, targeting the process goal Leverage and Enhance Existing Infrastructure. As part of this goal, you should decide on the Work With Process Assets decision point that enables updating existing process assets, taking into account the difficulties experienced, transferring the lessons learned to the corporate knowledge pool and preventing similar conflicts in subsequent projects when the need for flexibility in the R&D process cannot be met and choose among the DAD-based options that suits you the best.
33	The life cycle model applied is based on the waterfall approach,	Ongoing	Evolve Way of Working (WoW)	Select Life Cycle	Hybrid	the team to work in the balance they created by blending waterfall and agile methods with the choice of	In order to resolve "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	limiting flexibility.					a hybrid life cycle model, even if the project started with the decision to implement a waterfall life cycle	decide on the Select Life Cycle decision point that enables the team to work in the balance they created by blending waterfall and agile methods with the choice of a hybrid life cycle model, even if the project started with the decision to implement a waterfall life cycle and choose among the DAD-based options that suits you the best such as Hybrid.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Visualize Existing Process		the team to analyze the process they are implementing, raise awareness and identify points that need to be changed	In order to resolve "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Visualize Existing Process decision point that enables the team to analyze the process they are implementing, raise awareness and identify points that need to be changed and choose among the DAD-based options that suits you the best.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Identify Potential Improvements		the team to discover potential areas for improvement after defining and implementing their WoW and	In order to resolve "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Identify Potential

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
						encourage continuous improvement	Improvements decision point that enables the team to discover potential areas for improvement after defining and implementing their WoW and encourage continuous improvement and choose among the DAD-based options that suits you the best.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Reuse Known Strategies	Idea from Disciplined Agile (DA) Tool Kit	the team to get help and inspiration from the DA Tool Kit regarding areas they want to change in WoW	In order to resolve "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Reuse Known Strategies decision point that enables the team to get help and inspiration from the DA Tool Kit regarding areas they want to change in WoW and choose among the DAD-based options that suits you the best such as Idea from Disciplined Agile (DA) Tool Kit.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Implement Potential Improvements	Guided Continuous Improvement (GCI), Controlled Experiment	the team to implement the potential improvements they have identified in small and incremental steps and/or to implement the	In order to resolve "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Implement Potential Improvements decision point that enables the team to implement the potential

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
						improvements in a controlled manner and determine the most appropriate methods through trial and error	improvements they have identified in small and incremental steps and/or to implement the improvements in a controlled manner and determine the most appropriate methods through trial and error and choose among the DAD-based options that suits you the best such as Guided Continuous Improvement (GCI), Controlled Experiment.
33	The life cycle model applied is based on the waterfall approach, limiting flexibility.	Ongoing	Evolve Way of Working (WoW)	Capture WoW		the new WoW determined by the team to be documented and recorded, and if necessary, to share best practices within the organization with other teams or to inform new members of the team	In order to resolve "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should decide on the Capture WoW decision point that enables the new WoW determined by the team to be documented and recorded, and if necessary, to share best practices within the organization with other teams or to inform new members of the team and choose among the DAD-based options that suits you the best.
33	The life cycle model applied is based on the waterfall approach,	Ongoing	Evolve Way of Working (WoW)	Share Improvements With Others		the internal/inter-team sharing of improvements, setting an example for other teams, increasing	In order to resolve "The life cycle model applied is based on the waterfall approach, limiting flexibility." challenge, see the Ongoing phase of DAD, targeting the process goal Evolve Way of Working (WoW). As part of this goal, you should

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	limiting flexibility.					the awareness of teams that are considering making changes to their working style, and disseminating GCI	decide on the Share Improvements With Others decision point that enables the internal/inter-team sharing of improvements, setting an example for other teams, increasing the awareness of teams that are considering making changes to their working style, and disseminating GCI and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	DevOps	Release Management	Plan Release Schedule		the existing plan to be revised (switched to a different plan that suits the team better) or to plan from scratch in order to eliminate problems that arise when the release and subsequent integration work is carried out without a plan or without a plan	In order to resolve "Involvement of multiple subcontractors causing integration problems." challenge, see the DevOps phase of DAD, targeting the process goal Release Management. As part of this goal, you should decide on the Plan Release Schedule decision point that enables the existing plan to be revised (switched to a different plan that suits the team better) or to plan from scratch in order to eliminate problems that arise when the release and subsequent integration work is carried out without a plan or without a plan and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors	DevOps	Release Management	Schedule Solution Release		the existing solution plan to be revised	In order to resolve "Involvement of multiple subcontractors causing integration problems." challenge, see the

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample of DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	causing integration problems.					(switched to a different plan that suits the team better) or to create a solution plan from scratch in order to resolve problems that arise when specific solution release and subsequent integration work is carried out inconsistently or unplanned	DevOps phase of DAD, targeting the process goal Release Management. As part of this goal, you should decide on the Schedule Solution Release decision point that enables the existing solution plan to be revised (switched to a different plan that suits the team better) or to create a solution plan from scratch in order to resolve problems that arise when specific solution release and subsequent integration work is carried out inconsistently or unplanned and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	DevOps	Release Management	Manage Infrastructure Configuration		access to information such as which version affects what/when it was deployed, to identify other components it affects when a problem is encountered, and to facilitate reverting to the previous stable state if there is a	In order to resolve "Involvement of multiple subcontractors causing integration problems." challenge, see the DevOps phase of DAD, targeting the process goal Release Management. As part of this goal, you should decide on the Manage Infrastructure Configuration decision point that enables access to information such as which version affects what/when it was deployed, to identify other components it affects when a problem is encountered, and to facilitate reverting to the previous stable state if there is a faulty release/deploy/integration

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
						faulty release/deploy/integration	and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	DevOps	Release Management	Govern Releases		tracking of disruptions during release and integration with metric measurements, conducting audits, and identifying actions to be taken by monitoring progress	In order to resolve "Involvement of multiple subcontractors causing integration problems." challenge, see the DevOps phase of DAD, targeting the process goal Release Management. As part of this goal, you should decide on the Govern Releases decision point that enables tracking of disruptions during release and integration with metric measurements, conducting audits, and identifying actions to be taken by monitoring progress and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	Transition	Deploy the Solution	Release Strategy		stakeholders to answer the questions "which features are we deploying, to what extent (full/partial), at what usability level" and to complete the integration	In order to resolve "Involvement of multiple subcontractors causing integration problems." challenge, see the Transition phase of DAD, targeting the process goal Deploy the Solution. As part of this goal, you should decide on the Release Strategy decision point that enables stakeholders to answer the questions "which features are we deploying, to what extent (full/partial), at what usability level" and to complete the integration accordingly during the release

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
						accordingly during the release	and choose among the DAD-based options that suits you the best.
42	Involvement of multiple subcontractors causing integration problems.	Transition	Deploy the Solution	Release Into Production		in case of a problem during integration and failure, the most appropriate release method(s) to be determined and the integration to be tried again accordingly	In order to resolve "Involvement of multiple subcontractors causing integration problems." challenge, see the Transition phase of DAD, targeting the process goal Deploy the Solution. As part of this goal, you should decide on the Release Into Production decision point that enables in case of a problem during integration and failure, the most appropriate release method(s) to be determined and the integration to be tried again accordingly and choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with	Value Stream	Portfolio Management	Identify Potential Value		the addition of new features or improvements that will provide a competitive advantage to the product through competitor product analysis and user feedback after the start of the project	In order to resolve "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Portfolio Management. As part of this goal, you should decide on the Identify Potential Value decision point that enables the addition of new features or improvements

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	of	Corrective Impact of the Option	Corrective Approach
	the development activities after the product development has already begun.							that will provide a competitive advantage to the product through competitor product analysis and user feedback after the start of the project and choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.	Value Stream	Product Management	Monitor the Market			changes to the direction and scope of the project in light of data such as user feedback and ROI after product development begins	In order to resolve "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Monitor the Market decision point that enables changes to the direction and scope of the project in light of data such as user feedback and ROI after product development begins and choose among the DAD-based options that suits you the best.
49	Starting an R&D project	Value Stream	Product Management	Market Offering(s)	Create Marketing Plan,		the identification of potential	In order to resolve "Starting an R&D project without conducting market

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	of	Corrective Impact of the Option	Corrective Approach
	without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.				Identify Potential Customers		customers after product development begins, market positioning of the product according to their needs, and possibilities such as changes in the usage scenario	research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Market Offering(s) decision point that enables the identification of potential customers after product development begins, market positioning of the product according to their needs, and possibilities such as changes in the usage scenario and choose among the DAD-based options that suits you the best such as Create Marketing Plan, Identify Potential Customers.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research	Value Stream	Product Management	Evolve Vision			the roadmap to be reviewed and the product strategy to be reshaped by gathering feedback from stakeholders if the vision is unclear or incompatible with the real need	In order to resolve "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Evolve Vision decision point that enables the roadmap to

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	of	Corrective Impact of the Option	Corrective Approach
	in parallel with the development activities after the product development has already begun.							be reviewed and the product strategy to be reshaped by gathering feedback from stakeholders if the vision is unclear or incompatible with the real need and choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.	Value Stream	Product Management	Explore Potential Functionality			product direction to be revised through small-scale trials or rapid user validation if market misalignment is discovered after development has begun	In order to resolve "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Explore Potential Functionality decision point that enables product direction to be revised through small-scale trials or rapid user validation if market misalignment is discovered after development has begun and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun.	Value Stream	Product Management	Capture Roadmap		the roadmap to be revised, taking into account market data, and to re-communicate with stakeholders with new priorities and target dates after development has begun	In order to resolve "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Capture Roadmap decision point that enables the roadmap to be revised, taking into account market data, and to re-communicate with stakeholders with new priorities and target dates after development has begun and choose among the DAD-based options that suits you the best.
49	Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and	Value Stream	Product Management	Evolve Roadmap	Rolling Wave	the roadmap to be updated based on the market research conducted after the product development has begun, thus correcting faulty priorities and	In order to resolve "Starting an R&D project without conducting market research and without clearly identifying the market need or gap, and conducting the market research in parallel with the development activities after the product development has already begun." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	conducting the market research in parallel with the development activities after the product development has already begun.					orientations and setting new targets	should decide on the Evolve Roadmap decision point that enables the roadmap to be updated based on the market research conducted after the product development has begun, thus correcting faulty priorities and orientations and setting new targets and choose among the DAD-based options that suits you the best such as Rolling Wave.
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for	Inception	Develop Common Vision	Vision Strategy	Collaborative	reviewing the vision again with the users and communicating the goals more clearly if there are still misperceptions after the project progresses	In order to resolve "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Inception phase of DAD, targeting the process goal Develop Common Vision. As part of this goal, you should decide on the Vision Strategy decision point that enables reviewing the vision again with the users and communicating the goals more clearly if there are still misperceptions after the project progresses and choose among the DAD-based options that suits you the best such as Collaborative.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	prototype or initial use.						
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.	Inception	Develop Common Vision	Capture the Vision	Expected Outcomes	the preparation of a simplified summary document and the re-communication of objectives with a targeted focus on user groups, if the intended outcomes are misunderstood	In order to resolve "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Inception phase of DAD, targeting the process goal Develop Common Vision. As part of this goal, you should decide on the Capture the Vision decision point that enables the preparation of a simplified summary document and the re-communication of objectives with a targeted focus on user groups, if the intended outcomes are misunderstood and choose among the DAD-based options that suits you the best such as Expected Outcomes.
79	Resistance to R&D projects on the user side, perceiving the prototype	Inception	Develop Common Vision	Level of Detail of the Vision	Lightweight	the preparation of a quickly updated detailed vision document for the user if the level of	In order to resolve "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.					detail is insufficient	to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Inception phase of DAD, targeting the process goal Develop Common Vision. As part of this goal, you should decide on the Level of Detail of the Vision decision point that enables the preparation of a quickly updated detailed vision document for the user if the level of detail is insufficient and choose among the DAD-based options that suits you the best such as Lightweight.
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to	Transition	Ensure Production Readiness	Ensure Stakeholder Readiness	Train/Educate Stakeholders	focused interviews with targeted user groups after deployment to reduce the user's negative perception of the prototype, collecting user experience by encouraging feedback	In order to resolve "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Transition phase of DAD, targeting the process goal Ensure Production Readiness. As part of this goal, you should decide on the Ensure Stakeholder Readiness decision point that

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use.					mechanisms, explaining that the product is a prototype and not the final version, and emphasizing that their suggestions will contribute to the development	enables focused interviews with targeted user groups after deployment to reduce the user's negative perception of the prototype, collecting user experience by encouraging feedback mechanisms, explaining that the product is a prototype and not the final version, and emphasizing that their suggestions will contribute to the development and choose among the DAD-based options that suits you the best such as Train/Educate Stakeholders.
79	Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product	Value Stream	Product Management	Evolve Vision		user-focused additional sessions to be organized, explaining that the product is a feedback-oriented output, demonstrating user-specific usage scenarios and concretely demonstrating the contributions it will provide, and creating an environment that will directly answer user	In order to resolve "Resistance to R&D projects on the user side, perceiving the prototype product as an incomplete or defective final product rather than a development-oriented output, and refusing to use it. This indicates a lack of R&D perspective and an unawareness that the product is intended for prototype or initial use." challenge, see the Value Stream phase of DAD, targeting the process goal Product Management. As part of this goal, you should decide on the Evolve Vision decision point that enables user-focused additional sessions to be organized, explaining that the product is a feedback-oriented output, demonstrating user-specific usage scenarios and concretely demonstrating the contributions it will provide, and creating an environment that

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	is intended for prototype or initial use.					questions and concerns	will directly answer user questions and concerns and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan the Release	Scope of Plan		rapid testing planning by narrowing the scope if there is still time before acceptance tests as a result of skipping or inadequate dry-run tests	In order to resolve "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Scope of Plan decision point that enables rapid testing planning by narrowing the scope if there is still time before acceptance tests as a result of skipping or inadequate dry-run tests and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan the Release	Scheduling Strategy		a test plan that tests narrow scope but critical functions before acceptance tests	In order to resolve "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Scheduling Strategy decision point that enables a test plan that tests narrow scope but critical functions before acceptance tests and choose among the DAD-based options that suits you the best.

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan the Release	Level of Detail of the Plan		a high-level test definition to test critical functions under tight scope and time pressure before acceptance	In order to resolve "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Level of Detail of the Plan decision point that enables a high-level test definition to test critical functions under tight scope and time pressure before acceptance and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Inception	Plan the Release	Choose Schedule Cadences	Production Releases	creation of cadence for narrowed testing	In order to resolve "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should decide on the Choose Schedule Cadences decision point that enables creation of cadence for narrowed testing and choose among the DAD-based options that suits you the best such as Production Releases.
91	Skipping or poorly executing dry run tests causes critical errors to surface during	Inception	Plan the Release	Capture Plan		visibility and monitoring of test activities that are subsequently included in a narrow scope.	In order to resolve "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Inception phase of DAD, targeting the process goal Plan the Release. As part of this goal, you should

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	Corrective Impact of the Option	Corrective Approach
	acceptance tests.						decide on the Capture Plan decision point that enables visibility and monitoring of test activities that are subsequently included in a narrow scope. and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Transition	Deploy the Solution	Release Strategy		the effects of inadequate or non-existent dry run tests to be reflected minimally on the user	In order to resolve "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Transition phase of DAD, targeting the process goal Deploy the Solution. As part of this goal, you should decide on the Release Strategy decision point that enables the effects of inadequate or non-existent dry run tests to be reflected minimally on the user and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Transition	Deploy the Solution	Release Into Production		mitigating the impact of errors, if dry runs were not performed or were insufficient, through interventions such as restoring the previous data/version, activating the	In order to resolve "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Transition phase of DAD, targeting the process goal Deploy the Solution. As part of this goal, you should decide on the Release Into Production decision point that enables mitigating the impact of errors, if dry runs were not performed or were insufficient, through interventions such as restoring the

Table 28 (cont.)

CHL ID	Challenges of Software System R&D Projects	DAD Phase	DAD Process Goal	DAD Decision Point(s)	Sample DAD-Based Options	of	Corrective Impact of the Option	Corrective Approach
							support system, and informing users	previous data/version, activating the support system, and informing users and choose among the DAD-based options that suits you the best.
91	Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests.	Ongoing	Coordinate Activities	Coordinate Release Schedule			rearranging the release schedule, reordering tests, making temporary resource allocations if necessary, and trying to reduce the effects of delays and errors	In order to resolve "Skipping or poorly executing dry run tests causes critical errors to surface during acceptance tests." challenge, see the Ongoing phase of DAD, targeting the process goal Coordinate Activities. As part of this goal, you should decide on the Coordinate Release Schedule decision point that enables rearranging the release schedule, reordering tests, making temporary resource allocations if necessary, and trying to reduce the effects of delays and errors and choose among the DAD-based options that suits you the best.