TMAP®:

Quality Engineering for SAP

Syllabus

Version 0.9

Released 18 August 2023

Copyright notice

Revision history

Version	Date	Author	Remarks
0.1	18 July 2022	Rik Marselis	Initial setup and instructions for contents creation.
0.2	28 December 2022	Rik Marselis & Pepijn Paap	Setup of order of learning objectives and chapters with extra knowledge.
0.3	3 March 2023	Rik Marselis & Pepijn Paap	Learning objectives & extra know-ledge chapters for internal review.
0.4	31 March 2023	Rik Marselis & Pepijn Paap	Version for initial review by SME's and SAP community
0.5	26 April 2023	Rik Marselis & Pepijn Paap	Version for team that creates pilot training material.
0.6	12 May 2023	Rik Marselis, Pepijn Paap & Guido Nelissen	Version for TMAP SIG members
0.7	24 May 2023	Rik Marselis & Pepijn Paap	Version for internal pilot-training course
0.8	26 July 2023	Rik Marselis & Pepijn Paap	Version for external pilot training course
0.9	18 August 2023	Rik Marselis & Pepijn Paap	Version for initial live training course
1.0		(to be created)	Final version

Table of Contents

0. Introduction to this syllabus

0.1. TMAP®: Quality engineering certification scheme

The TMAP® certification scheme supports people involved in IT delivery in extending their knowledge and skills, to empower them to play their part in delivering business value for their organization, its customers and other relations.

The TMAP® book "Quality for DevOps teams" (2020) is the foundation of the TMAP® body of knowledge. The website www.TMAP.net contains most of the knowledge from the book and many additional items such as downloadable templates and the TMAP® glossary (in 5 languages).

In today's IT world cross-functional teams are expected to deliver business value with the right quality at speed. This requires high-performance IT delivery models such as DevOps and Scrum, which can be extended to a hybrid IT delivery model such as the SAFe® framework.

The TMAP® body of knowledge for quality engineering and testing supports working towards built-in quality and takes the need for quality in products, processes and people far beyond just testing.

0.2. Purpose of this syllabus

The training course "**TMAP®: Quality Engineering for SAP**" enables professionals that are responsible for accepting and implementing SAP systems, to acquire the necessary knowledge and skills to enable them and their teams to achieve quality ownership.

This syllabus is the basis for the training course "TMAP®: Quality Engineering for SAP" and provides directions for the associated examination and certification. This is a 2-day training course, consisting of four sessions. The candidate can achieve a certificate by taking a separate exam of 1 hour.

0.3. Target audience and prerequisites for candidates

This training course is mainly intended for key users, business users, operations and maintenance teams. These are the people that often are involved in testing and implementing new or changed versions of SAP systems and whom are involved in the acceptance process.

The candidates are expected to have basic IT knowledge and experience, and average SAP knowledge and experience. There is no required previous certification.

0.4. Format of the training course and this syllabus

The 2-day training course consists of 4 sessions with a minimum of 3 hours (that is 12 contact hours in total). The number of hours mentioned is excluding homework (such as self-study), logistical preparation of the exam and breaks. Candidates must prepare to spend about 6 to 12 hours on individual study and preparation for the exam.

The order of chapters and sections in this syllabus is according to the sequence of the training course, which gives a mix of theoretical and practical subjects. Every training session is a separate chapter in this syllabus and the sections each cover a learning objective.

The chapters 5 through 7 of this syllabus contain supporting knowledge from the TMAP body of knowledge, which is additional to what is described in the TMAP book "Quality for DevOps teams".

0.5. Learning objectives and K-levels explained

Learning objectives (LO's) are brief statements that describe what you are expected to know after studying each subject. The relevant information for the learning objectives can be found in the TMAP book "Quality for DevOps teams" and in chapters 5, 6 and 7 of this syllabus. With each LO there is a reference to the relevant chapter(s) or section(s). The LO's are used to create the examination for achieving the TMAP®: Quality Engineering for SAP certification. Each learning objective has a corresponding cognitive level of knowledge (K-level).
These K-levels, based on Bloom's modified taxonomy, are as follows:

- K1: Remember (knowledge). The candidate should remember or recognize a term or a concept. e.g. is able to recognize, has knowledge of, knows.
- K2: Understand (comprehension). The candidate should select an explanation for a statement related to the questioned subject.
  Examples are: The candidate… can explain, recognizes examples related to the subject, understands, is able to recite, is aware of, can indicate, can distinguish.
- K3: Apply (application). The candidate should select the correct application of a concept or technique and apply it to a given context.
  Examples are: The candidate… can relate, can enumerate, can select, can compose, can identify, is able to apply, can assign, can propose.

An overview of the learning objectives and their corresponding K-levels is given in the next section.

0.6. Learning objectives and K-levels for this certification

The literature referred to in the last column of the table below, are the TMAP book "Quality for DevOps teams" (3rd edition 2022) and the chapters 5, 6 and 7 of this syllabus.

Learning objectives (the order is basically appearance in the sessions, with a few exceptions)		K-level	Section	
			in this syllabus	Literature in the book or syllabus
LO01	ERP Systems	K2	§ 1.1	Syllabus § 5.1
LO02	What is SAP	K1	§ 1.2	Syllabus § 5.2
LO03	SAP Main flows	K2	§ 1.3	Syllabus § 5.2 & 5.3
LO04	Other SAP solutions	K1	§ 1.4	Syllabus § 5.4
LO05	IT delivery models for SAP	K2	§ 1.5	Ch 7 introduction, §7.1, Ch 8 introduction, §8.2, Ch 9 introduction, §9.1, Ch 10 introduction, §10.1. Syllabus § 5.5
LO06	Introduction to Quality Engineering & Testing	K2	§ 1.6	§1.2 (incl 1.2.1 – 3rd edition), Ch 5 introduction, Ch 11

Learning objectives (the order is basically appearance in the sessions, with a few exceptions)		K-level	Section	
			in this syllabus	Literature in the book or syllabus
LO07	Business value and the VOICE model	K2	§ 1.7	Ch 3
LO08	Introduction to built-in quality	K2	§ 1.8	Ch 1 introduction, §1.2.1 (of 3rd edition), A.1, A2, A3 and A.4
LO09	Stakeholder management in SAP projects	K3	§ 3.1	§3.3, §5.2, §5.4 Syllabus § 6.1
LO10	ARCI matrix for stakeholder responsibilities	K3	§ 3.2	§3.3, §5.2, §5.4 Syllabus § 6.2
LO11	The SAP Project	K2	§ 2.1	Syllabus § 5.6
LO12	SAP Activate	K1	§ 2.2	Syllabus § 5.7
LO13	SAP Quality Risk Analysis	K3	§ 2.3	Ch 26, §5.2.1, §5.2.2 Syllabus § 6.4
LO14	SAP Test Strategy	K2	§ 2.4	§15.4.3, §26.5, §26.6 Syllabus § 6.5
LO15	SAP Test Plan	K2	§ 2.5	Ch 11, § 15.4.3 Syllabus § 6.6
LO16	Quality gates	K1	§ 2.6	§ 10.1 Syllabus § 6.7
LO17	Test Design - Introduction	K3	§ 1.9	Ch 43, § 45.1
LO18	Test Design - Equivalence Partitioning	K3	§ 2.7	§ 46.5
LO19	Test Design - Boundary Value Analysis	K3	§ 2.8	§ 46.5
LO20	Authorizations managed with RBP	K2	§ 3.3	§ 5.8
LO21	SAP End-to-end testing vertical and horizontal	K2	§ 3.4	Ch 3, Ch 33, Ch 37 introduction, § 37.5.1 Syllabus § 7.7
LO22	Test data (management) in SAP	K2	§ 3.5	Ch 31 Syllabus § 7.1
LO23	SAP organizational change management	K2	§ 3.6	Syllabus § 6.3
LO24	SAP test execution	K2	§ 3.7	Ch 33 Syllabus § 6.8
LO25	Indicators and Test Reporting	K2	§ 4.2	Ch 4, § 5.4, Ch 19

Learning objectives (the order is basically appearance in the sessions, with a few exceptions)		K-level	Section	
			in this syllabus	Literature in the book or syllabus
LO26	Test Design - Path testing	K3	§ 3.8	§ 46.3
LO27	SAP Anomaly Management	K2	§ 4.1	Ch 18 Syllabus § 7.4
LO28	Continuous everything	K1	§ 4.3	§ 1.2, § 1.2.1 (not 1.2.2 and 1.2.3), § 6.2
LO29	SAP and CI/CD pipelines	K1	§ 4.4	§ 6.1, § 6.2 Syllabus § 7.2
LO30	Test Management Tooling for SAP Projects	K2	§ 4.5	Ch 12, § 23.1.2 Syllabus § 7.3
LO31	SAP Test Automation & Tooling	K1	§ 4.6	Ch 23 introduction, § 23.1, § 32.1, § 32.2, Syll. § 7.5
LO33	SAP Performance Testing	K1	§ 4.7	§ 38.1, § 38.2 Syllabus § 7.6
LO34	Test Design - Exploratory Testing	K3	§ 4.8	§ 36.1, § 47.4

Note: LO32 was deleted and no longer exists.

0.7. The TMAP®: Quality engineering for SAP - exam

The format of the exam is multiple choice. There are 25 questions. There are no explicit questions regarding K1 learning objectives. Each correctly answered question for a learning objective at K2- or K3-level gives 1 point. There are 17 K2 questions and 8 K3 questions so in total 25 points can be gained. To pass the exam, at least 66% of the points (that is 17 points) must be gained.

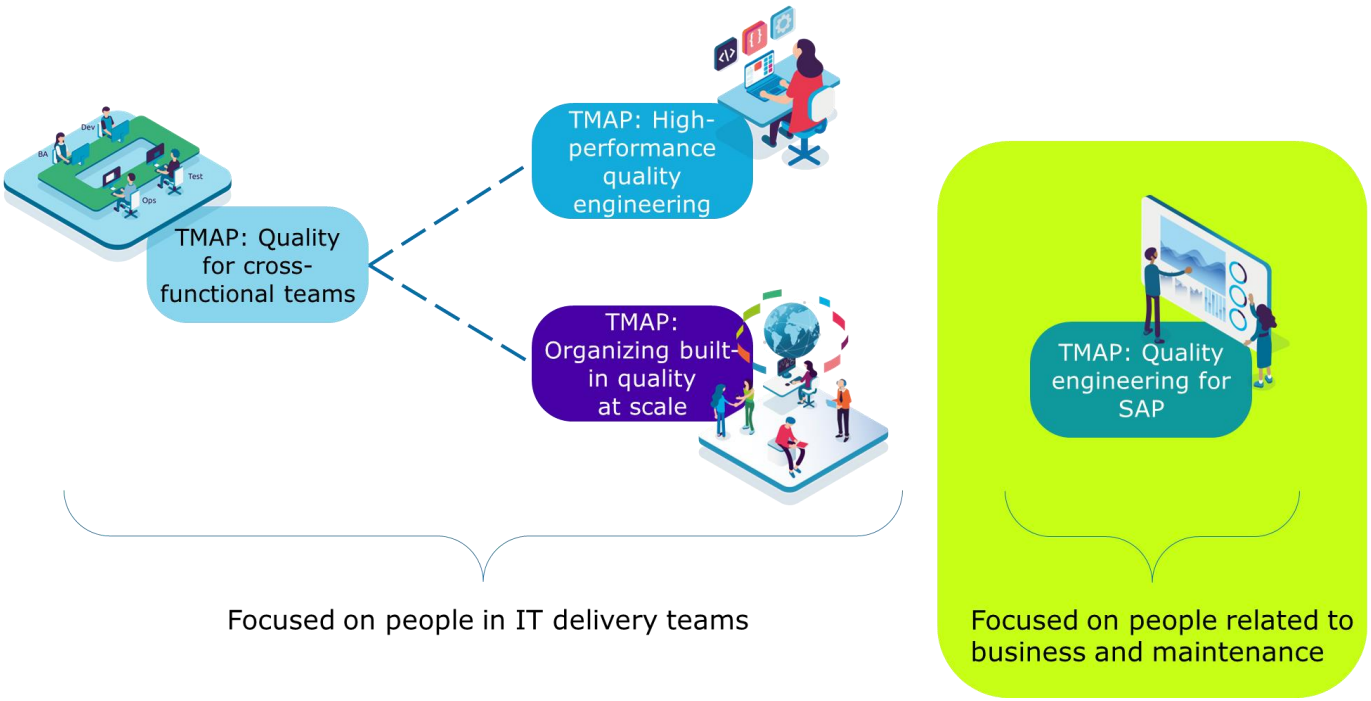
The candidate has one hour to complete the exam. This time is sufficient for non-native speakers. The only reason for getting extra time would be medical reasons, such as dyslexia, in that case contact the exam provider before scheduling the exam.

The exams and certificates are provided by the independent exam provider iSQI.

For more information about exams please visit: www.isqi.org or www.TMAPcert.com.

0.8. Brief introduction to the other TMAP certifications

The TMAP® certification scheme tailors to the needs of four target audiences. The figure below shows the certifications and indicates that the first certification "TMAP: Quality for cross-functional teams" provides knowledge necessary for two other certifications. The figure also shows that TMAP:Quality Engineering for SAP is aimed at key users, business users, maintenance – and operations teams that are involved in accepting and implementing SAP systems.



Besides TMAP:Quality engineering for SAP, there are three other certifications in the TMAP certification scheme, as listed below.

Many people are working in, or are related to, a high-performance IT delivery team, such as in DevOps or Scrum. In the training course "**TMAP®: Quality for cross-functional teams**" these people will acquire the required knowledge and skills that are important for building quality in their IT system and gathering information necessary to establish confidence that the pursued business value can be achieved. It is a 3-day training course with a 1-hour exam.

Performing QA & testing activities in an organization requires a wide variety of knowledge and skills. The training course "**TMAP®: High-performance quality engineering**" enables professionals to perform these operational activities. It is a 3-day training course with an exam of 1.5 hours.

Organizing QA & testing requires orchestrating, arranging, planning, preparing and controlling the activities. The training course "**TMAP®: Organizing built-in quality at scale**" enables professionals that are responsible for organizing QA & testing to acquire the necessary knowledge and skills to enable teams to achieve this. It is a 3-day training course with an exam of 1.5 hours.

0.9. Accreditation of training providers

Training providers that want to prepare candidates for the exam will need to acquire accreditation from iSQI. For more information, please contact TMAP2020@iSQI.org

0.10. Literature

Exam literature:
- The TMAP book "Quality for DevOps teams" (ISBN 978-90-75414-89-9), available on www.ict-books.com and other bookstores, both in paper and ePub version.
- TMAP glossary: https://www.TMAP.net/page/tmap-glossary-online.
- Descriptions in chapters 5, 6 and 7 in this syllabus, based on building blocks of www.TMAP.net. *Note: for the exam, texts in this syllabus supersede texts on the website.*

Additional literature:
- The TMAP body of knowledge website – www.TMAP.net
- More info about SAP - https://www.sap.com/about/company/what-is-sap.html.
- SAP free tutorials with openSAP- https://open.sap.com/
- Interesting SAP Blogs - https://blogs.sap.com/
- SAP Best Practices - https://rapid.sap.com/bp/

Other additional literature (specifically for trainers to acquire more in-depth knowledge):
- The Agile Manifesto – www.agilemanifesto.org
- The Scrum Guide – www.scrumguides.org
- ISO25010 - www.iso.org/standard/35733.html
- Also please refer to the references in the TMAP book Quality for DevOps teams.

0.11. Acknowledgements

This syllabus was created by a diverse team. We would like to thank the following people (in no particular order) for their contributions in writing and reviewing this document:

Sogeti and Capgemini people: Pepijn Paap, Robin Klein, Prabakaran Vaiyanan, Folkwin Kloezen, Sapna Singh, Jeanine Hoogerbrug, Bob Zandvliet, Bo de Vries, Sankar Sundaram, Leo Janssen, Martin van Genderen, Guido Nelissen, Tijs Wonders, Marco van Winsen, Rik Marselis, Gerrit Matser, Shashank Lokhande, Jan Sleutjes, Stefan Gerstner, Andreas Holm, Kaushik Dutta, Tomasz Furmaniuk, Agnieszka Flis, Roman Sudol, Aleksandra Trzcionka, Ayat Fazil, Chetan S Jadhav, Kisan Shirke, Mika Jauhiainen, Patrick Langeveld, Ralf van der Ven, Adryan Bikker, Ankur hadke, Appie Pries, Bo Zinkstok, Christy Brouwer, Clemens van der Molen, Jeyantha van der Plas Kathiravelu, Manoj Kumar, Narmadha, Kumarasamy, Omkar Madhav Khatavkar, Shanna Maassen, Tim Oosthoek, Timo de Groot, Wessel van der Kaaij, Parimal Singh, Chetan Jadhav, Ashok Jangam, Kanchan Kumari, Shailly Suxena.

SAP people: Monica Hostiuc, Raja Spaeth.

iSQI people: Stephan Goericke, Erika Paasche, Valida Saronjic.

TMAP Special Interest Group members: Mohit Mantri, Gilbert Smulders, Philippe Bourdeau.

1. Session 1

The chapters 1 through 4 describe the learning objectives for this training course and certification. At the end of each section is a reference to the relevant literature.

The "book" that is referenced is the TMAP book "Quality for DevOps teams" (3rd edition 2022).

References to "syllabus" refer to chapters 5 through 7 of this syllabus.

1.1. ERP systems (LO01; K2)

Enterprise Resource Planning (ERP) systems are software tools (often large and complex) that support organizations in their business processes. They manage enterprise data related to, for example, supply chain management, production, inventory management, procurement, sales, accounting, and human resource management. The focus of this training is to support business users, maintenance - and operations people during acceptance, implementation and eventual usage of this type of IT systems.

Instead of offering a solution for one department or one business activity, ERP systems are generally used throughout the organization. They are connected to one overarching enterprise database which contains the organization's master data, configurational data and transactional data. Furthermore, ERP systems require organizations to standardize their processes and use more common ways of working, as the software is designed with specific end-to-end processes in mind. For this training course, there are five ways of distinguishing between ERP systems and other IT-solutions, namely: size of investment, imposed process streamlining, high complexity, 'configuration' instead of 'programming' and the test varieties that are generally involved.

The candidate understands what ERP systems are used for.

The candidate understands how ERP systems differ from other IT solutions.

Syllabus: section 5.1.

1.2. What is SAP (LO02; K1)

SAP SE is the official name of the German multinational software company based in Walldorf, Baden-Württemberg. This company, hereafter referred to as SAP®, provides Enterprise Resource Planning (ERP) solutions and services.
At the moment of creation of this syllabus (Q2 2023) the latest business suite is called 'SAP S/4HANA®'.
An SAP implementation consists of modules, which support transactions to execute key business processes.

The candidate recalls how SAP supports all core business processes and which technologies it can include.

Syllabus: section 5.2.

1.3. SAP main flows (LO03; K2)

SAP solutions include several modules, which support transactions to execute core business processes (examples of modules are described in section 5.2).

In general, these modules are represented in 4 SAP main flows:

- **Lead-to-Cash** (Lead, Opportunity, Quote, Sales Order, Fulfillment, Invoice)
- **Source-to-Pay** (Sourcing, Contracting, Procurement, Payment, Analytics)
- **Recruit-to-Retire** (Plan, Staff, Onboard, Work, Travel, Pay & Close)
- **Design-to-Operate** (Design, Planning, Production, Logistics, Operation)

The candidate understands the purpose of the SAP main flows and SAP modules.

Syllabus: sections 5.2 & *5.3.*

1.4. Other SAP solutions (LO04; K1)

Besides the SAP modules, discussed in LO03, SAP also offers many other solutions for its customers. These solutions are not focused on critical business processes, but they are becoming more frequently implemented for SAP customers. We introduce a set of the most commonly used solutions, keep in mind this is not the complete list of SAP Solutions.

The candidate recalls other SAP solutions and SAP Fiori.

Syllabus: section 5.4.

1.5. IT delivery models for SAP (LO05; K2)

An IT delivery model is a conceptual framework which supports a software development process and describes all assets and competencies. In SAP projects we distinguish three mainly used IT delivery models: V-model based Sequential IT delivery, Scrum-based High-performance IT delivery and Demand/Supply model based Hybrid IT delivery.

The candidate understands the different IT delivery models for SAP.

The candidate understands how to move towards the Demand/Supply Model from a standard V-model approach.

Book: chapter 7 introduction, section 7.1, chapter 8 introduction, section 8.2, chapter 9 introduction, section 9.1, chapter 10 introduction and section 10.1.

Syllabus: section 5.5.

1.6. Introduction to Quality Engineering & Testing (LO06; K2)

Quality Engineering is about team members and their stakeholders taking joint responsibility to continuously deliver IT systems with the right quality at the right moment. With a focus on building quality from the start, testing will demonstrate if the quality is at the expected level, instead of trying to find all problems that resulted from a lack of quality focus and fix them at the end. With ERP systems such as SAP, people often think the quality will be OK because it is supplied by an established vendor. But even the highest quality software has to be integrated with the specific business processes of an organization and the quality of this implementation also has to be assured and tested to establish the confidence that it will deliver the pursued business value.

TMAP distinguishes twenty QA & Testing topics that describe quality engineering activities.

The candidate knows the definitions of quality, quality engineering and testing.

The candidate understands that quality engineering focuses on built-in quality.

The candidate understands that the main goal of testing is to supply information about quality and related risks to establish confidence in the pursued business value.

Book: section 1.2 (including 1.2.1 – 3rd edition), chapter 5 introduction, chapter 11.

1.7. Business value and the VOICE model (LO07; K2)

Today's organizations expect that their IT systems will enable them to generate business value.

IT teams and their stakeholders use the VOICE model to establish the level of confidence that the pursued business value can be achieved with the IT system.

The candidate understands that delivering business value is the goal of IT delivery activities.

The candidate can give a description of the VOICE model and knows that it is an acronym of Value, Objectives, Indicators, Confidence and Experience.

Book: chapter 3.

1.8. Introduction to built-in quality (LO08; K2)

Built-in quality means that the proper quality measures are selected and implemented to deliver the right level of quality at the right moment and to achieve the business value. When looking at quality, it is important to look at both functional and non-functional quality characteristics.

The candidate understands that built-in quality relates to the quality of products, processes and people.

The candidate knows the difference between functional and non-functional quality characteristics.

Book: chapter 1 introduction, sections 1.2.1 (of 3rd edition), A.1, A.2, A.3 and A.4.

1.9. Test Design – Introduction (LO17; K3)

Creating tests and executing them may sound easy, but structured testing requires careful consideration. We use the term "test design" for the complex of activities to create tests, even though some approaches to testing have no actual up-front design.

The candidate can distinguish the two ways of creating and executing tests: coverage-based and experience-based test design. The candidate understands why these should always be combined.

The candidate understands the basics of test design and the four coverage groups of coverage-based test design techniques.

The candidate knows what a test case consists of (input & action, expected results, actual results, pass/fail, observations) and can create test cases for a given test situation.

Book: chapters 30 and 43; section 45.1.

2. Session 2

2.1. The SAP project (LO11; K2)

Implementing a new IT system can be a daunting task for any organization, but when that system is an SAP system, the process becomes even more complex.

One of the biggest differences between an SAP IT project and a "normal" IT project is the level of expertise and experience required. Because SAP is a complex and customizable system, it requires teams with specific SAP knowledge and experience (additional to their business process knowledge) to implement it effectively. Another key difference is the impact that implementing an SAP system can have on an organization's operations. Because SAP is designed to integrate with a wide range of business processes, it can have a significant impact on how an organization operates and how it interacts with its customers and suppliers. This means that careful planning and coordination are required to ensure that the implementation goes smoothly, and that the organization can continue operating during the transition.

Typically, one of the success factors for an SAP implementation project is that the project is considered as a business transformation project for the customer where IT (SAP in this case) is an enabler of the business transformation. The SAP implementation should not be considered as just an SAP IT project with main focus on "technical implementation" of the processes. More important is the impact of the change to the business processes of the organization.

There are several types of SAP implementations, we distinguish 8 examples of types of SAP projects.

The candidate understands what is important when initiating an SAP IT project and what types of SAP projects exist.

Syllabus: section 5.6.

2.2. SAP Activate (LO12; K1)

The SAP Activate methodology is a modular and agile framework which helps project teams to accomplish their tasks to deliver an SAP system. SAP Activate provides a clear guided methodology to deploy, adopt and extend new capabilities across organizations. Start fast, build smart, and run simple, while continuously innovating with SAP Activate.

The candidate recalls the basic features of the different SAP Activate methodology phases and test varieties.

Syllabus: section 5.7.

2.3. SAP Quality Risk Analysis (LO13; K3)

The time available for testing is limited; not everything can be tested with equal thoroughness and intensity, the number of possible tests in an SAP system is simply too large. Teams do not want to spend too much time on testing 'Standard SAP' processes. 'Standard SAP' processes are processes which are generally used by many organizations amongst different industries. Because many organizations use these processes, the risk of anomalies are low. Teams should use the available testing time and effort on the high-risk areas first, which are mainly new additions and changes, for which progression testing is organized. The 'Standard SAP' steps and unchanged parts will be incorporated in the end-to-end regression testing.

During the Quality Risks Analysis, the scope of the change or project (regardless if it is an implementation, a rollout or an upgrade) is important. Local requirements, legal requirements, language requirements etc., should be included in the Quality Risk analysis.

Risk based testing means choices must be made, resulting in a risk-based test strategy. The starting point is: an SAP system must function in such way that unacceptable quality risks have been covered. Where the delivery of a certain SAP process brings along many quality risks, thorough testing is needed. At the other end of the spectrum, you should decide: 'no risk, no test' (where TMAP adds 'no implementation', because no risk actually means nobody has a problem if it fails, therefore nobody needs it, thus the feature should not be implemented at all).

The candidate can contribute to performing an SAP Quality Risk Analysis.

Book: chapter 26, section 5.2.1 & 5.2.2.

Syllabus: section 6.4.

2.4. SAP Test Strategy (LO14; K2)

The SAP Test Strategy contains the information about quality measures and activities to be performed and organized to establish grip and control on the SAP landscape. It indicates all relevant subjects to be covered for the SAP project and the support organization. The SAP test strategy is based on a quality risk analysis to establish the intensity of the quality measures that will be applied.

An SAP Test Strategy is part of the SAP Project and should not act independently. It must be within SAP project boundaries and methodologies. For different types of SAP Projects (implementation, rollout or an upgrade) a different SAP Test Strategy can be applicable.

The candidate understands which information is necessary to create an SAP Test Strategy.

Book: section 15.4.3, section 26.5 and 26.6.

Syllabus: section 6.5.

2.5. SAP Test Plan (LO15; K2)

A test plan is the description of the general structure and the choices with respect to the tests to be executed and the way to supply information.

A test schedule is a detailed overview of test activities to be performed and executed in a specific sequence and time.

The candidate understands the generic structure of an SAP Test Plan.

The candidate understands the difference between SAP Test Plan and SAP Test Schedule.

Book: chapter 11, section 15.4.3.

Syllabus: section 6.6

2.6. Quality gates (LO16; K1)

A quality gate is a milestone in an IT project that requires predefined criteria to be met before the project can proceed to a next phase. Quality gates are commonly used throughout the IT delivery process to provide information whether a delivery complies with quality expectations.

In an SAP project, quality gates are used to organize the handover between Solutioning teams, the System integrator, the (business) testers and other internal and external parties when starting a different testing phase in the project.

The candidate recalls the use of quality gates in an SAP project.

Book: section 10.1.

Syllabus: section 6.7.

2.7. Test Design – Equivalence Partitioning (LO18; K3)

In the application of equivalence classes, the entire value range of a parameter is partitioned into classes. In a specific class, the system behavior is similar (equivalent) for every value of the parameter.

The candidate can apply Equivalence Partitioning (EP) to a given test basis.

Book: section 46.5.

2.8. Test Design- Boundary Value Analysis (LO19; K3)

Boundary Value Analysis is a test design technique. This technique is based on the fact that around a boundary in the value range of a variable, there is a higher risk of faults in a system.

The candidate understands the difference between two-value -, three-value – and four-value Boundary Value Analysis.
The candidate can apply Boundary Value Analysis (BVA) to a given test basis.

Book: section 46.5.

3. Session 3

3.1. Stakeholder management in SAP projects (LO09; K3)

Stakeholders are defined as "anyone with viable interest in the business value delivered by the team, at all levels in the organization and even outside the organization".

Stakeholder management is about how to involve, enthuse, and engage the stakeholders that matter.

In SAP projects (as in any other ERP project), stakeholder management is even more important than in non-SAP projects. This is because of the complexity and major organizational impact of SAP projects. SAP projects often impact multiple parts of the organization. Aligning the stakeholders from all parts of the organization is crucial for the success of an SAP project.

The candidate can select the relevant stakeholders and determine their information needs in a specific situation.

Book: sections 3.3, 5.2, 5.4.

Syllabus: section 6.1.

3.2. ARCI matrix for stakeholder responsibilities (LO10; K3)

An ARCI-matrix contains a list of deliverables and/or activities on the rows of the matrix and specifies the people involved (stakeholders) in the columns. For every deliverable/activity the table shows per role or person in what way they are involved, which can be Accountable, Responsible, Consulted, or Informed.

The candidate understands the four types of involvement.

The candidate can classify stakeholders in an ARCI-matrix.

Book: sections 3.3, 5.2, 5.4 and the template of www.TMAP.net.

Syllabus: section 6.2.

3.3. SAP Authorizations managed with RBP (LO20; K2)

Role-Based Permissions (RBP) manage the permissions in SAP suites. RBP controls access to the applications, and controls what users can see and do. RBP is a suite-wide authorization concept which applies to most SAP modules. The main elements in RBP are permission groups and permission roles that allow SAP users access to specific parts of the application. The responsibility for setup, maintenance and managing authorizations lies with the SAP Basis team or GRC/Security.

The candidate understands the basics of authorizations and Role Based Permissions for SAP.

Syllabus: section 5.8.

3.4. SAP End-to-end testing - vertical and horizontal (LO21; K2)

SAP systems today are rarely standalone and are at the center of an increasingly large and complex network of both internal applications and business partner systems. Therefore, SAP end-to-end business processes can become very complex.

Integrations play a critical role in the SAP landscape and architecture. A basic understanding of integration is needed to understand end-to-end flows in SAP systems.

During the different test varieties, the focus is moving from stand-alone functionality and individual processes, solution trains and modules (Verticals) towards complex end-to-end scenarios overarching SAP modules, SAP systems and non-SAP systems (Horizontals).

The candidate understands the importance and challenges of SAP end-to-end testing.

The candidate understands the difference between vertical and horizontal testing in SAP.

Book: chapter 3, chapter 33, chapter 37 introduction, section 37.5.1.

Syllabus: section 7.7.

3.5. Test data (management) in SAP (LO22; K2)

To start testing any SAP system, it is a prerequisite to have test data identified and in place. Practical experience shows that test data preparation is a time-consuming activity of software testing, this is especially true for SAP projects. In SAP we use both regular test data (for testing specific testcases like creating a sales order) and master data (that needs to be set up in advance to make testing possible).

Master data tends to be relatively static. Examples of master data in SAP include the information in business partner records. This is all the static data about suppliers and customers. Master data can also determine the behavior of SAP (e.g. condition records). An example of master data is employee master data with information like employee name and social security number.

Selecting and using test data in SAP can be very time-consuming for the following reasons: Complex data structures, data duplication, data privacy, data consistency, lack of standardization, and specific data & systems settings.

The candidate understands the structure of SAP test data and master data.

The candidate understands the challenges of selecting and using proper test data in SAP systems.

Book: chapter 31.

Syllabus: section 7.1.

3.6. SAP organizational change management (LO23; K2)

Organizational Change Management (OCM) is a discipline that supports organizations and their employees in smoothly and successfully introducing an intended change into their ways of working. Implementing a change within an organization is often complex and has an impact on people's everyday work. Therefore, consciously thinking about how to introduce the change and guiding organizations and their employees towards it is very important.

The candidate understands the general aim of Organizational Change Management and which elements are frequently used to achieve successful change implementation.

Syllabus: section 6.3.

3.7. SAP test execution (LO24; K2)

Test execution is the execution of tests by running the system under test. Test execution obtains the actual results that can be compared with the expected results to determine whether the tests have passed or failed. This is part of dynamic testing.

The candidate understands what test execution is and how test execution is done in SAP projects with one or more test varieties.

Book: section 5.5, chapters 33 and 34.

Syllabus: section 6.8.

3.8. Test Design – Path Testing (LO26; K3)

Path testing aims to demonstrate that all combinations of N consecutive paths in a process flow are covered. A path in this context consists of all steps between a decision point and the next decision point, or between the start and the first decision point, or between the last decision point and the end.

The candidate can apply the coverage type "Path Coverage" with Test Depth Level 1 (TDL-1) and the test design technique "Process Cycle Test" to a given test basis.

Book: section 46.3, template path testing on www.TMAP.net .

4. Session 4

4.1. SAP Anomaly management (LO27; K2)

An anomaly is a difference between the expected behavior and the actual outcome of a test. This is registered so that the cause can be analyzed and resolved.

The process of identifying, investigating, and resolving anomalies is known as anomaly management. An anomaly must be investigated, and when the cause of the problem is found, it can be fixed.

The candidate understands the anomaly management process.

Book: chapter 18.

Syllabus: section 7.4.

4.2. Indicators and Test Reporting (LO25; K2)

To measure whether the objectives (from the VOICE model) are achieved, one or more indicators per objective are defined. These indicators are measured by means of data collection and data analysis. Measuring is generally done by testing, but other quality measurement activities are also used.

Testing is about providing different levels of information. Usually there are multiple stakeholders for the information that the team generates based on their quality engineering activities.

The candidate is aware of relevant indicators to measure whether objectives are achieved.

The candidate can explain relevant information for dashboards & reports.

Book: chapter 4, section 5.4, chapter 19 introduction, sections 19.1 and 19.2.

4.3. Continuous everything (LO28; K1)

To implement business processes with their supporting IT systems that deliver business value, IT teams need a continual focus on building in quality by applying the appropriate quality measures throughout all IT delivery stages. Continuous quality engineering is about continuous integration and continuous delivery supported by continuous testing. Also, it includes continuous improvement of products, processes and people.

The candidate recalls that built-in quality is the goal of continuous quality engineering.

Book: sections 1.2 and 1.2.1 (not 1.2.2 and 1.2.3) and section 6.2.

4.4. SAP and CI/CD pipelines (LO29; K1)

Modern high-performance IT delivery teams (such as in Scrum or DevOps) aim to achieve continuous integration (CI) and continuous delivery (CD). This means that changes are integrated with the existing system as early and often as possible and the system is continuously kept in a state in which it is deployable to the live environment. A CI/CD-pipeline is the set of tools that supports continuous integration and continuous delivery.

The candidate knows what a CI/CD-pipeline is and how it could be used in SAP implementations.

Book: sections 6.1 and 6.2.

Syllabus: section 7.2.

4.5. Test Management Tooling for SAP Projects (LO30; K2)

A test management tool for SAP supports the continuous testing journey of the SAP testing team. The test management tool should be aligned to support the IT delivery model in use (such as Agile, Scrum, V-model, and hybrid).

The candidate understands what test management tools can contribute to SAP projects.

Book: chapter 12, section 23.1.2.

Syllabus: section 7.3.

4.6. SAP Test Automation & Tooling (LO31; K1)

Because release cycles occur in quick succession of one another, testing can become the bottleneck when solely relying on manual testing. Spotting problems in software sooner rather than later can save rework and prevent delays in releasing the software. Automated test execution can support to meet the timelines.
Test automation for SAP can be defined as: "automatically executing scenarios of realistic business processes for testing purpose, to get information about the behavior of the application to make informed decisions on the quality of the SAP system."

There are 4 different types of test tool capabilities: test control, test design, test execution and test environment. Test Automation Tooling mainly focuses on test execution even though there are tools that are part of a platform that spans over all these capabilities that are necessary to successfully test your SAP environment.

The candidate recalls the possibilities, advantages, and limitations, that Test Automation can bring to an SAP environment.

The candidate recalls considerations for choosing test automation tooling that adds value in an SAP environment.

Book: chapter 23 introduction, sections 23.1, 32.1 and 32.2.

Syllabus: section 7.5.

4.7. SAP Performance Testing (LO33; K1)

The SAP user may experience performance issues during certain business operations, and this will impact the productivity of the business users. To prevent such issues, SAP performance testing ensures that all SAP applications are tested adequately to give sufficient information about the expected user experience during peak load.

The candidate knows what performance testing and its benefits are, including how various types of performance testing will help to improve the efficiency of business processes.

Book: sections 38.1, 38.2.

Syllabus: 7.6.

4.8. Test Design – Exploratory Testing (LO34; K3)

Exploratory testing is the most versatile experience-based approach to testing. It is a structured approach that is performed by pairs or mobs of testers, who use charters and logs, and end every exploratory testing session with a debriefing with one or more stakeholders.

The candidate understands the characteristics of exploratory testing and the importance of a test log and debriefing.

The candidate is able to create and execute a charter for an exploratory testing session and report the results.

Book: section 36.1; section 47.4, template Exploratory testing charter on www.TMAP.net.

5. Description of additional subjects – ERP & SAP

This chapter and the following chapters contain the in-depth descriptions to support learning objectives that are not based on contents of the book "Quality for DevOps teams". These additional subjects are based on information that is available on the TMAP body of knowledge website (www.TMAP.net).

This chapter contains the general descriptions of ERP systems and of SAP as a predominant example of ERP systems.

Note: For the exam the descriptions in this chapter supersede any texts on the website, even in case the website would contain other (more up-to-date) descriptions. This syllabus is updated regularly to include the latest insights.

5.1. ERP systems: Their usage and unique characteristics

5.1.1. Enterprise Resource Planning systems

Many companies worldwide use *Enterprise Software* which integrates many different software modules and a centralized database. With this software, organizations can create an *Enterprise Resource Planning (ERP) system*, also simply known as an 'Enterprise System'. Unlike applications that deal with one separate activity (for example, a payroll system) or department (for example, Sales), ERP systems combine all kinds of different business processes (like manufacturing and production, finance and accounting, sales and marketing, and human resources) into one single software system. This means that an organization that uses an ERP system has a centralized database to which all kinds of different (sub-)systems are connected. Through these smaller systems ('Line of Business' (LoB), 'Business Areas' or 'modules'), management and users can perform and monitor different business activities (or 'business processes') that are needed for an organization to perform well and make it function as efficiently as possible.

Business Processes are the (often unique) ways in which work activities have been organized to eventually produce a valuable product or service. They are supported by material, information and knowledge flows between the participants of the business processes. Such processes belong to certain *functional business areas*, for example:

- Manufacturing and/or Production
- Sales and Marketing
- Supply Chain
- Finance and Accounting
- Sourcing and/or Procurement
- Asset Management
- Research and Development (Engineering)
- Human Resources

An example of a business process within 'Sales' could be the identification of (potential) customers and for 'Human Resources' it could be the evaluation of an employee's job performance. An ERP system keeps track of all these different business processes and enables the organization to work from centralized data, instead of scattered bits of information.

There are many providers of ERP systems. A well-known provider with a large market share is SAP. Other familiar global players within this industry are Oracle, Workday, Salesforce, and Microsoft Dynamics 365. Many other ERP solutions operate on a smaller scale (in specific countries or regions). Even though this training material focuses on an SAP-context, the product goal and

business process orientation of these other software products and providers are in line with one another, and skills taught in this training course are applicable to these environments as well.

Figure 1 Standard ERP-functionalities
(Source: https://www.deskera.com/blog/frequently-asked-questions-about-erp/)

5.1.2. ERP systems compared to other IT-solutions

The distinguishing nature of *Enterprise Software* (or the ERP system) is its organization-wide use and the large degree of interconnectedness of systems, applications, interfaces, and databases. The implementation, testing and eventual usage of an ERP system requires a different approach compared to other IT-solutions.

For this, five general distinctions can be made between an ERP system and different IT-solutions.

Major investment

Although every form of software development has its price tag, the implementation of an ERP system is a *major investment*. Depending on the range of the purchased Enterprise Software, it is common for an organization to spend between fifty thousand and hundreds of millions of dollars in ERP-software. And besides the investment in ERP-software, elements like hardware, technical support, overall project management, internal team commitment, external support/consultants, and training also need to be considered. In other words, the Total Cost of Ownership (TCO) for an ERP-implementation can become quite high. A survey amongst 181 ERP users showed that 38 percent of the ERP-projects experienced cost overruns, and they averaged a 66 percent over budget. Companies are wise to complete a thorough cost-benefit analysis before investing in an ERP system, because a change towards a different supplier will be very costly afterwards. This investment should be earned back by lower operational costs and the lack of costs for development and maintenance of bespoke software.

Restricted level of customization

A second difference is the *restricted level of customization* and the realization that ERP systems impose processes on the organizations that implement it. Before implementation, companies need to make a selection in functionalities of the system they wish to use and then map their business processes to the predefined business processes in the software. Company-specific configurations can be made, but in general, an ERP system follows the 'best practice' processes as set up by the software supplier which will then be the same for all companies buying and using said software. Redesigning Enterprise Software to fit an organizations current way of working (and as such differentiating from the best practices and standards) might lead to higher expenses/ implementation/ maintenance costs. And this will have an impact on scalability and maintainability and take away the benefits of streamlined processes.

High complexity

Because ERP systems can be used in practically every type of business operation, there is often a *high complexity within the software landscape*. The many different interfaces, shared data, connections to cloud and on-premises environments, supplier/customer websites and third-party systems that have been bought from outside the larger ERP-solution, can create a tangled and inaccessible IT-architecture. This third ERP-characteristic opposed to other IT-products demands many kinds of knowledge fields and skills. Nevertheless, this (inter-)connectedness of the ERP system will benefit the organization in the long run due to its efficiency, standardization, and real-time insights.

Configuration oriented

The fourth general distinction between ERP systems and other IT-solutions is related to the way ERP-suppliers create and sell/distribute their products. As said before, Enterprise Software is developed beforehand and is then sold to interested organizations as a largely 'off-the-shelf' or 'on demand'-type of product. Because of this, the IT-development team at the organization that buys the software is *less occupied with programming/coding*, and *more with configurations, workflows, data, and authorizations*. The more technical aspects of the software have been dealt with by the developers of the ERP supplier and although customized changes are possible, any desired modifications generally go through requests back towards the system integrator or software supplier. A change request in SAP is called RICEFW.

Less conventional unit tests

Zooming in more on ERP Testing, the fifth difference connects to the previous notion of ERP systems being sold relatively 'ready-made'. Because of this, there are *less conventional 'unit tests'* in which a developer and tester will, for example, check code and/or an initial small functionality. Testing within an ERP system is more often concerned with functionality, proper (flow) configuration and data handling. As such, testing of an ERP system deals more with process checks, interface testing, acceptance tests, output validations and end-to-end testing. This does not mean that the test variety 'unit testing' does not exist for ERP Testing, however, its content and aim generally differs to unit tests within other IT-product development processes.

Sources:

Laudon, Kenneth C. Management Information Systems: Managing the Digital Firm (Global Edition). Pearson Education Limited (Harlow), 2022. P. 73, 82, 372 and 388.

Sumner, Mary. Enterprise Resource Planning (Pearson New International Edition). Pearson Education Limited (Harlow), 2014. P. 1-2 and 11.

SAP. "SAP History: Building on a track record of innovation. The Early Years." Accessed September 23, 2022. https://www.sap.com/about/company/history/1972-1980.html

5.2. What is SAP®?

SAP stands for System Analysis Program Development (Systemanalyse und Programmentwicklung). As a company, SAP has been a part of the ERP-evolution (which started in the 1960s) since very early on. In 1972, the SAP founders set out to "create software that integrates all business processes and makes data available in real-time" (SAP History).
SAP is the world leader in enterprise applications in terms of software and software related service revenue. SAP is supporting all kinds of industries and various sizes of organizations. SAP helps them to improve profitability, grow sustainably and stay ahead of the competition in the market. SAP relies on their implementation partners as a system integrator to serve their customers. SAP supports their partners during and after the implementation.
SAP systems have been created in multiple generations. At the moment of creation of this syllabus (Q2 2023), the latest (fourth) generation is SAP S/4HANA® which means "Business Suite 4 – **H**igh performance, **An**alytical **A**ppliance".

An SAP implementation consists of modules (Line of Business (LoB) and Business Areas), which support transactions to execute key business processes, such as:

- Financial Accounting (FI)
- Financial Supply Chain Management (FSCM)
- Controlling (CO)
- Materials Management (MM)
- Sales and Distribution (SD)
- Logistics Execution (LE)
- Production Planning (PP)
- Quality Management (QM)
- Plant Maintenance (PM)
- Project System (PS)
- Human Resources (HR)

And many more.

Apart from ERP software the SAP company supports:

- Database software and technology (particularly its own brands)
- Cloud engineered systems, and other ERP software products, such as human capital management (HCM) software
- Customer relationship management (CRM) software (also known as customer experience)
- Enterprise performance management (EPM) software
- Product lifecycle management (PLM) software
- Supplier relationship management (SRM) software
- Supply chain management (SCM) software
- Business technology platform (BTP) software
- Programming environment SAP AppGyver for business

And many more.

SAP supports different types of deployments:

- On-premises: SAP is deployed internally by the organization. Located on their own servers and managed by the organization.
- Cloud: where the organizations that use SAP do not manage their own data centers but deploy their solution in the cloud, likeSAP Private Cloud or a Public Cloud (AWS, Azure, Google).
- Hybrid: combination of On-premises and Cloud to provide flexible options to organizations.

We have covered only the high-level basics about SAP in this chapter, there is a lot more to know about SAP but that is beyond the scope of this training. For more info about SAP, please refer to the following sources:

- More info about SAP can be found on the SAP website: https://www.sap.com/about/company/what-is-sap.html.
- To learn more about the latest developments at SAP, refer to the SAP Blogs: https://blogs.sap.com/.
- SAP free tutorials with openSAP can be found here: https://open.sap.com/.

5.3. SAP main flows and modules

In general, the SAP modules (see section 5.2) are represented in four SAP main flows:

- **Lead-to-Cash** (Lead, Opportunity, Quote, Sales Order, Fulfillment, Invoice)
- **Source-to-Pay** (Sourcing, Contracting, Procurement, Payment, Analytics)
- **Recruit-to-Retire** (Plan, Staff, Onboard, Work, Travel, Pay & Close)
- **Design-to-Operate** (Design, Planning, Production, Logistics, Operation)

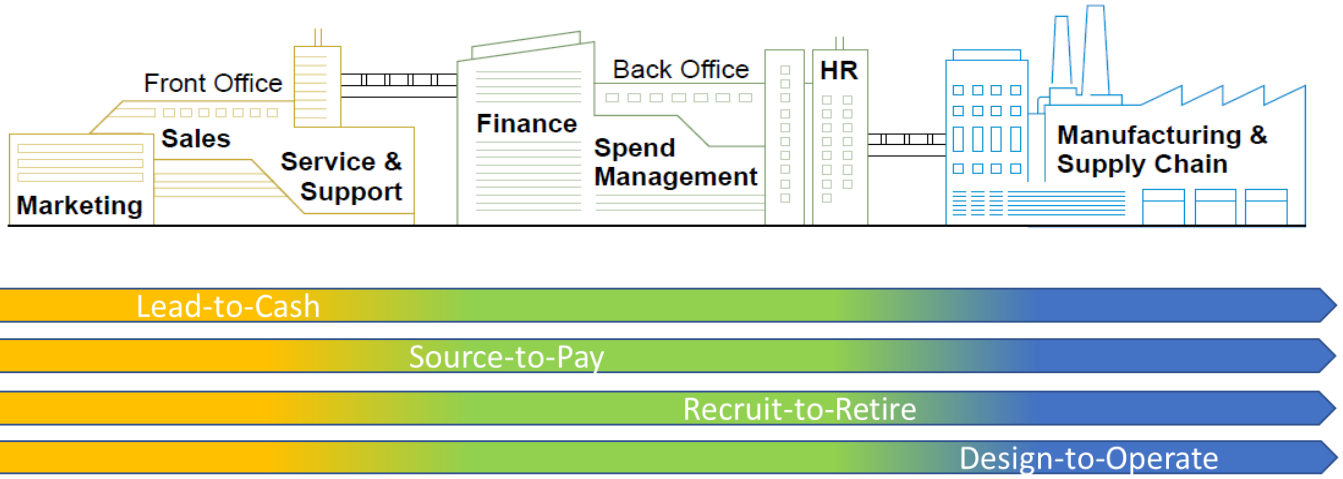


Figure: SAP main flows

The main flows of SAP consist of business functions that are supported by the SAP modules. Although these are the 4 main flows, the implementation and naming of these flows can differ per organization.

SAP Financial Management is a combination of two modules (Line of Business), i.e. Finance Accounting (FI) and Controlling (CO). Under Finance in SAP and at an enterprise level, the following modules take part:

FI – Finance
CO – Controlling
IM – Investment Management
TR – Treasury
EC – Enterprise Controlling

SAP FI (Financial Accounting) is accountable for tracking the flow of financial data across the organization in a controlled manner and integrating all the information for effective strategic decision-making.
SAP CO (Controlling) module facilitates coordinating, monitoring, and optimizing all the processes in an organization. It controls the business flow in an organization. This module helps in analyzing the actual figures with the planned data and in planning business strategies.

Some important financial elements managed in CO are:

- Cost elements
- Revenue elements

Sales & Distribution Management (SD) is one of the most important modules in SAP. It has a high level of integration complexity. SAP SD is used by organizations to support sales and distribution activities of products and services, starting from enquiry (lead) to order, and then ending with delivery.

In all these processes, multiple modules are involved such as FI (Finance Accounting), CO (Controlling), MM (Material Management), PP (Production Planning), LE (Logistics Execution), etc., which shows the complexity of the integration involved.

Material Management (MM) deals with movement of materials via other modules like logistics, supply chain management, sales and delivery, warehouse management, production, and planning.

Production Planning (PP) deals with planning processes, such as capacity planning, material planning, execution of production order, bill of material and goods movement. SAP PP module handles the master data required for Bill of Materials (BOMs) activity, work center and routing, and keeps it in a separate component.

Quality Management (QM) is an integral part of logistic management, and it is used to perform quality functions such as quality planning, quality assurance, and quality control, at various stages such as incoming material stage, in-process manufacturing process stage, and after production as well.
QM is integrated with other SAP modules like SAP Material Management (MM), Production Planning (PP), and Plant Maintenance (PM).

Plant Maintenance (PM) is a software product that manages all maintenance activities in an organization. Plant Maintenance module consists of key activities to include inspection, notifications, corrective and preventive maintenance, repairs, and other measures to maintain an ideal technical system.
Using SAP PM, you can perform automatic repairs and facilitate maintenance requests in an organization. It allows you to record problems in SAP system, plan labor and material activities, and to record and settle the cost.

Project Systems (PS) performs project and portfolio management. It helps you to manage the project life cycle starting from structuring to planning, execution, until the project completion.
Project system is closely integrated with other SAP modules like logistics, material management, Sales and Distribution, Plant Maintenance, and Production planning module.

Human Resources (HR) also known as Human Capital Management (SAP HCM), SAP Human Resource Management System (SAP HRMS) or SAP Human Experience Management (SAP HXM)
Human capital management products from SAP can help your organization hire and retain the right people, manage the work environment, streamline HR processes, ensure legal compliance, and create a people-centric organization.

Master Data Governance (MDG) The SAP Master Data Governance application provides ready-to-run, domain-specific master data governance, so you can locally own and consolidate or centrally create, change, and distribute master data across your enterprise system landscape, like business partners, material master data and financial master data.
Master Data Governance is very important within an SAP landscape as it connects to all other available modules by providing relevant and necessary data elements.

Industry-specific solutions

Based on the main flows and modules, SAP offers a great number of industry-specific solutions that contain additional industry-specific functionality. Examples are SAP Retail (for retail organizations), SAP ISU (for utility organizations), SAP Oil, Gas & energy (for energy companies) and more.

5.4. Other SAP solutions

Besides the SAP modules, discussed in section 5.3, SAP also offers many other solutions for its customers. These solutions are not focused on critical business processes but are becoming more frequently implemented. We introduce a set of the more often used solutions, keep in mind this is not the complete list of SAP Solutions.
A selection of SAP solutions:

- SAP Ariba
- SAP Concur
- SAP Fieldglass
- SAP Customer Experience
- SAP HR/ SuccessFactors
- SAP Hybris
- SAP IBP

Below we briefly describe each solution and at the end we describe the user interface Fiori.

SAP Ariba
SAP Ariba is a cloud-based Procurement solution to perform business transactions on a single platform. It can be easily integrated with other SAP ERP products without using middleware and can be customized as per business requirements. SAP Ariba provides out of box functionality to buyers and suppliers to do business and to get maximum benefits from procurement management.
It improves the overall vendor management system of an organization by providing less costly ways of procurement and making business simple. SAP Ariba acts as supply chain, procurement service to do business globally. SAP Ariba digitally transforms your supply chain, procurement and contract management process.

SAP Concur
SAP Concur is an online and mobile solution for Travel and Expense management. It includes corporate travel booking, expense report automation, reimbursement, audit, business intelligence and corporate card integration. It is offered in multiple editions: Small Business, Standard, Professional, Premium.

SAP Fieldglass
SAP Fieldglass provides a cloud-based Vendor Management System (VMS) to manage contingent workforce and services procurement programs. The SAP Fieldglass Vendor Management System (VMS) gives the customer total visibility into global external workforce to reduce costs, enforce compliance, improve worker and supplier quality, and increase program efficiencies.

SAP Customer Experience
SAP Customer Experience (CX) helps businesses around to move beyond legacy customer relationship management to a modern-day customer experience. The customer experience is how interactions with the brand or product make customers feel. A customer can be a business (B2B) or a person (B2C) the approach is the same. SAP Customer Experience aims for a positive experience for all customers.

SAP HR/SuccessFactors

SAP HR or SAP SuccessFactors focuses on what employees need to be their best. It shifts from human capital management (HCM), its processes, steps, and procedures and moves to individualized experiences designed to keep employees happy, productive, engaged, and improving.
SAP HR/SuccessFactors provides:

- Core HR and Payroll
- Time and attendance
- Recruiting and onboarding
- Learning and Development
- Performance and Compensation
- Workforce planning and Analytics

SAP Hybris

SAP Hybris is a cloud-based e-commerce platform solution for B2B and B2C. Hybris' omnichannel e-commerce capabilities are deeply integrated into the SAP cloud ecosystem, giving sellers the enhanced data and tools to optimize margins and drive customer loyalty.
SAP has integrated its own backend system – SAP CRM and SAP ERP with the Hybris solution, so any organization that has SAP ERP or SAP CRM implemented can easily move to the SAP Hybris solution.

SAP IBP

SAP Integrated Business Planning for Supply Chain (SAP IBP) features supply chain analytics, what-if simulations, alerts, and more to help improve responsiveness. It is a cloud-based solution that combines sales and operations planning (S&OP), forecasting and demand, response and supply, demand-driven replenishment, and inventory planning.

SAP Fiori®

SAP Fiori is not a solution for a business process but a solution for a more user-friendly Graphical User Interface (GUI). SAP Fiori is an update to the SAP user interface where the focus is no longer on huge amounts of functionality but rather a comfortable user experience.

Each SAP Fiori application is built around the user, rather than the function. As a result, the screens are very simple and uncluttered. A key goal of any SAP Fiori application is to ensure that a user can complete a task with as few clicks as possible.
In the old SAP GUI, transactions and transaction codes are required, in SAP Fiori the transactions are replaced by and embedded in tiles. SAP Fiori tiles are shown based on the user's role.

5.5. IT delivery models for SAP

In the last 20 years, most SAP projects used a sequential IT delivery model (especially the V-model). In current SAP projects we see the shift towards a Demand/Supply Model where parts of the Agile way of working are implemented in SAP projects (For an explanation of the IT delivery models see chapter 7 of the TMAP book Quality for DevOps teams).

In this section we first describe how to transition from a sequential to a hybrid IT delivery model. Next, we describe good practices of the Agile mindset that can be implemented in SAP projects.

5.5.1. Working towards a hybrid model

Many organizations with SAP projects that want to benefit from the Agile way of working will actually need to implement a hybrid IT delivery model. When an SAP project wants to move from a V-model approach towards a hybrid model (especially the Demand/Supply model) it is advisable to start small. SAP projects are usually major in size and impact and consist of multiple teams working on the same solution. For this change in way of working, start with a minimum viable product (MVP), for example for the Finance Module, and after this approach has been proven successful, expand to the core value chain.

Begin a transition towards a hybrid model by adding smaller custom functionality to a sprint and start expanding from there. It is important to consider that if a team is working on an object in a sprint that another team cannot work on the same object. Coordinating which team is working on a specific SAP object and managing the integration of these objects is crucial when multiple teams are working in a hybrid model. The system integration test (SIT) to verify the quality of the integration of multiple deliverables is a good method to guarantee the quality of these releases.

Demand/Supply model

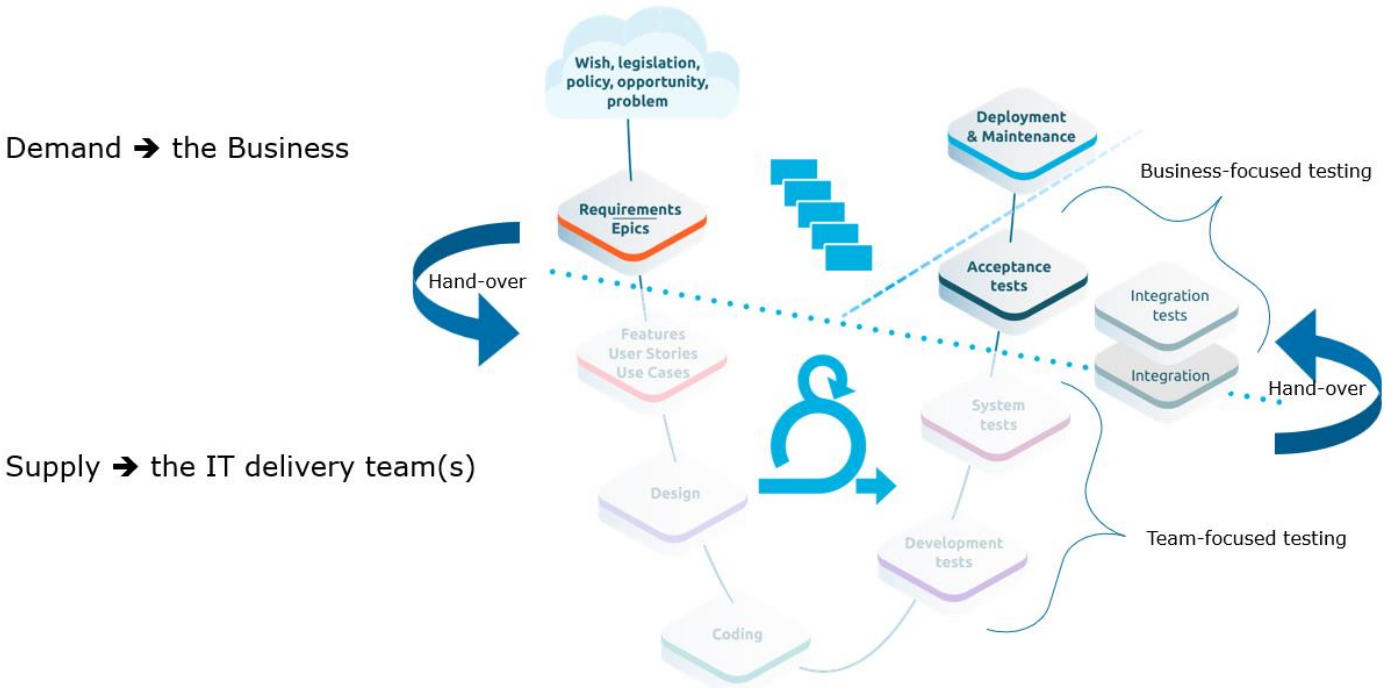


Figure: Demand/supply model

The Business is the Demand side ➔ the business demands new changes, requirements, legislation etc. This is the non-agile part of the hybrid model. Then the business needs are translated in requirements / Epics / Feature / User Stories and handed over to the Development team(s).

The IT delivery team is the Supply side ➔ the development team(s) will transform the demands into useful (business) processes using design / coding / Unit Test(UT) and System Test(ST) in an agile way of working. After successful UT / ST (teams focused UT and ST testing) the solution is handed over back to the business for final integration, acceptance and regression test before it can be deployed to production.

5.5.2. Agile good practices in SAP

An overview of the Agile good practices that are commonly implemented in SAP projects:

Delivering functionality in sprints; (Non-)functional requirements for SAP products can be delivered in smaller iteration than the waterfall release schedule. By using sprints for each Solution Train, the project becomes more manageable. Testing these sprints will require regression testing preferably by using Test Automation each sprint to guarantee the quality of each sprint. During each sprint the scope of the (automated) regression test set can be expanded.

Create user stories; Splitting up (non)-functional requirements into user stories is required for the use of sprints in the project. This helps in making the project scope more manageable. Consider to focus the user stories within the Solution Train on the (non-)functional requirements within that Solution Train and have a separate set of user stories to focus on the end-to-end solution covering multiple Solution Trains.

Create a backlog for user stories; Having a backlog for the user stories allows the team to combine related functionalities in the same sprint. A project can link specific user stories to each Solution Train. The user stories that cover multiple Solution Trains can be marked as end-to-end user stories. For example, in the Hire to Retire process the team can split up this process into specific epics and user stories for: Setting up different parts of master data, setting up organizational structure, recruitment, onboarding etc.

Set up planning sessions; Planning sessions are required when using sprints in the project. Planning sessions allow the team to set up the scope of each sprint. Planning sessions should also include the check for dependencies with other teams, stakeholders and solution trains.

Set up daily stand-up sessions; A daily stand-up with the team to discuss what each team member did yesterday, what they are planning for today and to check for impediments.

Set up retrospective sessions; A retroactive session after each sprint will help to optimize the performance of the team.

Set up refinement sessions; During the refinement sessions the team can check the impact of a user story within the team and/or with other teams and departments and set up end-to-end testing.

Set up demo sessions; Having the developers demo new functionality to the end users is a good way to keep the business involved in the SAP project.

Assign the role of Product Owner; The role of Product Owner is very useful in an SAP project. The Product Owner is the linking pin between developers and business.

Assign the role of Scrum Master; The Scrum Master of a team sets up the planning sessions, retrospectives and daily stand-up sessions and helps team members solve impediments.

Definition of Done, Definition of Ready; To ensure the definition and verification of quality goals it is critical to define when a specific work item is completed. For two very important states – "ready" and "done" the Definition of Ready (DoR) and the Definition of Done (DoD) have to be defined and agreed upon between the relevant stakeholders.

5.6. SAP projects

5.6.1. Starting an SAP project

One of the most important things that an organization should do when embarking on an SAP IT project is to carefully assess its needs and goals. This includes identifying which modules and functionalities of the SAP software are relevant to the organization, as well as how the software can be configured and customized to meet its unique requirements. It also means understanding the potential impact that implementing an SAP system can have on the organization's operations and identifying any potential risks or challenges.

Once an organization has a clear understanding of its needs and goals, it can begin to plan and execute the implementation of the SAP software. This includes identifying the resources that will be required, such as hardware, software, and personnel, as well as developing a detailed project plan that outlines the various tasks and milestones that need to be completed. It also means working closely with the SAP implementation team and other stakeholders, such as IT staff and business users, to ensure that the implementation goes smoothly and that any problems are quickly resolved.

The focus on quality for SAP projects is different from non-SAP projects. SAP solutions can consist of standard SAP best practices (available per module) which are commonly used by multiple companies or custom solutions (also known as Z-transactions) which are specific custom-made functionalities and code for a single company. The main risk areas for testing SAP solutions are the custom solutions, interfaces, test data and authorizations (so less on the standard SAP best practices). These main risk areas require most attention from quality measures and testing activities. However, the SAP best practices are important to validate the end-to-end processes.

5.6.2. Types of SAP projects

There are several different types of SAP implementations. The choice of the type of implementation will depend on the organization's specific needs, resources and goals. Each implementation methodology requires a different SAP Test Strategy.

Examples of most common SAP implementation project types (that may even be combined) are:

Greenfield Implementation

Greenfield implementation is a type of SAP implementation where the organization is implementing the software for the first time or starting from scratch in a new environment.

Brownfield Implementation

Brownfield implementation is a type of SAP implementation that takes place in an existing IT environment where there is already an established system (or multiple systems) in place. The goal of a brownfield implementation is to integrate the changes to the SAP system with the existing systems and processes, rather than replacing them entirely.

Bluefield Implementation

Bluefield implementation is a more gradual type of SAP implementation (compared to Greenfield or Brownfield). Instead of upgrading or replacing a company's processes, systems and data in one large approach, a Bluefield implementation means e.g., that only a few teams make the transition per go-live and that the others will do so at a later point in time. It ensures that the everyday business activities are not fully disrupted and that the implementation is done step-by-step.

Big Bang Implementation

A big bang implementation is an approach where all the modules and functionalities of the SAP software are implemented at once, in a single go-live event. This approach is usually used when the

organization has a high degree of urgency and wants to see results as soon as possible, however it can be risky and challenging. Especially for organizations planning to do a global big-bang rollout covering multiple time zones, a big-bang implementation is a complex and risky operation.

Phased Implementation

A phased implementation is an approach where the SAP software is implemented in stages, starting with the most critical modules and functionalities, and then adding additional modules and functionalities over time (minimum viable product (MVP)). This approach reduces the risk of the implementation and allows the organization to see benefits as they are delivered.

Hybrid Implementation

A hybrid implementation is a combination of different implementation approaches, such as big bang and phased implementation, where the organization takes advantage of the benefits of both.

Rollout Implementation

A rollout implementation is an approach used when an organization wants to implement the SAP software in multiple locations, or when an organization is implementing the software in a new subsidiary. In a rollout implementation a template solution is used for generic processes in multiple locations. Country or location specific processes are covered in localized templates. Both require specific attention from a testing perspective.

Upgrade Implementation

An upgrade implementation is a type of implementation where an organization already has SAP software in place and wants to upgrade to a newer version of the software.

Cloud-based Implementation

A Cloud-based implementation is a type of implementation where the organization chooses to run its SAP software on a cloud-based infrastructure, rather than on-premises.

5.7. SAP Activate

The SAP Activate methodology is a modular and agile framework which helps project teams to accomplish their tasks to deliver an SAP system to support the business process in bringing business value. SAP Activate consists of 6 phases:

- **Discover**
  - Familiarize with SAP (S/4HANA) before starting a project to implement SAP (S/4HANA).
- **Prepare**
  - Initial project planning, where the project plan for S/4HANA implementation is defined which includes team assignments, defining project goals, scope, budget, roles and responsibilities and project timelines and trainings.
- **Explore**
  - Fit – Gap analysis is done which helps to identify the gaps with standard S/4HANA
  - Parallel activities include master data preparation, SAP test strategy & planning and training set up.
- **Realize**
  - Build, test and validate the business scenarios and processes identified in the previous phases along with end-users.
  - End-users' training.
  - Multiple varieties of testing such as Unit Testing, Integration Testing and User Acceptance Testing is performed by different stakeholders to ensure the SAP system is configured according to the customer requirements and meets the pursued business value.
  - Data migration testing to ensure migrated data is in the correct format, ready to use and ready to import to the new SAP system.

- **Deploy:**
  - Setup of production system and cutover activities involve uploading master and transaction data, validating roles and authorizations of end users.
  - Perform regression testing to check earlier deployed objects are not impacted.
- **Run:**
  - Business is live with new the SAP solution. After the first period of hyper-care (where any issues, errors or incorrect entries occurred are corrected) day-to-day operation and maintenance is starting.

SAP Activate helps to shift from a Traditional ERP approach (Design to blueprint – Waterfall) towards a transformative (Fit-to-standard – Agile) implementation approach.

Traditional ERP (Design to blueprint)	Transformative (Fit-to-standard)
Consultative approach	Business owns the solution
Waterfall project methodology	Agile, Modular, Scalable
Customized solution	Lead with 'standard', best practices
Development, not configuration	Rapid, repeatable delivery steps
Historically been time consuming and costly	Accelerators: tools, templates, and content

SAP Activate supports different transition scenarios for organizations adopting SAP S/4HANA and provides dedicated solution specific Methodology, Content and Tools.

The SAP Activate methodology is part of the SAP Activate framework. This framework consists of three important pillars to help project managers use the SAP solution to achieve business goals. The three pillars are SAP Best Practices, Guided Configuration, and the SAP Activate Methodology.

SAP Best Practices

SAP has developed the knowledge and experience to deliver ready-to-run business processes which are optimized to run on SAP S/4HANA. This is the first pillar of the SAP Activate framework. Organizations can access the SAP Best Practices Explorer for all the SAP standard business process flows, roles, responsibilities, test scripts, etc. which can be integrated alongside the organization's own unique processes.

Guided Configurations

Guided configurations make it easier for organizations to configure their SAP systems. To globalize and standardize best practices across industries, SAP is continually developing standard configurations that can be used to run business processes.

SAP Activate Methodology

Lastly, the SAP Activate Methodology is a project implementation methodology used to deliver SAP implementation solutions. Using solution-specific roadmaps, the methodology is then designed to continuously improve project quality and success of SAP projects.

5.8. Testing Role Based Permissions for SAP

Testing the Role Based Permissions (RBP) in SAP projects is very important, time consuming and often underestimated. Organizations have complex requirements for user authorizations, the setup of RBP is mainly customized for organizations. High customization in general leads to high risks, which requires high testing effort. The impact when the user authorization is not properly set up is very high. We need role-based permissions to have proper business controls in place and to restrict access to sensitive information. A secondary reason for RBP is the need for strict privacy rules (e.g. compliance with General Data Protection Regulation -GDPR) that need to be followed. Authorizations are subject to audit activities to verify if the system is correctly configured, and segregation of duties are assured.

SAP projects should start RBP setup and testing during the early stages of the project. Starting late might result in missing deadlines and/or authorization issues in the live environment. Testing Role Based Permissions (RBP) can be challenging in SAP projects. Below you find a description of the challenging complexity, the need for starting early with planning and the specific considerations related to testing the RBP.

Complexity: Setting up RBP is a complex and important activity in SAP applications; in SAP projects it may take a long time to properly set up the RBP. There are a lot of detailed business rules involved with setting up RBP, that can easily be overlooked when setting up general business requirements.

Every field, object, transaction and FIORI tile in the SAP application must have the correct CRUD (Create, Read, Update, Delete) rules set up for each business role represented in the system. Depending on the number of roles and fields in the system many discussions with the business owners need to take place to get clarity. The complexity of setting up RBP for SAP applications is often underestimated by members of SAP projects. Setting up RBP is often a combination of specific roles and authorization for specific groups of people in specific areas of expertise. For example, a warehouse clerk should not be able to execute financial transactions, and a Financial Manager should not be able to execute Hiring employee processes. There will be roles which have overlapping responsibilities and duties, in this case roles can be combined and assigned to groups or individuals (in SAP also called **composite roles**).

Planning: The specifics of setting up the RBP for the SAP applications are not always clear at the start of the SAP project. As a result of this, projects have the tendency to start late or move the setup of the RBP towards the end of the project where it often becomes a bottleneck for the project and ends up on the critical path. Becoming a bottleneck is due to the complexity and the effort needed to fix problems if the testing of RBP results in many anomalies. Therefore, it is recommended to start with the configuration of RBP and RBP testing as early as possible. As a hard entry-criteria, user roles should be in place for the start of the User Acceptance Test (UAT) execution.

Testing: The testing of RBP in an SAP project can be very complex and time-consuming depending on how the RBP is set up for the organization. Some companies require more than a hundred roles and composite roles! Testing all these roles and their access can be very time consuming and can lead to many anomalies.

Test Preparation: While planning and creating new User Stories, it is worth to check, whether User Permissions Matrix is updated or if there is a merit to add Role Tests to that particular Story. By reviewing User Stories upfront, missing authorizations or roles can be reported. User Roles should be part of User Story creation and part of the Definition of Ready and Definition of Done. Test Automation is also an important tool to minimize the risk and save time, since the process of testing the permissions can be a long-lasting process, and it is error-prone when done manually and executed multiple times.

During the testing of the RBP for an SAP application, it is very important to test all the roles and the authorizations. The setup of the roles for RBP in SAP is custom work for each project and can result in conflicts in role authorizations. When testing the RBP the focus should be on the authorizations for all the roles, are the employees with these roles able to do what they are supposed to do, is there no conflict in segregations of duty. The SAP authorization consultant is the responsible and main stakeholder to collect, configure, and set-up the user-roles and system-authorizations. Based on all information the SAP authorization consultant gathers from all business parts, they create the authorization matrix for the SAP-project. This matrix is the input to create test cases for the different (composite) roles and to execute RBP testing.

Note: In small organizations the segregation of duty may be challenging because of the limited number of people involved.

6. SAP quality management

This chapter describes the content related to quality management for SAP.

These additional subjects are based on information that is available on the TMAP body of knowledge website (www.TMAP.net).

Note: for the exam the descriptions in this chapter supersede any texts on the website, even in case the website would contain other (more up to date) descriptions. This syllabus is regularly updated to include the latest insights.

6.1. Stakeholder management in SAP projects

Stakeholders are defined as "anyone with viable interest in the business value delivered by the team, at all levels in the organization and even outside the organization".

Stakeholder management is about how to involve, enthuse and engage the stakeholders that matter.

6.1.1. How to identify and involve your stakeholders

When you are involved in organizing IT delivery, for your team, a group of teams, or an organization as a whole, start with answering the following questions:

- Who are the stakeholders?
- How can these stakeholders be involved?
- What is at stake for each stakeholder?
- What contribution can each stakeholder bring?
- What information does each stakeholder need?

6.1.2. Specific SAP stakeholders

For SAP projects there are specific stakeholders to consider. Depending on how the SAP project is organized (Agile, V-Model or hybrid), the roles below can be part of an (SAP) Operations team, Agile team or centralized team. For example:

- **SAP Basis Consultant**
  Provides technical support and performs system administrations tasks.
- **SAP Authorization Consultant**
  Responsible for ensuring the internal and external audit requirements are met. Develop and maintain standards and procedures for the SAP Security (Fiori, Application and S/4HANA) and user access controls for all SAP instances.
- **(SAP) Business Process Owner (BPO)**
  Active decision maker and owner of specific local or global business processes. Can determine change impacts, educate business teams and initiate new business enablement. The process owned by the BPO can overarch the SAP solution, it can include complete end-to-end processes (including legacy/ 3rd party systems).
- **SAP Key User**
  An experienced representative of a number of business processes, who knows the processes in a specific department or for the whole organization in detail and is involved in taking decisions. They have a leading operational role.
- **SAP Master Data Management (MDM) Consultant**
  Is responsible for the creation and maintenance of Master Data that are fundamental to business processes that influence the customer experience. Relevant systems and processes

include, but are not limited to, the SAP system (like Business Partners, Material Master Data and Financial Master Data).

- **SAP Functional Solution Expert**
  Is involved in the design, configuration and implementation of functional and module enabled business solutions (LoB) and functions and plays a critical role in connecting business and IT.
- **SAP Technical Solution Expert**
  Is involved in the design and implementation of technical module enabled business solutions. They determine clients' business needs, create customized SAP solutions, and integrate SAP applications with existing IT infrastructure. They act as advisors for SAP software deployment and integration. They oversee programming and software development and evaluate existing IT infrastructure and recommend improvements.
- **SAP Integration Specialist**
  Is responsible for the design, development, and execution of innovative integration solutions between internal and external information of SAP and Non-SAP systems that support the IT strategy and overall business objectives.
- **SAP Enterprise Architect**
  Evaluates all business requirements and creates solutions that provide an integrated approach for SAP processes. This includes deploying SAP solutions and stabilizing core and non-core SAP systems.
- **SAP Test Manager**
  Is responsible for the planning, management and execution of the testing process, on time and on budget and at the right quality, for multiple test varieties. The SAP Test Manager reports about progress of the testing process and the quality of the test object.

6.2. Involved stakeholders in an ARCI-matrix

It is important to identify in what role stakeholders are involved in an IT delivery process. This identification can be made concrete by listing all stakeholders in an ARCI matrix and assigning them an involvement type.

In the ARCI matrix we distinguish 4 different types of involvement, the name ARCI is an acronym and based on the first letters of each type of involvement. The involvement-types are:

- **Accountable** people are also known as the principal stakeholders. They make the final decisions for example about budget and go/no-go. They must sign off or approve when the task, objective or decision is complete. This person must make sure that responsibilities are assigned in the matrix for all related activities. There is only one person accountable per activity. A person can be both Accountable and Responsible at the same time.
- **Responsible** people are important because they have a role in making sure that work gets done, these people are the "doers" of the work. In pure high-performance teams such as in Scrum or DevOps the team as a whole is responsible and the team members execute the tasks. In sequential or hybrid IT delivery models there may be just one person responsible or several people can be jointly responsible and do the work for a task together.
- **Consulted** people have valuable information or opinions that must be heard prior to making decisions or who need to give input before the work can be done and signed-off on. This may be high-level information or detailed information, so people may need to be consulted in very different stages of the IT delivery process. These people are "in the loop" and active participants.
- **Informed** people are the kind of people that do not actively contribute to the IT delivery process but need to know what's happening, for example to keep activities aligned across teams or across organizations. They often are the informal influencers, people that do not have formal power but do have influence on other people involved.

Filling in the ARCI matrix is the result of a proper investigation of the stakeholders, which often involves a discussion with these stakeholders. Also keep in mind that the stakeholders are not a static group, so the list of stakeholders in the ARCI matrix and the types of involvement regularly need to be reviewed and, whenever necessary, adjusted.

6.3. SAP Organizational change management

Organizational Change Management (OCM) is a *discipline* that supports organizations and their employees in smoothly and successfully introducing an intended change into their ways of working. Implementing a change within an organization is often complex and has an impact on people's everyday work. Therefore, consciously thinking about how to introduce the change and guiding organizations and their employees towards it is very important.

Why is Organizational Change Management important?

Within IT, 'Organizational Change Management (OCM)', or 'Change Management' for short, refers to the different activities that contribute to a successful implementation of a change within an organization from a people's perspective. This 'change' is generally the introduction of a new (technical) solution, initiative and/or product, which alters both how an organization might function as a whole and how individual employees perform their everyday work. In other words, the organization decides to kick-off a transformation journey towards certain changes in their operations which will affect its employees. And even though the aim of a change is to achieve organizational improvements (for example more efficiency, a more up-to-date IT-landscape or opening new business opportunities), the route towards this change and a full acceptance of it by the employees, is often complex. The desired change will most likely have a large impact on different areas within the organization. Think, for example, of employees having to learn about new systems, tools, structures, roles, and responsibilities and often having to change their mindset or work approach as well. The support of an OCM team is important for all organizations, but especially when implementing a (new) SAP-system. This is because:

- A change in or towards SAP-systems often involves many different groups of employees (teams with different work activities and individuals with different roles/authorizations)
- A change towards an SAP-product often has a long trajectory with many voices. It is therefore essential to consciously involve end-users early on. If they are forgotten their confidence and/or support may be lacking, and the implementation may be unsuccessful.

How to create an ambassadors' network?

For each organizational change and large business transformation, support from the key stakeholders is essential to accept or reject the change. Getting SAP stakeholders' commitment and successfully managing resistance to change, are prerequisites for effective change management. Acceptance of change (commitment) and rejection of change (resistance) are typically treated as separate, unrelated phenomena. However, commitment and resistance are closely linked in the sense that they represent a polarity— two sides of the same coin.

Building on this notion, sequential phases of acceptance of and resistance to change are: *Knowing*, *Feeling*, *Doing* and *Promoting*.

To engage stakeholders in the change process and deal with these different phases appropriately, it is important to involve them as early as possible. A useful approach for this is the creation of an 'ambassadors' network'. Key stakeholders within the organization undergoing the change (for example, key business users) participate in the change-process from the starting and while doing so, experience the new solution and its positive benefits quickly. Ultimately, they will become

'ambassadors' for the new solution and/or way-of-working and hopefully transfer their positive attitude towards the change to others who will adopt it later.

It is important to explain the "why" of the change and support them along the whole business transformation journey.

The table on the next page shows how to work with stakeholders in a way that turns them into true ambassadors for the organizational change.

	Commitment	**Resistance** *(result if change is not well managed)*
Knowing	Stakeholders are *contacted* and *awareness* about the change is created	Stakeholders are *unaware* and *confusion* will rise when confronted with the change
Feeling	Stakeholders will understand the **why** of the change and become curious, the necessity is *sensed* and the *desire* for this change is created	Stakeholders are not involved and feel a *negative perception* for the upcoming change. They show *inactivity* and are against the change
Doing	Due to stakeholders' involvement, they *experiment* with the new solution, and while doing this, they slowly *master* the new solution	Because stakeholders are not involved, they *reject* the change/new solution and might even *terminate* their labor contract or involvement in the department
Promoting	Eventually, the new solution becomes the stakeholders' *new normal* which will result in them becoming the *ambassadors* of the change or transformation	This results in stakeholders' feeling of *isolation*

Elements of a successful Organizational Change implementation

1. People centric view

Change Management teams work towards a successful implementation by creating awareness within the organization of the upcoming change and make sure that end-users and their demands are involved with the change process at an early stage. Also, by working with this employee-centric approach, it is possible to create *personas*, fictional characters which represent a certain user type and why/how they use a certain product or process.

2. Shared vision on the change

There are several reasons why an organization decides to invest in, for example, new tooling or restructured ways of working. Organizations have certain "Drivers of Change" which can run from *monetary benefits* to *technological advancements* to *cultural shifts* or *customer demands*. Clarifying and propagating why a change is needed from an executive level towards the organization will increase the chances of having employees understand the change and eventually accepting it.

3. Clear communication and training plan

In general, the communication surrounding large organizational changes is driven and managed by a specialist from the OCM-team (so not by Testers, although they are in close contact with the Change Management Team). The communication towards all possible stakeholders and trainings they are eventually provided with, need to be *tailored, well-timed* and *right the first time*. A change is more likely to be accepted and well-used when specific and useful information is given to the different roles that are involved. Often, a smaller group of end-users is introduced to the change at an earlier

stage which means they will later serve as *ambassadors* towards the other, larger group of end-users when the change is implemented organization wide.

Organizational Change Management (OCM) is a discipline that supports organizations and their employees in smoothly and successfully introducing an intended change into their ways of working. Implementing a change within an organization is often complex and has an impact on people's everyday work. Therefore, consciously thinking about how to introduce the change and guiding organizations and their employees towards it is very important.

6.4. SAP Quality Risk Analysis (SQRA)

Risk comes from NOT knowing what you're doing: identify your SAP quality risks!

In order to identify where the major quality risks are in your SAP project, execute an SAP Quality Risk Analysis (SQRA).

The general approach for the SQRA is to conduct a workshop with all involved stakeholders from the business streams (or SAP Solution Trains/ Line of Businesses (LoB's)) like Finance, Supply Chain, HR, BW and even for the Non-SAP systems to determine the processes and areas with the most risk. Participants for this workshop are from both the **Business** side and **IT** side.

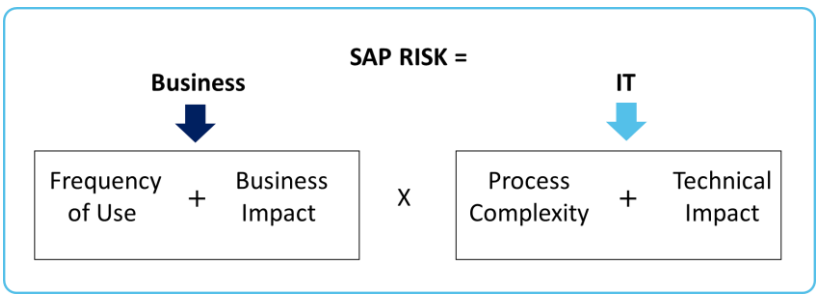
From the Business side, the following stakeholders should be invited to participate: the Key User, Functional SAP Consultant, Functional Business Analyst, Product Owner. Stakeholders from the IT side are: Technical Leads, Technical SAP Consultants, Integration Consultants, System Integrator.

During the workshop, how to rate each process is explained. **IMPORTANT**: to do a good SQRA make sure that the detailed scope is clear (preferably on process level), defined and signed off. In case this is not 100% clear, the SQRA still will identify the risk areas, however it will not be on the lowest desired detail level. In such case, when the scope becomes more detailed, additional SQRA workshops should be organized to update the risks.

During the Quality Risks Analysis, the scope of the change or project (regardless of an implementation, a rollout or an upgrade) is important. Global and local requirements, legal requirements, language requirements etc., should be included in the Quality Risk analysis.

A quality risk is the chance that the process fails in relation to the expected impact if this failure occurs. The SQRA is a weighted risk approach where risk input from both Business and IT are merged into a risk classification:

- The Business input consists of the "Frequency of Use" and the "Business Impact" (Business: end Key User/ Functional SAP Consultant/ Functional Business Analyst/ Product Owner)
- The IT input consists of the "Process Complexity" and the "Technical impact" (IT: Technical Leads, Technical SAP Consultants, Integration Consultants, System Integrator (SAP domain specialist))



To determine the risk, each process in scope is assessed and rated using specific rating definitions. The rates in the following tables are indicative and can be modified for each SAP Project.

Determined by Business

Business Input

Criteria for **Frequency of Use (FU)**	Rating
Used incidentally/ on a monthly basis or less	1
Used on Weekly basis or monthly basis and over 10% of all users involved	2
Normal use is on a daily basis	3
Used continually (during office hours or normal productive hours)	4
Heavy duty: continual usage by a significant number of users	5

Criteria for **Business Impact (BI)**	Rating
Limited impact (may be caught up or corrected without impacting related business processes)	1
Errors will induce significant hours to be spent on internal corrections or rework. Primary business process not affected	2
Errors are likely to affect primary business processes (e.g. standstill or under performance) but impact will be local and have no external visibility or are likely to have internal financial impact, but financial impact limited to single transactions	3
Errors may lead to significant financial losses (normally on local scale) or may have external visibility	4
Errors may have structural negative impact on profitability or organization image	5

Determined by IT

IT Input

Criteria for **Process Complexity (PC)**	Rating
Very simple process, main flow + max 2 alternate flows visible to the user	1
Simple process, max 6 alternate flows, max 10 data tables involved	2
Medium complex algorithm, max 6 alternate flows, max 10 data tables involved	3
Complex algorithms: Multiple decisions or many dependencies or complex computations	4
Very complex (combination of complexity factors above)	5

Criteria for **Technical Impact (TI)**	Rating
Standard SAP, simple parameterizations only	1
Extensive parameterizations or relevant upstream/downstream processing	2
Simple RICEFW* or data setup that has significant impact on processing (e.g. basic reference model setup)	3
Normal RICEFW* or processing significant data setup	4
Complex RICEFW* or high impact (master) data setup	5

*A change request in SAP is called RICEFW

Combined/ weighted risk

The values for each risk component rate from 1 to 5 and have been predefined using the definitions and guidelines above. The definitions are adaptive and best practices, it is always possible to adjust and finetune according to the project specifics and or client needs. The risk classification is the combined and weighted outcome of the "Business input" and the "IT input" risk score = (FU+BI)*(PC+TI). With a minimum score of 1 and a maximum score of 100 per process/ transaction/ test case. (score 0 is No Risk which implies No Test, and also implies no need for development & implementation)

Score	Risk Class
75 -100	A
40 -74	B
16 -39	C
1 - 15	D

No Risk	No Test

The values are auto calculated in the template (download from www.TMAP.net) based on the weighted rates. These risk ranges are indicative and adaptive. Based on the totals per risk class (the total amount of processes, SAP transactions, E2E scenarios) the risk boundaries can be adjusted to come to a balanced risk analysis.

NOTE: Every SAP project is different and will lead to their own balanced overview. Not all objects can be classified as critical, not all can be classified as low. And there will be objects with no change, so no risk, no test. There must be a well-balanced average. Therefore the given risk class boundaries can be adjusted to meet or come close to these references.

Example sheet

The results can be captured in an Excel sheet calculating the risk classes.

SAP Quality Risk Analysis - Example		Business		IT			Risk
Process group	Business Process	Frequency of use	Business Impact	Com-plexity	Technical Impact	Score	Risk Class
1 Organizational Structure and Master Data							
1.1 Organizational Structure and Master Data							
	1.1.1 Organizational Structure	2	3	4	4	40	B
	1.1.2 Warehouse Structure	1	1	1	1	4	D
	1.1.3 Stock types	1	1	1	1	4	D
	1.1.4 Product Master	5	2	2	2	28	C
	1.1.5 Allergens	3	1	3	3	24	C
	1.1.6 Batch Management	3	1	3	3	24	C
	1.1.7 HU Numbering	3	1	1	1	8	D
	1.1.8 Pallet Labelling	4	5	4	5	81	A
	1.1.9 Resource management	3	1	1	1	8	D
	1.1.10 Packaging Specification	3	1	1	1	8	D
	1.1.11 Hazardous Substance Master	3	1	1	1	8	D
	1.1.12 Quality Inspection Rule	3	1	1	1	8	D

The output of a SQRA is input for an SAP Test Strategy (see LO14) and SAP Test Plan (see LO15).

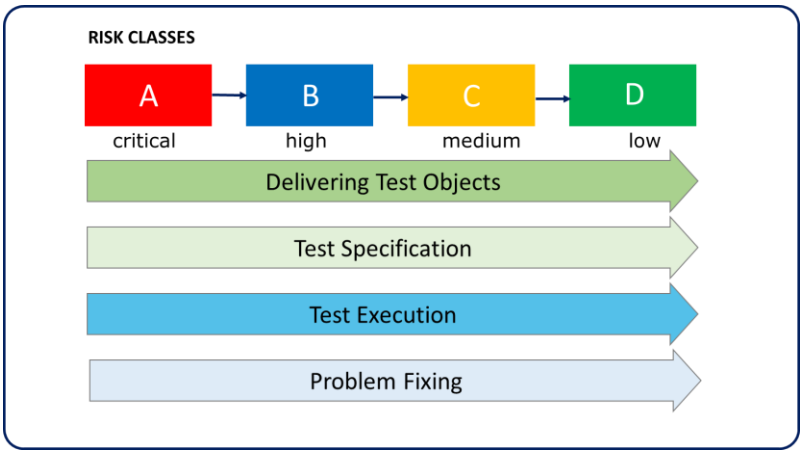
For example: for all objects identified as critical, we have to define 1 or more test cases to thoroughly test this object (positive flow, negative flow, happy flow etc.). For each risk class a metric and assumption can be defined to determine your test planning. This metric and assumption will help to calculate, roughly, the total effort for designing and executing test cases. Critical risk test cases might take more time to test then low risk test cases.

Test Life Cycle

Based on the location of the test object/ process in the risk matrix (Risk Class), all test objects and processes are prioritized. The result is ordering of all processes, the most important / highest risk ones first. In addition to prioritization, a differentiated test approach for the processes can be defined based on their Risk Class.

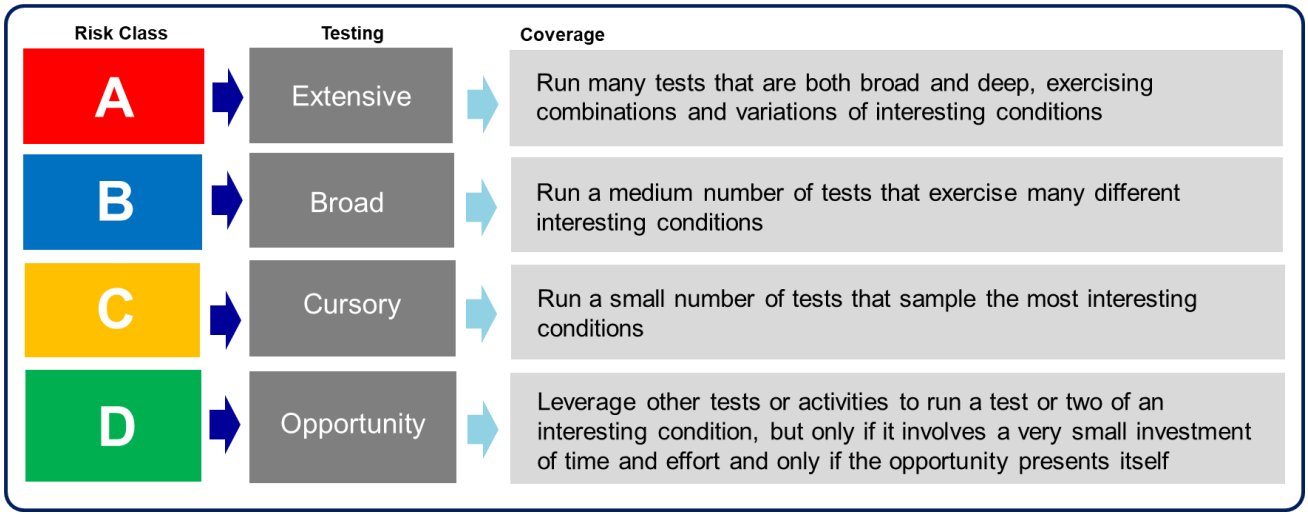
This can be used throughout the whole development life cycle:

- Delivering test objects
- When specifying tests
- When executing tests
- When fixing anomalies



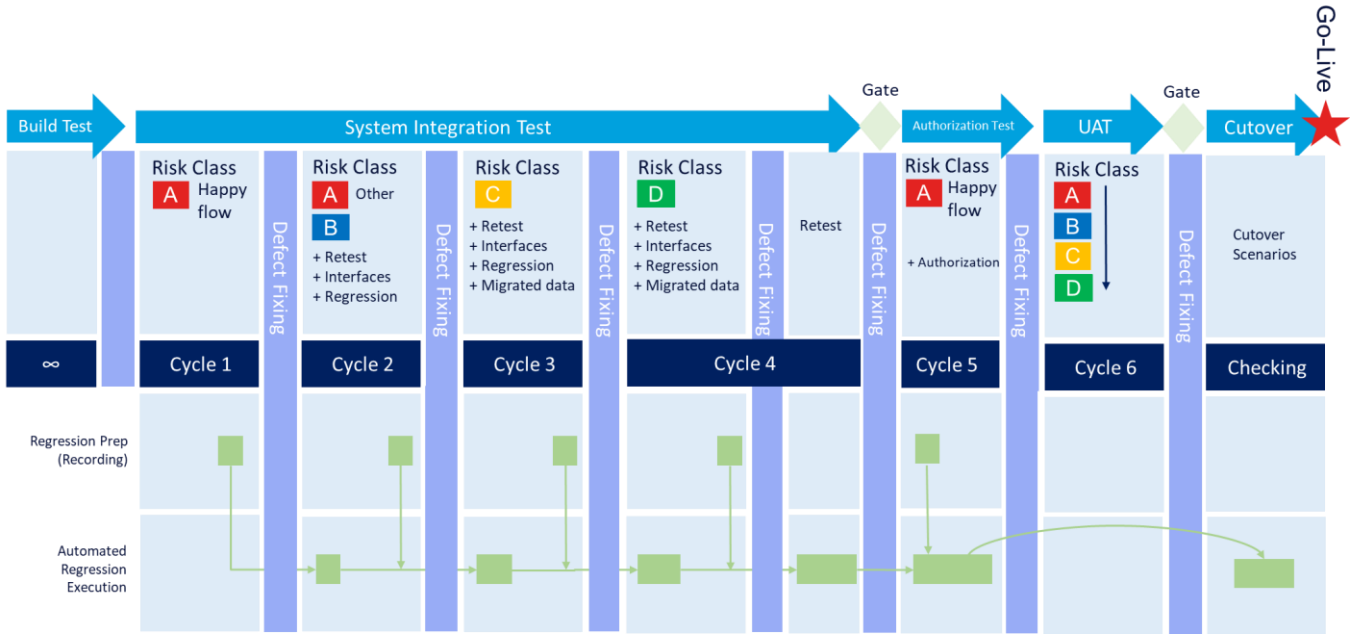
Confidence

Based on the relative level of risk (Risk Class), test design techniques can be selected that will give the proper level of confidence (see LO07 VOICE MODEL). Keep in mind that within SAP the focus is on business and E2E processes, meaning that process-oriented test design techniques will bring the most value (see LO26 Path Testing). Some other test design techniques are still applicable but should be used earlier in the development life cycle (e.g., during Unit or System Test)



Example: Use SQRA in test strategy and test plan

Below an example how the outcome of an SQRA can be translated, converted and used for a test strategy, test plan and an automation approach.



The outcome of the SQRA will give insights in the Critical to Low-risk areas/ processes. Critical processes should be tested as soon as possible, at least focus on the happy flow in an early testing stage, for example SIT. In many big SAP programs, multiple SIT cycles are planned, divide the risk classes over the several SIT cycles (see picture) and add negative flows for Critical risk classes as well. When the happy flows are successfully tested, they can be nominated for (manual) Regression Test Suite and for Automated (Regression) Testing. Per cycle, expand the Regression Test and Automation Suite.

During UAT, the focus shift to E2E scenarios and processes – Vertical and Horizontal (see LO21) and all risk classes are involved in these processes as the process steps can be linked to each other as a chain.

Control mechanisms (quality gates, indicators and metrics) must be in place after each cycle to reflect insight in status and quality and be input for Go/No Go decisions.

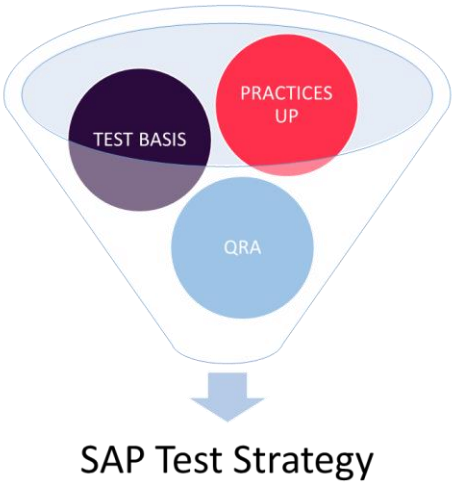
6.5. SAP Test Strategy

The SAP Test Strategy and SAP Test Plan may be described in a combined document or in separate documents. There is a strong relationship between the SAP Test Strategy and SAP Test Plan, both cover specific elements for testing SAP. Both topics are part of the Generic SAP Test Approach. SAP PRACTICES UP (see chapter 6.5.1) is a great starting point to define the SAP Test Strategy.

Keep in mind, the SAP Test Strategy is part of the SAP Project and should not act independently. It must be within SAP project boundaries and methodologies. For different types of SAP Projects (implementation, a rollout or an upgrade) different elements can be applicable for the SAP Test Strategy.

The SAP Test Strategy is derived from:

- SAP PRACTICES UP
- Test basis (like User Stories, Process Flows, Functional Docs)
- SAP Quality Risk Analysis (LO13)



The SAP Test Strategy is used for:

- Test Plan (LO15)
- Test Design (LO17)
- Test Execution (LO24)
- All kinds of quality measures, quality gates and metrics during various Test Varieties

The SAP Test Strategy is the heart of the SAP testing. The SAP Test Strategy is a linking pin and input for many topics to be planned, prepared, designed and executed. The SAP Test Strategy itself is an important foundation for the test design and test schedule.

More details about the Test Strategy can be found in sections 26.5 and 26.6 of the book.

6.5.1.PRACTICES UP

PRACTICES UP is an acronym for all SAP focus areas and provides insight into what needs to be addressed in the SAP Test Strategy. What focus areas have been impacted by a change? Together with SAP Quality Risk Analysis (see learning objective LO13) and the available Test Basis, PRACTICES UP is a helpful guideline for defining an SAP Test Strategy.

The focus areas of PRACTICES UP are described below. Also see www.TMAP.net for more info.

Processes

Business processes are leading!

Verifying and validating the output of SAP business processes is the main focus for SAP Testing. Business Processes are embedded across SAP and non-SAP. SAP and other systems support critical business processes.

Reports

Everything that is being sent out the organizations must be 100% OK!

All outbound communication needs to be accurate and trustworthy. Reporting requires attention during SAP testing, especially content and readable layout.

Authorizations

Authorizations have an important role in SAP process handling! (LO20)

SAP is used by large companies with lots of different users: Purchase, Production, HR, Sales, Accounting, etc. All these users have different business roles and need different permissions in the application. Some sensitive data, like HR or Financial data, needs to be shielded from standard users. Some actions, like approving certain amounts of sales orders is only available for certain people. Authorizations have an important role in SAP process handling and are important to test thoroughly.

Configuration

Understand the intended behavior that is achieved through customizing!

SAP is an "out of the box" solution, however, to make it fit and operational for the organization, configuration of business processes, organizational structure, setting up master data and all kinds of organization specific parameters have to be set.

Transports

A mistake in transport can cause serious issues!

To make SAP functionalities available for the users, all changes and modifications on the system must be pushed and deployed through the system landscape. Transports ensures, moving changes made in the **D**evelopment system to other systems in the SAP landscape, such as **T**esting, **A**cceptance and **P**roduction environment (DTAP). Within SAP these are called Transports. Challenges of transports are:

- Changes must be transferred in the proper sequence
- Sometimes an object is forgotten in a transport
- Object dependencies
- Overwriting of code is a possible risk, especially with variables used
- Rollbacks, in case of any issues during the transport, it may be necessary to roll back to the previous state

Interfaces

Testing interfaces is a multi-discipline activity! (LO21)

SAP will most likely not exist by itself only, integrations to other (Non-)SAP solutions are linked and integrated with SAP solutions. During the E2E testing, it is important that processes, data and communication between systems, are aligned and managed. Besides functional testing of the integration to validate the business process, non-functional tests are important as well like: connectivity, performance and security of the interfaces.

Conversions

Verify (early) if the processes can handle the converted data!

When new processes in SAP are implemented, different types of data can be needed for verification of these processes:

- Master- or transaction data from SAP or other systems
- Owner of data is not always clear (e.g.: when used by multiple departments)
- Inadequate monitoring of converted data
- How to check conversion is complete
- Do (new) business processes correctly process converted data?
- Data cleansing

Enhancements

Enhancements require extra test attention and effort during testing!

SAP is an "out of the box" solution, (see Configuration), however not all "out of the box" configuration will fit the specific business and organization needs. Therefore, custom development is needed (in SAP this is called ABAP) which is "high risk" as it is new, never used before, code.

- New code created specifically for customer process -> e.g.: Z-transactions
- New code which is part of a new or existing process -> e.g.: specific user exits
- New introduced code which is not part of Standard SAP or SAP Best Practices

Screens

SAP Screens can be heavily modified!

SAP screens and user interfaces can be adjusted and modified to the needs of each user or team. Screens can be adjusted so only relevant objects are visible. Therefore it is important that the user interface is fully supporting an efficient way of working, and tested as such, to support the business needs.

User Experience (UX)

SAP User Experience is how a user experiences, and interacts with, an SAP solution. Improving UX is important for organizations for End User adaptiveness.

End Users can customize how to work with an SAP solution to suit their personal needs and improve their overall experience and interaction with the solution (Graphical User Interface (GUI) or FIORI tiles). User Experience is subjective, however the attributes that make up the UX are objective.

Platform

How does the system landscape influence the SAP Testing Strategy?

SAP can run and connect to many solutions and platforms which can make the landscape complex:

- Cloud (Private, Public, Hybrid)
- On-premises
- Multi-cloud/ Cross cloud (SAP, Google, Azure, AWS, …)
- Platform Data Management
- Integration Suite
- SAP and Non-SAP

6.6. SAP Test Plan

Various important Quality Engineering activities need to be prepared for an SAP test project. These activities and subjects are part of the SAP Test Plan. The activities and subjects are divided for the SAP Test Preparation phase and the SAP Test Excution phase (see LO24). Some of these activities and subjects are also part of the SAP Test Strategy (see LO19) and are relevant input for other activities and subjects.

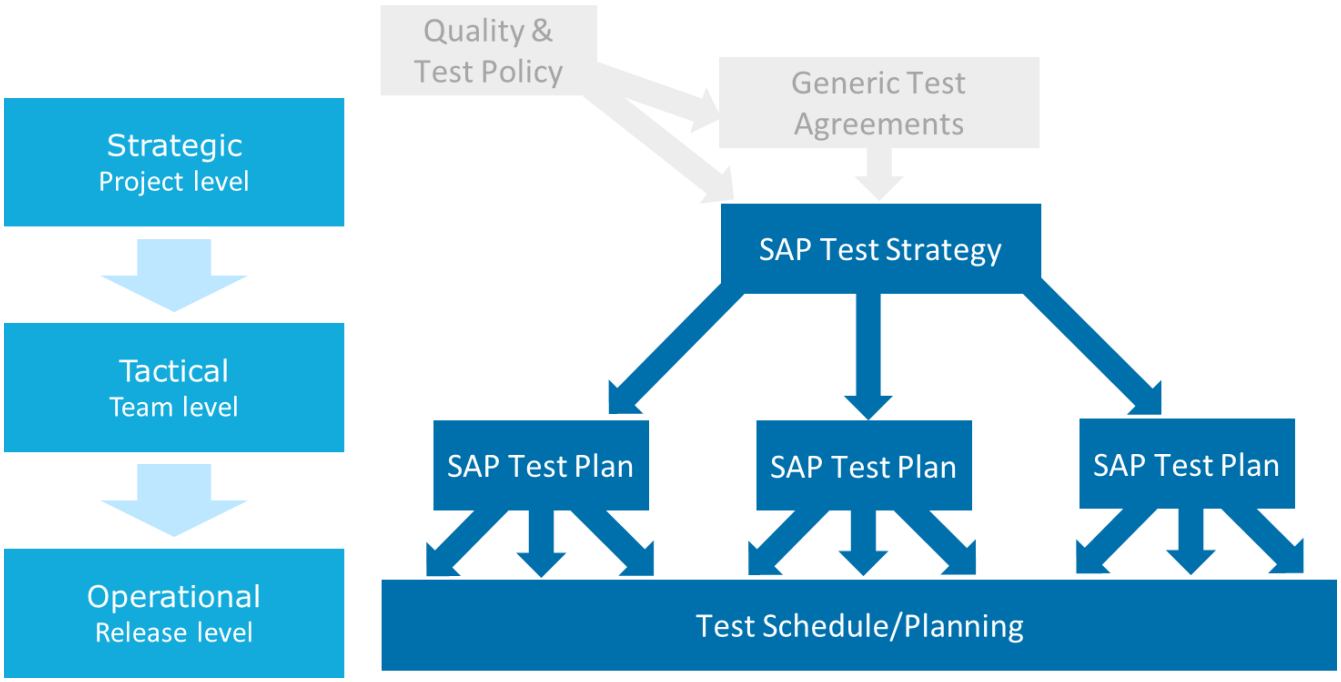
How to deal with an SAP Test Plan and an SAP Test Schedule starts with their definition:

- The **SAP Test Plan** is an overview of activities and items to be in place for managing the SAP Test Project, including a description of the activities and the schedule (also called planning).
- The **SAP Test Schedule** is the detailed breakdown of testing activities in time, for example, when to design, prepare, execute and report specifics tests, aligned with the schedule of the overall SAP Project Plan.

(Note: the general definition of a Test Plan is in section 15.4.2 of the book and in the glossary. A test schedule in general is defined as: A detailed overview of testing activities to be performed and executed in a specific sequence and time.)

In any SAP IT delivery lifecycle model, a schedule with work items and timelines needs to be created to manage the execution of test activities. This is an SAP (Master) Test Plan in a sequential IT delivery model, and it is a backlog and scrum board in a high-performance IT delivery model.

The SAP Test Strategy is the reference of the organizing and performing activities of the test tasks and serves as an instrument to communicate with the stakeholders on strategic and tactical level. The SAP Test Strategy balances the allocation of quality measures and the investment of testing, to make an optimal distribution of effort over test varieties and test approaches and determines test coverage and test intensity. The SAP Test Plan describes the SAP test project, including the activities and the schedule. Keep in mind that a test plan is NOT a description of the actual tests (logical and physical test cases). The SAP Test Plan is the linking pin between the tactical and operational level. The Test Plan translates the Test Strategy in such a way that everyone in a test project can understand the activities to be done.



Input for the SAP Test Schedule:

Besides the SAP Test Plan, which describes the roadmap to achieve the agreed goals and quality, the SAP Test Schedule uses the Project Scope and the SAP Quality Risk Analysis (see LO13) as input for a detailed overview of tasks and activities in the project's timeline. The output of SAP Quality Risk Analysis (risk classes) is used to determine test intensity and the sequence of test activities to be executed. It balances the time used for test case design and test case execution. Higher risk parts get more effort than lower risks. The schedule should start with the most critical risk areas and processes first, spread out over the different test varieties (like SIT, FAT, UAT, E2E, RT). See the glossary on www.TMAP.net for the definitions.

Governance, Indicators & Reporting in the SAP Test Plan

An important part of the SAP Test Plan is to have a test governance structure in place which is in line with the project needs and stakeholder expectations. Examples are: which meetings will be scheduled, which deliverables will be shared, what is the frequency of meetings and reports, and which stakeholders will be involved.

Furthermore, an overview of relevant indicators and metrics should be included in the SAP Test Plan. These indicators will give insight in progress during test design and test execution stages. More on indicators and reporting in LO25 SAP Indicators and Test Reporting.

Eventually, all insights in quality gates, indicators and metrics, contributes to establish the confidence that the business solution, consisting of the whole SAP landscape/ scope, other systems and business processes, will deliver the expected business value.

6.7. Quality gates

What is a quality gate?

A quality gate is a milestone in an IT project that requires predefined criteria to be met before the project can proceed to a next phase. It is important that the demand and supply party are aligned on the expected quality levels. These responsibilities should be transparent and clear in advance.

A quality gate can represent the start or end of a testing phase and can be visualized by a checklist. This checklist is used during and at the end of a testing phase in an SAP project. It requires predefined criteria to be met before the project can proceed to the next testing phase. This checklist contains entry and exit criteria. The most important aspect of a quality gate is that all involved stakeholders agree that a certain testing phase is completed and that the project is ready for the next testing phase or go-live. Fill out the quality gate checklist with all stakeholders involved and discuss the status of the quality gate at the end of a testing phase. Besides using quality gates to start a particular testing phase, quality gates are also used for project phase transitions.

Quality gates in the Demand/ Supply model (hybrid)

In SAP projects quality gates are often used for the handover between solution-teams, the System integrator, the (business) testers, and internal and external parties, when starting a different testing phase in the project. This is called a Demand/Supply model (see section 5.5.1).

When the demand party works according to a sequential IT delivery model, a project manager and a test manager are assigned to the project. The supplying party working with Scrum will have a Scrum team with a product owner, scrum master, and team members. This setup may lead to tensions between demand party and supply party, for example when the project manager has a clear end

date of the project, but the Scrum team determines what to deliver for every individual sprint. This can be mitigated by having clear agreements about the handover between demand- and supply party and (later) between supply – and demand party.

At a general level, you could distinguish the goal of the demand and supply parties as follows:

- The demand party establishes what is required and validates if that has actually been delivered and whether they have actually achieved the pursued business value.
- The supply party evaluates the requirements and uses these to configure the SAP solution, working towards the definition of ready. The supply party delivers the IT system and demonstrates that what is demanded, is actually delivered.

In this situation there are two clear quality gates: one where the demand party hands over their requirements to the supply party, and one where the supply party delivers the IT system to the demand party (see LO05 IT delivery models for SAP).

Example quality gate checklist

Some examples to include in a quality gate checklist to start a SAP User Acceptance Test (UAT):

- Are SAP business testers selected and are their schedules blocked for the UAT period?
- Are SAP business roles ready and available?
- Are SAP business roles and SAP logons mapped for the attending SAP business testers?
- Are the required interfaces for the SAP application available?
- Is the set-up of integration partner profiles ready and available?
- Is the test environment set up and available for the SAP business testers?
- Is the test environment filled with correct test data?
- Is availability and correctness of SAP master data validated?
- Is the in/ outbound communication verified for all interfaces?
- Are test cases for UAT available?
- Is there a physical room booked for the UAT?
- Is all the required hardware available?
- Is anomaly management procedure available, clear and set up?
- Are SAP business testers properly trained?
- Are developers available to fix anomalies found during UAT?
- Are all blocking problems from previous testing phases fixed or handed over as known error?
- Are work instructions and release notes available?

A quality gate is monitored during the testing phase and has a deadline that matches the end of one testing phase. If the quality gate is not completed at the deadline, it is important that the test manager takes the following actions:

1. Discuss with the involved stakeholders which actions need to be completed to start the next testing phase or go-live.
2. Set new actions and deadlines together with stakeholders and make sure the actions are assigned.
3. Make sure that all required resources are available to complete the open actions to meet the quality gate.
4. Inform all stakeholders about the delay in the next testing phase or end of the project and discuss and share how to move forward. This can impact the Go/No-go for the go-live of the project.

6.8. SAP Test Execution

The execution of tests is one of the most important parts of dynamic testing. Test execution is described in the book (chapter 33). Various people with the role of tester will execute test cases in the SAP test environment. A test case consists of preconditions, steps with input and actions, and expected results.

Before the test execution starts the tester performs some pre-activities, such as test environment setup, test case design, and test data preparation.

During test execution the tester uses the test scenario to follow the steps of each test case and determines if the test is passed or failed by comparing the expected result (of all steps) with the actual result. When the tester observes an anomaly during the test execution, the anomaly will be logged according to the anomaly management process, see chapter *7.4*.

After the test execution has ended the tester investigates and assesses the outcome of the testing (see chapter 34 of the book). If any anomalies are observed these are reported, so that the anomaly management process can be followed. And as a closing activity there are "test cleanup" activities such as making sure the user is logged out of the system and the database is cleaned up when needed.

The test execution may differ for different test varieties, for example because the scope is different, different people are involved and different tools are used. Based on the nature of the SAP project some specific test varieties may be applicable, separately or combined. As per the SAP Activate methodology (refer to learning objective LO12) the following test varieties are often relevant:

- Unit Test
- System Integration Test
- User Acceptance Test
- Regression Test

Unit tests are developer specific and not relevant for the target audience of this training course.

Business users, operations – and maintenance people are mainly involved in User Acceptance Testing and sometimes in System Integration Testing. They often may be involved in Regression Testing. During test execution, the testers will assess actual outcome versus expected outcome. Progress and any observations or anomalies will be logged.

The following sections briefly describes these relevant test varieties.

6.8.1. System Integration Test (SIT)

System Integration Testing is performed to verify proper execution of the entire application including interfaces to external applications (Refer to learning objective LO21 end-to-end testing). This aims to ensure that the integrated components are functioning properly according to the requirements and specifications. Mainly focused on in- and outbound communication to check if connectivity is established between systems in scope.

It is a test carried out by operations- and maintenance people, and possibly involving future users, with the aim of demonstrating that (sub)system interface agreements have been met, correctly interpreted and correctly implemented.

6.8.2. User Acceptance Test (UAT)

UAT is a test variety carried out by (or on behalf of) the future user(s) in an optimally simulated production environment, with the aim of demonstrating that the system supports the operational process of the users. Activities included for this phase are:

- Prepare a User Acceptance Test plan,
- Prepare and document User Acceptance Test Cases,
- Execute User Acceptance Test Cases,
- Handle anomalies according to the anomaly management process agreed within the organization,
- Obtain User Acceptance Test Sign Off to formalize the acceptance.

6.8.3. Regression Test (RT)

The implementation of a new system or changes to an existing system may impact existing IT systems and SAP business processes. Therefore, after each change a regression test should be executed to confirm that no unforeseen impact exists in the parts that should not have been changed. Because regression tests usually have to be executed very often the execution is preferably automated using a test execution tool.

A regression test may be a separate test variety, but often it is combined with a SIT or UAT.

6.8.4. Other Test varieties

It is also recommended to assess the need for other test varieties (such as non-functional testing). Examples are Performance Testing (Refer to learning objective LO33 and chapter 37 of the book), Usability Testing (see chapter 39 of the book) and Security Testing (see chapter 40 of the book).

7. SAP Infrastructure and tooling

This chapter describes the content related to quality management for SAP.

These additional subjects are based on information that is available on the TMAP body of knowledge website (www.TMAP.net).

Note: for the exam the descriptions in this chapter supersede any texts on the website, even in case the website would contain other (more up-to-date) descriptions. This syllabus is regularly updated to include the latest insights.

7.1. SAP Test data (management)

7.1.1. Understanding SAP data

In today's businesses the speed of change is continuously accelerating. And every change in an SAP system drives test data needs. A Test Data Management (TDM) strategy and solution, is critical and enables testers to find and use the relevant test data for SAP systems.

In SAP, data is built up through various modules such as Material Management (MM), Sales and Distribution (SD), Financial Accounting (FI), and Production Planning (PP). These modules allow the entry and management of different types of data, such as material master data, customer master data, vendor master data, and financial data. The data is stored in tables within the SAP database and can be accessed and modified through transactions within the SAP system. It is also possible to extract or input data using API's (Application Programming Interface) to interface with SAP. The data structure in SAP is organized in an hierarchical manner, ensuring data consistency and integrity throughout the system.

Configuration data and master data are a prerequisite to start testing in any SAP project. All other test data can be generated using the master data.

Understanding the use of Master Data in testing SAP E2E processes is critical, regardless of whether testing is taking place on ECC or S/4HANA, as well as external applications.

SAP has the following data classes:

- **Configuration Data:** Defines the system and the limits of all elements, e.g. Organizational structure, warehouse set-up, and product-specific configuration (preconfigured settings are adjusted to better fit the needs of the business).
- **Master Data:** Defines the material-, vendor-, customer-, and financial data and how they will behave in the system.
- **Conditional Master Data:** Applies only in specific situations (e.g. for this customer and material, use this price)
- **Transactional data:** Depends on conditional data and master data, includes key operational data.
- **Reporting:** Depends on transactional activity.

Master data will determine the behavior of SAP (for example condition records).

7.1.2.Ideal test data set

Software development and testing will only be successful with carefully prepared test data. Do not use just some data or just a random test case because in that case you do not know what result to expect. To test a software application effectively, you'll need good and representative data. The ideal test set covers all relevant application parts with the smallest possible test data set. In short, you need a relatively small test data set that is realistic, valid, and versatile.

Manually generating test data is a time-consuming activity. Without a structured approach it does not guarantee an appropriate test coverage.

Using a copy of the live production data has several drawbacks:

- Development and testing teams will have access to sensitive information, so data needs to be scrambled and/or anonymized (to comply with privacy rules such as the General Data Protection Regulation of the EU, also known as GDPR).
- Creating copies of production data into non-production environments typically requires a lot of time, leading to a lack of environment availability.
- Non-production environments need to have the same capacity as the target landscape, which means that infrastructure costs will be higher than necessary.
- Data requirements can be different for different applications and can have different formats.

Synthetic data

Synthetic data is artificial data that is generated from original data and a model that is trained to reproduce the characteristics and structure of the original data. Selecting and using test data in SAP can be time-consuming. Even generating synthetic test data instead of copying data from the live environment, has a number of challenges. Examples are:

- Complex data structures: SAP systems have complex data structures, making it difficult to locate the specific data required for testing.
- Data duplication: SAP systems often have duplicate data, making it difficult to determine which data is relevant for testing and which data is not.
- Data privacy: There may be sensitive data in the SAP systems that needs to be masked or removed before it can be used for testing purposes.
- Data consistency: The data in SAP systems may not be consistent, making it difficult to find and use accurate data for testing.
- Lack of standardization: There may be a lack of standardization in the way data is stored in the SAP systems, making it difficult to locate the specific data required for testing.
- Specific data & systems settings especially for any Test Environment to avoid and block any outbound communication to the real world.

Below we describe a number of possibilities to properly create test data sets for an SAP system.

Sub-setting

Sub-setting is the process of selecting and retrieving a subset of data from a larger dataset, based on certain criteria. Data sub-setting and extraction can help to achieve the ideal test data set. The goal of data sub-setting and extraction is to extract the relevant information from a large dataset, so that it can be analyzed and used to support decision making or other purposes. Data sub-setting involves selecting a portion of the data that is of interest and excluding the rest. This process is used to reduce the amount of data that needs to be processed, which can make the testing more efficient and manageable. The criteria used to select the data can vary, but they often involve specific attributes, such as date, location, or type of data. Sub-setting can also be sustainable as less data is stored in the database, so less resources are used.

Sensitive data

Handling sensitive data during testing in an SAP system requires a careful approach to ensure that the data is protected and that the testing process does not compromise security and privacy regulations. Here are some key considerations for handling sensitive data during testing in SAP:

Data masking

During testing, sensitive data should be masked or replaced with fake values that still preserve the overall structure and relationships of the data. This can be achieved using data masking techniques, such as substitution, redaction, or encryption.

Access control

Access to sensitive test data should be restricted to only those who have a legitimate need to access it. This can be achieved through role-based access control, which assigns permissions based on the user's role within the organization.

Secure testing environment

The testing environment should be secure and separate from the production environment to prevent unauthorized access or data breaches.

Compliance

Organizations must comply with relevant laws and regulations regarding the handling of sensitive data, such as the General Data Protection Regulation (GDPR) in Europe and the Health Insurance Portability and Accountability Act (HIPAA) in the United States, these apply even during the testing phase.

It is important to keep in mind that the specific measures required for handling sensitive data during testing in an SAP system will depend on the nature of the data and the specific regulations and laws that apply to the organization. A risk assessment should be performed to determine the specific security measures that are required, and a security plan should be developed to ensure that the data is protected during the testing process.

7.1.3. The end-to-end process in SAP

It is important to keep in mind that the end-to-end (E2E) process in SAP is a complex and interdependent process, and any changes or updates to one part of the process can impact other parts of the process. A thorough understanding of the E2E process is crucial for successful implementation and use of SAP in an organization.

Testing provides a comprehensive view of the behavior of the business processes that are supported by the SAP system. Testing with an E2E perspective shows whether all components of the system work together seamlessly, and if the system meets the business requirements.

Test data plays a crucial role in the testing of the E2E process in SAP, testers typically use a subset of the production data that represents various business scenarios. The test engineer needs to charter the E2E process and detail what’s happening with the master data and transactional data.

7.2. Specific considerations for a CI/CD pipeline in SAP

Modern IT delivery teams strive to reduce the duration time of delivery of a change to a system to the minimum. For this reason, many tasks are preferably automated using a CI/CD pipeline. A CI/CD pipeline is a set of automated activities (using tools) that implements the Continuous Integration & Continuous Delivery (CI/CD) principle for specific capabilities that are required in the IT delivery process. For instance, when committing a change, a set of quality assurance checks is done, such as automated code review and the regression test cases are executed.

SAP can provide predefined CI/CD pipelines to automatically build, test and deploy your specific code changes and to speed up your delivery cycle. CI/CD can be achieved with a mix of tools both from SAP and others, for instance Azure DevOps.

SAP can provide various ready-made SAP CI/CD pipelines, for example an ABAP environment pipeline and a General Purpose Pipeline. And SAP provides a shared library with reusable step implementations to create customized pipelines.

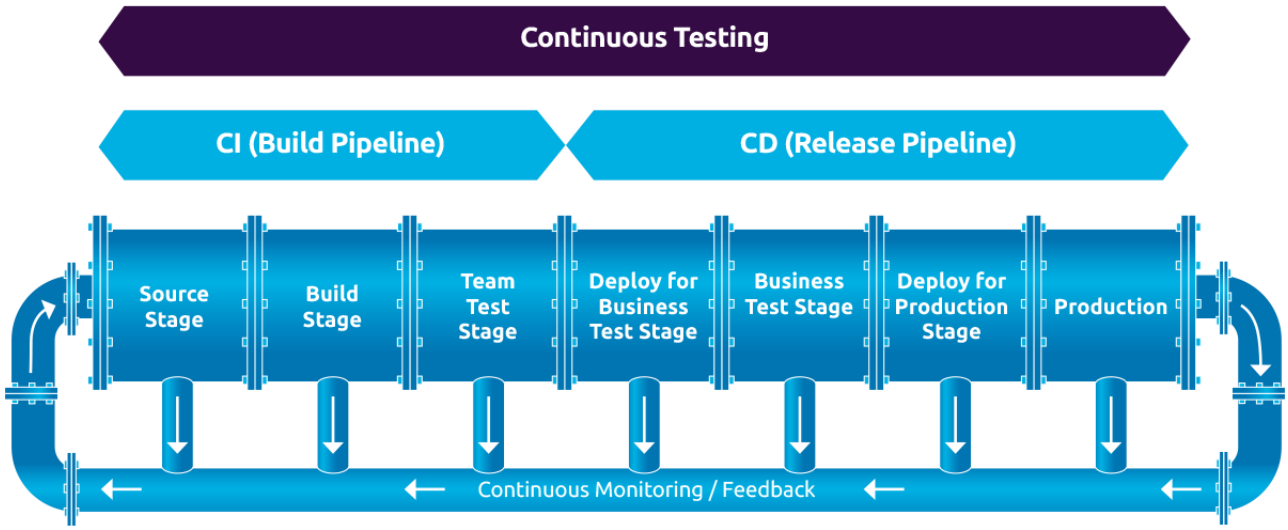


Figure: Basic setup of a CI/CD pipeline (Figure 6.1 of the book Quality for DevOps teams)

7.3. SAP Test Management tools

7.3.1. Introduction to test management tools

Note for the reader: This section is an extension of the information in chapter 23 of the book.

A test management tool can support the test team in an SAP project in the following ways:

- Setting up the test strategy
- Creating and maintaining release/ project cycle information
- Managing (Agile) planning activities
- Integration with open-source frameworks
- Creating and maintaining the test artifacts (Requirements, test scenarios/ suite, test cases, anomalies) specific to each release/ cycle
- Establishing traceability and coverage between the test artifacts
- Test execution support – test run execution and status and screenshot capture
- Metric collection/ reports and graphs generation for analysis
- Setting up and maintaining anomaly management
- Set up regression testing and orchestrating the test automation

Some examples of test management tooling that are commonly used for SAP projects are:

- SAP Solution Manager
- SAP Cloud ALM
- Microfocus ALM
- Tricentis qTest
- Microsoft Azure DevOps
- Jira
- Zephyr
- XRAY
- *And many more*

7.3.2. Effects of test management tools

Some positive effects that a project can achieve by using test management tools are:

- Combining the ability of managing business requirements, test cases and anomaly management with traceability, coverage and insights in requirements that require additional attention.
- Reducing the total time of the testing activities of a project. Effective use of a test management tool can, when efficiently used, decrease the required time to create and execute all required test cases.
- Being able to assign test cases to different testers and track the progress.
- Test management tools can trigger test execution (tools), which accelerates test execution and generates the information about quality and related risks. It gives all stakeholders insights in the quality of the delivered SAP solution.
- Getting better coverage of the test cases and being able to give insights in the coverage of the test cases.
- Create real-time management reports with the progress of the testing.
- Able to reuse test cases for different test varieties

7.4. SAP Anomaly management

An *anomaly* is a difference between the expected behavior and the actual outcome of a test. This is registered so that the cause can be analyzed and resolved. In SAP projects, often an anomaly is called a defect, but because this term can be very confusing, we use the term anomaly as specified by the IEEE 1044 standard. Synonyms commonly used in SAP are Defect, Issue and Bug.

The process of identifying, investigating, and resolving anomalies is known as anomaly management. An anomaly must be investigated and when the cause of the problem is found, it can be fixed. If the problem was caused by a fault in the IT system, then a change to the IT system (and/or the data) is needed. If the anomaly was caused by a fault during testing, then the test must be changed.

After fixing an anomaly, the test involved is retested to confirm that the fix has solved the anomaly. At the same time, a regression test is often done to confirm that the fix did not introduce any new problems.

When the fix of anomalies found during SAP testing is not possible as part of the sprint, anomaly meetings should be held to discuss possible actions:

- Prioritize the resolution of the anomaly: Assess the business impact and prioritize it accordingly. If it is a critical problem, consider moving it to the top of the backlog and addressing it as soon as possible.
- Workaround: Develop a workaround to temporarily resolve the problem until the fix is implemented. Or consciously decide, with the appropriate stakeholders, to make it a permanent workaround and not fix the problem.
- Defer the fix: If the impact is low defer the fix to a future sprint.
- Escalate the anomaly: If the impact of the anomaly is significant, escalate the anomaly to the appropriate level of management for a decision on how to proceed (like a dispute meeting).
- Update stakeholders: Keep relevant stakeholders informed of the status and action taken to resolve it.

The goal of anomaly meetings is to bring the right people together to assess the impact of the anomaly, prioritize it, and work towards its resolution. Participants to include in anomaly meetings:

- Project Manager (or Product Owner in Agile teams): To ensure the resolution is aligned with project timeline and budget.
- Business key user(s): To provide a functional perspective and to prioritize anomalies based on their business impact.
- Development team representatives: This includes both ABAP developers and functional developers. ABAP developers provide a possible technical implementation of the solution, technical feasibility of the solution and effort required to resolve the issue. Functional developers provide the perspective on functional design and configuration related changes if needed.
- Testing team representatives: To provide detailed analysis of the anomalies found during testing and to provide an estimate of retesting efforts related to the fix.
- Scrum Master: May or may not be required, depending on the specific circumstances of the project.

The purpose of anomaly management is to fix problems but also to provide information to improve the IT delivery process. It is important in the continuous monitoring of product quality throughout the whole lifecycle of the product.
Anomaly management in SAP projects is different from other projects in the following ways:

- Systems are often customized according to specific business requirements.
- SAP systems integrate with multiple other systems.
- It may be difficult to isolate the root cause of an anomaly and determine its impact.
- Correct working of an SAP system also heavily depends on quality of (test) data.

Anomaly management should be supported with tools. Usually these are Test Management tools.

7.5. SAP Test Automation & Tooling

7.5.1. Why test automation?

Note for the reader: This section is an extension of the information in chapter 32 of the book.

Test automation focuses on automating the execution of test scenarios (preferably for the entire end-to-end business process) to analyze the quality of the application(s). These test scenarios are coming from realistic business processes, which might also consist of back-end calls (API testing) to help with speed and efficiency and enable very frequent execution of tests (e.g.: in a CI/CD pipeline). In the automation process checks/verifications are a vital part of building tests to ensure that the actions are taken correctly, since automation is in essence telling a machine what to do and validating what's happening in the application to ensure that the scripts are executed correctly and failures/ unexpected results are shown. Examples for SAP would be to verify the message in the status bar and store the created/changed order for later usage to ensure the action was performed successfully.

When deciding on implementing test automation, the reason for starting it is key to being successful. Ensuring speed in the testing process might be a reason. A test automation tool itself cannot solve issues such as delays within your systems or missing data. Stakeholders can do this by being aware of the shortcomings in the processes that are related to quality engineering & testing and selecting tools to mitigate these shortcomings. By doing so, more benefits of test automation can be achieved. The effects of using test tools is described in figure 23.1 of the book.

Knowing on which layer to automate and which tests to select for different purposes is a vital part of effective test automation, for more information see the description of the test automation pyramid in section 37.2 of the book. Overall, the main opportunity for SAP Test Automation would be for regression testing purposes, since this test variety tends to be linear in nature, which ensures predictability of the outcome of a test. This helps to identify where issues lie that need to be solved.

Examples of tools for automated test execution are:

- Tricentis Tosca
- SAP S/4HANA Cloud Test Automation Tool (TAT)
- Worksoft certify
- Selenium
- Cucumber
- Robot Framework
- Qualibrate
- *And many more*

7.5.2. Prerequisites for starting test automation in an SAP environment

Business success factors:

- Clearly specified end-to-end test cases (including expected outcome) are available.
- Common understanding of the impact of processes and cut-off points.
- Awareness of the trail the data will travel, and how this impacts specific processes/triggers.
- Understanding functional changes of new releases for maintaining and implementing these changes in the automated test cases.
- Business alignment by engaging all stakeholders to share advantages of SAP Test automation as well as challenges faced.
- General understanding of SAP Test Automation possibilities and limitations.

Technical success factors:

- Infrastructure for the tool to be deployed, with access to the applications to be tested, also considering cloud environments for unattended execution.
- Access rights for the test automation engineer, and also for the test automation tool itself, to the different systems, for automation purpose with the right authorizations for different roles.
- Configuring SAP for allowing scripting to be possible with the test automation tool.
- Selected tool is the right fit for steering SAP, the test environment is stable (or mitigating factors are considered) and test data is available /can be created to replicate the scenarios to be tested.

7.5.3. Dealing with complexity of SAP test automation

SAP brings complexity for test automation compared to other systems due to the large overlaps in the processes and many different variables such as Master Data & User role set-up. There are quite some dependencies when testing end-to-end, as an entire E2E-process can consist of many different systems that can be regionally different. It is important to carefully select test cases for automation of the end-to-end test, to prevent it from being too large, and to prevent overlap with other tests.

7.5.4. Reusability (Master Data & User Roles)

Within test automation it is useful to work with reusable steps and for SAP processes this is quite easily done through making blocks for different transaction codes or Fiori tiles that only differ in the data that has to be processed throughout the application or user that will perform the action. Reusable blocks also ensure that maintenance can be done in an efficient way, considering it only needs to be done in one place when parameters change for a sales order or extra steps are added.

7.5.5. Bottlenecks in test automation in an SAP environment

The following challenges and bottlenecks may be experienced when applying test automation. Discussing these bottlenecks upfront of the SAP Test Automation project will create awareness and helps solving these issues:

Automation is an isolated island

- This leads to not being aware of new releases and the impact on test automation.
- Not getting the benefits of collaboration and awareness of what test automation can do for different teams.
- Overlap in what is tested manually and through automated testing.

Bad test cases

- The results of the automated test execution are not useful when the test cases that are automatically run do not align with the goals of the test variety and the information needed by the stakeholders.

Test data

- Incomplete, incorrect and changing master data are concerns for effective test automation.

Thinking test automation assures higher speed of the testing process

- Sometimes parts must be executed manually.

Instability of the environment/ technical issues

- System time outs,
- Installation/ configuration errors,
- Network/ hardware errors,
- Application errors.

Complex end-to-end processes

- With multiple SAP and non-SAP (e.g.: 3rd party and legacy) steps, are not well defined nor clear on what the outcome should be, thus these should be broken down into logical scenarios to avoid SAP integration dependencies for SAP Test Automation.

7.6. SAP Performance Testing

7.6.1. Why SAP performance testing?

Applications that have the right performance level will enable users to complete transactions quickly, which will speed up business operations during peak performance.

Performance testing for SAP will reduce the risk of the business processes to not perform as per the non-functional requirements. It will provide insights into the time behavior, resource utilization and capacity of SAP applications and the business processes they support.

Examples of tools for performance testing are:

- Tricentis NeoLoad
- LoadRunner
- JMeter

7.6.2. Types of performance testing

Load Testing: used for exercising the system to perform the various expected loads on a component level as well as an end-user level. On a component level, performance testing will test for conforming to basic performance requirements (database transactions per second, API-calls per second etc.). At the end user level, the performance in a real-life situation with users "hitting" the system from all possible interfaces in real life is tested (mobile/ web/ workstation etc.).

Stress Testing: this aims at going beyond the regular load expectations/ requirements. This may vary from looking ahead to an expected increase in load over the months or years to aiming for the system to break (in order to test failover/ restore processes).

Endurance Testing: this is used to determine whether the system can sustain continuous expected load. Duration can be for example from 8 hours to 2 weeks for the endurance test. One of the purposes of an endurance test is to identify memory leaks.

Volume Testing: a volume test is executed with a huge volume of data in an SAP performance test environment to identify and validate the performance with realistic data volumes.

7.6.3. Common issues in SAP performance testing

Test Data: To execute performance testing, large quantities of test data are required. The data are used multiple times. Testers need to make sure test data does not expire after one iteration. In SAP, test scenarios are executed with master data (like Material Master, Business Partner master) and transaction data (like Purchase Requisition, Purchase Order, Invoice etc.), so creating large numbers (1000 transactions = 1000 Purchase Requisitions, 1000 Purchase Orders, 1000 Invoices) may be a very difficult and time-consuming process.

Real-time performance environment: Performance testing should be executed in a production-like environment. Performance metrics like number of users, number of transactions, response time are derived based on the production environment. However, performance tests are commonly executed in non-production environments which often have a lower capacity than the production environment. This means the results of the performance tests may not be 100% accurate.

Project Stakeholders: Many of the project stakeholders (Business Team, Infrastructure Team, Basis Team) are not aware of the importance of performance testing.

7.7. SAP End-to-end testing, vertical and horizontal

End-to-end (E2E) testing in SAP environments is often complex and involves many teams and stakeholders. End-to-end testing is the responsibility of and executed by the test team (and (future) users. It is intended to demonstrate that the consecutive series of systems support the business processes according to specifications and business needs. End-to-end testing has many approaches, in this training we will focus on the Vertical and the Horizontal approach.

The following business challenges emphasize the need for end-to-end testing:

- Demand for seamless SAP workflows, analytics, and integrated customer experiences.
- Complicated global and increasingly diverse integrations of many applications and data stores.
- Keeping up with upgrades/ updates of SAP and legacy applications to deliver changing business demands, while managing security and compliance.

The subject "end-to-end testing within SAP" has 4 main building blocks:

- Vertical end-to-end testing
- Horizontal end-to-end testing
- Scope and approach
- Stakeholders

7.7.1. Vertical end-to-end testing

In SAP, "Verticals" refers to software solutions, line of businesses or modules that are designed to provide common functionality that can be used across multiple industries or business sectors. Verticals in SAP typically include solutions that provide core business functions that are common across all industries. Some examples of vertical solutions in SAP include SAP S/4HANA Finance, SAP S/4HANA Supply Chain, SAP S/4HANA Sales, SAP S/4HANA Procurement, and SAP S/4HANA Marketing. A vertical can also be an essential non-SAP system which is part of the eco-system.

Different names (synonyms) used for Verticals in SAP testing are:

- Domains
- Modules
- Solution Trains
- Streams
- Line of Business
- Or any other fancy project terminology an organization is using

Within SAP projects these verticals are tested during a system integration test (SIT) mainly with wide authorizations, meaning that role-specific authorizations are not in place yet. The main goal is to verify and validate that the vertical processes are working and meet business needs.

Each vertical needs to work fine before we can bring the solution one step higher to the overarching end-to-end testing which is "horizontal end-to-end testing".

7.7.2. Horizontal end-to-end testing

The next phase is to test the complete end-to-end business process (including legacy systems, 3rd parties, overarching modules, different platform solutions and authorizations). It focuses on how the complete eco-system works together and how data and processes are behaving when we push data through the end-to-end business scenarios. Within the vertical and horizontal testing, test data management is key, for verticals it is a little easier to manage test data then during the horizontal

end-to-end test. Big risks and challenges during the horizontal testing are the availability, synchronization, alignment and dependencies on test data.

During horizontal testing, full integration and the complete business role authorizations should be available. Before starting the horizontal end-to-end test (which involves user acceptance), one of the most important quality criteria to start this phase is that the full solution must be ready, in place and available in the test environment. In these criteria attention is paid to:

- (Master) Data available,
- Integrations are available (API),
  - An Application Programming Interface (API) is a messenger that allows two applications to talk to each other. An API delivers a request from one system to another, then returns a response.
- Users are set up,
- Business Role Authorizations are in place,
- Scope is clear.

When one of these key prerequisites is not in place, **DO NOT** start with the Horizontal end-to-end testing. In the weeks prior to this testing phase, manage and control with all project stakeholders that these preconditions are worked on, that the tasks and activities are allocated and assigned and part of the integral project plan. Discuss progress frequently. Setting up role base authorizations in SAP is a long, tedious, complex and skilled activity executed by the Security Team (see LO20). Working closely together with all sub-projects to define the needs and align with stakeholders that within the project planning all these activities come together at the start of the horizontal end-to-end tests that includes the user acceptance test (UAT). When one of the sub-projects is delayed (e.g., data migration/ integration/ authorizations), the horizontal end-to-end test should not start!

To improve quality early in the development lifecycle and to simplify the SAP landscape and integration dependencies, service virtualization can be introduced. Service virtualization simulates the communication between the systems without using these systems physically. Benefits of using service virtualization are:

- Start SAP testing early in the project,
- Less dependent on test data,
- Less dependent on system availability.

Service Virtualization can minimize dependencies from external systems and streamlines end-to-end testing.

7.7.3. Scope & Approach

For end-to-end (E2E) testing (both vertical and horizontal), it is important the test scope is clear. Which processes, which scenarios, which integrations, which systems etc. are in scope (and which are out of scope). The SAP Quality Risk Analysis is a good input to define E2E testing and connect the individual processes to an E2E process. However, to build proper E2E scenarios, you need to have input from the specialists (business owners and functional/ technical resources). The one who is (or will be) using the system most, the end user, is the best specialist out there. They should know what the business needs are to achieve the business value and how the system should be used.

As soon as the E2E scenario (process-wise) is defined, it is important to define the data you want to validate (data-wise). Process-wise is a forward-thinking process, data-wise is a backwards thinking process. For determining the test data needed, start at the end of the process with the last team in the E2E scenario (often Finance) and ask them what they want to validate, what specific conditions they want to check in the, for example, general ledger or cost & profit centers. When this is known, it is important to think backwards which product, material, service, ship-to-party/ sold-to-party and

or client you want to use to validate this outcome. Determine the output and manage the (master) test data. Work backwards to make sure the data is aligned, available in all systems (enough stock, customer and sold-to parties are in sync and available, material numbers exist etc.).

When this is all in place, documented and agreed, you are ready to execute the horizontal E2E test. To track progress of the E2E test execution, a test management tool is recommended where you can assign different steps in the E2E flow to different resources/teams (see LO30).

Preferable, to do efficient, effective and faster manual E2E test execution, bring all involved E2E stakeholders in the same room. This will increase and improve communication, accelerate execution, increase understanding and will contribute to team building.

7.7.4. Stakeholders

When setting up a test organization & test team, it is important to include stakeholders from all solution trains and modules. A wide knowledge of business processes is required to be able to test properly, especially within the horizontals. It is also important to have stakeholders (like process owners) in your test team who have mandate and the power to change procedures and processes whenever this is needed and who are able to determine impact of these changes.

Stakeholders can be local process owners (they own the process for example for specific locations or regions) and there are global process owners, who own and oversee the impact of changes on a global level). Changes made for a specific region might impact the global solution or other regions which local process owners do not always oversee. It is important to have a mix of these business people in your test organization & test team, especially when designing and executing the E2E flows.

Creating awareness and ownership

Key users who are involved in testing are more likely to feel ownership of the SAP solution and its success. By involving them in testing, they become more familiar with the SAP processes and are more likely to adopt it and use it effectively. They are part of the journey to become the ambassador of the change (see LO23).

However, ownership of SAP quality engineering should be implemented on operational, tactical and strategical level. For example, who owns:

- Test data and test cases
- Test policy and strategy
- Test planning
- Test environment
- Test tools
- Test processes
- Authorizations
- Business processes
- ….

Quality awareness must be addressed throughout the whole (project & operation) organization. With quality ownership comes quality awareness. Early quality awareness of stakeholders improves the entire result of the SAP solution.

This syllabus is maintained by the members of the TMAP Special Interest Group and the Sogeti Academy. You can contact the Sogeti Academy in the Netherlands at academy.nl@sogeti.com.

You can contact exam provider iSQI at tmap2020@isqi.org

About Sogeti

Part of the Capgemini Group, Sogeti operates in more than 100 locations globally. Working closely with clients and partners to take full advantage of the opportunities of technology, Sogeti combines agility and speed of implementation to tailor innovative future-focused solutions in Digital Assurance and Testing, Cloud and Cybersecurity, all fueled by AI and automation. With its hands-on 'value in the making' approach and passion for technology, Sogeti helps organizations implement their digital journeys at speed.

A global leader in consulting, technology services and digital transformation, Capgemini is at the forefront of innovation to address the entire breadth of clients' opportunities in the evolving world of cloud, digital and platforms. Building on its strong 50-year heritage and deep industry-specific expertise, Capgemini enables organizations to realize their business ambitions through an array of services from strategy to operations. Capgemini is driven by the conviction that the business value of technology comes from and through people. It is a multicultural company of almost 220,000 team members in more than 40 countries. The Group reported 2019 global revenues of EUR 14.1 billion.

Visit us at www.sogeti.com