# 5. Process and Industry-Specific Needs of Requirements Management

**Study Goals**

On completion of this unit, you will be able to…

…understand the basic process of requirements management, shared by all fields and industries.

…understand the specifics of project requirements of particular industries and fields.

…understand, how all fields and industries can benefit from insights into the specific conditions for requirements management in specific industries.

## Introduction

Requirements, in their most basic form, can be identified in any business transaction. Requirements are not always specified, nor would a specification be necessary for all given scenarios. In more complex transactions, clients can barely avoid specifying their needs for the contractor to understand and deliver systems that produce actual value for a client.

Requirements Management is relevant in all industries and sectors, from business to arts, from politics to the social sector. We will illustrate the necessity and specifics of different sectors in this unit.

1. First, we will learn the very basic terms necessary for an understanding of the core message of this course book.
2. Second, we will lay out the commonalities in Requirements Management that are relevant in all sectors.
3. Third, we will demonstrate the differences based on four sectors and evaluate how all requirements professionals can benefit from insights into the specifics of different sectors.

We will start by recalling the basic terms to demonstrate how requirements are an element of any business transaction and, as some may argue, of any human interaction. These terms have more specific definitions in any given business context - the following definitions are made in the most abstract sense possible. It is the purpose of high - level definitions to illustrate how requirements are relevant for any area of organized human interaction. Please be mindful to only apply these definitions when explicitly asked for the most high - level definition. In all other cases, the previously provided definitions apply in business, academic, and exam environments.

*Transaction*: A transaction is a social situation in which two individuals or organizations agree on exchanging goods, services, and/or financial resources. The concept of a transaction applies to any situation with at least two parties. One party provides the other with a resource that is desired by that party - and vice versa. Once they agree upon the exchange of these resources, this exchange is called a transaction. All organizations, be they companies, social associations, or public organizations, are resource - dependent and rely on receiving these resources through transactions.

*Complexity*: Once involved in a transaction, the level of complexity becomes critical. Simple transactions without complexity do not require much consideration. The desire to purchase five boxes of A4 paper 4,4g is simple enough for the client to formulate and for the contractor to understand. Transactions, however, are often more complex. Especially when the transaction is executed as a project, both partners usually perform the transaction under certain conditions that they have not experienced previously. The lack of certainty and the consequent inability to predict causal relationships is referred to as complexity. In practical terms, clients do not know exactly what they want, contractors do not understand the clients, and the clients do not understand the contractor. In these situations, dedicated Requirements Management alleviates both parties from the high degree of complexity. Organizations with a lower level of traditional business drive, such as NGOs, governmental organizations, and social clubs, need more requirements - related attention as they are often unfamiliar with requirements - specific terms and project - specific processes.

*System*: While we have technically applied the term so far, systems can be created in different forms and can, thereby, be desired by all kinds of organizations. A social system, for example, can be a community of people. If an organization has an interest in forming such a community, it can commission a contractor to establish this. Think of a private university that wants to tap into the potential of its alumni community. Social networking companies offer services to integrate alumni into one community. Furthermore, systems can be biological, such as when rejuvenating a biosphere, or completely digital, when developing software for a very specific application. Think of a system as the object of a project, regardless of the industry or sector.

*Client*: In the following sections, we will understand the client as any organization that could commission another organization with a project. Again, these can be organizations from all sectors, not just profit - oriented companies.

*Contractor*: Contractors are on the opposite side of the transaction; organizations commissioned with executing (parts of) a project. Non - profit organizations rarely take on this role, although it is not completely unheard of.

*Requirement*: In the most general sense, a requirement is a specified desire by both parties of a transaction. At a high level, requirements exist in any transaction. When purchasing bio - bread in the bakery, customers expect certain quality requirements attached to the bio - label. Since the bio - label implies certain characteristics, customers usually do not discuss their requirements further. Both parties agree to some extent on what the requirements mean and proceed with the transaction. If we imagine a kindergarten that is contracting an art collective to create a pedagogically worthwhile playground, both might have very different ideas in mind. In this case, the kindergarten needs to be extremely specific in specifying their requirements regarding pedagogical concepts, safety, design, and materials, as it cannot be expected for most artists to intuitively know these requirements.

In the following sections, we will introduce the commonalities and differences between some illustrative industries and sectors and discuss the specific conditions regarding requirements.

## 5.1 Basic Process of Requirements Management

Regardless of the sector, most nontrivial projects share the need for a certain number of requirements - related tasks. Any system that is developed in a project is motivated by the various requirements of a client. Regardless of industry or sector, the project manager or members of the project team need to ensure that the finished system fully complies with all implicit and explicit expectations. Implementing a conscious planning process for Requirements Management is the solution that is usually applied in successful projects across all industries.

The project manager, the client, or any other responsible stakeholder will have specified the project's requirements; therefore, a planned process for the identification, assessment, tracking, documentation, implementation, and control of each requirement is usually applied.

The relevance of a planned process can be ascribed to the need to ensure that each and every demand connected to the project and the project development process is tracked, captured, addressed, and analyzed. Furthermore, a planned process will prevent project team members from losing track of a requirement that has been established by the client, the contractor, and the stakeholders involved in the project. A planned process also resolves all of the common reasons that can result in the failure of a project such as requirements risks, uncontrolled expansion of the project scope, loss of control over the budget, and delayed milestone delivery.

In the following, we will examine how to develop a basic planning process that is shared by all sectors and industries before we delve into the specifics of particular domains.

#### Basic structure of commonly shared requirements planning process

While we have applied the content of the previous units to technical projects, the following steps are an abstraction from this application. The steps are compiled to emphasize the need for particular planning tasks in the requirements process, regardless of whether they are technical, digital, or social projects:

* 1. Specification of the project’s purpose and scope
	2. Involving and listening to all stakeholders of the client’s organization
	3. Establishing an accountability structure
	4. Resolving requirements - related conflicts between stakeholders
	5. Defining priorities of requirements
	6. Setting up traceability standards
	7. Monitoring, integrating and administering requirements changes
	8. Outlining and disseminating requirements to all relevant stakeholders
	9. Choosing the right methods for requirements analysis and administration

We will go through these processes in more detail and elaborate on how they are generally necessary, independent of the project domain.

### Specification of the Project’s Purpose and Scope

By definition, a project is a unique endeavor to perform a task in a limited period of time. In any domain, this endeavor needs to be defined in a project scope. The scope specifies all the project's deliverables, expenses, objectives, activities, and due dates, as well as everything the client hopes to accomplish through the project and all of its components (Haley et al., 2006).

Once defined, the scope is then integrated into a project charter or project plan and is often the final piece before the approval process.

Without the scope, the biggest threat is that project managers design and implement a system that goes beyond the limitations of the project. Project management, furthermore, will lack the knowledge needed to recognize all the changes that become project requirements.

### 5.1.2 Involving and Activating Stakeholders of the Client’s Organization

The second domain - independent step is to identify and involve all relevant stakeholders in the requirements process. This way, project organizations ensure they do not leave out important functions and elements from the system but also build connections for easy and rapid contact with each one during the project process (Project Management Institute, 2016). Different domains have different styles of communication and different organizational cultures - so while the process of involving and purposefully activating stakeholders may vary, systematic involvement is key in any domain.

### 5.1.3 Establishing an Accountability Structure

The third domain - independent shared task of the basic planning process is to define responsibilities. Any project is a consolidated effort of multiple people to execute tasks that, when purposefully connected, resulting in the creation of the desired system. By nature, a project is a shared effort with the aim of exploiting the division of labor. The creation of an accountability structure is an essential aspect, regardless of industry or sector. This structure attributes the requirements to phases and parties (individual managers, teams) and allows for holding them accountable for the work done (Larson & Larson, 2013).

Additionally, project organizations of any domain need to ensure that the requirements process is accessible and transparent to anyone involved, as it outlines each person's responsibility in the project process.

### 5.1.4 Resolving Requirements-Related Conflicts Between Stakeholders

Any project, no matter how professional, will experience some conflicting requirements that are not readily acceptable to all stakeholders. Depending on the context of the project, the number of distinct managers, stakeholders, and people involved varies; and even though conflicts will increase in number, the more stakeholders are involved, the more difficult it will be for any project to avoid any kind of conflict.

A strategist, for instance, might request a tool that can carry out a significant number of separate activities simultaneously, but the operating team might view most of these capabilities as unnecessary and unworkable (Kossmann, 2016).

To get all stakeholders to agree on the system’s features and resolve this requirements conflict, projects in any domain must include a solution in the requirements process plan. Consequently, getting all stakeholders on the same page is a crucial part of project management in any industry or sector.

### 5.1.5 Organizing the Process of Requirement Prioritization

Be aware that the more intricate the initiatives in a particular sector are, the more requirements the stakeholders related to these initiatives will create.

When confronted with a large number of requirements, projects are forced to correctly prioritize them, so that the project development team will know when and how to implement each requirement (Larson & Larson, 2013).

Thus, it is part of any project to identify all requirements that are essential to the progress of the project*.* These need to be allocated to the members of the implementation team who will work on them during the upcoming project phase.

To make a clear and educated decision when prioritizing requirements, the influence of stakeholders, the technical requirements, and the approval by key stakeholders should always be taken into account.

### 5.1.6 Setting Up Traceability Standards

Defining standards and procedures for traceability is the sixth phase of the requirements planning process. As discussed previously, requirements traceability refers to the method used to monitor project requirements over the course of the entire project in question. An efficient traceability system is used to support the implementation as desired by the client.

Traceability standards are used in most projects across domains and are usually defined in documents that map and trace all requirements in accordance with their unique use cases. In order for the development team to know what was committed and what needs to be delivered to the client, any contractor needs to ensure that they have a requirements baseline in place, while the responsible parties are handling the requirements traceability (Rupp, 2014).

### 5.1.7 Monitoring, Integrating, and Administering Requirements Changes

Projects in all industries must realize that adjustments to the specifications and the project's overall development process are unavoidable. No matter how thorough a project strategy is, changes will nonetheless occur.

All project managers need to set up a procedure to handle the changing needs as they occur over the course of the whole project development lifecycle.

In most cases, requirement strategies include a change control process to accommodate this condition of changing project environments. If structurally integrated into the basic requirements process, project development strategies will remain flexible throughout the lifecycle and allow for a variety of changes that may arise.

Based on experience, a number of main points need to be addressed in the planning process to set up a solid requirements change structure:

* Justifications for the change request
* A brief statement that relates the before and after to each other
* Stakeholders that need to formally approve and implement the changes
* The effects that the changes might have on the project as a whole

### 5.1.8 Structures for Disseminating Requirements to all Relevant Stakeholders

The next step of the process to bear in mind is that the requirements planning process should explicitly lay out the channels of communication and collaboration between the project's stakeholders and the project team (Haley et al., 2006).

Therefore, an important element of any requirements process is to define who will communicate the requirements (especially in the case of changes) to all stakeholders and participants. Furthermore, when they will be informed, who should be made aware of the adjustments, and how stakeholders will be made aware of the changes must be defined.

### 5.1.9 Choosing the Right IT Tools for Requirements Analysis and Administration

Project teams of any domain can manage, document, prioritize, and specify requirements for system development and implementation with the aid of various Requirements Management applications. Additionally, these programs link development teams with relevant stakeholders and, thereby, open channels for discussion regarding the system’s specifications and adjustments.

Tools for Requirements Management can provide contractors with a thorough, top - down understanding of every aspect of determining the scope of a new product or service. Using this program, contractors can ensure that new systems meet their client’s standards, their budgetary restrictions, and the needs of their stakeholders (Alebrahim, 2017). Software for managing requirements enables a more systematic approach to developing and implementing systems. In addition, they usually integrate well with other tools for managing the project lifecycle.

According to Alebrahim (2017), in the most general sense, the application of Requirements Management current standards should meet the following criteria:

* document requirements and connect them to the respective steps of the project process
* support the analysis of the requirements regarding the goals and restrictions of a system
* accommodate the need for flexibility by supporting a structured change process
* encourage an ongoing dialogue between development teams, stakeholders, and relevant parties involved and affected by the system and the project

Keep in mind that a number of further individual needs for requirements - related IT tools are necessary for different domains.

### Self-check questions

Q: What are the stages of the basic Requirements Management process?

A: *1) Specification of the project's purpose and scope, 2) Involving and listening to all stakeholders of the client’s organization, 3) Establishing an accountability structure, 4) Resolving requirements - related conflicts between stakeholders, 5) Defining priorities of requirements, 6) Setting up traceability standards, 7) Monitoring, integrating, and administering requirements changes, 8) Outlining and disseminating requirements to all relevant stakeholders, 9) Choosing the right methods for requirements analysis and administration*

Q: Which four elements need to be planned to establish a solid change mechanism later on in the project?

A: *1) Justifications for the change request, 2) a brief statement that relates the before and after with one another, 3) stakeholders, that need to formally approve and implement the changes and 4) the effects, the changes might have on the project as a whole*

## 5.2 Specification for Projects in Mechanical and Plant Engineering

Mechanical and plant engineering projects are predominantly characterized by volume and technical complexity. The related systems, the industrial plants for the production of chemicals (e.g., polyethylene), the processing of metals (e.g., steel), or the development of natural resources (e.g., mining) regularly tie up more resources than most other industries. The systems are usually complex technical systems that are designed and developed for individual customers. Since they tie up large amounts of resources, development projects have long been on a high professional level with intense utilization of Requirements Management concepts.

### 5.2.1 Increased Need for Resilient Supply Chains

The volatility of the social and economic environment (e.g., the COVID - 19 crisis, developments in the financial markets, radical political developments, and economic sanctions) has left its mark on the corporate policies of the plant manufacturing industry. Companies have heavily invested in setting up supply chains that are resilient to crises since unforeseen environmental developments have a detrimental effect on value - adding supply and demand. It is apparent that the previous mantra of reducing costs before any other consideration has transformed international supply networks into an unstable structure. To stabilize this vast network of suppliers, companies have put more emphasis on crisis plans and scenarios, and the spectrum of viable courses of action should be established (Mukherjee, 2021).

* Clients are well aware of their contractors’ lack of control over the production of their own components. While clients are often heavily dependent on this supply chain, they rarely specify their concerns about supply chain reliability as requirements. While this condition is unique in the context of the four industries discussed in this course book, considering supply chains in requirement specifications may be valuable to all projects. The European Union has implemented laws that force companies to thoroughly analyze their supply chains in case they might be held responsible for human rights violations somewhere up the supply chain. Implementing supply chain requirements in the specification is, therefore, a necessary step for all industries.

### 5.2.2 Combination of Reliable Planning and Flexibility

Artificial intelligence is a crucial element of the industrial and plant manufacturing industry’s efforts to benefit from the promises of digital transformation. Yet, the industry still faces some barriers to fully exploiting the new opportunities. Even though some tangible implementations of the new technologies have now arrived in practice, other efforts, such as General Electric’s open - source plant operating system PREDIX, have lowered the expectations for the digital transformation of industrial plants (deutschlandfunkkultur.de, 2020). Consequently, companies have been hesitant to implement their digital strategies. Current attempts to move on rely on making digital transformation efforts measurable in terms of specific objectives; only then are they transformed into tangible actions.

* The complexity and the volume of most mechanical and plant engineering projects, in combination with shorter development cycles, challenge projects to combine two imperatives that appear contradictory: a) planning the development with maximum efficiency and a minimum of redundancy; and b) allowing more flexibility to accommodate new developments in the system during the process (Zontar, 2022). This challenge is not entirely uncommon in other industries. Even smaller projects are often under a lot of pressure to combine planning efficiency with a flexible approach. Agile project management has found its place to counter the inflexible approach of traditional project management. Contemporary approaches have successfully combined the advantages and disadvantages of both traditional and Agile project management and accommodate the need for requirements specification (Steinle et al., 2021). This may be interesting to industries, which still struggle with the inflexibility of Requirements Management.

### 5.2.3 Increased Focus on Services

Clients’ needs for complementing industrial products with industrial services has risen. Plants have gotten more complicated, new companies have entered the competitive landscape, and technological substitutes have been developed. In terms of service, however, plant manufacturers still struggle to maximize their clients' sales and profitability potential. They are often a long way from turning a significant amount of the operating costs of their clients into service revenue. Manufacturers have identified this untapped potential and are investing in this transformation (Friedli et al., 2021).

* Clients have become aware that no one knows the complex system of a large industrial plant better than the manufacturer itself. Once there is an agreement on not only developing and implementing but also operating and maintaining a plant, this agreement must be reflected in the requirements specification. As the contractor takes on some roles that have traditionally been in the hands of the client, we might observe an unprecedented shift in the way Requirements Management is carried out (see the principal agent concept in the next unit).

### Self-check questions

Q: What are the main requirements - related challenges in mechanical and plant engineering?

A: *Finding ways to combine flexibility and efficiency*

Q: What are clients’ main concerns regarding the value chain of plant manufacturing companies?

A: *Reliability of supply in case of external shocks*

## 5.3 Specification for Projects in Civil Engineering

Civil engineering refers to the design and development of building technical infrastructural systems and is traditionally contrasted with military engineering. Civil engineering comprises the construction of streets and highways, buildings, housing, airports, and harbors. Projects are of varying size and complexity; while the development of a playground in a residential neighborhood may be specified and implemented in a straightforward fashion, the construction of an airport is likely a tremendous effort, as the example of Berlin International Airport has suggested(von Gerkan, 2013).

The wide variety of projects summarized under the umbrella term civil engineering leaves little room for generalized trends that shape all segments of the industry. To provide an idea for current challenges, we will familiarize you with a selection of current developments in individual segments of civil engineering.

### 5.3.1 Transformation of Urban Areas

Urban social planning in Western European cities emphasizes the strategic development of residential areas to fit the world's changing standards. Open spaces, communal areas, and other facilities such as gyms, pools, and cafés are increasingly demanded by residents to improve the quality of life in their neighborhoods (Duvernoy, 2016).

* Elements of civil society are getting stronger and need to be integrated into the requirements elicitation process by companies involved in respective projects.

### 5.3.2 Digitalization of Heavy Labor

The utilization of technology and the automation of labor are among the current developments that change the way companies approach construction projects. Companies have heavily invested in operating with modern heavy equipment and automated technologies that minimize error margins and substitute hazardous human labor. With the appropriate technology, updated machinery, and robotic equipment, the danger of accidents is drastically decreased, opening the way for safer and more intelligent working conditions.

* Health and safety have long been a concern of companies in industries that have traditionally been vulnerable to accidents. Process requirements in these industries often explicitly state health and safety standards, which are usually complied with in most Western projects. In recent years, health and safety have become a trend in industries whose conditions have no risk of fatal injuries (e.g., IT). These industries can learn from civil engineering to integrate these concerns into their requirements practices.

### 5.3.3 Remote Progress Monitoring

GPS tracking systems, monitoring, 3D inspection, and the deployment of drones reduce the need for project personnel to be present on the project site at all times. The usage of GPS has steadily increased, and it is currently being employed in innovative ways to monitor progress and daily updates. The correct gathering of data frees engineers from site - bound responsibilities, enabling them to grow their workload and customer base.

* Civil engineering clients are often public authorities without the market pressure to adapt to new technologies. Instead, these client organizations tend to place a greater emphasis on process requirements and regulations that were designed for predigital conditions. This may create conflicts regarding process requirements. It may also require some time to thoroughly evaluate the requirements and regulations; related industries may greatly benefit from the experience of working with civil engineering contractors.

### 5.3.4 Productivity-Enhancing Equipment

Productivity - enhancing equipment, such as smart excavators, are devices that work in collaboration with human operators. In civil engineering, they are applied by contributing to the restoration of human performance by enhancing mobility and physical strength. While their impact remains to be evaluated, the implication is that construction sites will appear drastically different.

* As a matter of reliability and accountability, clients may insist on a certain level of human intelligence involved in the heavy work of civil engineering. This will be reflected, to an increasing degree, in the requirements specification. Civil engineering contractors will set a precedent for this question that, thus far, has rarely been part of requirements - related negotiations. Other industries are well advised to keep a close eye on this development.

### 5.3.5 Sustainable Use of Construction Materials

Environmental considerations have moved to the center of political and administrative decision - making. Using recycled material in the construction of buildings has become a major trend in recent years. Reusing material to lower communal carbon footprints is beneficial for the environment and has been increasingly called for by local governments (Halliday, 2018). Recent innovations include self - healing concrete, the application of 3D printing technologies, structures that consume pollution, and even kinetic pavement (although not fully developed).

* While many local governments already require contractors to apply sustainable materials, the environmental trend could lead to a new requirements category altogether. Sustainability requirements could soon be part of most requirements specification sheets - consequently, their development might be beneficial for most industries

### Self-check questions

Q: Who is the main addressee of requirements in civil engineering projects?

A: *Public authorities*

Q: What are the main requirements - related issues connected to the automation of construction sites?

A: *Reliability and accountability*

## 5.4 Specifications for Projects in the Social Sector

Social sector projects refer to the development of systems for the purpose of benefiting society. These systems are usually made of human interaction - examples include the establishment of structures for childcare, educational institutions, or the empowerment of marginalized groups. It is usually more difficult to measure the success of the development of a social system than it is to measure the success of a construction project. The condition that most resources spent on social projects are public resources or private donations makes social project management, even more demanding (Poulin et al., 2021). Specifying requirements plays a crucial role in solving this contradiction.

### 5.4.1 Experimental Project Methodology

The progressive and less key performance indicator (KPI) - oriented environment of the social sector has prevented individuals and organizations from developing a methodology - related tunnel vision. While project and Requirements Management methodologies have found their way into the social sector, organizations are free from routines and open to combined and experimental approaches. Possibly, for this reason, the notion of hybrid project management has received attention in social projects (Poulin et al., 2021).

Hybrid project management, in its simplest form, refers to methodologies that combine approaches from the conventional Project Management Institute (PMI) methods with agile approaches.

This may suit the interpersonal and cultural work environment of the social sector. When intertwining the conventional approach with Agile project methodology, project members with differing perspectives and working styles may collaborate in their own way, which has the potential for increased stability, engagement, and efficiency in the project (Steinle et al., 2021).

* While the concepts of Requirements Management and agility may seem contradictory, the term *requirements* can actually be translated into *user stories* (Steinle et al., 2021). This calls for a careful setup of requirement specification documents and a mindful, process - oriented structuring of the project. Project organizations need to determine which techniques work best for a certain project using both their insights into the social domain and their project management expertise. For the best of both worlds, social projects are challenged to attract project managers who match this profile. Arguably, this may impose a challenge in this particular domain, which can only be solved by project - specific professional training and the specification of training as a requirement in the specification sheet.

### 5.4.2 The Impact of Human Emotions

The fundamental motivation in the social sector is different from the other domains discussed in this unit. Hard numbers are always a critical element in social projects as the spending of public resources exposes them to a higher degree of public scrutiny. The motivation of individuals to enter the social sector is arguably linked more closely to the social purpose of the domain. Thus, empathy is a greater emotional driver for entering a career path in the social domain than a high income and self - interest in general (King, 2011). While subordinating self - interest may impose a challenge to motivation from the perspective of classical economic theory, empathy also provides social project managers with advantages. Empathy increases the capacity to comprehend and identify emotions related to project success. The impact of project management extends beyond establishing the scope, meeting deadlines, and determining the budget. Additionally, project managers must manage people, which adds complexity. Failure to comprehend the emotions of team members might result in a great deal of emotional activity inside a team, with outcomes that are not always ideal.

* These conditions can be manifested in Requirements Management. The entire setup of the requirements elicitation and administration process can emphasize collaboration. The challenge is to find the optimal balance between centralized and cooperative decision - making. This, of course, refers to requirements administration to a higher degree than is relevant for each specification.

### 5.4.3 Introducing KPI to Social Projects

In order to keep up with the professionalization of project management in the social domain, large amounts of information are required for realizing the potential for optimized efficiency in projects. Increasingly, social project managers are using data insights based on KPIs to make educated choices to better use their limited resources for the benefit of their clients (Taylor, 2016).

In different activities, such as project planning, quality control, or risk assessment, the application of big data analysis has changed the way projects are managed in most project domains - and has now started to receive some attention from the social domain. The gathered data is valuable for learning the optimal way to staff project teams, the number of positions for each workstream, and the necessary skill sets for managing projects more effectively.

* Social clubs or project companies in the social sector are well - advised to take a look at other domains where the use of KPIs is long - established. Clients are, by nature, interested in the efficient use of their resources and may very well insist on specifying them in the requirements specification sheet. Arguably, KPIs are difficult to measure in the development of systems with a high level of human integration. This is, however, even more of an imperative for social project managers, to proactively come forward with their own ideas on how to measure project success and how to implement these measures into the requirements specification sheet.

### 5.4.4 Remote Project Management

Public policy measures to battle the COVID - 19 crisis have forced companies to adjust to trends in the setup of the physical office structure that several other industries had long gotten used to. The home office trend could be established in social project management as well, and there is no indication this tendency will not persist.

Even in traditionally consensus - and communication - intense domains, such as social work, remote project management provides several advantages. The first is greater scheduling freedom, and the second is not having to travel to the workplace every day. Additionally, it is crucial to consider investing in solutions that might assist safeguard project organizations in a remote work environment.

The term social project management is sometimes referred to as a new collaborative project management methodology (Dalcher, 2017). While applying the term in its original sense, the collaborative nature of the methodology may be beneficial to the domain that shares the same name (confusion expected).

* The social domain deals with systems that have a greater degree of human interaction than, for example, an automated power plant. This central condition of the sector needs to be accommodated in the requirements specification, as well. Contractors and clients can, for example, specify the required scheduling of daily meetings and phone calls to assess project progress and hold team members responsible by requesting regular status reports or utilizing team collaboration software that facilitates human interaction, instead of eliminating it.

### Self-check questions

Q: Who are the clients of projects in the social sector?

A: *Clients are predominantly social clubs and public authorities.*

Q: What is the source of financial resources in social projects?

A: *Public funding and private donations.*

## 5.5 Specifications for Projects in the Software Sector

When talking about IT projects, we are focusing on projects, where a client commissions a contractor with the design, development, and/or implementation of an IT system. Obviously, the entire spectrum of the software sector is much broader; but from the perspective of Requirements Management, this focus provides the best contextualization with both the previous units of this course book and the other industries discussed in this unit (Alebrahim, 2017).

IT development projects can range from small volumes and (relative) simplicity to extreme complexities that necessitate the involvement of multiple partners, such as PMO service providers, requirements engineering companies, software developers, and business consultants.

Even for experienced professionals, it is difficult to keep track of the current trends and their consequences for requirements specification - as many current developments are of a strictly technical nature. We will, however, provide you with some examples to familiarize you with the pressing importance of intense Requirements Management efforts in most IT projects.

### 5.5.1 Automated Code Auditing

The increased velocity of life necessitates that IT companies implement new software systems more rapidly into their client’s IT structure. For this reason, many developers have turned to automated code review, in which particular tools examine the functionality and reliability of code automatically based on predetermined standards. Considering the number of lines of code necessary to fulfill a single requirement, the usage of these tools is highly appreciated by IT project managers (Coenders & Rolvink, 2014).

* As tools for the automated review of code are still in the early stages of successful application, informed clients may codify their own standards on automated reviews in the requirements specification sheet. Once industry standards have been established for this method, clients may even specify the review with these standards in the requirements documentation.

### 5.5.2 Concentration on Software Quality Standards

A growing number of clients expect their software developers to provide certification from internationally recognized agencies. This is occurring as a result of the integration of software applications into critical domains, including critical infrastructure, public security, military, and health. The popularity of the International Organization for Standardization (ISO) certification is likely to continue since it assists businesses in enhancing their reputation and attracting more customers by indicating they adhere to high - quality standards (Nazeer & Marnewick, 2018).

* It has been an established practice in larger and more professional projects to place strict requirements on certifications. While clients can decide on only proceeding with certified companies, they have often been unsure about the qualification of the project personnel. These can be mitigated by providing special training to employees that can be proven with certifications in IT development, project management, or Requirements Management. The need for a selection of these certifications can be part of the requirements specification sheet.

### 5.5.3 System Migration

Many businesses continue to use older IT products as part of their IT structure. Typically, they are built on obsolete technology that is incompatible with the most recent innovations, which can result in a variety of practical problems. One reason why companies are hesitant to migrate to a new system is the effort of migrating data to the new system and integrating it into the overall IT structure of the company.

* Another requirements category that may become an integral part of Requirements Management is migration requirements. While this aspect is often specified in larger projects, it has not fully arrived in the project management mainstream. Other industries are well served, using this as an example for their own integration of new systems into existing structures.

### 5.5.4 Cloud Technologies

Evidently, software development organizations will use cloud - native technologies when clients commission them with app development, team administration software, and communication tools. They are, by nature, infrastructure agnostic and can operate on different servers, so any business may employ them without difficulty.

Cloud - native systems enable flexibility and scalability and boost the productivity of software development teams by using containers and microservices.

* The requirements - related issues that come with the need for cloud - hosting of IT systems are highly specific to the IT sector. Besides the main concern is security, clients need to decide if they prefer hosting on a public, private, or hybrid server.

### 5.5.5 Artificial Intelligence and its Limits

The hype of artificial intelligence is regularly limited by disappointment in its practical usefulness. Developers distinguish between three types of AI, which can be applied to manage expectations in the requirements specification process. According to Page et al. (2018), IT project managers need to familiarize clients with three very different concepts, to avoid confusion.

Narrow AI: Intelligent systems that concentrate on a single objective and accomplish a single task. While naturally limited in their applicability, these systems are the most reliable. Common examples of narrow AI include language tools in word - processing applications such as Microsoft Word.

General AI: Intelligent systems that reproduce the human brain's full cognitive processes. They have the capacity to acquire new information and apply it to address new challenges. Clients need to be made aware that companies are still far from creating intelligent robots with this degree of intellect.

Artificial superintelligence: At this moment (and for the foreseeable future) artificial intelligence will not be able to imitate human behavior and cognitive processes or achieve self - awareness and exceed our capacities. While this topic is often discussed, there must be no confusion by the client that, at present, this is anything other than a theoretical concept.

* It is crucial to manage the expectations of clients in terms of AI applications. Experience has shown that technologies cannot replace human cognition and intuition. Unrealistic media coverage may lead to unrealistic expectations when a client reads terms like machine learning in a requirements specification sheet. While software developers may use these terms regularly in an appropriate context, clients may have unrealistic ideas of what these terms imply. Caution with the usage of these terms in Requirements Management is therefore necessary.

### 5.5.6 Low-Code/No-Code Programming

Low - or no - code development is a novel approach to producing software solutions, which aims to simplify software engineering. Through graphical user interfaces and setup, low - code systems allow for software development without using conventional code (Apurvanand et al., 2020) These programming environments may be desired by clients since they enable their IT staff with minimal or no particular software development expertise to add new functionality or interfaces at a later stage.

* While tech - savvy clients will be aware of this trend and will specify their respective needs in the specification sheet, this trend highlights an aspect that is relevant for all industries: clients must consider their requirements in terms of independently extending their systems. In most cases, a strong dependency on the contractor is to be avoided and even translated into specified requirements.

### Self-check questions

Q: What type of artificial intelligence can be safely specified in current requirements specification sheets?

A: *Narrow AI*

Q: Which requirements toward certifications are typically part of a requirements specification sheet?

A: *Professional certifications of individual staff members*

Summary

In the fifth unit of this course book, we have discussed the basic process and all the steps of Requirements Management that are generally necessary for complex projects, regardless of their domain. These steps include the specification of the project's purpose and scope, the systematic involvement of all stakeholders in and around the client’s organization, the establishment of an accountability structure, identifying and resolving requirements - related conflicts between stakeholders, the prioritization of requirements, the definition of traceability standards, the development of a requirements change process, communication of all requirements-related activities to all relevant stakeholders, and the selection of the right methods for requirements analysis and administration.

We then elaborated on the current developments in mechanical and plant engineering, civil engineering, the social sector, and software development. We then elaborated on current developments in each domain and derived implications for Requirements Management in general and requirements elicitation in particular. Where applicable, we commented on insights relevant to other domains and what they can learn from these domain - specific challenges.

# 6. Critical Reflection

**Study Goals**

On completion of this unit, you will be able to:

understand which costs are related to Requirements Management efforts.

understand the requirements - related aspects of current trends to combine traditional and agile project management methodologies.

understand the limitations of Requirements Management.

## Introduction

We are nearing the end of our course book. To wrap up the complex topics that have been covered in the previous units, we will reflect upon different aspects of Requirements Management that have not been addressed by the classic requirements content so far.

This includes a critical reflection on measuring the costs and benefits of Requirements Management, a brief assessment of the concept of requirements in the context of agile concepts, as well as a more elaborate discussion of the limitations of Requirements Management.

## 6.1 Costs/Benefits of Requirements Management

The overall costs of a complex technical system development and implementation project are impacted by the quality of Requirements Management. To optimize schedules, budgets, and the overall success of the projects, both contractors and clients rely on approaches that enable the gradual, systematic improvement of Requirements Management.

Since the discipline was established in the 1970s, all companies that develop technical systems in projects have encountered costly requirements issues (Sawyer et al., 1999). The logic of traditional Requirements Management implies that, instead of eradicating these issues, companies must uncover them at a stage when the monetary damage to the project is still acceptable. Even if uncovered in an early stage, these requirements - related issues cause delays in project delivery, cost more than expected, and are of lower quality, while falling short on important client demands.

Consequently, it is safe to assume that Requirements Management efforts generally contribute to project success and that poor Requirements Management generally results in higher costs.

In the first four units of this course book, we elaborated on how to improve the quality of Requirements Management based on tasks, tools, and practical considerations. There are, obviously, costs attached to these efforts. These costs manifest themselves in expenditures on human resources and possibly specific training efforts. The benefits are related to the very same aspects, as a precise requirements analysis, for example, not only costs financial resources but also prevents costly misunderstandings between the client and contractor.

There are a number of issues attached to the idea of measuring the monetary impact of increased Requirements Management efforts. All costs and benefits of Requirements Management are inseparably connected to *hypothetical errors* on a level that is specific to any industrial and economic environment - and to any company and project. Thus, while attempts to calculate investments in this area may lead to a false sense of security, some aspects can clear up the confusion for students and practitioners alike.

### 6.1.1 Costs of Requirements Management

Costs of Requirements Management are generally broken down into tasks of the project staff. Project controlling can measure precisely the time that each person has spent on certain tasks - and contractors can even agree upon these metrics with their clients (Project Management Institute Project Management Institute, 2021). Examples include:

Time spent on

* defining the scope of the project from a requirements - perspective
* analyzing requirements
* modeling requirements
* quality management efforts
* management and control activities
* requirement administration processes
* implementation support and risk mitigation
* managing requirements changes

These tasks are usually executed by internal staff. The efforts of these employees are usually measured in man - hours. In total, there are four cost factors to take into consideration:

* **Manhours:** Costs for internal staff
* **Consulting:** Contractors are often forced to hire external consultants in case qualified personnel is not available for the project
* **Training:** Many contractors invest in training their personnel in Requirements Management techniques, often based on IREB - certifications, to reduce the number of requirements - related errors in a project
* **IT Applications:** IT tools are designed to reduce manhours spent on a variety of requirements - related project tasks

Investments for these elements can generally be measured, and, combined with internal manhours, they provide a sense of what it takes to put a solid Requirements Management structure in place.

### 6.1.2 Benefits of Requirements Management

Benefits, on the other hand, are more difficult to measure. It is natural in any project that manhours will generate costs, regardless of whether the tasks are performed by an internal employee or a consultant. In contrast to most other project management tasks, Requirements Management tasks are *preventive*, not *constructive*. The costs/benefits of the training of maintenance personnel, for example, can be measured by dividing the cost of the training hours by the cost of manhours of the contractor’s training staff. The activities of the training staff are constructive because they directly lead to monetary benefits; both can be measured and compared. In contrast, the Requirements Management efforts do not directly lead to financial gain; rather, they prevent financial loss. The potential loss is always tied to unforeseeable events, such as errors or misunderstandings. These efforts are not constructive but preventive.

Measurable benefits can be identified based on:

* Reduced number of errors and rework
* Shorter project lifecycles
* Rehiring of contractor for later project stages (in iterative projects)
* Reduced operating costs, especially manhours

These benefits, however, can only be measured in absolute terms and are not relative to a hypothetical scenario, where the benefit - related costs were saved.

Be mindful that the benefits and costs of Requirements Management are not only dependent on the Requirements Management budget. They can also be attributed to factors unrelated to the requirements, such as:

* Requirements awareness in the client organization
* Centralized/decentralized subject - matter expertise in the client organization
* Organizational structure of the client organization
* Volatility of the project environment
* Level of organizational complexity of the project
* Size of the project

At some point, it must be conceded that it is up to the experience and discretion of the management personnel of a project organization to determine the necessary level of investment in Requirements Management. With the uniqueness of any project comes the necessity for a constant redetermination of the question of how to balance the costs and benefits of Requirements Management.

### Self-check questions

Q: Why can’t the impact of Requirements Management be precisely measured?

A: *Requirements Management prevents potential/hypothetical errors; once prevented, the potential impact of these errors cannot be measured.*

Q: What are the main factors that produce Requirements Management costs?

A: 1*) Manhours of internal personnel, 2) External consultants, 3) Training of internal staff, 4) IT applications*

## 6.2 Requirements Management and Agility—A Contradiction?

At first glance, the concept of Agile project management concepts conflicts with the basic ideas of classic Requirements Management. Requirements Management is built upon the idea that the implementation of initially specified requirements can be planned in advance, while Agile project management specifically recommends planning as late as possible. Yet, Agile approaches to project management can very well supplement traditional project management and the related requirements - based approach. Backed by their focus on the client, Agile thinking has the potential to create a sufficiently abstract and solution - neutral view of requirements. If done with care and consideration, Agile concepts in Requirements Management can support capturing, documenting, and implementing requirements in a way that supports a highly effective integration of project stakeholders and their needs. Practical experience shows that companies find their particular ways to work around the theoretic contradiction of agile and traditional project management. The success of these hybrid projects suggests promising new ways, especially regarding the management of stakeholders and requirements.

In this section, we will illustrate how traditional and Agile methods are not mutually exclusive in the practical reality of project management and familiarize you with ideas that practically bridge this conceptual gap.

As a consequence of the VUCA - world, systems in client organizations - whether they are technological, digital, or organizational - must be updated more often in comparison to the decades previous. This often leads to the necessity of updating existing systems or including new solutions in the technological or organizational structure. Deciding on the right system and implementing it in a project poses a challenge in most situations. Since all clients have unique organizational environments and characteristics, typical projects only have one element in common - they are all different and necessitate decisions under ambiguous circumstances. Consequently, system development projects are frequently labor - intensive endeavors with significant risk.

There is an ever - growing necessity for new process models, which assist businesses in the process of selecting solutions that are manifested in effective new systems. The complexity of the decision on which systems are beneficial to solving the business needs of the client can be managed by breaking them down into organizational, functional, and process - related elements (Steinle et al., 2021). Nonetheless, the traditional idea of applying analytical methods to specify the system - related requirements has its weaknesses in comprehension and applicability.

Traditional Requirements Management methods are ideal for outlining the functionality and the organizational integration of a system. Their thoroughness, in particular, provides an excellent foundation for creating agreements between suppliers and users (Steinle et al., 2021). Nevertheless, practical experience has shown that these methods have difficulties in understanding the system from both the user and the process perspectives. They furthermore require a substantial amount of subject matter expertise in both the technical and business aspects of the system, which contractors - especially PMO service companies - can often deliver only on a very fundamental basis.

In the following subsections, we will elaborate on current trends and methods that combine agile methods with traditional concepts of Requirement Management.

### 6.2.1 Requirements-related issues in traditional project management

The early stages of any system development project are characterized by choosing the system that best meets the client’s needs in terms of budget, time, technological and operational structure, and business needs. When the project's goals, budget, and system characteristics are decided but its duration is flexible, traditional project management is the obvious choice in methodology. Agile methods twist this approach and recommend an initial decision on time and budget while leaving the system characteristics open to a more flexible future decision.

The practical realities of the management of complex technology projects have shown that even in more traditionally managed projects, the most common (and pressing) challenge is not the implementation of all required functions - but a lack of time and resources. Based on this observation, it is evident that companies are increasingly moving to an application of methods that allow for prioritizing time and budget.

Contractors in larger projects are forced to deal with many requirements - related issues, both in a) the very early stages of the planning and system design phases and b) throughout the implementation processes.

The involvement and activation of the affected organizational stakeholders present one of the most important, sensitive, and demanding challenges. Usually, clients make their best effort to involve the most relevant internal stakeholders in their considerations early on, but there are also peripheral stakeholders, such as support functions (HR, Finance/Accounting/IT Support) and additional operational units that are indirectly affected by the new system. All these stakeholders are, by definition, presented with new working procedures and procedural steps through its replacement and a new introduction, which causes uncertainty and leads to resistance (Steinle et al., 2021). Not only do all stakeholders need to be involved from a change management perspective, but they also tend to ask questions that potentially guide requirements managers to new technical and organizational insights.

Figure X

 *Most typical questions of stakeholders leading to insights during the analysis (Author)*

Complex technological projects are, therefore, organizational projects rather than purely technological projects. The organizational, and consequently human element, is a critical dimension that is not accommodated by traditional Requirements Management to the degree that it merits. Technological system development and implementation projects usually involve a sizable number of the organization’s members who will be affected by the system, necessitating a significant amount of change management activities. In this thinking, the foundation for a successful project can be found in the proactive handling of the opposition and anxieties as well as the innovative ideas of the direct users (stakeholders).

In addition, to change management considerations, the actual technical system (in terms of a solution to the business challenge and the consequent technical problem) as well as time constraints present another difficulty. There is some leeway available if a legacy system is replaced or complemented with a new system. A new technical and/or operational solution does not necessarily have to replace a legacy system to promote harmonization (Steinle et al., 2021). When the current system performs essential functions whose greenfield design would increase costs to a prohibitive degree, one option may be to only partially replace the legacy system. At this stage, the client and the contractor need to decide whether to use the standard system developed for and implemented in projects for similar clients (including associated standard processes) or to modify the technical structure to the specific technical system and processes used by the current client. No doubt, this results in additional design and implementation efforts, but the increasing organizational/technological/operational individualization of businesses has forced contractors to develop respective capabilities. At the same time, it has emboldened clients to enter negotiations with this option in mind.

Greenfield/brownfield

Projects whose goal is to build a system from scratch without building upon or being constrained by any legacy system are called greenfield projects. Greenfields are the opposite of brownfields where systems need to be integrated into a technical and operational infrastructure.

Complex technological systems are often developed and implemented as **brownfield** projects. While **greenfield** projects have their advantages from a design and implementation point of view, the reality is that companies and their technical setup are both constantly evolving and have increasingly become historically divergent or heterogeneous as a result of restructuring and even mergers and acquisitions. Therefore, the most complex projects have mandates for harmonization, which necessitates a multi - layered approach that includes organizational, i.e., change management, considerations.

As a result of these considerations, the initial phase of the development of a system that constitutes a solution to both the business problem and the technological challenges necessitates the definition of a clear project vision. On a high level, a project vision constrains the scope of the system to keep the project manageable. These visions tend to remain the same even in highly volatile organizational environments. Amidst these environmental complexities, ambiguities, and volatilities, a project vision provides the project team with an orientation when dealing with stakeholders, procedures, target systems, and constraints.

These practical realities of managing complex technical system development and implementation projects demonstrate the challenges in eliciting requirements and managing stakeholder relationships.

### 6.2.2 Project Management Concepts: Traditional vs. Agile

The project phase and the conditions of the current framework play a significant role in the decision of whether to work with traditional waterfall project methods or opt for agile methodologies.

While traditional project management handles requirements as described in this course book, Agile methods take the approach of user stories. Both concepts recognize the need for the definition of minimum requirements, at least before a respective project phase is initiated. The concepts vary, however, when it comes to structure, level of detail, and the changeability of requirements and Requirements Management.

If requirements managers over - specify by developing a lengthy requirement specification document, stakeholders may have difficulties understanding and supporting the process. The standardized language and template - based documentation make it difficult to re - use elements of one phase in a later stage of the project. Furthermore, requirement specification documents are difficult for users to understand because they are formulated separately from the actual system design and implementation process. Stakeholders may experience challenges in understanding a specification without prior training in the technical subject matter and requirements - related terminology. This lack of stakeholder orientation has the potential to interrupt any change management effort and frequently results in unreasonable challenges for stakeholders involved with the system (e.g., operation and maintenance).

Based on a concept developed by Steinle et al. (2021), the different approaches to user stories and requirement specification documents can be applied together to deal with the listed drawbacks and realize their respective benefits. User stories can unfold a high level of user orientation and can be applied throughout the spectrum of domains. By integrating user stories in system development and implementation projects, the involvement and activation of all stakeholders are facilitated and the change process will be supported by reflecting on the desired requirement and crafting it as a story. Thereby, user stories function as a supplement to the requirements specification documents and as an accessory to the tender in the later stages of the project.

Given that the free formulation of the story is frequently unfamiliar territory for stakeholders, training in the methodology is crucial for a positive manifestation in the involvement and activation of stakeholders. Stakeholders can be supported by introductory training. When working with requirements specification documents and user stories at the same time, requirements managers need to ensure the level of detail is the same in both documents.

To manage the project with an expedient methodological setup, it often makes sense to combine both traditional and agile project approaches and Requirements Management in a hybrid form to combine the various benefits. Practical realities have limited the initial enthusiasm of the project management community and have often led to the recognition that the drawbacks of both methods cannot be fully eliminated and to the call for mindful handling throughout the project.

### 6.2.3 Experiences from Combined Requirements Documentation

Steinle et al. (2021) refer to several projects within which a combined approach to Requirements Management based on traditional and Agile project management methodologies was tested. Despite the increased workload in documentation, their experience shows an improvement in requirements elicitation and documentation under the involvement of user stories as an addition to the traditional requirements specification.

The central problem faced by these projects that used a combined methodology is identified in one of the key criticisms made by proponents of Agile project management of classical Requirements Management, that the requirements are solution focused and (by nature) disregard the development and implementation process. Just translating traditional requirements specification into user stories leads to the same problem. A simple translation places the weight of contextualization of user stories without any attribution to steps in the design, development, and implementation process on the stakeholders. Steinle et al. (2021) point out that user stories require a precise assignment to both the project phases and the operational environment after completion. This cross - referential effort establishes not only a visible and tangible connection between user stories and their respective context but also guides stakeholders to a detailed understanding that enables their active involvement in a successful design, development, and implementation process.

### 6.2.4 Conclusion and Further Sources

The authors of the article cited in this section are high - ranking members of the Forschungsinstitut für Rationalisierung (in English, Research Institute for Rationalization, FIR). The FIR is part of the Rheinisch - Westfälischen Technischen Hochschule Aachen, one of Europe’s most productive academic powerhouses for technological development, where countless successful high - tech startups have been founded.

Reference model

Theoretic attempt to integrate all relevant elements of a business challenge (e.g., implementation of software projects). It is the goal to display all relevant elements and show how they relate to each other. Oftentimes, reference models serve as helpful tools for orientation in practical corporate management.

The ideas which we have elaborated on in this section are based on the Aachen Implementation Model (ImplAiX) (Reschke & Treutlein, 2019). While this **reference model** is focused on the implementation of software projects, it provides an ideal foundation for the idea of integrating user stories into Requirements Management. The ImplAiX Implementation Methodology is based on the identification and formulation of user stories at the beginning of a project without disregarding the need for requirements specification.

Its main advantage is the integration of three crucial elements of the management of complex technological projects:

1. **Requirements Management:** Engineering, elicitation, specification, and administration of requirements (both in user stories and in requirements specification documents)
2. **Change Management:** Change management, especially regarding structural and processual changes necessary, as a consequence of technological change
3. **Project Management:** Integration of a and b into any step of the overall management process of the project

In traditional project management and related Requirements Management techniques, an integration of these crucial elements is only possible with a confusing number of documents and cross - references. We recommend looking into the concept to build upon the content of this course book as the cited models serve as a great foundation for comprehensive knowledge management that makes requirements accessible throughout all project phases.

### Self-check questions

Q: What is the agile equivalent of requirements specification?

A: *User stories*

Q: Which three areas of project activity are integrated into the ImplAiX Model?

A: *Requirements Management, Change Management, and Project Management*

## 6.3 Limits of Requirements Management

At the end of this course book, we will complement the insights into Requirements Management by providing a special take on the limitations of the discipline as a whole.

In the previous units, we have come across multiple practical challenges, which seem to imply limitations to Requirements Management. One example is the lack of connection between requirements specification and project implementation processes. This problem, as well as all other issues we have discussed, however, are methodology related; and these can always be mitigated by adjusting structures and processes, possibly even strategies of Requirements Management. We will close this course book with more fundamental considerations of what we have learned, up to this point. The goal of this final exercise is to understand the challenge of Requirements Management on a deeper level. This may serve you in your understanding of complex situations when being confronted with requirements - related challenges that appear to defy basic logic. Making sense of these situations on a more fundamental level will give you an advantage over other managers who can only interpret events based on their textbook requirements knowledge.

### 6.3.1 Bounded Rationality in Requirements Management

The fundamental assumptions about the human condition, which traditional project management and Requirements Management are built upon, are in part conceptually stuck with the traditional idea of John Stewart Mill’s (1836) Homo Economicus. While the human element in requirements elicitation is frequently addressed, for example, regarding conflicts, traditional concepts naively assume that these conflicting requirements, if they exist, will be brought forward, one way or another. In order to understand the limitations the human element imposes on Requirements Management, we can turn to the Nobel Prize - winning ideas of Herbert Simon. The concept of bounded rationality was developed as a reaction to contemporary rational choice thinking (Simon, 1990). Even if replaced decades before its development, we can still find rational choice thinking embedded in the assumptions and tools of Requirements Management; for example, in the belief that stakeholders would deliver the best requirements as it is in their best interest to do so. The concept of bounded rationality questions this assumption and argues that stakeholders’ judgment on the requirements of a new system is limited by their own cognitive constraints.

Bounded rationality is based on three primary restrictions that limit the stakeholders’ rationality in the requirements elicitation process (Simon, 1990).

1. Cognitive limitations
2. Imperfect information
3. Time constraints

We will elaborate on each of these, connect the concepts to Requirements Management, especially requirements elicitation, and illustrate how these conditions of the human condition impose limitations on the fundamental ideas of Requirements Management.

#### 6.3.1.1 Cognitive limitations

Cognitive limitations refer to the incapacity of humans to optimally digest all information that might be relevant at a given moment. In other words, stakeholders cannot evaluate all accessible variables when asked for their opinion about a certain function of a system (Simon, 1990).

When a maintenance professional is asked for his or her role preference in a maintenance process of a system, he or she may opt for the solution that sounds best at the moment. Based on rational choice thinking, it is assumed that the individual has complete information on all variables that may be important in this decision. How well does the role in the new maintenance process match the role in the maintenance of other systems? How manageable are the new geographic distances? Does the new process allow for the same flexibility that the maintenance professional has become accustomed to in the old process?

As the example demonstrates, there are several questions that must be addressed to make an accurate conclusion. Yet, the majority of questions relevant to an assessment of the respective requirement will not even be examined, while some will just become too difficult to comprehensively answer on the spot.

Requirements Management tends to oversimplify the elicitation process, to an extent that may do more harm than good. Even though complexity in the presence of an insurmountable number of available options necessitates a higher degree of processing, Requirements Management creates the illusion of simplicity. Admittedly, this is one of the essential functions of Requirements Management - but the point remains: requirements are rarely the product of a fully rational cognitive process.

#### 6.3.1.2 Imperfect information

The stakeholders’ lack of complete information only contributes to the problem of cognitive limitations. For example, a machine operator is unlikely to distinguish between two kinds of processors that run the operating system of a machine, and not many operators are going to devote hours to understanding what it is and how it impacts their machine’s performance.

Additionally, there is important information that stakeholders do not necessarily know. We addressed this issue earlier when stressing the importance of requirements managers explaining details. The same condition, however, applies to them, as well. They may be aware of the price, performance, and reliability of both processors, but they may not know that a crucial application is not supported by the technology.

#### 6.3.1.3 Time constraints

The requirements elicitation process is often constrained by the time set by the PMO. Additionally, management choices must be made with limited information and time. For instance, an online shop may have the choice between two locations for a new logistics facility in the hope of reducing their delivery times. At the same time, the shop may lose more customers the longer it takes to make a decision.

Time constraints limit stakeholders’ capacities to evaluate and assess a situation and make the best possible choice. Even for requirements that are unaffected by their cognitive limitations, time constraints impede their capacity to digest new information that is necessary for an informed assessment of a given requirement.

In summary, when stakeholders are pressured by deadlines, they tend to make suboptimal judgments.

#### 6.3.1.4 What this means for Requirements Management

It is evident that these limitations of human cognition are impossible to eradicate. It may be argued that they are limitations not only in eliciting optimal requirements, but in the very purpose of the entire Requirements Management discipline. Without these limitations, requirements elicitation would merely be a minor step in the project management process. So why is bounded rationality still important when elaborating on the limitations of Requirements Management?

The problem can be identified in the way requirements are treated, once elicited and approved. Traditional Requirements Management regards requirements as decisions made by the client. Based on the concept of bounded rationality, we can very well question this assumption. Requirements are often not the result of well - thought - out, rational considerations based on complete information under the consideration of all related consequences - instead, they may very well be the product of obscure cognitive processes.

In the following, we will integrate this thought into consideration of another limit of Requirements Management that focuses on the role of the contractor.

### 6.3.2 The Principal-Agent Problem in Requirements Management

We have now identified the first major limitation to the fundamental idea of Requirements Management - the requirements provided by the client are not necessarily reliable while the contractor treats them as if they were. This condition is much less of a problem when we follow the assumption of traditional Requirements Management in which both client and contractor unequivocally work toward the best possible solution for the client.

As the principal - agent concept (and more than enough practical experience) suggests, this may not always be the case. As opposed to Requirements Management’s implication, the principal - agent concept presumes that the interests of the contractor and client are not perfectly aligned toward reaching the optimal solution, and instead views both parties as wanting to maximize their benefits in the course of the project (Kleine, 2013).

#### 6.3.2.1 Roles

The concept analyzes the relationship between a principal and an agent in any given business transaction. To apply this to the limits of Requirements Management, we need to clarify the roles in this line of argument.

**The Principal:** The principal is a client who requests the design, development, and implementation of a system for monetary compensation (Kleine, 2013). Inspired by the fundamental assumptions of Requirements Management, the principal does so with the expectation that the services will be performed in his best interest and accepts the dependence on the agent to complete the project. Due to the information asymmetry between the principal and agent, the principal is unable to influence or even witness the agent's commitment or attributes and, hence, has an information disadvantage (Kleine, 2013).

**The Agent:** The agent is the contractor commissioned with designing, developing, and/or implementing the requested system by the principal and receives compensation in exchange for his services. Compared to the principal, the agent is usually more skilled and has a greater competency base upon which to build all further project activities. The basic argument of the principal - agent concept is that the contractor's need to maximize his own benefit creates strong incentives to exploit this information advantage to the disadvantage of the client, whenever given a chance to do so (Kleine, 2013).

#### 2. Principal - agent problem

Let’s turn to the problem and elaborate on the basic assumptions that may lay out some limits to the concept of Requirements Management. It is natural in any business transaction that the contractor’s objective differs from that of the client. The client desires a system and the contractor desires remuneration. Traditional Requirements Management works with the assumption that the transaction element of a project naturally aligns both interests. Conflicts may arise, however, when opportunistic behaviors result in a divergence of interests. Opportunism refers to the maximization of one party’s utility and accepting that this occurs at the cost of others (Kleine, 2013). There are a number of scenarios that have been formalized in the framework of the principal - agent concept.

**Asymmetric information:** The principal - agent concept examines the uneven distribution of information as a core issue (Kleine, 2013). More precisely, the concept of information asymmetry depicts a situation in which a contractor has more information available than the client. When, for example, a stakeholder issues a requirement that works well for the moment but may cause significant issues in a couple of years, Requirements Management assumes the contractor will point this out. Doing so may be beneficial to the contractor, as this behavior generally increases client satisfaction. If, however, the contractor realizes some sort of benefit by not addressing this issue, he may take the opportunity and not address it. There are multiple scenarios in which this is possible. If the aforementioned requirement is a core function of the contractor’s system and any alternative requirement that is more beneficial to the client would necessitate subcontracting a further contractor, the original contractor will be tempted to exploit this imbalance and not mention the alternative.

**Moral hazard:** Moral hazard is an asymmetry of knowledge that occurs *after* the approval of a requirements document and refers to concealed activities or information that are carried out or exploited after the fact by the contractor (Kleine, 2013). There are a number of scenarios to connect this issue to Requirements Management and illustrate the discipline’s limitations. Moral hazard contrasts the traditional notion of aligning the interests of the client and the contractor with the reality that any client is dependent on the contractor. If a contractor discovers one or multiple requirements that are beneficial to him and disadvantageous to the client, the contractor may be tempted not to raise the issue. Once again, presenting oneself as a reliable contractor by openly renouncing benefits and standing up for the client against one’s own interests is not a disadvantage. If the benefits of moral hazard outweigh the costs, the decision to take this route will be more likely. Requirements Management, as it is applied, does not consider this very real condition.

**Adverse selection:** The asymmetry of knowledge prior to the approval of the requirements specification document is referred to as adverse selection (Kleine, 2013). In this scenario, contractors know their inability to fulfill requirements, before they are approved. If, for example, the client insists on an unfeasible requirement during requirements elicitation, the contractor will be tempted to agree to this initial requirement to be allowed to move on to the next project phase. Once the implementation has started, the contractor may suggest a workaround that technically fulfills the requirement but fails to fully satisfy the client.

**Hidden intentions:** In addition, one of the parties may conceal some objectives and reasons prior to the approval of the requirements specification sheet. These hidden intentions might result in a breach of commitment after the requirements document has been agreed upon. While moral hazard and adverse selection may very well never be discovered by the client (and are, therefore, very tempting to the contractor), hidden intentions will necessarily become evident (Kleine, 2013). The risk of customer dissatisfaction is often outweighed by the benefits, which is not uncommon in many business relationships. Examples include agreeing on a price that will be increased later, agreeing on impossible requirements, or promising nonexistent manpower or subject matter. Even if the client may not appreciate this turn of events, the costs of changing the contractor may be higher than accepting an undesirable workaround suggested by the current contractor. Looking back, the client would have opted for another contractor or would have followed the contractor’s indication that their way is the only way to deal with the problem.

### 6.3.3 An Appreciation of Traditional Requirements Management

While these issues illustrate the limits of the very idea of traditional Requirements Management, they do not delegitimize the entire discipline. Many of the arguments made are common conditions of any business transaction, even beyond requirements. Requirements Management should be seen as an attempt to mitigate these conditions - an attempt that reaches its goals, not to the fullest degree. But at the same time, Requirements Management efforts specifically target problems such as moral hazard or imperfect information. Without these efforts, the problems that are outlined by principal - agent concepts and bounded rationality theories would be more problematic.

### Self-check questions

Q: Which principal - agent problem will certainly lead to conflicts between the contractor and the client?

A: *Hidden intentions, as the client calculates his benefit based on the assumption, their intentions will be uncovered at some point after the approval of the requirements specification document.*

Q: According to bounded rationality, what are the three reasons why stakeholder interviews often fail to create a complete image of the client’s needs?

A: *1) Cognitive limitations, 2) imperfect information, and 3) time restrictions*

Summary

In the final unit of this course book, we reflected on the Requirements Management discipline beyond tools and methodology as applied in consulting and manufacturing firms.

While elaborating on the costs and benefits of Requirements Management, we learned how requirements - related project efforts are primarily preventive. Preventive measures are aimed at preventing costly events from happening; their primary success is rooted in ensuring that negative events do not happen. It is, therefore, difficult to measure and quantify the return on investment of Requirements Managements efforts.

We then elaborated on the relationship between traditional Requirements Management and agile project management. While agile project management seems to contradict the idea of early requirements specification, agile ideas can still eliminate some of the defects of classical Requirements Management. By translating requirements into user stories, project managers allow for a deeper involvement of stakeholders and the integration of requirements into the implementation process.

We then turned to the limits of Requirements Management and introduced the concepts of bounded rationality and principal - agent relations. Bounded rationality helps elaborate a more realistic view of the cognitive process of eliciting requirements from stakeholders. It is key to understand that traditional Requirements Management takes stakeholders’ views at face value, while their rationality is limited by several factors. The principal - agent - concept can uncover traditional Requirement Management’s limitations regarding the risks of moral hazard. The concept delivers valuable insights into the relationship between contractors and clients and how information imbalances impair classical Requirement Management’s assumptions on fair play.

We have pointed out, however, that Requirements Management is not only limited by these conditions of practical realities but is explicitly designed to counter them - if not to the fullest degree, then certainly to a satisfactory level.