



USING AGILE TECHNIQUES FOR SETTING UP A QUALITY MANAGEMENT SYSTEM FOR STARTUPS¹

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Abstract

Startups are often active in the field of digital economy and generate a large part of their sales with business customers. In this context, evidence of existence and effectiveness of suitable processes and procedures required for quality-oriented action are essential to meet customer expectations.

Quality management systems are established concepts for ensuring quality-oriented action. However, the adoption of existing concepts and approaches for introducing a quality management system and their formal application in startups is not effective. This is due to the fact, that startups in most cases have poorly defined and implemented their company processes. Furthermore, requirements quickly vary in terms of number, relevance, specification and content. As a result, an agile approach is required, as this enables an interactive and flexible reaction to changing requirements.

This paper presents an implementation concept for setting up a perfectly fitting quality management system for startups and small businesses step by step by using agile techniques.

Keywords Startups; Micro Enterprises; Quality Management System; Requirements, Agile Techniques, Flexibility

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1. Introduction

Startups have a significant impact on the development of the national economy (Escalfoni, 2020). They are often active in digital economy and generate a large part of their sales with business customers. In order to deal with the inherently high risks associated with startups and also micro-enterprises, strategies for the implementation of processes and procedures to ensure quality-oriented action are of great importance.

Quality management systems according to DIN EN ISO 9001 are widespread among large and medium-sized enterprises. For setting up and improving such systems, there is a large number of manuals. However, since their processes are often not sufficiently specified, these approaches are not suitable for micro-enterprises and startups (Antilla, 2019). Rather, this requires intuitive methods and practices that can later be expanded and formally installed (Komus, 2017). Although there is a lot of research dealing with quality management in small and medium-sized enterprises (SME), research about quality management in microenterprises and startups is rare (Pimentel, 2019).

In this context, it is important to know that, compared to SME, startups and micro-enterprises are structured differently. Processes are often hardly defined and implemented, requirements change quickly in terms of relevance, specification and content, and new or different requirements often have to be added. Rather, the use of agile methods is expedient, as they enable quick, flexible and iterative reactions to changing requirements and framework conditions. Furthermore, the responsibilities have often not yet been finally clarified, so either all employees participate in all processes or only one person has the necessary knowledge and therefore independently is in charge for specific tasks. Since also a quality management team is still missing, for micro-enterprises and startups it is often difficult to decide if a quality management system should be implemented, which requirements are relevant and how the corresponding requirements can be fulfilled in a goal-oriented manner. Furthermore, it is difficult to measure the impact of a quality management system on a company's performance or rather business results.

Studies that assess potential benefits of quality management systems (Poksinska et al., 2006; Psomas & Fotopoulos, 2009; Psomas & Pantouvakis, 2015; Valmohammadi & Kalantari, 2015; Rogala, 2016) show ambiguous results so that the decision for or against such a system is difficult. Although, in some cases there seems to be no need for an implementation in order to get a certification, the content or at least specific parts of a quality management system without doubt are useful for these companies to improve and establish companies processes and hence, to enable the company to act successfully in the long term (Anholon et al., 2017).

This paper designs a concept for setting up a quality management system for startups and small businesses by using agile techniques and in this context shows first guidelines for implementation. This should facilitate the process of deciding if and how to implement an adequate management system for the regarded companies. The aim here is to supplement the classic procedure of implementing a capable quality management system with agile methods and thereby meet the need for flexibility of startups and micro-enterprises. The procedure model therefore is designed in such a way that the compatibility of agile methods with the requirements of the DIN EN ISO 9001:2015 is given. Here, the focus of the implementation concept is initially on the most important aspects from the company's point of view, since their pragmatic implementation creates direct added value for startups and micro-enterprises.

For this purpose, established agile methods such as user stories and sprints are applied, combined and adapted, since these - according to the company's needs - can be used flexibly, deliver visible and usable results for the company quickly and have the advantage that not all requirements must be known and specified when starting the project.

2. Characteristics of startups and microenterprises

As a first step for developing an implementation concept for setting up a perfectly fitting quality management system, this section contains the definition of microenterprises and startups followed by an analysis of their specific characteristics.

SMEs, which can be further subdivided into medium-sized enterprises, small-sized enterprises and micro-sized enterprises are considered to be the growth drivers of industry and the service sector. However, the distinction between small and micro-enterprises is only made by the European Union. In other institutions such as tax offices or health insurance companies, the terms are not differentiated from each other. In this context, micro-enterprises as the relevant business group in this contribution have a maximum of nine employees working in full-time and an annual turnover of no more than two million euros (cf. table 1). The threshold values mentioned in table 1 have been defined by the European Union (EU) and have been in force in the EU since January 1st, 2015. They were defined in order to be able to control the receipt of funds and support through funding programs in a targeted manner (IfM, 2022). Using this definition, approximately 80.7 % of all companies in Germany are microenterprises.

Table 1: Categorization of companies

company's category	number of employees	annual sales	balance sheet total
medium-sized	< 250	≤ 50 m. euro	≤ 43 m. euro
small-sized	< 50	≤ 10 m. euro	≤ 10 m. euro
micro-sized	< 10	≤ 2 m. euro	≤ 2 m. euro

Source: Based on (EU-Commission, 2020)

Medium-sized enterprises on the other hand of the scale, can have a maximum of 249 employees and generate annual sales of up to 50 million euros. Apart from the limits shown in table 1, there is no general definition for SMEs, rather they traditionally have been defined differently regarding industry and respective location. Hence, research dealing with SMEs is hardly comparable (Brooksbank, 1991). Distinctions in research often differ from the official quantitative definition of the EU because in research SMEs are especially indicated by their qualitative characteristics. Concerning (van Hoorn, 1979; Welge, 2014) these characteristics for example comprise

- the ownership structure (private),
- the management (owner-manager),
- participation of management in operative activities,
- direct communication and leadership,
- the limited resource base (financial, knowledge, management),
- low stock of globalisation knowledge,
- the concentration on niche markets,
- low capacity to absorb risks,
- flat hierarchy,
- high capacity in the creation of innovations.

It can be expected that the former mentioned characteristics for SMEs exist in a higher extent also in microenterprises, meaning for example the hierarchy is flat, processes are more informal

and employees are more involved in decision-making and creative processes. Within this paper microenterprises are understood to be companies with up to 15 employees, two hierarchy levels and a top management consisting of one or two persons. According to the definition of microenterprises startups usually belong to the category of microenterprises, but there are certain characteristics making them special. Hence, they should be seen as an own group.

Startups are young companies that want to implement an innovative and scalable business idea with a high growth potential and expand it as quickly as possible. In this context, the term innovation refers to something new, modern and unprecedented and is also often used for advanced solutions to a problem or a challenge. Unlike the concept of quality, the concept of innovation does not describe any property. Innovation rather describes the process of creating something new (innovation as a process), the effect of something new (innovation as an effect) or the new object itself (innovation as an object) (Sommerhoff, 2021). By developing (disruptive) innovations startups contribute to the technological progress and positively influence the national economy. However, startups are confronted with high external and internal risks due to the innovative character of their business.

According to the German Startup Monitor 2021 published by the Federal Association of German Startups, the term startups furthermore is defined by the following characteristics (BDS, 2021).

- Startups are less than ten years old,
- Startups strive for high revenue growth and strong employee growth,
- Startups are innovative in their products and services,
- Startups have a scalable business model,
- Founders of the company are also shareholders.

In the German Startup Monitor 2021 also the industry sectors in which startups are active were analysed. The result of the analysis clearly shows the dominance of startups in the sector of information and communication technology. In the course of the digital change, the majority of startups assign themselves to a digital business model (BSD, 2021). With regard to the customer groups of startups, it was found that the largest sales of about 70 % are generated in the business-to-business (B2B) area. About a quarter of all sales of startups are currently generated in the business-to-consumer (B2C) sector and only a small proportion of about 5 % is generated in the business-to-government (B2G) sector.

However, due to the ever-increasing pressure to perform and the high quality demands that companies place on suppliers, certified quality management systems according to ISO 9001: 2015 are increasingly required in the B2B sector (Antilla, 2019). Startups and micro-enterprises are therefore often under pressure to set up certifiable structures right from the start. But when they do, it empowers companies to build up structures that secure their existence systematically and at an early stage, thereby achieving sustainable growth and competitive advantages (Cox, 2016).

3. The agile manifesto and the agile framework “Scrum”

Agile approaches have their origins in the field of software development. Due to increasing customer requirements and increasing complexity, the so-called "agile manifesto" was developed in 2003 to meet these challenges. The manifesto contains 12 principles to be observed. This includes, in particular, iterative and consistent communication and cooperation with customers, including feedback on intermediate statuses and a positive, flexible approach to any changes that may arise (Trepper, 2015, Sauter, 2018).

For identifying varying and often changing requirements the agile framework "Scrum" from project management seems to be a suitable approach. “Scrum” represents a reservoir for a large

number of agile methods and techniques. Table 2 shows and shortly explains the most frequently used agile methods within the framework “Scrum”.

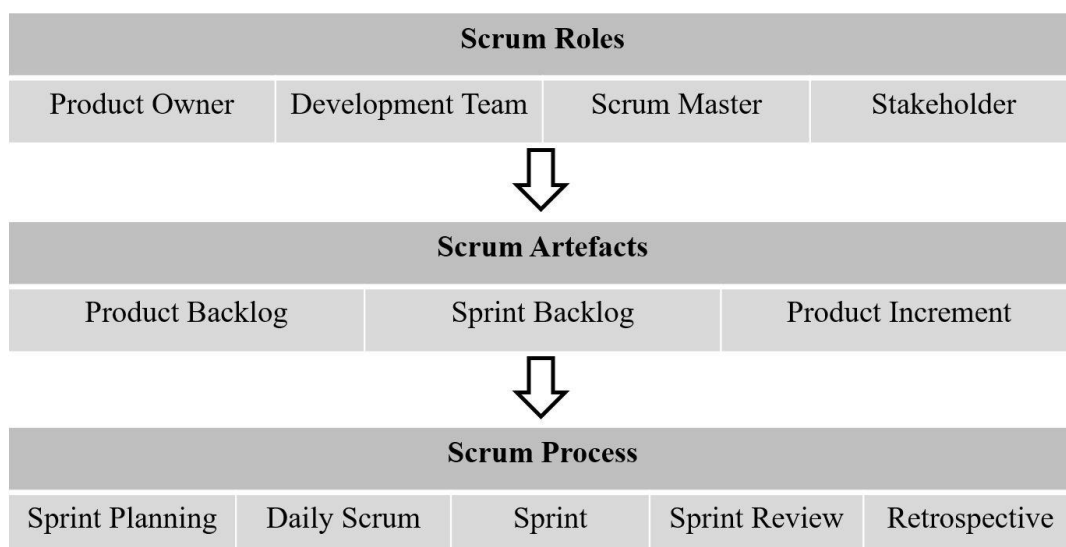
Table 2: Commonly used agile methods

Agile Method	Short Description
Task Board	Overview of current tasks
User Stories	Describe requirements from the customer's point of view
Daily-Standup-Meetings	Efficient status meetings, done standing up
Work-in-Progress-Limits	Limit parallel tasks to maintain productivity
Burn-Down-Charts	Visualization of the work status
Timeboxing	(Really) fixed timings
Planning Poker	Dynamic method for estimating efforts

Source: Based on (Preußig, 2018)

The original idea of Scrum is the incremental iterative approach to a project. It is not important to plan the project rigidly from the beginning, but to gradually break it down into so-called sprints (Gloger, 2016). Since "Scrum" is generally understood as a framework and not as a rigid method, it can be used differently and in a constantly modified form. The original approach, however, deals with three different roles of the participants and a process with five events and three types of results (cf. figure 1) (Preußig, 2020).

Figure 1: Process and results of Scrum



Source: Based on (Preußig, 2020)

The roles mentioned in figure 1 reflect the team structures. Stakeholders as interest representatives provide requirements and functionalities to the product owner. The Product Owner is responsible for the product vision, goals and profitability. The Development Team takes care of the implementation, is self-organized and acts interdisciplinary. The Scrum Master supports the team. This ensures that rules and values are observed, and it also ensures that obstacles that arise are removed. The Product Owner collects all stakeholder requirements in the product backlog. Here all features, improvements, and effort estimates are listed, as well as changes that are incorporated throughout the process. In the product backlog, the wishes and needs of the customers are also presented using user stories. The backlog is dynamic and agile to accommodate possible changes over time. Based on acceptance criteria, these user stories can be prioritized in order to achieve a common understanding. In the further course of the process, the Scrum Team iteratively selects tasks from the product backlog that are to be worked within a special time period. These tasks are referred to as sprints, which cover a time frame of two to four weeks. The sprints are distributed equally in time, but contain different events. This includes sprint planning, the daily Scrum, the sprint review and the retrospective at the end of the project phase. Each sprint has a clearly defined goal and a plan for implementation. The sprint backlog supports the progress of the respective sprint (Sommerhoff, 2019).

Lately there are the agile approaches "Modern Agile" and "Lean Startup", which implement the principles of the agile manifesto in a more general way, strives for a detachment from software development and describes principles for the development of innovative products and services under uncertainty (Lang, 2018).

4. Process model for the agile development of a quality management system for startups and micro-enterprises

The process model for the agile development of a quality management system for startups and micro-enterprises is developed in cooperation with industrial partners within a current research project of the authors of this contribution and is dedicated to the following question:

How can startups and micro-enterprises introduce a quality management system in an agile manner and build it up modularly with the aim of establishing a (certifiable) quality management system in the long term?

In order to be able to answer the research question mentioned above, an implementation concept for the development of a company-specific (expandable and adaptable) quality management system, in the sense of a Minimum Viable Product (mvp), is being developed within the project framework. The implementation concept is intended to enable technology-oriented startups and micro-enterprises to use an agile approach to systematically identify the first steps towards establishing a needs-based quality management system and then to implement it with little effort. Therefore, the project plan is divided into an analysis phase, an implementation phase and a transfer phase.

At the beginning of the project, the requirements relevant from the company's point of view are identified in the form of so-called user stories. In the next step, the determined requirements are structured in the form of so-called user story maps, which creates an initial product backlog (analysis phase).

The subsequent implementation of the determined user stories happens iteratively within the framework of so-called sprints, in which pragmatic implementation options (e.g. methods/techniques/processes/documents) are developed to meet the identified requirements (implementation phase).

Based on the results achieved, IT-supported roadmaps, recommendations for action and implementation aids for the development, introduction and continuous further development of a flexible, needs-based and indirectly certifiable quality management system with agile methods are then compiled as part of an implementation concept (transfer phase).

4.1 Analysis phase: creation of user story map and initial product backlog

The aim of the first work package is to develop a structured procedure that enables the identification, systematization and prioritization of relevant, beneficial requirements for a quality management system by using agile methods from the point of view of startups and micro-enterprises. In this context, the starting point are state-of-the-art analysis of the processes and structures of selected companies involved in the project, from which the respective need for action for the development of a company-specific quality management system can be derived.

Based on the current state analysis, the agile technology "user stories", which represents a short description of a requirement from the user's point of view, is used to identify the relevant requirements for a needs-based quality management system. In this context, it should be pointed out that user stories in agile companies have a distribution rate of 90% within requirements management (Dalpiaz, 2018). User stories should follow a rigid structure and answer the following questions (Lucassen, 2016):

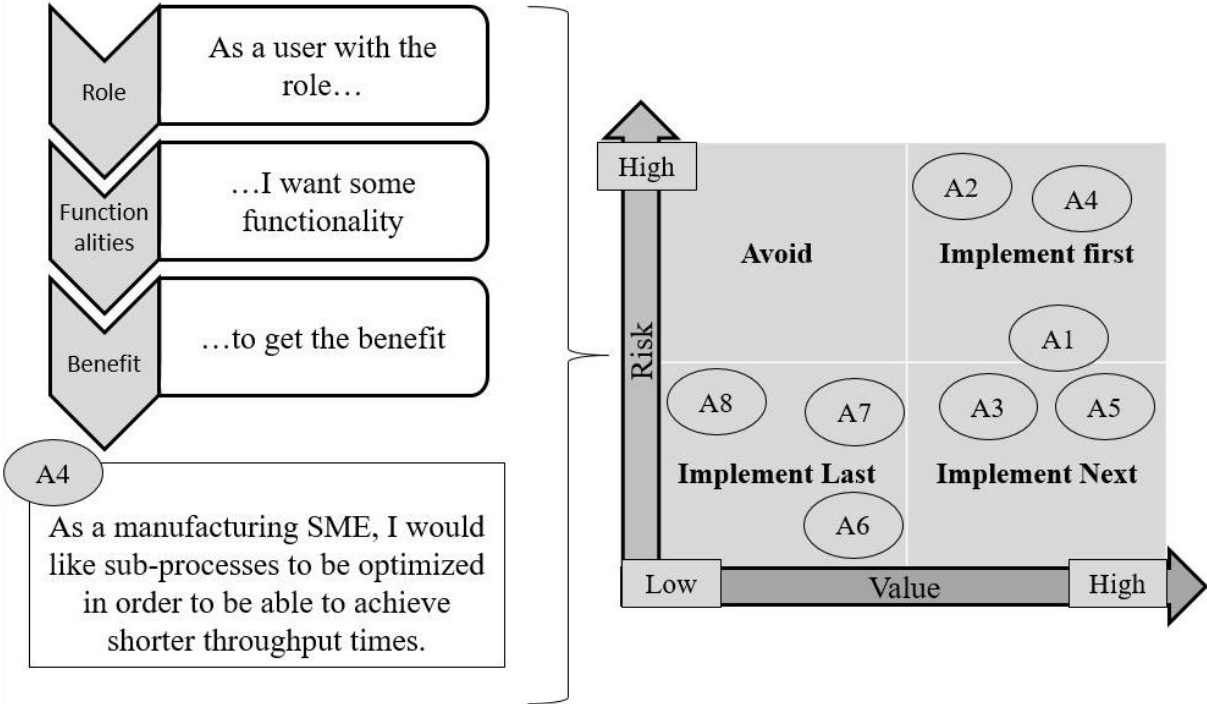
- who wants to achieve something?
- what does he want to achieve?
- why does he want to achieve it?

It is important to know that user stories should be formulated short and concise. The limitation to a short sentence should be clarified within the rule "3C". If possible, the user story should fit on a card (first "C") in its form in order to avoid writing down too much information. The second "C" stands for the term conversation because the agile approach relies on dialogue and close cooperation in teams. User stories should be talked about and discussed. Due to the abstract nature of user stories, writing them down often is not sufficient to be able to correctly analyze the requirements of the stakeholders. The third "C" stands for confirmation and describes what the result of the user story should look like by formulating concrete acceptance criteria (Kusay-Merkle, 2021). The acceptance criteria form the verification unit testing whether the user stories are fulfilled. Normally, the acceptance criteria are created as a kind of checklist that can be ticked off in the course of implementation (Hoffmann, 2020). Here, the so called "Definition of Done" (DoD) indicates when a user story is complete. In this context, the agile method user stories ensures a clear focus on aspects that provide added value for the companies involved. In addition, the collection of user stories from the company's perspective involves promoted communication in the development process, so that misunderstandings and misinterpretations can be detected and subsequently avoided.

As mentioned above, in the next step, all user stories collected before will be systematized using suitable criteria, evaluated comparatively and prioritized with the help of agile estimation methods. In this context, the prioritization of the user stories refers to central criteria. On the one hand, the business value, which reflects the benefits and profitability of a user story, and on the other hand, the dependency on the content and the degree of uncertainty of a user story (Hoffmann, 2020). A high business value should therefore be given high priority in order to promote timely implementation. If the user story is associated with a high level of uncertainty regarding implementation and development, it should also be prioritized high. This is based on the high risk of an unsuccessful implementation of the user story, which should be resolved at an early stage to avoid uncertainties within the development process. The prioritization criteria

mentioned above can be presented in a matrix that visualizes the relationship between the value of a user story and the uncertainty associated with the realization of the user story. If there is a high risk of implementing the requirement and a low value for stakeholders and the company, the requirement should be avoided and not implemented at all. The higher the risk for the same value of the requirement, the sooner the requirement should be implemented. For the purpose of illustration, figure 2 visualizes the structure of a typical user story and, based on this, illustrates the process of requirement prioritization using the example of a requirement formulated as a user story (requirement A4).

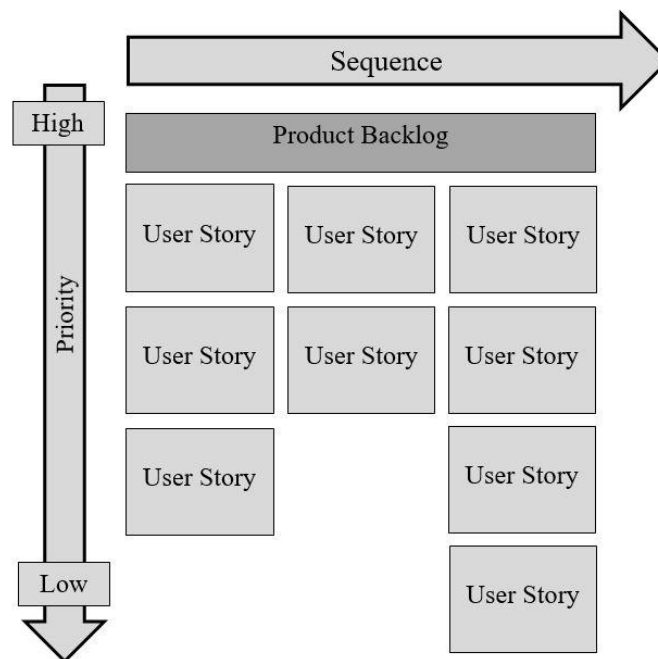
Figure 2: Collection and prioritization of requirements in the form of user stories



Source: Own elaboration

After prioritizing all user stories collected before will be bundled into so-called “user story maps” which, as a kind of landscape, enables a holistic view of a development process. These user story maps then serve as the basis for the creation of the initial “product backlogs” in the sense of company-specific specifications for the development of needs-based quality management systems (cf. figure 3). Consequently, in the product backlog the requirements of the stakeholders are collected in the form of user stories and sorted according to importance with the order of the entries reflecting their priority. The most important entries are therefore in the upper part of the product backlog and are described in the most detail so that the development team can quickly access them (Hoffmann, 2020).

Figure 3: User Story Map and Product Backlog



Source: Own elaboration

In addition to the company's perspective, requirements analyses will be carried out from the point of view of the standard ISO 9001 and awareness for the requirements of other potential stakeholders will be raised. This step is based on the relationships shown in chapter 4 and in particular will demonstrate how standard and stakeholder-related requirements influence the company requirements that have already been recorded in user stories in terms of content, design and relevance. If necessary this step will be accompanied by a context-specific expansion and completion of the previously determined user stories.

Since it is a major challenge for micro-enterprises and startups to meet the requirements of DIN EN ISO 9001:2015 or to set up a quality management system based on the minimum requirements listed there, on the basis of all previously shown work and results a process model for implementing such a system in an agile way was developed. For this purpose, based on the agile method Scrum, the three roles of Product Owner, Development Team and Scrum Master were defined. In this context, the Scrum Master ensures that the project runs smoothly. He must always be approachable, but does not require precise specialist knowledge. Therefore, this position can also be assigned to an external consultant. The role of the product owner should be occupied by an employee from the company, as good specialist knowledge of all processes in the company is required. Only someone who knows all the connections and dependencies knows what is important when defining the processes for the quality management system. The development team, on the other hand, can consist of different people from the company. If they belong to different departments specific specialist knowledge is available and problems after the introduction of the quality management system will be minimized.

In the next step, the agile method "user stories" is used to capture relevant requirements from a company perspective within a requirements workshop. The participants of this workshop are the Product Owner, the Scrum Master and the Development Team. The Product Owner plans and moderates the meeting. During the workshop, all ideas from each participant are of equal value. It's just a collection of ideas and suggestions. The group collects requirements for a quality management system in a brainstorming session. These requirements can first be noted

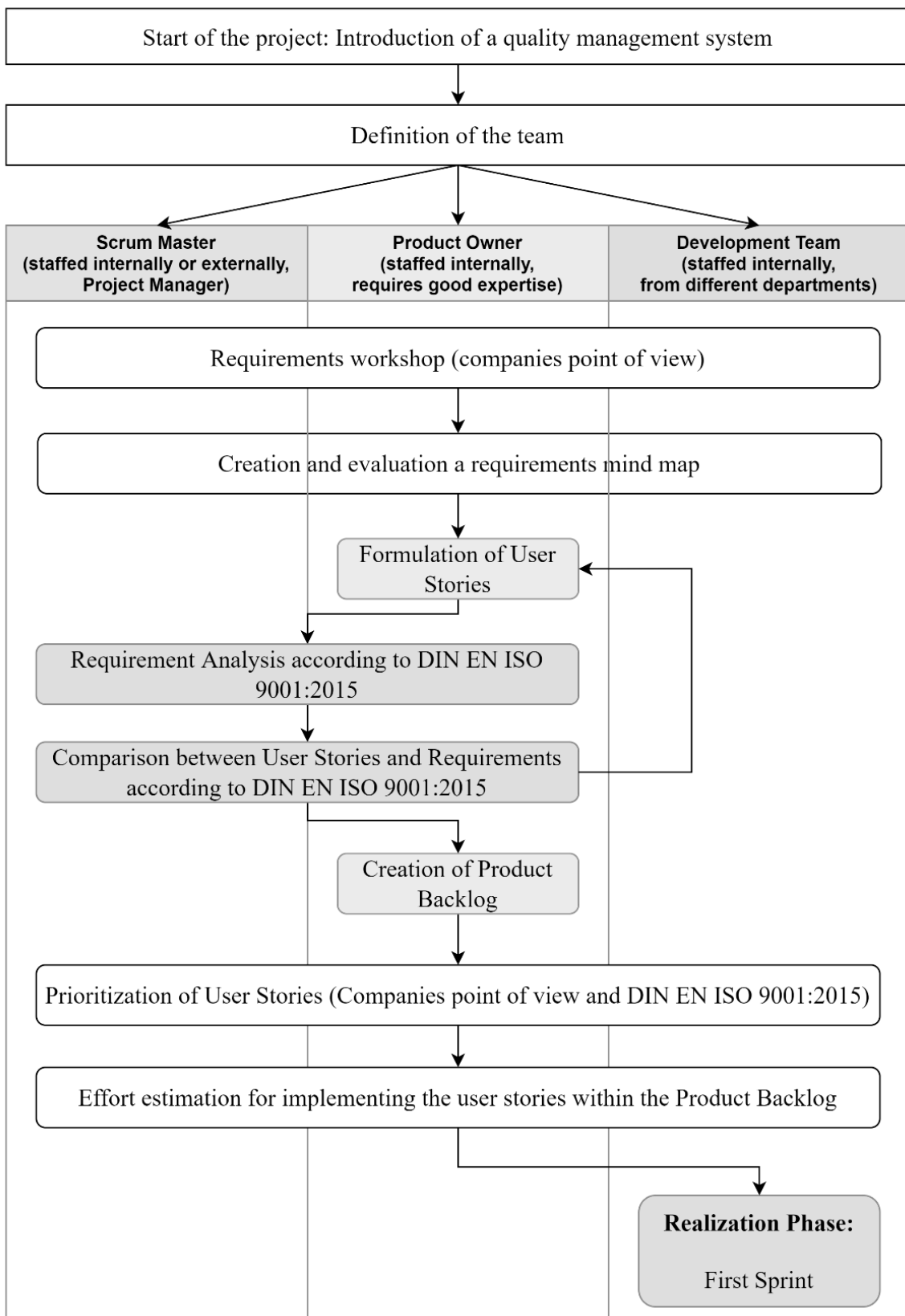
on index cards. Then, groups of similar requirements can be formed in order to create a mind map. In the next step, all points of the mind map are formulated as user stories, which then represent the to-dos for the introduction of a quality management system. In order to turn the ideas into user stories, they are formulated in a structured form. This means that the cards are supplemented by the user role and the goal to be achieved with the requirement. To complete the user stories, acceptance criteria are written on the back of the user story card. Only if these criteria are met the user story is fulfilled and can be completed. Therefore, the acceptance criteria help the development team to understand what the initiator of the user story wants to achieve.

As mentioned before for the development of a quality management system, not only the requirements of the company are relevant but also the requirements of DIN EN ISO 9001:2015 should be considered. Even if certification is not planned in the company at the moment, it is still advisable to check the standard, since the company is then at least aware of the requirements of the standard. Thus, in the event of later certification those requirements that have not yet been met can be realized with less effort. When analyzing requirements according to DIN EN ISO 9001:2015, it is advisable to go through all the chapters of the standard. The resulting requirements were then also recorded in the form of user stories. This simplifies the subsequent implementation of the requirements, since both the requirements from the requirements workshop and the requirements from the standard then have the same form, which enables a direct comparison and the disclosure of intersections.

After the determination of requirements has been completed, the developed user stories are transferred to the product backlog, which henceforth represents the specification for the implementation of the desired quality management system. Since the order of the user stories in the product backlog is the order of processing, at this point all user stories developed before must be prioritized. In this context, it must be considered whether the goal is a needs-based quality management system or a certifiable quality management system. Depending on this, different user stories generate the minimum viable product. The prioritization itself can be done, for example, by using the previously explained value-risk-matrix (c.f. figure 2).

After the product backlog has been created and prioritized, the next step deals with estimating the effort of implementing the user stories. Due to a lack of experience, startups and micro-enterprises in particular need a targeted estimate of effort for the upcoming project in order to be able to achieve profitability and to prohibit the risk of working uneconomically. For estimating the effort of realizing user stories, for example the agile method "planning poker" can be used. Planning Poker is a type of card game in which each member of the development team gets a deck of cards with the numbers of the nonlinear Fibonacci sequence where the sum of two consecutive numbers represents the following number (1; 2; 3; 5; 8; 13, ...). Here, the numbers on the cards correspond to the effort that are required to implement the respective requirement (Bartonitz, 2018). When proceeding planning poker, first of all the product owner selects a user story from the product backlog. Because of the product owner's deeper knowledge of the requirement, members of the development team can ask him questions and thus develop a common understanding of the user story. After all questions have been answered, each team member selects a card. According to the team member's own opinion, this card corresponds to the effort of the user story. If there are discrepancies in the round of estimates, the individual estimates are discussed. After it becomes clear why the discrepancies have occurred, the user story is estimated again until all estimates are identical and a clear effort ranking of the user story is created. If all user stories are prioritized and estimated in terms of effort, the project can be concretely realized within the implementation phase (cf. figure 4).

Figure 4: Process model for implementing a quality management system



Source: Own elaboration

4.2 Further Steps - Realization phase and Transfer phase

In the implementation phase, the focus is on determining pragmatic solutions for implementing the previously determined user stories in order to set up a company-specific "basic" quality management system. For this purpose, likewise agile methods are used and assessed with regard to their suitability for setting up a quality management system. In particular, the technique of so-called sprints will be used. For this purpose, a sprint backlog is defined in which, based on the user story map, it is determined which and how many user stories are to be implemented in the planned sprint, with a sprint duration of 4 weeks being assumed. In this context, it is also necessary to analyze how additional or changing requirements and changes in prioritization can be taken into account and how this affects the product backlog and the sprints. The result of the research work regarding the realization phase will be a modular process model for implementing user stories by using sprints to set up a company-specific basic quality management system.

As part of the transfer phase, the results of the analysis phase and the implementation phase are prepared in a practical manner and combined into a holistic implementation concept. For this purpose, a roadmap with decision trees and IT-supported implementation aids are provided, which are specially tailored for the use of agile methods. In addition, a comparative analysis of the practical examples carried out in the research project will take place in order to identify patterns with regard to problem areas and basic requirements or user stories, with the aim of providing a generally suitable initial product backlog that can be used across companies as a starting point and basis for discussion. The result of the transfer phase is a practicable implementation concept which will be available in the form of an IT tool and corresponding guidelines that can be used independently by interested companies.

5. Conclusion

This article showed that it is difficult for micro-enterprises and startups to introduce a quality management system. This is mainly due to the fact that processes and procedures in these companies are often not yet precisely defined. In addition, the standard DIN EN ISO 9001:2015 only specifies what should be done to implement a quality management system, but not how. To solve the problem, at first the theoretical basics regarding agile techniques, in particular user stories, and quality management systems and DIN EN ISO 9001 were demonstrated. With regard to the further course of the contribution, the interfaces between the standard DIN EN ISO 9001:2015 and the agile manifesto were identified. In this context, it was also shown which methods and tools the agile framework "scrum" offers to identify, systematize and prioritize requirements for an object of investigation (here a quality management system). Based on these findings, a process model for introducing a quality management system in micro-enterprises and startups was developed. In the next step, the requirements documented in the form of user stories, can be implemented in an agile manner in the form of sprints.

The results achieved in the project demonstrated within this paper promote quality-oriented action and its systematic anchoring in a company right from the start of the company's activities. The research work thus supports especially startups and micro-enterprises in being able to build their business with less risk and more success-related, thereby ensuring their competitiveness in the long term.

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