A Holistic Approach for Integrating Methods in Quality Management

Florian Johannsen

University of Regensburg, Department of Management Information Systems, Regensburg, Germany
Florian.Johannsen@wiwi.uni-regensburg.de

Abstract. Quality management has become more and more important in the last couple of years. The user is faced with a multitude of methods such as Six Sigma, TQM or Theory of Constraints. Therefore quality managers are more and more engaged in the selection of an appropriate approach for achieving the quality goals as they have been defined. Due to the necessity of coordinating heterogeneous quality methods, employees usually oppose the use of more than one approach within an enterprise. However, guidelines on how to integrate several methods, while considering the strengths of the original approaches, are still missing. This problem is being dealt with in the paper at hand. The paper introduces an integration approach, supporting the user in establishing an integrated quality management method. The variety of quality management approaches within an enterprise can thus be influenced by the user.

Keywords: integration, quality management, quality technique

1 Introduction

According to Gartner Research "improving business processes" has been a business strategy of major priority in recent years and will be pursued by CIOs in the years to come (see [1]). In that context, process-oriented quality management has gained considerable attention [2], providing the process manager with a multitude of methods such as Six Sigma, Total Quality Management (TQM), EFQM or KAIZEN for example (see e.g. [3-5]). While many quality management methods have its origin in the production industry, they are increasingly used in service industries as well (see [4]). Quality management methods are usually characterized by specific strengths (see [4]). Lean Management (see [6]) for example enables the elimination of "non-value" adding activities. Regarding the multitude of existing methods, quality managers are often overstrained selecting an appropriate method to achieve a company`s quality goals. As a consequence, enterprises usually use more than just one method in parallel, e.g. Six Sigma and EFQM. On the one hand this seems reasonable, since synergies between quality management methods exist (see e.g. [7-9]). On the other hand the parallel use of more than just one quality management method needs proper coordination [10-11]. If the use of the methods (e.g. Six Sigma, EFQM, TQM, etc.) is not

11th International Conference on Wirtschaftsinformatik,
27th February – 01st March 2013, Leipzig, Germany

coordinated, results achieved by one initiative may be redone by a subsequent project using another quality management method [11]. Nevertheless, most employees do not have the time to become acquainted with the functionality of several different quality management methods [10]. Integrating quality management methods is a means for handling the variety of methods and generating a "single process improvement-based approach" [12]. Nevertheless guidelines on how to systematically integrate methods in quality management in a value-adding way do not yet exist. The paper at hand deals with that problem and introduces a holistic approach for combining methods in quality management following a design science approach (see [13]). The structure of the paper is as follows: In the following section, basics and challenges of quality management are described. Integration scenarios for specifying the application range of the integration approach are shown in section 3. Afterwards (section 4) requirements on an approach for integrating methods in quality management are derived. In section 5, the approach for integration is introduced, and applied at an automotive bank in section 6. The paper concludes with limitations of the paper and an outlook on further research.

2 Basics and Challenges

2.1 Elements of a Quality Management Method

According to Klefsjö et al. [14], quality management is lacking a theoretical foundation. A precise definition of the term "quality management method" cannot be found in literature. In that context, de Mast [15] introduces elements (steps, rules, concepts, tools) for comparing alternative methods in quality management. Andersson et al. [4] mention objectives, theories or strategies to describe a method from a strategic perspective. A more precise definition of a method can be found in method engineering. Consequently a method consists of activities (determining a procedure model), result documents, techniques (tools), roles, and a meta model (see [16]). Transferring these elements to the context at hand, a quality management method is characterized by activities, result documents, quality techniques and roles.[1] The activities of a quality management method make up its procedure model (e.g. DMAIC-cycle). The activities are performed by roles (e.g. team member) for producing result documents (e.g. performance data). Quality techniques (e.g. fishbone diagram) support the user in establishing the result documents. These method elements enable a structured description of a quality management method from an operational view, pointing out its functionality.

[1] We leave out the meta model as a constitute element (see [16]) for the research at hand since the quality management methods do not produce conceptual models as a main result.

2.2 Related Work

In literature, several combinations of quality management methods are described. To bring clarity to the topic a literature review (see [17]) has been conducted in a previous work (see [18]) to analyze integration efforts in quality management. The main focus was to identify those combinations of methods that are often dealt with in literature (e.g. Six Sigma and Lean Management), the underlying motivation for the integration effort as well as the steps taken for performing the integration. It became obvious that usually the result of the integration is presented. A systematic procedure or even guidelines on how the methods have been integrated are not given. Table 1 presents an overview regarding existing works, dealing with the integration of certain quality management methods. The first column shows the general steps taken by the authors to integrate the methods on an abstract level. These have been derived from the implicit description within the corresponding papers since a systematic and profound process of integration is not described. In the second and third column, the methods being integrated that way as well as the sources are shown.

Table 1. Examples for the integration of quality management methods

Steps taken for integration	Integrated methods	Authors
Search for common core concepts in quality management methods to derive synergies	• Six Sigma and ISO 9000 • Six Sigma and 5-S • ISO 9000, EFQM, BSC and Six Sigma	[7], [19], [20], [9], [21]
Analysis of weaknesses and strengths and derivation of synergies	• Six Sigma and ISO 9000	[22]
Creation of a framework in which quality management methods fulfill specific tasks	• Six Sigma, BSC and EFQM • TQM and ISO 9000 • TQM and TPM (Total Productive Maintenance)	[8], [23], [24]
The procedure model (e.g. PDCA-cycle) of a method is enhanced by activities of another method	• Six Sigma and Theory of Constraints (TOC) • Six Sigma and CQI (Continuous Quality Improvement)	[25], [26]
A completely new procedure model is derived from the activities of the methods considered	• Six Sigma and Lean Management	[27]
A specific method is enhanced by certain quality techniques from another method	• Six Sigma and Lean Management	[9]

Analyzing the quality management literature (see Table 1), it becomes obvious that integrating methods is performed in an ad-hoc manner, a fact that also holds true for related areas of application (e.g. systems engineering) (see [39]). While several integration efforts can be found, quality management is missing a profound and established theory for integration in general. A reason for that are specific challenges that need to be considered, making integration in quality management a complex discipline (see section 2.3). As a result, well-established and holistic approaches that both guide users in integrating quality management methods and, at the same time cope with these challenges, do not exist yet.

2.3 Challenges of Integration in Quality Management

Integration in quality management is a demanding discipline. However, the challenges associated with the process of integration are not externalized in literature. Therefore the challenges have to be derived from the authors` description of integration efforts in quality management (see [18]). In the following, we concentrate on those challenges that are generally valid and are independent of the combination of specific methods (e.g. Six Sigma and ISO 9000). A major problem in quality management is that *different interpretations* can be found. Magnusson et al. [28] introduce different perspectives on Six Sigma for example, which comprise its interpretation as a holistic companywide strategy, an improvement method as well as a mere toolbox of quality techniques. In literature (see e.g. Table 1), attention has thus been given to an author`s interpretation. While some authors reflect upon quality management methods from a strategic perspective (see e.g. [7], [20]), others take a more operational view instead (see e.g. [25-26]). Thus a classification scheme for interpreting quality management methods can be derived which is shown in Fig. 1. On each level different aspects of a method are focused (see [18]).

Level 1: On level 1, the authors focus on aspects such as organizational concepts, core values (e.g. process orientation), underlying philosophies, or quality goals for example (see e.g. [7], [20]). A strategic view on quality management is given.

Level 2: In a further category (level 2), authors interpret quality management methods as constructs compound of method elements (see section 2.1) that can be found in method engineering (see [16]). A quality management method is seen as a means for improving a business process, and not a philosophy or business strategy. Consequently, in most cases procedure models (e.g. DMAIC, PDCA, etc.) and result documents of the quality management methods (see e.g. [26-27]) are focused. Integration is usually reached by merging procedure models or deriving a new procedure model from the methods considered on that level.

Level 3: Some authors only consider quality techniques (e.g. fishbone diagram, quality function deployment, etc.). This perspective is similar to the “toolbox” perspective on Six Sigma as introduced by Magnusson et al. [28]. Thus a quality management method is considered as a collection of quality techniques (see [29]).

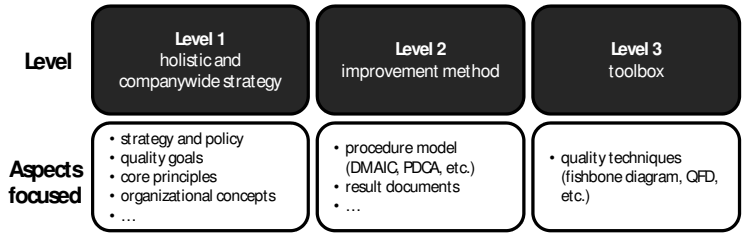

Fig. 1: Perspectives on quality management methods

A further challenge when integrating quality management methods are *naming conflicts* (see e.g. [30]). Due to the missing theoretical foundation of quality management (see [14]) the user is confronted with heterogeneous terms during integration which

hamper the identification of common concepts and differences between quality management methods. Synonyms may cause redundancies in the final method [31]. For example, the activities "definition of key performance indicators" (from quality management method A) and "definition of process metrics" (from quality management method B) may be transferred to the procedure model of the integrated method, because the user expects differences between these activities which do not exist. Also homonyms may cause problems. In quality management, the term "Six Sigma" is not only used to address the "improvement method" (see [28]) but also the sixfold standard deviation of a variable for example (see [3]).

Furthermore Bruhn [32] mentions "competing interdependencies" that exist between quality techniques. For example Lean Management techniques (e.g. value-stream-map) emphasize cost reduction, while Six Sigma and its techniques have a strong customer focus (e.g. VOC-/CTQ-matrix). According to Bruhn [32], this different focus may result in conflicts if corresponding techniques are used in combination.

3 Selection of an Integration Scenario

The sections above show that integration efforts in quality management can be diversified. For developing an approach for integration it is thus necessary to find an interpretation of a quality management method to work with. In the paper at hand, an operational perspective is taken (level 2 in Figure 1) and a quality management method is seen as a means for improving business processes. In section 2.1, the elements characterizing a quality management method have been introduced. Strategic aspects (e.g. organizational aspects) of a quality management method (see level 1 in Figure 1) are reflected in these method elements. Quality goals or core principles, such as reduction of waste, are realized by specific quality techniques (e.g. value-stream-map) for example. Organizational aspects on the other hand are managed by a corresponding role concept.

To structure integration efforts in quality management, integration scenarios can be established. Scenarios help in reducing complexity and are characterized by criteria [33]. The integration scenarios for quality management have been derived from a prior literature review (see [18]) analyzing case studies concerning integration efforts in quality management: At first, there is a certain motivation for integration efforts. In many cases, synergies between methods are searched for to eliminate weaknesses of certain quality management methods (e.g. missing activities for measuring process performance) (see e.g. [25]). Additionally, it becomes obvious that not only quality management methods (e.g. Six Sigma and Lean Management) are being integrated in literature, but also quality techniques (e.g. KANO-model and QFD) as well as quality management methods and quality techniques (e.g. FMEA and Six Sigma). Furthermore the integration can be performed regarding a specific improvement project or independent from a specific project constellation. If the integration is performed regarding an improvement project, project characteristics may require the availability of

certain activities or quality techniques in the resulting method.[2] In addition quality management methods can be "merged" or "joined" (form of integration) (see [34]). When merging methods one integrated quality management method results. Joining methods means that the original methods exist further on, but their parallel application is to be coordinated properly. This can be reached by exchanging result documents between the methods for example. The integration strategy determines whether two or more methods are integrated at a particular time (see [30]). Table 2 summarizes these characteristics.

Table 2. Morphological box to categorize integration scenarios

Characteristic	**Value**		
Motivation for integration	New methods are to be combined with existing methods	Synergies between methods / weaknesses are mitigated by integration	One method is the prerequisite for introducing another one
Objects for integration	Integration of quality management methods	Integration of quality techniques	Integration of quality management methods and quality techniques
	e.g. Six Sigma and Work-Out	*e.g. KANO-model and FMEA*	*e.g. FMEA and EFQM*
Situativity of integration	Project-related integration	Project-independent integration	
	Integration regarding a specific project constellation	*Integration independent from a specific project constellation*	
Form of integration	Merging	Joining	
Integration strategy	Binary integration	n-ary integration	

To manage the complexity of integration in quality management and to guarantee a decent level of detail a specific scenario is focused in the following. Thus this paper emphasizes the scenario most of the integration efforts found in literature (see [18]) can be ascribed to. Regarding the variety of integration efforts it is impossible to develop an integration approach that is suitable for all integration scenarios in an equal manner (see Table 2). In the scenario considered at hand, quality management methods (e.g. Lean Management and Six Sigma) are to be integrated, while synergies between methods are strived for. Quality techniques are part of quality management methods, so that solely focusing on techniques would restrict the range of application for the integration approach too much. The quality management methods are to be integrated independent from a specific project constellation. By that it can be guaranteed, that the integrated method can be used for different improvement projects, while it can be adapted for different contexts after the integration has been performed. The methods are to be merged, which means that the integration results in one integrated method. The problems in coordinating different quality management methods have been described in literature (see [10-11]). In addition employees appreciate using one method for quality management while no problem of selecting a method is given. The integration approach to be developed focuses the integration of two methods at a particular time which reduces complexity (see [30]). The coloring in Table 2 highlights the scenario considered in the following.

[2] No activities or quality techniques supporting the collection of data are required within the integrated method for example, if no data is to be collected in an improvement project.

4 Requirements on an Integration Approach

Following the design science paradigm (see [13]) requirements on the integration approach are defined in the following. In neighboring disciplines, such as method engineering, requirements on methods are defined which can be transferred to the context at hand. Greiffenberg [35] summarizes these requirements and categorizes them into "completeness", "consistency", and "intended purpose". Since these requirements stem from a comprising literature review they are referred to and specified accordingly. In addition, there are requirements that arise from the challenges of integration in quality management as described in section 2.3. These are summarized in the category "challenges in quality management" (see Table 3). The requirements are formulated in such a way that their fulfillment can unambiguously be judged. A detailed description of all requirements in this paper is not possible. Instead the requirement "consistency in the procedure model" is exemplarily shown.

Consistency in the procedure model: Consistency in the procedure model focuses on the logical sequence of activities within the procedure model (see [35]). It has to be assured that the activities (see [16]) are performed in an order in which no contradictions arise regarding their sequence (see [35]). For the integration approach at hand, the "integration potential" has to be determined first before the quality management methods can actually be integrated for example. Table 3 provides an overview of the requirements on the integration approach, which have been derived from *Greiffenberg* [35] and adapted accordingly, as well as of the challenges in quality management (section 2.3).

Table 3. Requirements on the integration approach

Category	Requirement	Summary
Completeness	Input-/Output-completeness	All input required by specific activities is produced as output by other activities of the approach.
	Completeness regarding the method elements	Completeness of the approach is given, if a procedure model, result documents and corresponding techniques can be found.
	Completeness regarding the procedure model	Each result document can be unambiguously assigned to one or more activities.
Consistency	Consistency in the procedure model	*See explanation above.*
	Consistency of the result documents to be produced	The approach must assure that the result documents a user produces are definitely consistent with each other. For example a modeling notation used for describing methods A and B must be clearly defined to enable a comparison.
Intended purpose	Construction adequacy	The integration approach must enable a proper integration of quality management methods.
	Efficiency	No redundant activities are given and no result documents are produced redundantly.
	Ease of learning	A rapid understanding should be given for all employees of the company, while the approach should be easy to use as well.
	Flexibility	An adaption to the needs of the user, for example by skipping specific activities, should be possible.
Challenges in quality management	Support of consistent method perception	The approach must support and build on a consistent and unambiguous interpretation (method elements) of a quality management method.
	Assurance of consistency of the terms used	The approach must consider means to avoid naming conflicts in the resulting quality management method.
	Assurance of consistency of quality techniques	There must be means to avoid "competing interdependencies" (see [32]) between quality techniques in the integrated method.

5 A Holistic Approach for Integrating Methods

5.1 Approaches for Integration in Literature

In many disciplines such as data modeling (see [30], [36]), process modeling (see [37]), software development (see [38-39]) or even IT-Governance (see [40]), integration is a widely established concept. Batini et al. [30] introduce a four-step approach for schema integration in database management for example. Also the work of Hars [36] deals with data models and their integration, while a corresponding procedure is introduced. Rosemann [37] develops an approach for integrating business process models, while Kronlöf and Ryan [39] present a general procedure for integrating methods in systems engineering. Van Hillegersberg and Kumar [38] integrate concepts for object-oriented systems development using meta models of the methods considered. Alter and Goeken [40] describe the integration of reference models in IT-Governance using a four-step approach and meta models. Table 4 shows the reflection of the these approaches against the design requirements as introduced in section 4.

Table 4. Reflection of the approaches against the design requirements

	Integration approach					
Requirements	[30]	[36]	[37]	[38]	[39]	[40]
Input-/Output-completeness	✓	✓	✓	✓	✓	✓
Completeness regarding the method elements	⊙	⊙	⊙	⊙	⊙	⊙
Completeness regarding the procedure model	✓	✓	✓	✓	✓	✓
Consistency in the procedure model	✓	✓	✓	✓	✓	✓
Consistency of the result documents to be produced	⊙	⊙	✓	✓	⊙	⊙
Construction adequacy	⊙	⊙	⊙	⊙	⊙	⊙
Efficiency	✓	✓	✓	✓	✓	✓
Ease of learning	⊙	⊙	⊙	⊙	⊙	⊙
Flexibility	⊙	⊙	⊙	⊙	⊙	⊙
Support of consistent method perception	○	○	○	○	○	○
Assurance of consistency of the terms used	✓	✓	✓	✓	⊙	✓
Assurance of consistency of quality techniques	○	○	○	○	○	○

(Legend: ✓: given and explicitly emphasized; ⊙: partly or implicitly given; ○: not given)

While the approaches are all based on a clear and consistent procedure model there are drawbacks in dealing with requirements that stem from the challenges of integration in quality management (see section 2.3). This especially concerns the support of a consistent method perception as well as a thorough consideration of quality techniques and their interdependencies (see e.g. [32]). An ill-conceived transfer to the domain of quality management is thus not possible, since the approaches have not been developed for that particular field of application. Therefore we introduce an approach for integration in quality management in the next section.

5.2 The Integration Approach for Quality Management

While the integration approaches introduced (see section 5.1) have problems in dealing with certain requirements stemming from quality management in particular, they

are all characterized by a consistent procedure model. Focusing the underlying procedures of the integration approaches it becomes obvious that (despite the different areas of application) there are many similarities. The following steps can thus be derived from the approaches (see [30], [36-41]):

1. Graphical visualization of the methods (see e.g. [40], [38])
2. Comparison and identification of conflicts (see [30], [36-37], [41])
3. Determination of an integration strategy (see e.g. [30], [36-37], [40])
4. Resolution of conflicts (see e.g. [30], [36-41])
5. Integration (see e.g. [30], [36-41])
6. Validation and Restructuring (see e.g. [30], [36-37], [40])
7. Selection of the methods (see e.g. [38])

These steps are generally valid and can therefore guide the integration of quality management methods as well. However, to fulfill the design requirements as defined in section 4, a proper specification of each step for the field of quality management is necessary (see section 5.3).

Figure 2 shows the integration approach on a generic level. It is based on the assumption that the quality management methods to be integrated have already been selected. Process managers are often expected to analyze a possible integration of newly developed methods with those already existing within an enterprise (see e.g. [42]). The introduction of new methods is usually expected by customers or dictated by management (see e.g. [42]). The methods to be integrated are already given in that case. In addition, literature presents a variety of value-creating combinations of quality management methods (see Table 1) which supports a practitioner searching for promising combinations. Thus our approach starts when the practitioner has already chosen the quality management methods to be integrated. The “graphical visualization of the quality management methods” (step 1) is helpful to illustrate the functionality of the methods to the employees. The comparison of the visualizations for methods A and B enables the identification of similarities and differences.

In the second step (“identification of integration potential and conflicts”) the quality management methods are compared. This way, integration potential is being recognized and the question as to which degree two methods complement each other is answered. Within a project for example two quality management methods A and B are given. By comparing both methods it becomes obvious that only some of the quality techniques from method B enhance method A in a value-adding way, for example. This insight is important for the later integration since in that case it does not make sense to derive a new procedure model from both methods. Much more the toolbox of quality techniques of method A should be extended by the corresponding quality techniques of method B. At the same time, conflicts (e.g. naming conflicts, competing interdependencies) have to be recognized to arrive at a consistent method during integration. The insights gained from step 2 are necessary for deriving an appropriate integration strategy (step 3 – “determination of an integration strategy”). The notion of “integration strategy” does not only address the differentiation between a binary and a n-ary integration but also a procedure for performing the integration. The quality management method A can be declared as a base method for example which is

selectively enhanced by activities, quality techniques, and roles from method B. This approach is advisable, if the method A produces the desired result documents to achieve the project goals (e.g. improving customer satisfaction). Nevertheless, enhancing method A (e.g. by the activity "collecting data") leads to more precise results, which may be important for a project (e.g. "verified process performance"). An overview of integration strategies is given in a previous study (see [18]).

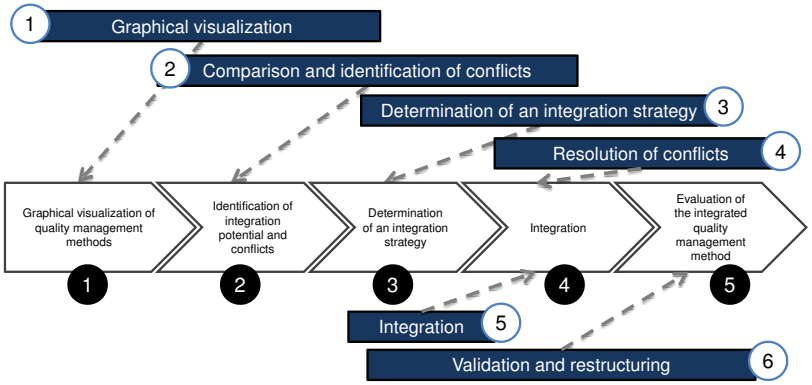

Fig. 2: Integration approach for quality management methods

After an appropriate integration strategy has been selected, the integration is performed. The integration varies depending on the integration strategy chosen. During integration also the conflicts are resolved. In a last step, the integrated method is evaluated, while the criteria as introduced by Greiffenberg [35] are modified and referred to. Each of the steps comprises several sub-steps. Step 4 (integration) is explained in more detail in the following.

5.3 Description of Step 4 – "Integration"

The integration itself (step 4) is the central step of the integration approach which merges two quality management methods A and B (e.g. Six Sigma and Work-Out). This step varies depending on the integration strategy chosen in the prior step 3. Nevertheless all integration strategies have a common pattern. At first the procedure models of the quality management methods are to be merged. The procedure model is the basis for embedding the quality techniques. The quality techniques are assigned to those activities supporting the creation of corresponding result documents (see [16]). Afterwards responsibilities respectively roles (see [16]) should be considered. Figure 3 shows the sub-steps that are to be performed for integrating methods A and B. In the example the following integration strategy has been chosen (see [18]): *"The quality management method A is declared as the base method which is enhanced by specific activities, quality techniques and roles of method B"*.

For integrating the procedure models five sub-steps have to be performed. At first (sub-step P1), the activities of the procedure model of method B should be specified regarding input-/output-relations (result documents). For example the activity "col-

lecting process data" has the input "data collection plan" and the output "process performance data". Afterwards (sub-step P2) these activities are transferred to the procedure model of method A (P2: Identification of integration points). Consistency in the procedure model (see Table 3) has to be paid attention to at that point. No activities may use result documents as input which are produced in later activities. Naming conflicts (e.g. „performance metrics" vs. „key measures") have to be resolved (sub-step P3). Afterwards the new procedure model is constructed on a conceptual level (sub-step P4) and the user may consider (sub-step P5) how this new procedure model can be adapted for specific project situations in the sense of a "roadmap" (see [43]). That way the procedure model is already specified for certain project situations. Hereafter the quality techniques of both methods A and B are considered. Only those quality techniques of method B are transferred to the toolbox of quality techniques of method A that actually support the new procedure model (sub-step QT1). In addition, quality techniques may support each other, an aspect that Bruhn [32] calls complementary interdependencies. For example, the KANO-model enables a more precise prioritization of customer requirements in QFD (see e.g. [44]). If such interdependencies are given between quality techniques of method A and method B, further techniques from B may be transferred to the final toolbox of quality techniques (sub-step QT2). As a final step, the roles of the quality management methods have to be considered. From the role models of methods A and B a final role model for the integrated method has to be derived (sub-steps R1 and R2).

Integration of the procedure models and the result documents	***Integration of the quality techniques***	***Integration of roles***
P1: Specification of the activities to be transferred and their input-/output-relations	**QT1:** Transfer of the quality techniques that support the creation of result documents in the new procedure model	**R1:** Merging of common roles
P2: Identification of integration points		
P3: Resolution of naming conflicts	**QT2:** Transfer of quality techniques that have complementary interdependencies	**R2:** Visualization of the new role model
P4: Visualization of the new procedure model		
P5: Enterprise-specific adaption		

Fig. 3: Integration of the quality management methods

As mentioned this procedure varies slightly for different integration strategies. The result of this procedure is the concept of the integrated quality management method.

6 Evaluation and Application of the Integration Approach

In the following the integration approach is reflected against the requirements defined in section 4. In addition, its application at an automotive bank is described. Table 5 shows those requirements focusing on the correct construction of the integration approach which can be confirmed at that point (see section 4). The practical applicability of the integration approach was tested at an automotive bank as a case study. At the automotive bank, Six Sigma (see [3]) had been introduced as the standard method

for quality management. Management intended to investigate a potential integration of Six Sigma and Work-Out (see [45]) to derive an integrated method. Work-Out was considered as a promising method for accelerating the implementation of improvement ideas within improvement efforts.

Table 5. Requirements regarding the correct construction of the integration approach

Requirements									
Input-/Output-completeness	Completeness regarding the method elements	Completeness regarding the procedure model	Consistency in the procedure model	Consistency of the result documents	Construction adequacy	Efficiency	Support of consistent method perception	Assurance of consistency of the terms used	Assurance of consistency of quality techniques
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

The task of developing an integrated method was assigned to the department "organization". The project team consisted of three employees experienced in the Six Sigma concept. The Work-Out method had not been implemented at the automotive bank while the bank was unfamiliar with its functionality at that point. It was the intention to create one integrated method (from Six Sigma and Work-Out) since employees at the bank opposed the use of several methods in parallel. Thus a scenario was given the integration approach has been designed for.

The integration approach was performed stepwise by the project team leading to the integrated quality management method which was to be communicated to the employees afterwards. The graphical visualization of the quality management methods (step 1 – Figure 2) helped in creating a better understanding of the Work-Out method which was necessary to identify integration potential in the following. Although the creation of the corresponding models proved to be time-consuming the benefit of this step was appreciated for the identification of integration potential. Much effort was put into the identification of naming conflicts (step 2 – Figure 2) since both methods (Six Sigma and Work-Out) have similar concepts which however have different names (e.g. "stretch goals" vs. "project goals"). The comparison of both methods to find integration potential showed that Work-Out could provide activities, roles and quality techniques for enhancing the Improve-phase of the Six Sigma cycle (see [3]) by control-mechanisms for the implementation of improvement ideas. Because of that it was chosen (integration strategy) that Six Sigma should be the base method which is partially enhanced by quality techniques (e.g. Gallery of ideas [45]) and activities (e.g. "conduct Town-Meeting" [45]) of Work-Out (step 3 – Fig. 2). The integration (step 4 – Figure 2) was performed as shown in section 5.3. From that procedure an integrated method resulted which was mainly based on the company's Six Sigma method and was extended by components of Work-Out to mitigate certain weaknesses in the Improve-phase of Six Sigma. Based on the use of the integration approach at the automotive bank its applicability as well as its ease of learning and flexibility (see section 4) could be judged. The integration approach proved suitable for integrating the methods Six Sigma and Work-Out in an adequate way, while the integration result was free from naming conflicts and competing interdependencies. Since the integration approach is characterized by a clear procedure

model and corresponding techniques, its ease of learning was confirmed after it had been applied for the first time. Nevertheless the identification of competing interdependencies was seen as a challenging task since profound knowledge regarding the quality techniques is necessary. Specific steps of the integration approach may be skipped emphasizing its flexibility. For example the quality management methods do not have to be visualized in case the user is familiar with their functionality.

7 Summary, Limitations and Outlook

Regarding the multitude of existing quality management methods, quality managers strive for ways to use the strengths of various approaches. Nevertheless the use of several methods in parallel is challenging, since a proper coordination is necessary.

Quality management is a discipline that lacks a theoretical foundation [14], hence no commonly accepted theory on integration exists. While some integration efforts are described in literature (see Table 1), integration is mostly performed in an ad-hoc manner in quality initiatives. Contrary to other disciplines such as data modeling (see [30], [36]), guidelines or well-known approaches for integration are missing in quality management. In section 5.1, it has been shown, that a transfer of established integration approaches from neighboring disciplines (e.g. [30], [38]) cannot be done due to specific challenges (see section 2.3). The paper at hand addresses this gap and introduces an integration approach supporting a quality manager to derive an integrated method for the purpose of quality management. The approach helps a company to combine existing methods (e.g. Lean Management) with newly arising quality management methods (e.g. Six Sigma). An ad-hoc introduction of quality management methods, which may cause problems in coordinating these methods, can be avoided. It became obvious that it was not possible to develop an integration approach equally suitable for all integration efforts. Because of that, a specific integration scenario is focused (see section 3). A limitation is that the integration approach is specially designed for that particular scenario. The integration approach is evaluated both against defined requirements and in a cooperation project. However a limitation is that the integration approach has so far only been applied in one cooperation project. Different interpretations of quality management methods require that a uniform way for describing the methods is found. In that context the method elements (see [16]) are used in the approach at hand. Strategic aspects (e.g. organizational concepts, etc.) are, however neglected; much more an operational interpretation of a quality management method is given. A limitation is that guidelines for implementing the integrated method in an enterprise are not part of the integration approach. Building ontologies for quality management in future research may support the user in comparing methods. These may be used for enhancing the integration approach as introduced.

References

1. McDonald, M.P., Aron, D.: Executive Summary: Reimagining IT: The 2011 CIO Agenda. Gartner Research (2011)
2. Stracke, C.: Process-oriented quality management. In: Ehlers, U.-D., Pawlowski, J.M. (eds.): Handbook on Quality and Standardisation in E-Learning. Springer, Berlin Heidelberg (2006)
3. Pande, P., Neumann, R., Cavanagh, R.: The Six Sigma Way - How GE, Motorola and other top companies are honing their performance. McGraw-Hill, New York et al. (2000)
4. Andersson, R., Eriksson, H., Torstensson, H.: Similarities and differences between TQM, six sigma and lean. The TQM Magazine 18, 282-296 (2006)
5. Imai, M.: Kaizen: The Key to Japan's Competitive Success. McGraw-Hill (1986)
6. Womack, J.P., Jones, D.T.: Lean Thinking. Simon & Schuster, New York (1996)
7. Pfeifer, T., Reissiger, W., Canales, C.: Integrating six sigma with quality management systems. The TQM Magazine 16, 241-249 (2004)
8. Töpfer, A.: Six Sigma, Balanced Score Card und EFQM-Modell im Wirkungsverbund. In: Töpfer, A. (ed.): Six Sigma. Springer, Berlin et al. (2007)
9. Snee, R., Hoerl, R.: Leading Six Sigma. Prentice Hall, New York et al. (2003)
10. Gijo, E.V., Rao, T., S.: Six Sigma Implementation – Hurdles and More Hurdles. Total Quality Management & Business Excellence 16, 721-725 (2005)
11. Samson, D., Challis, D.: Patterns of business excellence. Measuring Business Excellence 6, 15-21 (2002)
12. Bendell, T.: A review and comparison of six sigma and the lean organisations. The TQM Magazine 18, 255-262 (2006)
13. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design Science in Information Systems Research. MIS Quarterly 28, 75-105 (2004)
14. Klefsjö, B., Bergquist, B., Garvare, R.: Quality management and business excellence, customers and stakeholders: Do we agree on what we are talking about, and does it matter?. The TQM Journal 20, 120-129 (2008)
15. de Mast, J.: A methodological comparison of three strategies for quality improvement. International Journal of Quality & Reliability Management 21, 198-213 (2004)
16. Gutzwiller, T.A.: Das CC RIM-Referenzmodell für den Entwurf von betrieblichen, transaktionsorientierten Informationssystemen. Physica, Heidelberg (1994)
17. Cooper, C.M., Hedges, L.V.: Research Synthesis As a Scientific Enterprise. In: Cooper, C.M., Hedges, L.V. (eds.): The Handbook of Research Synthesis. Russell Sage Foundation, New York (1994)
18. Johannsen, F.: State of the art concerning the integration of methods and techniques in quality management – literature review and an agenda for research. In: Proceedings ECIS 2011, Paper 41 (2011)
19. Bucher, P.: Integration von Six Sigma und ISO 9000 am Beispiel von GECTIS Austria. In: Töpfer, A. (ed.): Six Sigma. Springer, Berlin et al. (2007)
20. Low, S.P.: Towards TQM – integrating Japanese 5-S principles with ISO 9001:2000 requirements. The TQM Magazine 13, 334-341 (2001)
21. Ruiz, U., Simon, J.: Quality management in health care: a 20-year journey. International Journal of Health Care Quality Assurance 17, 323-333 (2004)
22. Töpfer, A., Günther, S.: Six Sigma im Wirkungsverbund mit ISO 9000:2000. In: Töpfer, A. (ed.): Six Sigma. Springer, Berlin et al. (2007)

23. Schmutte, A.M.: Six Sigma im Business Excellence Prozess - Wertorientierte Unternehmensführung mit Balanced Scorecard, EFQM und Six Sigma bei Siemens. In: Töpfer, A. (ed.): Six Sigma. Springer, Berlin et al. (2007)
24. Cua, K.O., McKone, K.E., Schroeder, R.G.: Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. Journal of Operations Management 19, 675-694 (2001)
25. Revere, L., Black, K., Huq, A.: Integrating Six Sigma and CQI for improving patient care. The TQM Magazine 16, 105-113 (2004)
26. Ehie, I., Sheu, C.: Integrating six sigma and theory of constraints for continuous improvement: a case study. Manufacturing Technology Management 16, 542-553 (2005)
27. Bevan, H., Westwood, N., Crowe, R., O'Connor, M.: Lean Six Sigma: some basic concepts. NHS (2005)
28. Magnusson, K., Kroslid, D., Bergman, B.: Six Sigma umsetzen. Hanser, München (2004)
29. McQuater, R.E., Scurr, C.H., Dale, B.G., Hillmann, P.G.: Using quality tools and techniques successfully. The TQM Magazine 7, 37-42 (1995)
30. Batini, C., Lenzerini, M., Navathe, S.B.: A Comparative Analysis of Methodologies for Database Schema Integration. ACM Computing Surveys 18, 323-364 (1986)
31. Strecker, S., Kargl, H.: Integration Deficits of IT Controlling. Business & Information Systems Engineering 1, 204-212 (2009)
32. Bruhn, M.: Qualitätsmanagement für Dienstleistungen. Springer, Berlin et al. (2011)
33. Weidenhaupt, K., Pohl, K., Jarke, M., Haumer, P.: Scenarios in System Development: Current Practice. IEEE Software 15 (2), 34-45 (1998)
34. Rosemann, M.: Gegenstand und Aufgaben des Integrationsmanagements. In: Scheer, A.-W., Rosemann, M., Schütte, R. (eds.): Integrationsmanagement – Arbeitsbericht des Instituts für Wirtschaftsinformatik Nr.65. University Münster (1999)
35. Greiffenberg, S.: Methodenentwicklung in Wirtschaft und Verwaltung. Dr. Kovac, Hamburg (2003)
36. Hars, A.: Referenzdatenmodelle – Grundlagen effizienter Datenmodellierung. Gabler, Wiesbaden (1994)
37. Rosemann, M.: Komplexitätsmanagement in Prozeßmodellen. Gabler, Wiesbaden (1996)
38. Van Hillegersberg, J., Kumar, K.: Using metamodeling to integrate object-oriented analysis, design and programming concepts. Information Systems 24, 113-129 (1999)
39. Kronlöf, K., Ryan, K.: Conclusions and Recommendations. In: Kronlöf, K. (ed.): Method Integration. John Wiley & Sons, Chichester et al. (1993)
40. Alter, S., Goeken, M.: Konzeptionelle Metamodelle von IT-Governance-Referenzmodellen als Basis der Kombination und Integration in einer Multi-Modell Umgebung. In: 9. Internationale Tagung Wirtschaftsinformatik (Band 1), pp. 705-714 (2009)
41. Spaccapietra, S., Parent, C.: View Integration: A Step Forward in Solving Structural Conflicts. IEEE Transactions on Knowledge and Data Engineering 6, 258-274 (1994)
42. Fritsch, V., Stössl, M.: Implementierung von Six Sigma in Abstimmung mit KVP bei VA TECH ELIN Transformatoren GmbH & Co, einem Unternehmen der Siemens Gruppe. In: Töpfer, A. (ed.): Six Sigma. Springer, Berlin et al. (2007)
43. Mirbel, I., Ralyté, J.: Situational method engineering: combining assembly-based and roadmap-driven approaches. Requirements Engineering 11, 58-78 (2006)
44. Tontini, G.: Integrating the Kano Model and QFD for Designing New Products. Total Quality Management & Business Excellence 18, 599-612 (2007)
45. Ashkenas, R.: Why Work-Out Works: Lessons from GE`s Transformation Process. Handbook of Business Strategy 4, 15-21 (2003)