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Towards a Strategy Design Method for Corporate Data Quality Management

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Abstract. Large, multidivisional enterprises need corporate data of high quality in order to meet a number of strategic business requirements, such as enterprise-wide process harmonization, integrated customer management or compliance. Therefore, many enterprises today are in the process of establishing Corporate Data Quality Management (CDQM), which requires an overarching CDQM strategy. This paper presents a method for the development and implementation of a CDQM strategy. On the one hand the method provides guidance to a CDQM team. On the other hand, for corporate executives the method ensures that the CDQM strategy is derived from their objectives and that their requirements are systematically taken into account and fulfilled. Besides the method itself, the paper illustrates the entire design process which encompasses, among others, focus group and expert interviews, participative case studies and a multi-perspective evaluation.

Keywords: Data quality, data quality management, data quality strategy, design science research, method engineering

1 Introduction

1.1 Motivation and Problem Statement

Large, multidivisional enterprises - regardless of what industry they operate in - need corporate data of high quality in order to meet a number of strategic business requirements, such as business networking, enterprise-wide process harmonization, integrated customer management, effective and efficient reporting or compliance with legal and regulatory provisions. All these requirements demand that corporate data for the most important business objects are available, up to date, consistent and complete [1].

What these requirements have in common is that they are not related to single organizational functions or business areas, but affect the enterprise as a whole and therefore need to be dealt with on a corporate level. To do so effectively, different stakeholder groups from across the entire enterprise need to develop a common understanding of the data objects and define common objectives regarding corporate data quality management (CDQM). CDQM is an enterprise function that covers and

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includes all activities, methods, and systems for analyzing, improving and maintaining data quality, aiming at maximizing the economic value of corporate data [2].

As the following example shows, many enterprises today are in the process of establishing CDQM on an enterprise-wide level, which requires an overarching CDQM strategy: A global glass manufacturer, employing about 26,000 people, is in the process of a large organizational transformation. Acquisitions of businesses, the closing of plants combined with a global business process harmonization pose a challenge to the company's CDQM. A thoroughly defined CDQM strategy is needed to ensure that new business processes and systems can be rapidly integrated and that the archiving of data of plants to be closed can be done in a controllable manner [3].

Typically, the head of the CDQM function is called Chief Data Steward. Alternative terms are Leading/Global Data Steward, Head of Data Governance, Head of Master Data, Head of Global Data Management, and Head of Data Process Management. Further CDQM roles comprise Business Data Stewards, Technical Data Stewards, the Sponsor, the Data Governance Council and the Data Owners [4]. The Sponsor fosters CDQM throughout the company and grants the "mandate" for action. Since CDQM typically affects a company as a whole, the Data Governance Council (Data Owners and Chief Data Steward) is supposed to balance and match different interests of different stakeholders in CDQM, and which is also supposed to make binding decisions. While Data Owners are "accountable" for the immediate correctness and consistency of certain data, Data Stewards develop and provide the rules for the handling of this data.

Regardless of what the exact situation in an enterprise is regarding CDQM, focus group interviews revealed that the Chief Data Steward basically needs to deal with the following questions: Have the CDQM objectives been derived from the overall, strategic business objectives? Has the scope of the CDQM strategy - the data classes to be affected by CDQM, such as material data, customer data, or supplier data, for example - been clearly defined? Have the functional tasks of CDQM (controlling, implementation etc.) been clearly defined? How can the Chief Data Steward demonstrate the contribution of CDQM to the performance of the enterprise? Is there a long-term, regularly reviewed roadmap specifying the continuous implementation of CDQM in the organization? And, if there is such a roadmap, does it take project interdependencies into account?

1.2 Research Objective and Contribution

When looking at the current state of literature, researchers and executives alike do not find a lot of answers to their questions, since the interdependencies between single CDQM actions have not been sufficiently addressed and also many aspects of CDQM, such as e.g. CDQM cost analysis have not been dealt with yet in scientific publications. The consensus, that preventive CDQM is less expensive than a purely reactive approach [5-7] exists in the research and in the practitioner's community. However, most of this work is not executable in the sense that it provides guidance for actually calculating the CDQM costs. Methods for strategic management supporting the development of all-encompassing (i.e. cross-regional, cross-functional, cross-

divisional etc.) strategies have not been adapted for being used in CDQM so far. To close this gap in research the research goal of the paper is to present a method for developing and implementing a CDQM strategy. Guided by the principles of Design Science Research (DSR), the paper addresses both researchers and practitioners.

Applying the method in companies will contribute to the strategic management research, as the method includes the transfer of existing strategic management models to the domain of CDQM. Besides, the artifact developed is closing a gap in research on CDQM. The method is beneficial for practitioners (e.g. Data Stewards) responsible for designing and implementing CDQM. For executives the method ensures that the CDQM strategy is derived from their objectives and that their requirements are systematically taken into account and fulfilled.

2 Theoretical Background and State of the Art

Data quality management comprises activities for the improvement of data quality [8]. Going beyond mere reactive action (e.g. identification and correction of data defects), data quality management works as a preventive concept, characterized by a continuous cycle consisting of activities to define, measure, analyze and improve data quality [6], [9], [10]. Preventive data quality management includes the design and deployment of appropriate management structures such as data governance [4] or the specification and implementation of data quality metrics [11]. An overview of the most relevant approaches for data quality management is given by Batini et al. [12]. Data Strategy Management aims at evaluating a set of strategic choices around data management in order to be able to make decisions with regard to the way enterprise data is to be managed and used. It includes a vision, business benefits of data management, objectives of data management, and a strategic action plan.

With regard to CDQM, the state of the art in research and in practice mainly deals with the components of a CDQM strategy and - to a limited extent - with success factors for establishing and implementing CDQM [5], [7], [13-16]. The same is true for associations, like the Data Management Association (DAMA), software producers, analysts and consulting companies [17-20]. Publications on Data Governance [4], [21], [22], strategic data architecture management [23] or CDQM maturity models usually focus on isolated activities within the phases of the strategic management process for CDQM. A holistic view of the different CDQM activities and strategic decision options for developing and implementing a CDQM strategy has not been developed so far. Furthermore, little has been said so far in what chronological order (depending on the specific situation given) the CDQM areas of action such as “data quality controlling”, “data governance”, “data lifecycle processes”, “data architecture” and “CDQM applications” should be approached.

The large body of literature on IT, Business Intelligence, and Enterprise Resource Planning (ERP) strategies [24-28], and on frameworks such as ITIL [29], COBIT [30] and works by IAIDQ [31] relates to methods for developing and implementing a strategy in general. The specific elements of strategic managements in the field of CDQM, however, have not been examined so far.

The paper builds on established theories, methods, and models, which Hevner et al. have denoted with the term "knowledge base" [32]. This knowledge is taken up by the paper, ensuring that a consistent solution is developed. Table 1 lists contributions from the research community that were taken up by the paper.

Table 1. Literature Review

Topic		Selected literature	Maturity level	Relation to paper and assessment
CDQM strategy	Components of a CDQM strategy	[5], [7], [13-16]	Low	• Content for result documents of the method • Recommendations for strategy development (at best), but no methodological support
	Data Governance	[4], [21], [22]	High	• Reference model for CDQM organizations • Success factors
	Maturity model	[12], [33]	High	• Activity within the Analysis phase
	Data architecture	[23]	Medium	• Principles for designing the data architecture and the processes • Contingency factors for data integration
CDQM (overview and definitions)		[5], [10], [16], [34], [35]	High	• Motivation and definition of terms • Comprehensive literature • Mainly qualitative research
IT / BI / ERP strategy		[24-28]	High	• IT strategy as a contingency factor • ERP / BI strategies offer orientation for developing the method, but lack reference to CDQM

3 Research Approach

3.1 Research Methodology

This study follows the principles of Consortium Research. Consortium Research aims at the design of artifacts within a collaborative environment. While the foundations of Consortium Research were laid twenty years ago, the approach has lately been developed further into a comprehensive research method [36]. As a multilateral form of design-oriented IS research, Consortium Research explicates existing guidelines such as Design Science Research Methodology (DSRM) [37], by adopting principles of other research approaches, among them case study research and action research. Furthermore, the paper follows the principles of theory-guided artifact design [38]. Theories for the development of strategies are discussed controversially in the literature. In a nutshell, Mintzberg et. al. list ten different strategy schools [39]. The principles and the strategy development process of the Design School form the kernel theory [40] which guides the construction of the CDQM strategy method. So the latter adopts its phases and basic structure from the Design School procedure model (e.g. the Design School integrates an internal and an external perspective for analysis, the so called market-based view [41] and the so called resource-based view [42]). Moreover, the paper uses Method Engineering [43], [44] as a design technique to construct the

CDQM strategy method as an artifact [45]. Method Engineering defines that a method needs to consist of certain elements: a meta-model, design activities, techniques, design results, and roles [46]. A similar definition is provided by Nuseibeh et al. [47]. A procedure model specifies the chronological order of the method's activities. The context of the research presented in the paper is formed by the Competence Center Corporate Data Quality (CC CDQ), which is a consortium research project [36] aiming at the design of methods, models, and architectures supporting data quality management in large organizations. The consortium consists of the University of St. Gallen and several partner companies from various industries. Participation of several partner companies allows for multi-iterative design cycles in multiple different environments and access to several carriers of knowledge in several organizations.

3.2 Research Process

As proposed by the Consortium research method, the design of the CDQM strategy method was carried out in four steps: "Analysis", "Design", "Evaluation", and "Diffusion" (cf. Fig. 1).

The "Analysis" step started with identifying the gap in research. The research gap was identified by focus group interviews [48], [49] (focus group A) with representatives from the partner companies of the CC CDQ, who stated the need for a CDQM strategy and discussed the research goal. A search in literature for existing CDQM strategy methods and the evaluation of these approaches by means of the requirements showed no evidence of the existence of any methods living up to the requirements.

The "Design" step comprised two iterative design cycles, which took place between November 2010 and June 2012. DSR [32], [50], [51] guided the design process of the artifact. As mentioned above, Method Engineering was the central design technique. Subject matter experts reviewed the first draft of the method in Hamburg in June 2011 (focus group B), leading to the design decision in favor of a separate Phase III "Justification" and to additional activities in Phase I. In three participative case studies a CDQM maturity assessment was conducted, followed by the development of a CDQM strategy and the creation of result documents for these techniques. Two further participative case studies provided CDQM costing approaches for Phase I and III of the CDQM strategy development method. The results of the case studies determine the chronological order of the activities in the procedure model of the method. In the course of two expert interviews from companies showing a high level of CDQM maturity, the blueprint for the CDQM roadmap was developed, which was later confirmed in another expert interview.

In the third step "Evaluation" the method was evaluated. Activities included focus group evaluation in June 2012 (focus group C) and multi-perspective evaluation according to the guidelines proposed by Frank [9]. The focus groups A, B and C encompassed thirty to thirty-five participants, who fulfill the role Chief Data Steward in a large enterprise or who are responsible for CDQM in certain regions. Table 2 lists details of the expert interviews and Table 3 of the participative case studies.

The fourth step "Diffusion" includes communication activities. Both Hevner et al. [13] and Peffers et al. [27] stipulate that DSR results must be disseminated both in the practitioners' and the scientific community. While the former will be addressed by presentations at practitioners' conferences, the paper at hand aims at making the research available for the scientific body of knowledge. First, it describes the method itself so that it can be used, extended, and evaluated by future research. Second, the paper outlines the research process to make it verifiable and repeatable for other researchers.

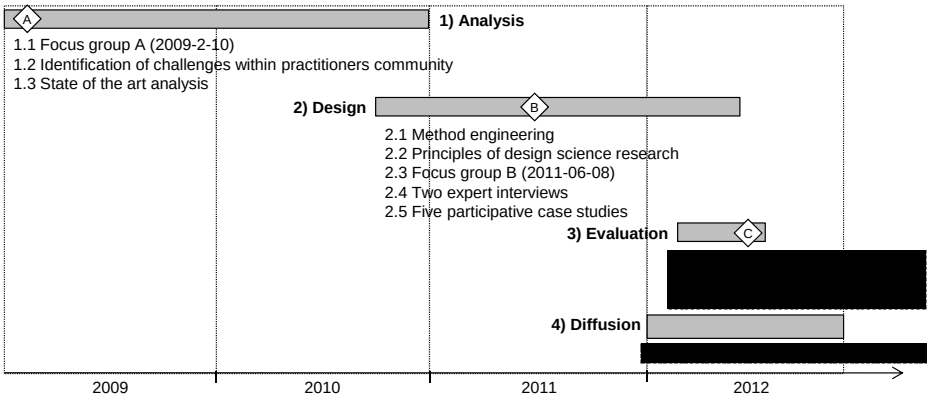

Fig. 1. The reseach design steps for the CDQM strategy method

Table 2. Expert interviews

Date	Organization	Participant's Function in the Organization
2012-05-24	Global software corporation	Head Master Data Management DACH region
2012-08-01	Global chemical corporation	Chief Data Steward
2012-08-02 2012-08-06	Personal care corporation	Chief Data Steward

Table 3. Participative case studies

Period	Organization	Description	Research method
09/2010-01/2011	Glass & cable manufacturer	Maturity assessment CDQM strategy development	Text analysis of internal documents, expert interviews
03/2011-06/2011	Telecommunication provider		
05/2011-09/2011	Automotive supplier		
07/2011-11/2011	Pharmaceutical corporation	Master data process cost analysis, identification of cost drivers, strategy development	
Since 10/2011	Industrial control & automation enterprise	Data object-oriented overhead cost analysis for parts	

4 Method Design

4.1 Method Overview

Fig. 2 shows the Strategy Method for CDQM. The method subdivides all CDQM activities into four phases. The order of the phases is not fixed and iterations and feedback loops are possible, which is further explained by the procedure model in chapter 4.2. Phase I "Analysis" aims at determining the baseline for the CDQM strategy. It covers both internal and external aspects. From an enterprise-internal perspective, the following results should be achieved: Corporate strategy and IT strategy analyzed for implications on CDQM; CDQM maturity assessment conducted (following guidelines of the EFQM Framework for Corporate Data Quality Management [33]); current project portfolio and initiatives with CDQM implications analyzed and assessed; current CDQM risks and potentials identified; cost analysis conducted (optional). If e.g. the strategy development is initiated in Phase III by a cost/benefit analysis and a mandate for a CDQM program is assigned, then an extensive cost analysis may be skipped in Phase I. Furthermore, cost drivers for CDQM can also be identified by a CDQM maturity assessment. In this case a qualitative CDQM effort evaluation may be sufficient and e.g. activity based costing for CDQM can be skipped in a first iteration of the method.

From an enterprise-external perspective, the following results should be achieved: CDQM Benchmarking with peer group conducted; regulatory requirements, major market and IT trends (e.g. consumer-centricity, external data services) assessed; CDQM requirements from business partner network derived [52].

Phase II "Strategy development" aims at defining the strategic CDQM directions in order to develop an implementation plan (Please refer to section 4.2 for details on the content of a CDQM roadmap). Key for adoption and success of a CDQM strategy is engagement with stakeholders regarding CDQM (from business and IT).

Phase III "Justification" provides different techniques for the cost and benefit analysis of CDQM. Experiences from the case studies and focus group interviews showed, that CDQM costs on the part of the data owners in the business are usually "hidden" in overhead costs, which can make a detailed differentiation of these costs time-consuming. Lean Management techniques such as the Brown Paper method for costing interviews or techniques of Quality Management Systems (QMS) can be used. For example an Ishikawa Diagram for visualization purposes is an exemplary result document of a QMS technique.

Phase IV "Implementation & controlling" ensures that the overall CDQM strategy is rolled out in the entire corporation, embedded in functional and divisional strategies and continuously improved. A CDQM directive or a simple CDQM flyer endorsed by the CEO (in favor of treating corporate data as an enterprise asset) are examples of change management measures. The activity IV.3 "Controlling" aims at controlling the entire strategy implementation, which encompasses qualitative key performance indicators (KPI) but also quantitative cost controlling.

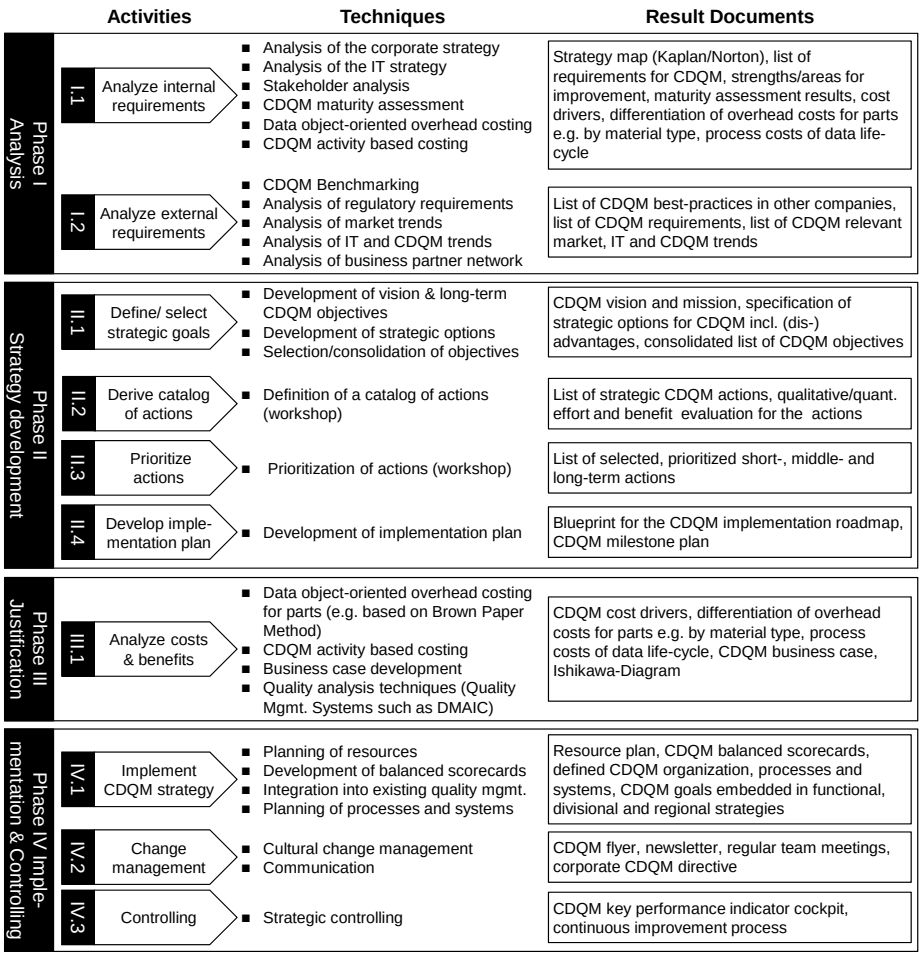

Fig. 2. Strategy Method for CDQM

The two subsequent sections present two selected method fragments in greater detail, namely the procedure model and the result document Activity II.4.

4.2 Procedure Model

The procedure model [46] shown in Fig. 3 shows the chronological order of activities within the single phases. The activities of the four phases are built upon each other, i.e. they occur in a certain chronological order, with feedback loops and iterations being possible. For example, the results of the cost/benefit analysis techniques taking place in Phase III can also be used to extend the CDQM mandate. In this case the Chief Data Steward then can move to Phase I and analyze requirements related to the new scope of the CDQM strategy (e.g. new data classes, regions etc.). Furthermore, the strategy controlling activities within Phase IV will necessitate iterations of the

previous Phases I and II. Subdividing the method into phases makes the method more flexible, allowing users of the method to execute only certain parts of it, depending on the design results already existing in the enterprise (e.g. CDQM maturity assessment results) [53].

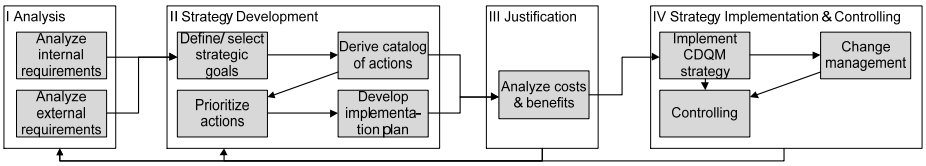

Fig. 3. Procedure model

4.3 Implementation Roadmap Blueprint

In order to permanently establish a CDQM strategy it is critical that the strategic scope of CDQM is clearly specified (e.g. the business divisions and data classes to be covered in the CDQM strategy) and stable. Another mission critical aspect refers to the CDQM mandate being reliable. Reliability of the CDQM mandate manifests itself in the willingness of the corporate leadership team to support CDQM and to advocate for CDQM goals [20]. Assigning a mandate for CDQM includes the appointment of an organizational unit to be responsible for CDQM, and the allocation of appropriate resources to this CDQM unit. In case a mandate is impaired (due to changes of personnel or restructuring of the unit, for example) the Chief Data Steward needs to make sure that the awareness for CDQM is rebuilt throughout the enterprise. He or she may do so by undertaking enhanced efforts of communicating how CDQM will contribute to the well-being of the enterprise as a whole. Among other things, the Chief Data Steward may try to "jump on the band wagon" by getting involved in ongoing initiatives taking place in the functional departments. The value creation brought about by CDQM can then be seen in the process savings or process accelerations accomplished by such projects. In order to gain support for the development of a CDQM strategy, the Chief Data Steward may also try to build strategic alliances with "renowned" executives who face business problems due to low data quality. Although certainly top-management support is vital for the success of a CDQM strategy, support for CDQM has to be ensured on all hierarchy levels of an enterprise in order to ensure the execution of the strategy.

The roadmap depicted in Fig. 4 answers the question in which order the content of a CDQM strategy should be developed and implemented. While the levels are the six areas of action according to the EFQM Framework for CDQM [33], the horizontal arrow depicts the timeline and at the same time the CDQM improvement which comes along with the execution of the roadmap. The duration of the CDQM program according to the roadmap depends on the available resources and on the scope (data classes, regions). Partner companies of the CC CDQ have taken up to ten years in order to implement the shown CDQM actions for all major data classes such as supplier, material, customer, vendor and finance data on a global level.

At first the enterprise needs to decide on the basic landscape, which leads to the question which data should be managed on a corporate level and which on a regional or local level. In many cases the trigger for initiating a CDQM program was the decision for a central application system architecture by the future sponsor on executive level. Once the executive sponsor has assigned the CDQM mandate and set the overall CDQM objectives, then the CDQM team needs to analyze the core data objects (e.g. what is an "active" customer) and define the conceptual data model. In parallel or slightly delayed the data lifecycle of the previously identified core data objects is analyzed and redesigned (first for a pilot domain and then rolled out for other domains). At the same time when designing the data lifecycle of the data objects the roles and responsibilities for the data owners and data stewards can be specified. The Chief Data Steward then has to establish CDQM committees and integrate them into the existing network of committees and processes. The data quality controlling e.g. for a specific data class such as material data can begin as soon as the target data architecture and the data lifecycle for the data objects are finalized. At the same time systems are analyzed and designed, which support the data architecture (storage and distribution, meta data management) as well as the data life-cycle (e.g. workflows).

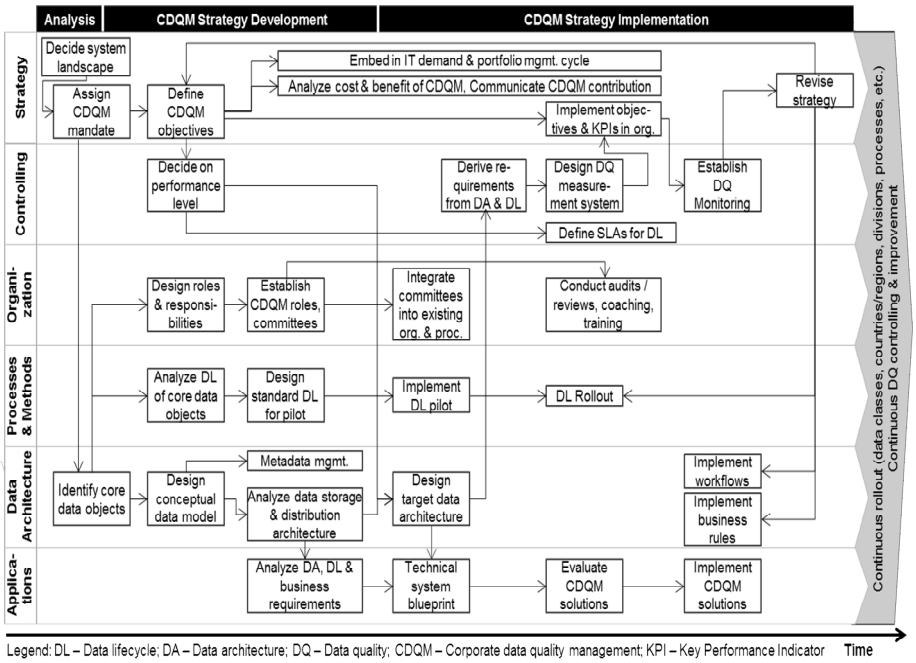

Fig. 4. Blueprint for a CDQM Roadmap

5 Multi-Perspective Artifact Evaluation

For the evaluation of the method a framework proposed by Frank comprising four dimensions is used [54].

- Economic Perspective. Due to the simple structure of the method (four steps) and clearly defined objectives, the costs for training, adaptation and application (see Deployment Perspective and Engineering Perspective) of the strategy development method itself are relatively low. On the other hand, the sum of the costs of the various strategic initiatives (e.g. data cleansing, CDQM process standardization or a highly detailed CDQM cost analysis) can be significant. Using the method does not lead to direct cost savings, but the techniques of Phase III identify CDQM cost drivers. Both the focus group interviews and the expert interviews have shown that the method is capable of simplifying exchange of knowledge.
- The method is beneficial for practitioners responsible for designing and implementing CDQM: The objectives of the corporate leadership team and the business process owners lead to CDQM requirements. For executives the method ensures that the CDQM strategy is derived from their objectives and that their requirements are systematically taken into account and fulfilled. Thus, the method facilitates preventive CDQM, the actions of which should be embedded in management decision cycles such as e.g. a global IT demand management or project portfolio process. Fig. 5 lists for the global glass manufacturer example of chapter 1.1 the CDQM requirements of executives and the benefits the method yields for the Chief Data Steward.

Role	Motivation	Enterprise-wide CDQM requirements
CEO, CFO	Growth, quality, shareholder value	▪ High data quality as a prerequisite for forecasts of the operating results ▪ Accelerate business growth through simplified integration of future M&A targets ▪ Avoid compliance violations, penalties and loss of sales
CIO	Global process standardization	▪ Global template for applications (e.g. SAP, Windchill)
Global Supply Chain Manager	Increase speed and time-to-market	▪ Product introduction via clearly defined MDM processes ▪ MDM workflow management and data ownership go hand in hand ▪ Variant configuration

Need for a CDQM strategy

Role	Motivation	Benefit of a CDQM strategy development method
Chief Data Steward	Mandate for developing a global CDQM strategy and for establishing a global CDQM organization; need for further resources	▪ "Tool box" for CDQM strategy development and for CDQM cost-benefit analysis ▪ Success factors and barriers for establishing a CDQM strategy ▪ Error prevention and constant improvement by preventive CDQM ▪ CDQM strategy controlling ▪ Communication and documentation tool (a structured, proven approach and common terminology avoid discussions about how to develop the CDQM strategy)

Fig. 5. Benefit of the CDQM strategy method in the case of a global glass manufacturer

- Deployment Perspective. The focus group interviews and the application of the method within the enterprise have shown that the method is easy to understand and

well applicable. Any rejection of the model due to the fact that it was developed externally (the not-invented-here-syndrome) could not be observed.
- Engineering Perspective. The simple structure of the method ensures its easy adaptability [54].
- Epistemological Perspective. The validation by application of the method in the enterprise has shown that the method is capable of abstracting and representing reality. Critical distance is ensured by explication of use cases. Moreover, explication of the method design process ensures that scientific principles are followed (such as verifiability and reproducibility of the artifact).

6 Summary and Outlook

The paper describes the design of a method for the development and implementation of a CDQM strategy. The design process spanned the four steps as proposed by the Consortium research method and includes several design cycles and one evaluation cycle. The method is beneficial with regard to both the advancement of the scientific state of the art and the state of the art in practice (see section 1.2). The description of the design process and of concrete design decisions allows scientific validation of the artifact presented as well as its extension by aspects previously not sufficiently considered or differentiated. Due to limitations of space the techniques, the related roles in the enterprise and the result documents could not be explained in greater detail. Further research should document CDQM roles in the context of the strategy method and also investigate means of gaining enterprise-wide support and commitment for an implemented CDQM strategy. Furthermore, the selection of certain strategic CDQM choices depending on the initial situation should be explained. This could be modeled according to situational method engineering [53].

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