



Development of a Model for the Implementation of Business Intelligence in SMEs

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ABSTRACT

In Switzerland, SMEs account for 99% of the market and employ around two-thirds of all employees. Many of these SMEs already use BI systems and generate business and operational data. Nevertheless, in many cases the potential that could arise from the data is not exploited. As a result, SMEs are falling behind large companies, as empirical studies show. From this, the problem can be derived that despite existing data in Swiss SMEs, the benefit in terms of Business Intelligence (BI) is unrecognized. The goal of this paper is to develop a framework model for the introduction of Business Intelligence in SMEs. The model should be structured generically and show on a meta-level which points are important for the introduction of BI and what the procedure for this is. In this paper we work within a research framework for information systems, using a design science research approach and a method engineering approach for the development of the model. In the development of the model, findings from a previous work were included as well as other studies dealing with the implementation of business intelligence. For the evaluation of the developed model, SMEs as well as business intelligence consultants were interviewed. The answers to the scope of the model were positive. However, there were suggestions to improve the model. Especially for SMEs it is important that business cases are discussed and solutions and their benefits are clearly shown.

CCS CONCEPTS

• **Information systems** → Information systems applications; Mobile information processing systems.

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1 INTRODUCTION

The growth of SMEs in Switzerland is impaired by the limited use of Business Intelligence in their business strategy [10, p. 2]. This has an impact in the Swiss economy because SMEs comprise 99% of the Swiss market and employ two thirds of the active population [8, p.1]. Many Swiss SMEs do not use the business and operational data they generate, due to lack of expertise or an understanding of the potential value to be obtained from its systematic analysis [26, p.2]. Even those that use BI software and acknowledge its importance [9, p.13] have not reached the goal of implementing it effectively to support their managerial decision making at both the strategic and operational levels. As a result, Swiss SMEs have not strengthened their business value [13, p.2]. Business Intelligence (BI) is defined as “a set of concepts and methods to improve business decision making by using fact based support systems” [23, p.1]. BI is also understood as an information system that uses a set of tools such as data warehouse, online analytical processing (OLAP) and dashboards [1, p.1], to give companies the capacity to analyze business information to reinforce or enhance management decision making across a wide range of business activities [12, p.1].

These technological solutions have grown in importance for organization of all sizes [5, p.7]. In the market share analysis from Gartner [22, p.34], earnings in the BI platform market increase by 19% in 2019, compared with 22% in 2018, to reach over \$6 billion. Pricing pressure and strong competition were responsible for this small deceleration. Nevertheless, the number of users of business intelligence and analytics platforms has further increased into the millions. The increase in the amount of users is due to the fact that the price per user is a fraction of what it was a decade ago. In fact, the BI services offered by Amazon Web Services (AWS) are seen as a potential price disruptor [22, p.5]. For its users, this company is charging less than half of the list price of competing products. Prior studies suggest that organizations of all sizes have not been able to profit from the benefits of BI systems [1, p.2] even though they have spent a great amount of money and other resources in implementing BI tools, but ultimately not taking them into account in their decision-making process [13, p.88–89]. This paper proposes a framework model that shows the general conditions for the introduction of Business Intelligence in SMEs. The model should be structured generically and show on a meta-level which points are important for the introduction of BI and what the procedure for this is. The model provides a readiness check evaluation in SMEs to

reduce risk of failure. Furthermore, it offers guidance regarding next steps in the context of implementation in the areas of BI DevOps and Data Governance.

2 PROBLEM STATEMENT AND OBJECTIVES

Nowadays, the advances of technology available to all companies have made it possible to collect a large amount of data in the areas of customer and supplier relationships, material or financial data. If this data is used wisely, it can offer companies a competitive advantage. This statement is corroborated by Xevelonakis [26, p.2], which shows that the Swiss SMEs studied gather enough data from their customers and therefore fulfill the basic requirements for business intelligence. However, they do not use this information for analysis due to a lack of efficient data management solutions. Furthermore, he concluded that Swiss SMEs acknowledge the value of their data but consider its quality and quantity insufficient. According to a study conducted by the University of Applied Sciences (ZHAW), Business Intelligence plays a more significant role on large Swiss companies (more than 1,000 employees) than in the Swiss SMEs. Moreover, large companies deal with the topic of business intelligence much more naturally and can release more capacities for it than smaller companies [9, p.13]. In this study, we address the problem that today SMEs in Switzerland use BI software but have not reached the state in which it helps them in their decision making. Many challenges originate in the organization. Management must recognize the importance of data, the benefits and the advantages that can be obtained from it. Also, employees need to be sensitized and trained regarding data. Finally, it is important to have data governance, which coordinates actions with the business and leverages synergies and reduces redundancy. This paper argues that a framework can be developed to enable the use of existing data within the context and limitations of Swiss SMEs. It further focuses on the development of this framework to be used by different SMEs and which will be based on some of the most relevant mechanisms used by large Swiss companies to develop a Business Intelligence readiness check for Swiss SMEs.

3 METHODOLOGY AND RESEARCH FRAMEWORK

Methods are considered an appropriate artifact of this study since they have problem-solving competence; also, they can be used to implement systematization and repetitiveness. As a decision-making support system, Business Intelligence can be researched in the form of methods to generate operational and strategic benefits for the organizations. Moreover, BI has research, design and development premises that center around the problem situation itself [11, p.2]. This work uses an information systems research framework based on Hevner et al. [18, p.6], and applies the design science research process based on Peffers [20, p.400-409] as can be seen in Figure 1, which includes the following phases:

- *Problem Identification*: “Despite existing basic systems for BI and data in Swiss SMEs, the benefits of Business Intelligence are very limited and unrecognized.” More details about the problem are described in section 2.

- The *objective* of the solution is to implement a method to introduce a BI solution guideline, which enables Swiss SMEs to benefit from their BI solution with lower risks of failure.
- *Method Development* includes a design of a methodology that SMEs can use to introduce BI in their company. This method will be based on method engineering (ME) and can be found in section 4.
- *Evaluation* involves the review of the proposed model through a survey done by previous work [10, p.27] also by conducting a survey with Swiss SMEs, and with business intelligence consultants to assess whether the proposed methodology can be used in practice by Swiss SMEs.
- *Communication* is the developed model results written in a scientific paper.

Note that the design science research process includes continuous iteration to fine tune the model so that it satisfies the requirements. The Environment component of the research process framework represents the domain in which the research takes place. Its dimensions are people, the organization involved (in this case, SMEs) and technology. It ensures that the research results are relevant to the problem domain. The *Knowledge Base* acts as a repository of knowledge for the research process, accumulating the foundations and methodologies that guide how the research project is conducted, including the fundamentals of method engineering (ME). The Knowledge Base grows as new results are available and is used as a guidance to ensure rigor in the research.

4 METHOD ENGINEERING

One of the key research methods in the field of business information technology is the creation of a reference model [19, p.9] to build simplified representations or ideal designs of systems and to enable the creation of BI templates to guide business decision making. In this study, we developed an applied readiness check model which SMEs can use to evaluate whether they are prepared to use Business Intelligence and to identify the gaps they may still have to make effective use of this system, based on the methodology by Gutzwiller [16, p.12]. This methodology built a reference model for the design of business transaction-oriented information systems. We use it as a base for our study since it summarizes all substantial aspects of an organization. Furthermore, it provides a good model of information processing from the business and IT perspective without having to go into the technical properties of the system. Through an extensive literature review of different method engineering approaches, Gutzwiller [16, p.13] identified five general applicable elements of method description. These five elements are described as follows Figure 2

- Design activities

The activities are a unit of execution developed to produce one or more design results. For the activities, a certain sequence can be defined and can also be divided into sub-activities, whereby an activity hierarchy develops. In the context of a business intelligence implementation in an SME, an activity could be “defining a well-thought-out business case”.

- Roles

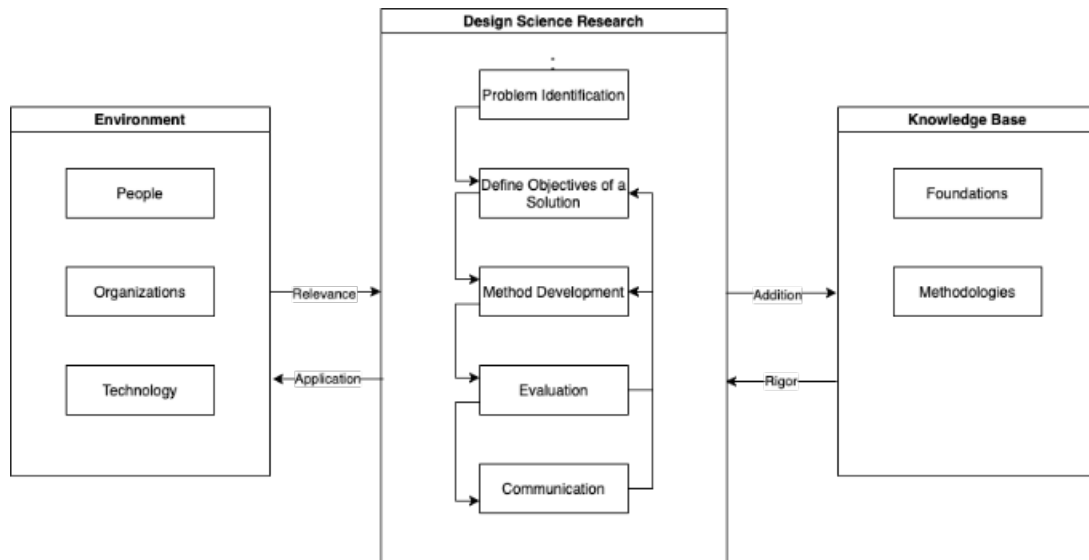


Figure 1: Research process framework

Roles are performed by people or entities who are responsible for the individual activities and are involved in them in some way. Examples for such roles could be the role of a project manager or a data architect.

- Design results

Results are used as input by the activities and generate or modify new results themselves. In method engineering, results are alternatively referred to as artifacts, documents, products, etc.

- Metamodel

The metamodel is a conceptual representation of the deliverables in a concise form with entity types, attributes, and relationships.

- Techniques

Techniques describe how to arrive at the results. For example, a result can be achieved through a workshop. The workshop in this case refers to the technique by which the activity produces the result [16, p.14].

4.1 Meta-Model

To develop a model for the introduction of business intelligence in SMEs, the Method Engineering model [16, p.13] was adopted and supplemented with additional elements to represent the requirements more appropriately. These adaptations are listed below.

- Cardinalities are introduced between the entities to show how the relationships between the entities are defined and to demonstrate its rigor.
- New elements are added to the elements already described. Among other things, the Stakeholder element is added to indicate that an activity executed by a role is performed for a certain stakeholder. In addition, the two Phase and Phase Model elements are included. These two elements should show in the model that activities are assigned to certain stages and that their sequence is regulated in a phase model.

- The metamodel element was removed because the introduction of business intelligence in an SME is primarily about starting with a clearly defined business case. The result is a data model that continues to develop in the course of development and through new business cases.

Figure 2 shows the developed model with all the elements already mentioned. This model should serve as a structured framework, which has as a goal the introduction of a Business Intelligence solution in an SME.

In addition to this meta-model, the phases in which the activities are divided were defined and represented by a phase model. This serves the understanding and should show the responsible persons of SME's how to work with this model to introduce a Business Intelligence solution in their own company.

4.2 Phase

During the implementation of Business Intelligence, various activities must be carried out. These activities have been divided into three phases which are to be processed in a certain sequence (see Section 4.3). The three phases are defined as follows: The next three subsections describe these three phases in more detail.

4.2.1 Readiness Check. The Readiness Check stage is about finding out whether an SME interested in implementing Business Intelligence meets the requirements. The reason for this phase to be carried out first and why this check is so important is that, according to Gina et al. [15, p.2], 70%-80% of all Business Intelligence projects fail due to technological and administrative factors. According to Farrokhi [14], business intelligence is the fastest growing IT spending area in an organization. If such a project or implementation fails, it can have a significance impact in terms of costs and resources. In order to design a readiness check for SMEs, it is important in a first step to find out the critical success factors in the implementation of

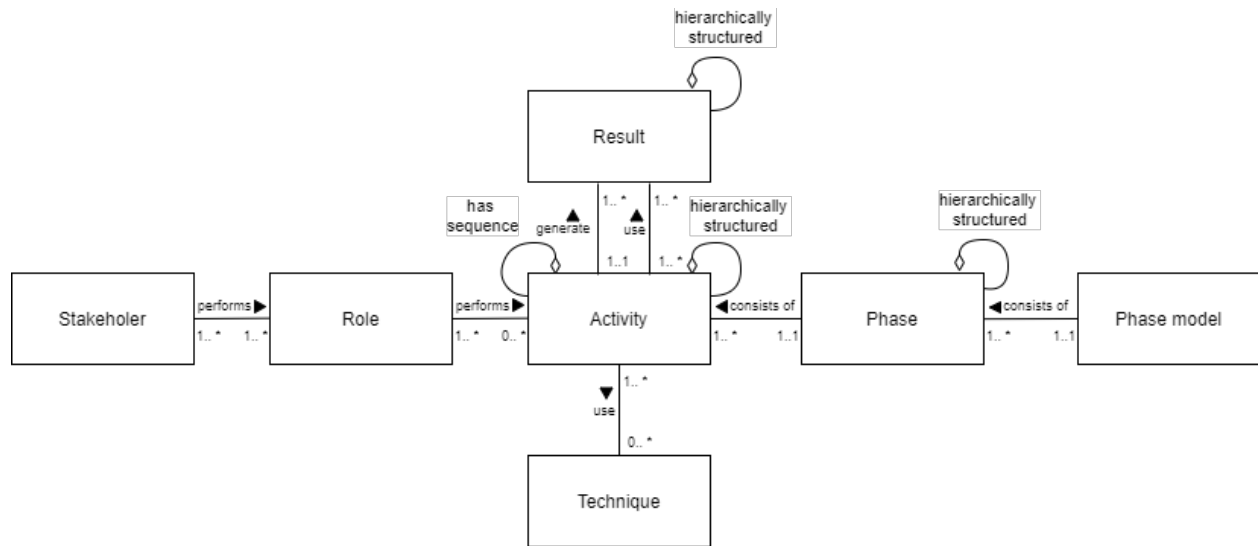


Figure 2: Visualization of the Meta-Mode

Table 1: The three phases in the introduction of business intelligence in an SME

Phase	Description
Readiness Check	Before the development of a BI solution begins, a readiness check should be carried out with the SME. This readiness check should represent an initial assessment of the situation and show the SME how it stands regarding the introduction of BI.
BI DevOps	In the BI DevOps phase, an initial BI solution is developed based on a business case. It is important to develop the solution in an agile way and always in close cooperation with the business unit.
Data Governance	The introduction of data governance should take place at an early stage. Among other things, this enables data quality to be monitored, projects to be managed, and new requirements to be defined on an ongoing basis.

a business intelligence solution. For this purpose, a systematic literature search was conducted. The result of this research was a list of critical success factors, which could be assigned to the category "Technical" or "Organizational". The category "Organizational" was further subdivided into "Culture", "Management", "Individuals" and "Strategy" and the category "Technical" into "Infrastructure" and "Data". The following critical success factors were identified for the "Culture" subcategory within the "Organizational" category:

Critical Success Factors	Reference
Continuous Process Improvement Culture	[14, 25]
Culture Around Use of Information and Analytics	[14, 25]
Decision Process Engineering Culture	[14, 25]
Cross-Organizational Collaboration Culture	[24]

The critical success factors for "Management" are:

Critical Success Factors	Reference
Management support	[3, 7, 24]
Clear vision and well thought out business case	[3, 7]

For Individuals, they are the following:

Critical Success Factors	Reference
Team skills	[3, 24]
User commitment	[3]

And last in the Organizational category are the critical success factors related to the company's "Strategy":

Critical Success Factors	Reference
Strategic Alignment	[25]
Strategic BI vision	[3]

For the "Technical" category, the following factors were identified based on the literature:

- Infrastructure

Critical Success Factors	Reference
Scalable solution	[7]
Choice of tools	[3, 15, 24]

- Data

Critical Success Factors	Reference
Data quality	[3, 7, 24]
Reliable Resources	[3]

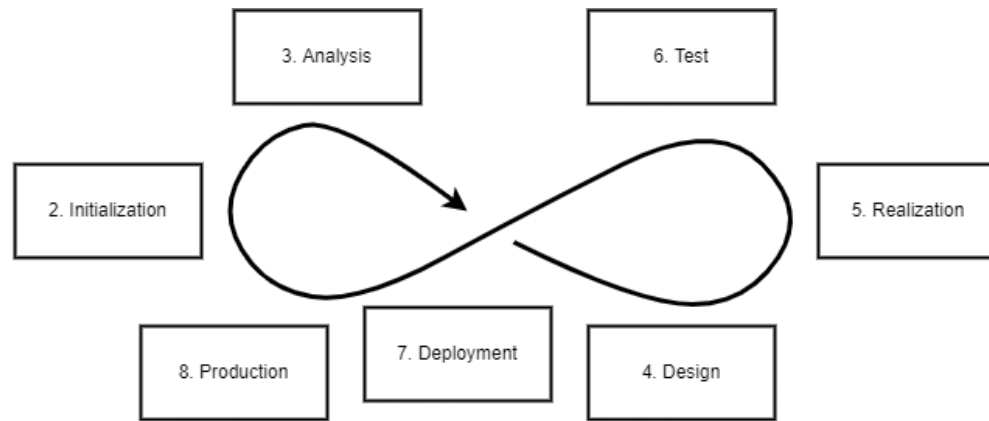


Figure 3: Visualization of the BI DevOps phase

With the help of these success factors, an SME can be assessed to identify gaps and take measures to close these gaps. In this way, an SME should be optimally prepared for the implementation of a business intelligence solution and the risk of failure can be minimized.

4.2.2 BI-DevOps. This phase is about implementing the business intelligence solution. The DevOps approach is used for this. DevOps was chosen because when developing business intelligence, it is important that IT and business work closely together to avoid missing the target. However, DevOps activities are nothing new. In DevOps, well-known methods such as agile development, continuous integration, continuous delivery, and continuous development are applied. Furthermore, the development of a solution should be done in iterations, which is why this is represented in an Infinity Loop [17, p.16]. The various activities during the development of the business intelligence solution were derived from different methodological approaches which are summarized in the work of Ranjbarfard et al. [21, p.180]. As a result, the labels for the activities are not those of the DevOps model but can be linked together.

As can be seen in Figure 3, seven activities are taken during implementation. The first activity is initialization (2), in which the business intelligence project is defined. Next, the analysis (3) of the business and technical requirements is started before the detailed design (4) of the BI solution and the design of the database and the ETL processes. As soon as the design is finished, the realization (5) of the Business Intelligence solution can be started. This involves the realization of the business and technical requirements up to the implementation. The next activity is to test (6) the developed solution to verify whether the solution works as a whole or whether further improvements need to be made. Once the testing phase is through, the solution can be deployed to production (7). In the last activity, before the whole development process starts again, the operation in production is checked (8) to detect possible errors early

and to be able to react immediately if necessary. In each of these development stages, different activities are performed by a role to produce a certain result using a suitable technique.

4.2.3 Data Governance . The central goal of data governance is to increase the value of the available data, among other things by maximizing data quality [2, p.3]. Data quality management is a sub-function of data management, which is led by data governance. However, data governance not only adds value in data management, but is also a driver for business transformation with the goal of evolving to a data-driven corporate culture. The foundation for this is provided by the most important data management tasks, which can be seen in Figure 4 [6, p.3].

These tasks from data management are intended to help review and further develop the business intelligence solution that was developed in the BI DevOps phase. The Assign Data Responsibility task is about assigning roles certain responsibility over a category of data. These can be categories such as customer data or product data. In a next step, the responsible persons define new data requirements. These requirements flow back into the BI-DevOps phase in the "Initialization" point. In addition, these roles are responsible for constantly checking the quality of the data. They should also have an overview of their projects and manage them. The last thing is to share the knowledge about the data in the company so that others can work optimally with the data.

For the success of a business intelligence solution, the two tasks "define data requirements" and "monitor data quality" are among the most important points of data management. Both defining new requirements and monitoring data quality are tasks that never end. A Business Intelligence solution should be constantly developed further. Therefore, new requirements are needed, which can come from internal or external sources. External requirements can be legal regulations that the company has to implement. Internal requirements can be new questions or improvement of data quality.

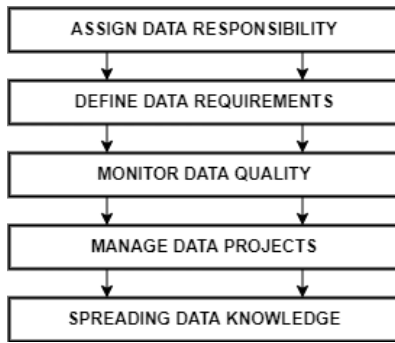


Figure 4: Tasks from Data Management [6]

Such requirements must be implemented using legacy data, existing data or new data.

Figure 5 shows these two tasks of data management in an infinity loop to demonstrate that data quality and the collection of new requirements is a never-ending process.

4.3 Phase Model

The various phases were explained in Chapter 4.2. and come together in the phase model. As can be seen in the 6 for the phase model above, the entire process consists of the three phases *Readiness Check*, *BI DevOps* and *Data Governance*. These phases are performed one after the other, with insights from Data Governance flowing into the BI DevOps phase. In the lower part of the figure, the BI DevOps phase is shown in a more fine-grained way. It is also clear in which part of the BI DevOps phase the findings from data governance flow back.

5 EVALUATION

This section uses a survey and an interview on the topic of business intelligence, which originates from previous work [10, p.21,27], to evaluate the extent to which the developed model can be justified. In addition, the model is presented to a few SMEs and business intelligence consultants to request an evaluation, which consists of seven questions about the model. The topic of the previous work [10, p.1, 2] was BI/DWH for SMEs and addressed the problem that SMEs gain little from business intelligence, despite having existing data and basic BI systems already in use in the company. The question that arose from this was whether and how SMEs

can benefit from the experience of large companies in the field of Business Intelligence. To investigate this question, we conducted a literature review, an online survey of large companies in Eastern Switzerland and an interview with a Principal Business Intelligence Consultant with more than 20 years of experience.

From the survey it emerged that the biggest challenges in the area of business intelligence originate in the organization. The challenges that were identified were:

- Management must recognize the importance of data, the benefits and the advantages that can be obtained from it.
- Employees need to be sensitized and trained regarding data.
- Data governance and data management must be modernized.

In addition to organizational challenges, technical challenges were also identified:

- Data quality is a big problem.
- The query speed of the data takes too long in many cases.
- The tools used should be easy to use for employees.
- The ability to analyze the detailed data should be simplified to answer follow-up questions faster.

These challenges were also discovered through the literature review [10, p.3, 4]. In a research by Ayoubi et al [4, p.3], the challenges of SMEs in using business intelligence solutions were investigated. One of the issues explained was the lack of commitment from top management. Bianchini et al [5, p. 25] also came to the same conclusion in their OECD report. In addition to the lack of management awareness of business intelligence, the difficulty in recruiting specialists in business intelligence and data analytics was mentioned. The research of Xevelonakis [26, p.6] concluded that management is not aware of the effective benefits of business intelligence in the company, and that the knowledge of employees in the field of business intelligence is underestimated by management. In addition, responsibilities in SMEs were not clearly defined and communication within the company was poor, both top down and bottom up.

Research conducted by the ZHAW [9, p.30] also shows that the majority of the challenges are organizational rather than technical. The difficulty is to develop suitable business cases and then quantify them with business intelligence. The survey as well as the literature research show why it is important that a readiness check should take place before the introduction of business intelligence. Furthermore, it becomes apparent that the introduction of data governance, which primarily takes care of data management, is an important

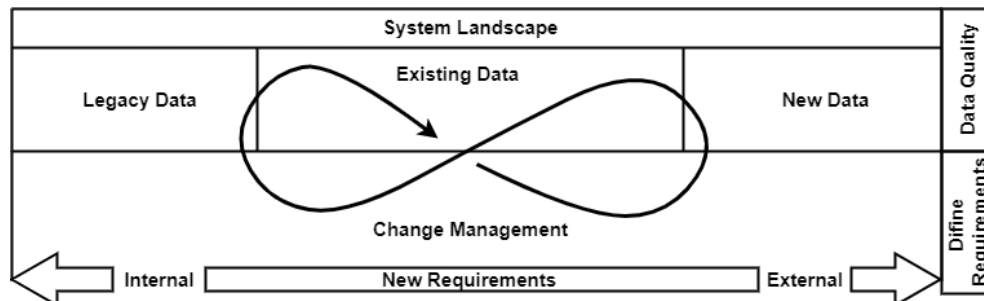


Figure 5: Data Requirements and Data Quality

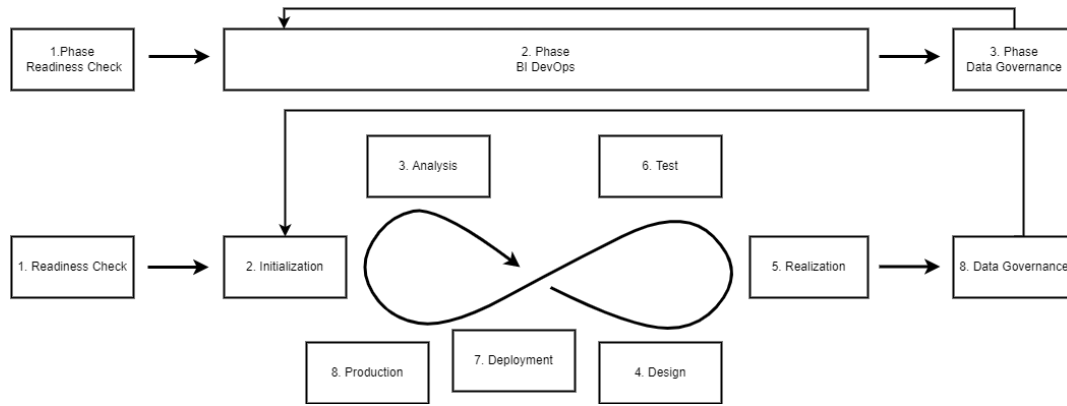


Figure 6: Phase Model

point to check data quality as well as to define responsibilities. During the expert interview with a principal business intelligence consultant, an agile approach to implementing a business intelligence solution was recommended. This makes it possible to react quickly to changes in requirements in order not to lose time and resources. Furthermore, it is important to always work closely with the business. By involving the business departments, the solution gains in quality and is also more accepted by the business. At the beginning of a Business Intelligence project, one should always work with a few clearly defined business cases. The next step is to analyze which data sources are available in the company, which additional external data is needed, and which questions can be answered with this data. These points were considered in the BI DevOps phase and integrated in an Infinity Loop.

Next, two SMEs and two business intelligence consultants were surveyed about the developed model. In this survey, first the whole model was explained to the respondents and then seven questions were asked about it. For the first six questions, the response options are a five-point Likert scale. Question 7 is formulated in an open way and can be filled in optionally by the respondents. The seven questions are outlined below and then the result of this survey is presented and explained.

- How do you evaluate the whole model for the implementation of a business intelligence solution in an SME?
- How would you rate the meta-model for the implementation of a business intelligence solution in an SME?
- How do you evaluate the three phases for the implementation of a business intelligence solution in an SME?
- How do you evaluate the readiness check which has to be performed first by an SME?
- How would you rate the BI DevOps phase for the implementation of a Business Intelligence solution in an SME?
- How do you evaluate the implementation of data governance in SMEs?
- Do you have any comments on this model?

As can be seen in 7, the questions were answered equally by the SMEs and the BI consultants. In question 3 about the three phases, both a BI consultant and an SME gave a rating of 3, which was the lowest rating of the questions in the survey. In question

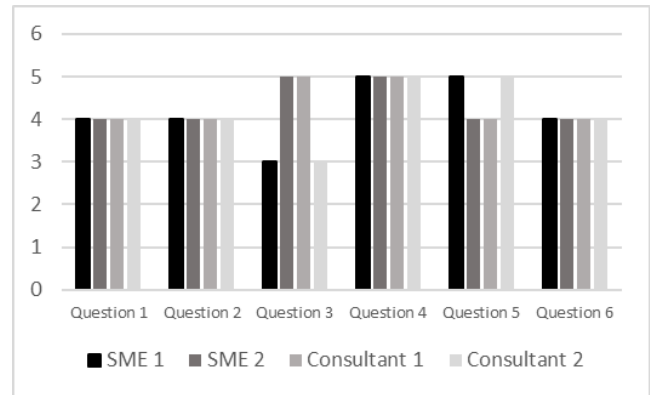


Figure 7: Survey of SMEs and BI Consultants

7, both SMEs gave different impressions of the model. One SME felt the model was a good framework overall for introducing BI in their own company, but the model was too general for the SME surveyed. The SME would have liked to see more detailed questions in the readiness check and a business intelligence-specific approach with more detailed activities in the BI DevOps phase. The second SME also found the model to be a good framework that can help the company implement business intelligence. However, for the interviewee, a phase was missing in which different business cases are discussed with the SME and proposed solutions are presented as well as its benefits that would result from a business intelligence to the SME. The two business intelligence consultants did not add any further suggestions to the model.

6 CONCLUSION

In the first survey, the votes on the developed model were consistently positive. However, it must be mentioned that the population of respondents is small, which allows the evaluation of the method only to a limited extent. The meta-model gives a good insight into how to work with this model. The scope of the model with the 3 phases is also rated well, with the readiness check in particular being seen as very useful. During the survey, the two SMEs

provided suggestions for improvement, which may be included in a next iteration of the model development. These include the points that a further phase should be added in which appropriate business cases are discussed with the SME and how these can be implemented as well as their benefits demonstrated. This gives an SME an overview of what benefits a business intelligence solution can bring to the company, for example, time savings or competitive advantages. Another point which could be included in further development, would be a questionnaire for the readiness check as well as a score card. However, such questionnaire should be tailored to each SME. Depending on its size and requirements for a BI solution, various points of the readiness check are more or less important. In conclusion, it can be said that the presented model can be used as a framework for the introduction of Business Intelligence in SMEs. It is important to understand that this model shows a holistic overview of the process, but not a detailed work plan, which can be used by every SME. This is because each SME has individual needs in terms of the scope of a BI solution. When introducing BI in an SME, it is therefore necessary to address the SME individually and to work out the next steps based on its needs.

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