

MASTER'S THESIS

Measures of Critical Success Factors of CI/CD processes

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Measures of Critical Success Factors of CI/CD processes

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Abstract

Numerous organisations are adopting continuous practices to keep up with customers' expectations. Applying continuous practices consists of multiple aspects and requires change in different levels of an organisation. It not only affects the IT teams and the employees of the organisation but also the customers and suppliers. Earlier research has identified Critical Success Factors (CSF's) of the Continuous Integration and Continuous Delivery/Deployment (CI/CD) processes.

The CI/CD-processes can be looked at from different perspectives. This research focuses on the customer perspective of the CI/CD-processes and the related CSF's. We aim to find measures that contribute to these CSF's by conducting a Systematic Literature Review (SLR). The results of this SLR will be validated at a case organisation that applies continuous practices.

Ultimately the goal of this research is to strive to an operational framework of CSF's and related measures that provides guidance and monitoring in adopting continuous practices.

Key terms

CI/CD, Continuous Practices, DevOps, Measures, Critical Success Factors, CSF, Continuous Deployments, Continuous Integration

Summary

Organisations are transitioning to a more digital world and demands on software delivery approaches that are able to release more frequently against high quality standards are growing. Adopting continuous practices can help organisations meeting these demands. However, transitioning from a more traditional delivery model to a continuous approach can be challenging and requires change on different levels of the organisation. Previous research on CI/CD presented a framework that contains Critical Success Factors (CSF's) of the CI/CD-processes. This framework was a first step to help in the adoption of continuous practices but the framework lacked measures that would contribute to these CSF's and is therefore difficult to operationalise.

The goal of this study is to find out what measures contribute to CSF's in the CI/CD-processes. More specifically this research will focus on the customer perspective of the CI/CD-processes and related CSF's. This perspective is important to focus on because the customer is on the receiving end of the process and is related to many CSF's.

To do so the following research question was defined:

What are measures of Critical Success Factors from a customer perspective of the CI/CD-processes?

To answer the research question a Systematic Literature Review (SLR) was conducted. The SLR resulted in a set of 20 potential measures that contributed to the CSF's from a customer perspective of the CI/CD-processes. This led to a theoretical framework containing CSF's with related measures that contributed to those CSF's.

To empirically validate the results of the SLR a single case study was conducted at an organisation that applied continuous practices for several years. For this case study six respondents from various DevOps teams in the case organisation were interviewed. During the interviews they were asked if they recognized and applied the measures in the framework. Also they were asked to give examples on the measures to substantiate them.

The study was able to verify 14 out of 20 potential measures. It does not mean the other six measures are not valid, for instance some of the measures could not be verified simply because of the fact these were not applicable for the case organisation.

The results of this research can be used by organisations that are aiming to adopt continuous practices but also organisations already applying it. The framework and the measures can be used as a tool for an implementation. Users must take into account that the results are validated by only one case organisation. We recommend follow-up research at multiple organisations to increase the generalizability of the framework.

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1. Introduction

1.1. Background

Software development practices that enable organisations to release new features and products on a frequent basis are referred to as continuous practices. These continuous practices are often abbreviated and named CI/CD which stands for Continuous Integration, Continuous Delivery/Deployment (Shahin, Ali Babar & Zhu, 2017). The continuous practices have emerged from the business needs for quicker delivery, shorter feedback loops to increase customer satisfaction and closing the gap between development and deployment (Bosch, 2012; Fitzgerald & Stol, 2015; Shahin et al., 2017).

According to Chen, companies that apply Continuous Delivery report significant benefits (Chen, 2017). Various benefits that are mentioned on applying continuous practices are improvements in time-to-market, customer satisfaction, quality, reliability, productivity and efficiency. However, adopting continuous practices can be challenging for organisations. The main challenges are caused by boundaries and different interests between divisions within the organisation (Chen, 2015).

1.2. Exploration of the topic

As indicated many organisations face challenges when implementing continuous practices on their software delivery approach. In an attempt to aid in adopting continuous practices an initial framework containing a list of critical success factors (CSF) on continuous practices was created by van Belzen (Belzen, Trienekens, & Kusters, 2019). As the CSF's in the framework cover a lot of different aspects around the CI/CD process and we have a limited amount of time and resources we have decided to group the CSF's. We have derived groups based on the Structured Analysis and Design Technique (SADT) model by Douglas Ross (Ross, 1977). This provides a distinction between the process, process control and customer as shown in figure 1.

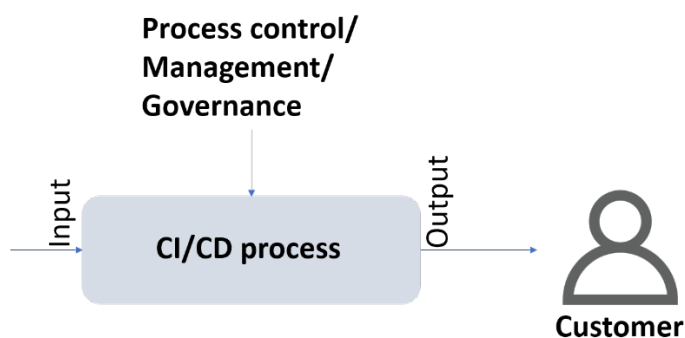


Figure 1: CI/CD process

The CI/CD process consists of input, process activities and output that is controlled by control mechanisms (process control, management, governance) and provides something (i.e. products/service) for its customers. This leads in this research to the recognition of three perspectives on the process that we have defined to group the CSF's:

- Process control/Management/Governance
- Customer
- CI/CD Process

The customer perspective has the focus of this research. The other two perspectives will be focussed on by other researches.

We have taken the CSF's from the research of van Belzen (Belzen, Trienekens, & Kusters, 2019) and filtered the CSF's that are related to the customer perspective. This results in the following list of CSF's related to the customer perspective in the context of the CI/CD-process:

- *Resistance to change (Customer perspective);*
- *Complexity across customer organisation boundary;*
- *Acceptance by customer;*
- *Sales and intermediaries;*
- *Quality;*
- *Customer involvement;*
- *Communication (Customer perspective).*

The CSF's above are abstract and do not indicate what action(s) or practices actually contribute to a CSF. To enhance and operationalise the list of CSF's van Belzen (Belzen, Trienekens, & Kusters, 2019) we aim to find measures that contribute to the CSF's. This would make the CSF's more concrete as a measure should be something actionable and be able to deal with the particular CSF. During the exploration of the topic we have not identified a definition on a measure that contributes to a CSF in the context of CI/CD processes. However we noticed that articles referenced by the research of van Belzen (Belzen, Trienekens, & Kusters, 2019) actually provide some suggestions on actions or practices to contribute to CSF's. In example, Shahin et al. (2017) uses the term '*practices*' to mitigate risks and challenges on CSF related aspects. In Olsson et al. (2012) we find terms like '*actions*' or '*needs*' that might indicate something like a measure. What exactly is the right definition of a measure in the context of CI/CD-processes needs to be researched. Furthermore the relation between CSF's and measures is not always clear and requires research.

1.3. Problem statement

Continuous practices are relatively new in the field of software engineering and have become increasingly popular (Chen, 2015). Organisations adopting continuous practices seem to benefit from it. However this new approach also creates new challenges for organisations. As literature on continuous approaches, tools, challenges and practices is growing Shahin, Ali Babar & Zhu (2017) conducted a systematic literature review in attempt to synthesize terminology used. They also came up with a set of critical factors to contribute to the success of continuous practices.

To aid in the adoption of continuous practices Belzen, Trienekens & Kusters (2019) developed a framework containing CSF's on CI/CD-processes. This framework however, does not contain measures that contribute to the defined CSF's. This calls for searching for measures that contribute to the CSF's as it is important to understand what actions or practices contribute to the CSF's. This would make the framework useful for improving the performance of CI/CD-processes. During the exploration of the topic we noticed there is no consensus or a definition for a measure in the context of CI/CD-processes. Further research on the definition of a measure is required.

1.4. Research objective and questions

The goal of this research is to aid in adopting CI/CD-processes by identifying and validating measures of CSF's.

This research is part of a larger research project that has the following research question:

What are measures of Critical Success Factors of the CI/CD-processes?

In order to contribute to the larger research project this research will focus on the CSF's with a customer perspective. This gives a more specific research question:

What are measures of Critical Success Factors from a customer perspective of the CI/CD-processes?

As we have not been able to identify a definition of a measure in the context of a CSF of the CI/CD-processes we have to answer the question below:

- *RQ1: What is the definition of a measure in the context of a CSF of the CI/CD-processes?*

To substantiate the answer regarding the multiple CSF's that are part of the main research question we will specifically try to answer the questions below:

- *RQ2: What measure(s) contribute to the CSF "Resistance to change" from a customer perspective?*
- *RQ3: What measure(s) contribute to the CSF "Complexity across customer organisation boundary" from a customer perspective?*
- *RQ4: What measure(s) contribute to the CSF "Acceptance by customer" from a customer perspective?*
- *RQ5: What measure(s) contribute to the CSF "Sales and intermediaries" from a customer perspective?*
- *RQ6: What measure(s) contribute to the CSF "Quality" from a customer perspective?*
- *RQ7: What measure(s) contribute to the CSF "Customer involvement" from a customer perspective?*
- *RQ8: What measure(s) contribute to the CSF "Communication" from a customer perspective?*

1.5. Motivation/relevance

More organisations are adopting continuous practices to benefit from its advantages and even more are expected to join (Rafi et al., 2020). However, adopting continuous practices also comes with challenges (Chen, 2015). Structuring organisations to introduce continuous practices have been addressed as a major concern (Leite et al., 2020). Yaman indicates a gap between the use of customer involvement in real-world scenarios and evidence on the implications (Yaman et al., 2016). In an attempt to know what the rigorously validated CSF's of continuous practices are van Belzen (Belzen, Trienekens, & Kusters, 2019) conducted a SLR and developed an initial framework on CSF's of continuous practices. Their research calls for more rigorous research on the success factors and operationalisation of the framework.

From a customer perspective of CI/CD-processes we see that customer acceptance can be challenging as, for instance, customers might feel disturbed or interrupted from their on-going work (Yaman et al., 2016). Also issues around customer organisations boundaries cause difficulties like lack of access to customer environments and complex and manual configuration of customer sites

Shahin et al. (2017). The role of the customer in the CI/CD-process can take on different forms and can go as far as integrating the customer in the test phase (Shahin et al. (2017)). Given these challenges and issues around the customer perspective of CSF's of the CI/CD-processes we want to research measures that contribute to the performance of these particular CSF's. This could eventually lead to providing actions, practices and needs that will help organisations in applying continuous practices successfully. Without a solid framework based on scientific research it is challenging for organisations to apply continuous practices. This research will contribute to a framework that can be applied when adopting continuous practices. The framework will provide validated measures that contribute to CSF's in CI/CD-processes. This enables organisations to apply continuous practices more effectively and be able to steer on the performance.

Additionally this research will extend the body of knowledge on the topic of continuous practices in software development. In regards to measures of CSF's of CI/CD-processes it will establish new insights and provide recommendations for further research. It will also try to create a common understanding or definition on a measure in the context of CSF's of CI/CD-processes.

1.6. Main lines of approach

To answer the formulated research questions a systematic literature review will be conducted. This will lead to a theoretical framework as described in chapter 2. In chapter 3 we will elaborate on the methodology of the research. The results of the research will be presented in chapter 4 and discussion, reflections and recommendations are shared in chapter 5.

2. Theoretical framework

This chapter provides the theoretical framework of this research. Section 2.1 elaborates on the research approach and provides a step-by-step overview. Section 2.2. describes the implementation of the research approach. The deviations from protocol are described in section 2.3. Section 2.4 gives insight in the results and conclusion. In sections 2.5 the objectives of the follow-up research and expectations are presented.

2.1. Research approach

This section elaborates on the approach of establishing a theoretical framework. The goal of this framework is to answer the research questions as stated in section 1.4.. To answer these questions and to gather data for the framework a systematic literature review (SLR) will be performed. The reasons to perform a SLR for this research are:

- to synthesize and summarize theory on measures that contribute to CSF's from a customer perspective in CI/CD-processes.
- To construct a theoretical framework on measures that contribute to CSF's from a customer perspective in CI/CD-processes

The SLR will be conducted by using guidelines described by Kitchenham, B., Pearl Brereton, O., Budgen, D., Turner, M., Bailey, J., & Linkman, S. (2009). This ensures us with an established method for conducting a SLR in the field of software engineering. In accordance to this method we will provide full disclosure on the process by means of including the input and output. This increases the reliability and traceability of the SLR.

2.1.1. Search process

The search process consists of two steps. The first step is to search for additional literature on CSF's that was published after June 2019 (the latest date of articles in Belzen et al. 2019). The second step is to search for measures.

Searching for additional literature on CSF's

The starting point of this research is the framework as defined in the research paper: Critical Success Factors of Continuous Practices in a DevOps Context by Belzen et al. 2019. A full description of the search process used for this framework can be found under section 3.1. 'Research Methodology' of their research paper. The search period used was 2001 - June 2019.

To answer our research questions based on the most recent insight we also want to review the latest published articles. To find relevant literature published after June 2019 we will conduct another search according to the same search process and criteria. For this search we will use the period June 2019 – August 2020.

The selection of databases is based on two main criteria:

- Peer reviewed articles;
- Research areas: business and computer science.

Database sources used:

- IEEE computer society digital library;
- ACM digital library;

- SpringerLink;
- Web of Science;
- Citeseer;
- SCOPUS.

Searching for measures

The second step in the search is to identify measures that contribute to CSF's in the CI/CD-processes from a customer perspective. As we didn't have a pre-defined description of a measure we first had to find or establish a definition of a measure (RQ1). In the search for a definition of a measure we will use the articles used referenced by the framework of van Belzen (Belzen, Trienekens, & Kusters, 2019) plus the results of the search for additional literature on CSF's. We use these articles because the measures we aim to find relate to these CSF's. During our exploration of the topic we were unable to find a definition of a measure but we have identified signal words that shape the meaning a measure. These signal words were found in the articles referenced by the framework of van Belzen (Belzen, Trienekens, & Kusters, 2019) and were mentioned in relation to the CSF's. We were able to find the following list of signal words:

- Mitigation of risk or challenge;
- Practice(s);
- Address concern(s);
- Enabler(s);
- Supports;
- Play an important role;
- Need;
- Action;
- Dealing with.

During the review of the articles we won't directly search for signal words listed above but keep them in mind to have an understanding of how a measure could be indicated. The search for measures will not be limited to measures that are indicated by or related to the above signal words. When reviewing the articles we will also keep an open mind on how measures can be described. As we have seen during the exploration phase, a measure is often described like something of an action, practice or need that contributes to a CSF or mitigates risk or challenges.

2.1.2. Inclusion and exclusion criteria

The inclusion and exclusion criteria used for the search for literature is included in Attachment A - CSFs 2018-Augus 2020_v03.xlsx.

The following inclusion and exclusion criteria will be applied for measures that were found. The first inclusion criteria indicates a measure must meet the definition of a measure. It could be that a certain measure doesn't fully qualify this definition. However, this won't automatically mean this measure is excluded. Instead we will discuss whether the measure should be included or excluded during a group session as part of the quality assessment and data analyse as described in section 2.1.5.

Inclusion criteria:

- A measure must meet the definition of a measure (an action or practice that contributes to a CSF, or mitigates risks or challenges);
- It should be clear how (on what aspects) the measure impacts/contributes to a CSF. (i.e. mitigates risks, improve performance, address concerns, play a role in, enable etc.);
- A measure has to be measurable, quantitatively or qualitative.

Exclusion criteria:

- The identified measure is ambiguous (based on the information from the article it is not possible to define a unambiguous definition);
- It is very difficult to make the measure measurable.

2.1.3. Quality assessment

To further enhance the quality of the measures found we will use a quality assessment. Kitchenham et al. 2009 identifies the following three quality concepts for a quality assessment:

- Bias (Systematic error)
- Internal validity
- External validity (Generalisability, Applicability)

The goal of the quality assessment is to minimise bias and maximise both the internal and external validity. To address bias and maximise the internal validity we will take a closer look at the measures we found to see how this measure was established. For instance has the author suggested this measures? Or has it been empirically validated? As in detail described in section 2.1.5. we will use a classification method named metaplan-method (Schnelle, 1979) for classifying the measures we found. During this session(s) we will also discuss the before mentioned quality aspects of the measures found. Evaluation is based on information available in the articles. As we are doing this in a group session we will have to reach consensus on the decisions taken.

Furthermore we will provide full disclosure on the steps we take from measures found to final output of the metaplan-session(s).

2.1.4. Data collection

For extracting data on the definition of a measure we will extract the elements shown in table 1 to substantiate our definition of a measure.

Element	Reasons
Term used	This indicates a signal word of a measure and will help to establish a definition of a measure.
Context	To understand in what context or relation a term was used we will collect the context. Doing so will increase quality and creates better understanding of how the term was used and how it should be interpreted.
Reference(s)	As part of our quality design we will provide references so that a term can always be tracked back to an article it was presented.

Table 1: Extraction elements definition measure

For every measure that we find, we want to extract the data as shown in table 2. We extract these elements because we need this data as input for our analysis.

Element	Reasons
Related CSF	This indicates the relation to what CSF a measure was found. This is required to relate measures and CSF's.
Definition	A definition of the measure that was found. The definition can either be cited or derived from a description.
Context	To understand in what context or relation a term was used we will collect the context. Doing so will increase quality and creates better understanding of how the term was used and how it should be interpreted.
References	As part of our quality design we will provide references so that a found measure can always be tracked back to the article it was presented in.

Table 2: Extraction elements measures

2.1.5. Data analysis

The goal of this step is to classify and deduplicate found measures based on the description and context. The approach for this step is to use the classification metaplan-method (Schnelle, 1979). This method can be used to facilitate group meetings and workshop aimed at building a common understanding. For our sessions we will use topics for grouping measures that are strongly related to each other. For our research it means per CSF is evaluated if a measure belongs to the same topic. The first measure determines the first topic after which the second measure either becomes a new topic or is added to the first topic and so on.

The metaplan session will be conducted with two students and two thesis supervisors. Consensus on measures has to be reached on determining topics.

The output of the metaplan session will be a list of topics per CSF. These new topics will be renamed to actionable measures based on the measures linked to this topic.

This session will not only analyse data on measures of CSF's of CI/CD-processes from a customer perspective but will also evaluate data collected by one fellow student on the process perspective.

2.2. Implementation

This section describes the implementation of the research. The implementation is based on the steps as described in section 2.1.

2.2.1. Search process

This section will describe the implementation and results of the search process. Section 2.2.1.1. describes the search process for new literature and section 2.2.1.2. provides insight in the search process for measures.

2.2.1.1. Searching for additional literature

The process below (figure 2) shows results of the conducted search for literature per step. It shows the amount of papers found based on the executed search queries (identification), of which how many were reviewed (Screening) and deemed relevant (Eligible). The included tab shows the actual number of articles that were used for data extraction.

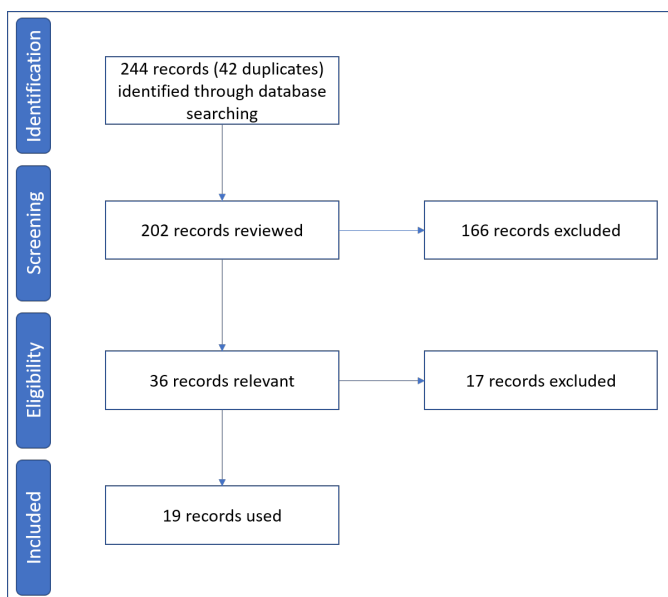


Figure 2: Literature search process (Source: Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009))

The 19 records included are in Attachment A: CSFs 2018-Augus 2020_v03.xlsx in the tab Study selection & quality asses. The articles used for Belzen et al. 2019 are included in Attachment B: Potential CSFs CI+CD+CDE_Classified_v1.3.xlsx under tab Potential CSF's. The combined lists with articles are eligible for data extraction.

2.2.1.2. Searching measures

The search for measures was conducted on the 38 papers that were the result of 2.2.1.1. During the search for measures we used the signal words we had identified during our exploration of the topic. As we were also trying to establish a definition for a measure we also extracted data that indicated a measure. This led to a set of terms that measures were often described by. The full list of terms and references are included in Attachment C – Measure definition – Boris Buis – v1.0.docx. Based on this we constructed the following preliminary definition of a measure in the context of a CSF of the CI/CD-processes.

A measure on CSF's in the context of CI/CD processes is:

- An action or practice that contributes to a CSF
or
- mitigates risks or challenges on a CSF.

To utilize a measure in an operational framework a measure has to be clearly defined and measurable in either a qualitative or quantitative way.

Our search for measures, using signal words and our preliminary definition on measures resulted in the extraction of 39 measures on CSF's in the process of CI/CD related to a customer perspective. The results are presented in Attachment D - Measures Customer Perspective - Boris Buis - v1.0.docx.

2.2.2. Inclusion and exclusion criteria

During this step the 39 extracted measures were tested against the defined inclusion and exclusion criteria. As indicated in section 2.1.2. we did not directly exclude measures in case not all criteria were met. Instead we would discuss during the metaplan sessions if these measures should be included. After testing the 39 measures none were excluded.

2.2.3. Quality assessment

We have included the inclusion and exclusion criteria on measures in section 2.1.2..

In accordance to section 2.1.3. we have conducted two metaplan sessions to go over all found measures. These sessions were attended by two students and two thesis supervisors. During the sessions all found measures were tested against the inclusion and exclusion criteria. For measures found with a customer perspective the session did not lead to the removal of measures.

Furthermore we have made the output of the steps that we took accessible in the attachments providing full disclosure.

2.2.4. Data collection

In the approach we defined elements that we want to extract for the definition of a measure and measures that we have found. The first result (data collected on the definition of a measure) is shown in a tabular format (Attachment C - Measure definition - Boris Buis - v1.0.docx) and contains a list using the elements that we had specified in our approach. This second result (measures found) is also presented in a tabular format (Attachment D - Measures Customer Perspective - Boris Buis - v1.0.docx), containing the elements we defined in our approach.

2.2.5. Data analysis

In our approach on data analysis we described the use of a metaplan session. As we would not only focus on the customer perspective during this session but also on the other two perspectives we defined a format as input for the session. Attachment E - Identified measures customer perspective - metaplan session input.xlsx shows the input that was used. Due to Covid-19 restrictions and physical distance between participants we decided to use Skype for a digital meeting. The participants of the sessions were two students and two thesis supervisors. During two sessions of in total 6 hours we went through all measures that were brought in.

Per CSF we validated the measures and placed them in topics. Some measures where moved to other CSF's and some measures turned out to have a relation with other CSF('s). The session also further established the preliminary definition of a measure that we had defined earlier as we reached consensus within the group of participants.

The result of the session was that the input, consisting of 39 measures, was compressed to 15 topics (customer perspective only) divided over the CSF's with a customer perspective. The full results of the metaplan session is shown in Attachment F - Measures Metaplan Session Results.docx.

As the topic names were designed to indicate a group of measures an actionable measure name for the topics was determined. The name of these new measures had to cover the example measures in the topics as much as possible. Also the names of the new measures were transformed to actionable names to comply to the definition of our preliminary definition of a measure.

2.3. Deviations from protocol

It was our intention to conduct the metaplan session with data on measures on all three perspectives. However, the student that focused on the perspective CI/CD process decided to drop-out. This meant more time was needed to find and extract measures on the CI/CD-process perspective and measure were not taken into account during the first two metaplan sessions. Another metaplan session will be scheduled to also include measures from the CI/CD-process perspective.

Our quality assessment approach indicates we would collect the nature of a measure that was found (i.e. suggestion, validated measure, etc.). However due to time constraints we were not able to include this in the research. Although this data was not included the nature of the measures we discussed during the metaplan sessions were taken into account when discussing whether a measure should be in- or excluded.

2.4. Results and conclusions

This section describes the results of the SLR and the conclusions that can be drawn from it. Based on the SLR we were able to construct a theoretical framework based on 38 articles. We will try to answer the research questions based on the insight we have gathered during the SLR.

First we will answer the first research question on the definition of a measure as this provides context to the other research questions.

RQ1: What is the definition of a measure in the context of a CSF of the CI/CD-processes?

As the reviewed literature didn't provide a pre-defined definition for a measure we have defined the following definition of a measure in the context of a CSF of the CI/CD-processes based on the reviewed literature.

A measure on CSF's in the context of CI/CD processes is:

- An action or practice that contributes to a CSF
or
- mitigates risks or challenges on a CSF.

To utilize a measure in an operational framework a measure has to be clearly defined and measurable in either a qualitative or quantitative way.

As this definition has been formed based on the articles used during the SLR the definition has not been empirically validated.

The answers to the other seven research questions (RQ2 – RQ8) are covered in table 3. This table consists of an overview of all measures that were derived from the SLR. The measures are grouped by CSF and contain a name, description and examples.

CSF	Measure	Description	Examples
Communication (Customer)	Integrate feedback in CI/CD-process	Integrate feedback of customers in the delivery process	- Respond and act based on instant customer feedback. (Olsson et al. (2012))
	Establish collaboration (communication) protocol	Improve collaboration for instance by establishing frequent communication and/or implement an engagement model compatible with the spirit of continues practices	- Frequent communication and coordination with customer regarding changes. (Ilyas and Khan (2017)) - Implement an engagement model with customer to be compatible with the spirit of CD. (Shahin et al. (2017))

Customer involvement	Implement collaboration strategy	Strategy to involve and engage customers in the delivery process	<ul style="list-style-type: none"> - Implement the concept of 'Lead customer'. (Shahin et al. (2017)) - Keep a close relationship with customer (Closer relationships with customers further can facilitate rapid innovation. (Rodriguez et al. (2017)) - Continuous and instant customer feedback. (Feitelson et al., 2013; Goodman and Elbaz, 2008)
	Integrate customer in CI/CD-process	Customer acts as an actor in the process	<ul style="list-style-type: none"> - Involving customer in testing phase (Shahin et al. (2017)) - Integration of the complete R&D organisation to process constant customer feedback. (Rodriguez et al. (2017))
Quality	Establish product agreements	How to deal with bugs and other agreements related to product quality	<ul style="list-style-type: none"> - Establish SLA with customer on bug fixes and/or roll back. (Claps et al. (2015)) - Limit the amount of people working on a product (Debbiche et al. (2014)) - Limit integration frequency (Debbiche et al. (2014)) - Involve not only the customer but also developers in defining quality gates. (Zampetti et al. (2020))
	Deliver process documentation	Description of the process and approach (guidelines, coding standards etc)	<ul style="list-style-type: none"> - Adopt 'social rules' which must be adhered to when deploying software (Claps et al. (2015)) - Apply coding standards/guides and code reviews to prevent technical debt and ensure consistency in source code (Yli-Huumo et al. (2014)) - Employing levels of abstraction while documenting quality requirements. (W. Behutiye et al. (2020)) - Ensuring the traceability of quality requirements. (W. Behutiye et al. (2020)) - Applying DevDocOps. (Rong et al. (2019))
	Deliver component documentation	Documentation on components, configuration management etc.	<ul style="list-style-type: none"> - Include component documentation as part of a release. (Ilyas and Khan (2017))
Customer acceptance	Arrange customer management support	Support for management to support continuous practices	<ul style="list-style-type: none"> - Customer should support close collaboration. (Laukkanen et al. (2017)) - Seek permission for from users to gather information. (Rodriguez et al. (2017))
	Arrange supplier support	Keep customer updated, train customer etc.	<ul style="list-style-type: none"> - A culture of open communication should be established. (Laukkanen et al. (2017))
	Conduct demonstrations for motivation	Demonstrate results of continuous practices to motivate	<ul style="list-style-type: none"> - Demonstrate results of continues practices to motivate and train customer. (Laukkanen et al. (2017)) - Show new features in blogs that can be viewed by customers. (Claps et al. (2015)) - Deliver high quality releases. (Agarwal (2011), Rodriguez et al. (2017))
	Align delivery practices with customer goals	Delivery practices should be in line with customer goals	<ul style="list-style-type: none"> - Customer preferences should be in line with goals and use case of CI. (Leppanen et al., (2015)) - Apply CD for non-business critical software development. (Claps et al., (2015), Leppanen et al., (2015)) - Buy-in from all stakeholders. (Rodriguez et al. (2017)) - Consider training/learning curve impact on end-users when delivering change to the customer. (Zade and Choppella (2012), Rodriguez et al. (2017))

Complexity across customer organisation boundary	Provide transparency	Provide transparency in ongoing development projects	- Be transparent; have an overview of current development projects with status. (Olsson et al. (2012))
	Involve customer in vision and approach	Involve customer in delivery vision and approach	- Involve product management units in the vision of delivering smaller features more frequently. (Olsson et al. (2012)) - Align goals between R&D organisation and product management. (Olsson et al. (2012))
Resistance to change (customer)	Guide cultural aspects of change	Provide guidance in the cultural aspects of change	- Involving a CI coach/driver. (Debbiche et al. (2014)) - Stimulate a culture of open communication. (Laukkanen et al. (2017)) - Bringing experience to the team. (Debbiche et al. (2014))
	Guide process aspects of change	Provide guidance in the process aspects of change	- Involving a CI coach/driver. (Debbiche et al. (2014)) - Stimulate a culture of open communication. (Laukkanen et al. (2017)) - Align rules, regulations, policies and strategies to enable continuous. (Shahin et al. (2017))

Table 3: Theoretical framework

During the metaplan sessions we noticed that measures might not always have an one-to-one relationship with a CSF. In some cases it seemed like a measure contributed to multiple CSF's or that measures strongly relate to one another or overlap. For our analysis this led to no issues.

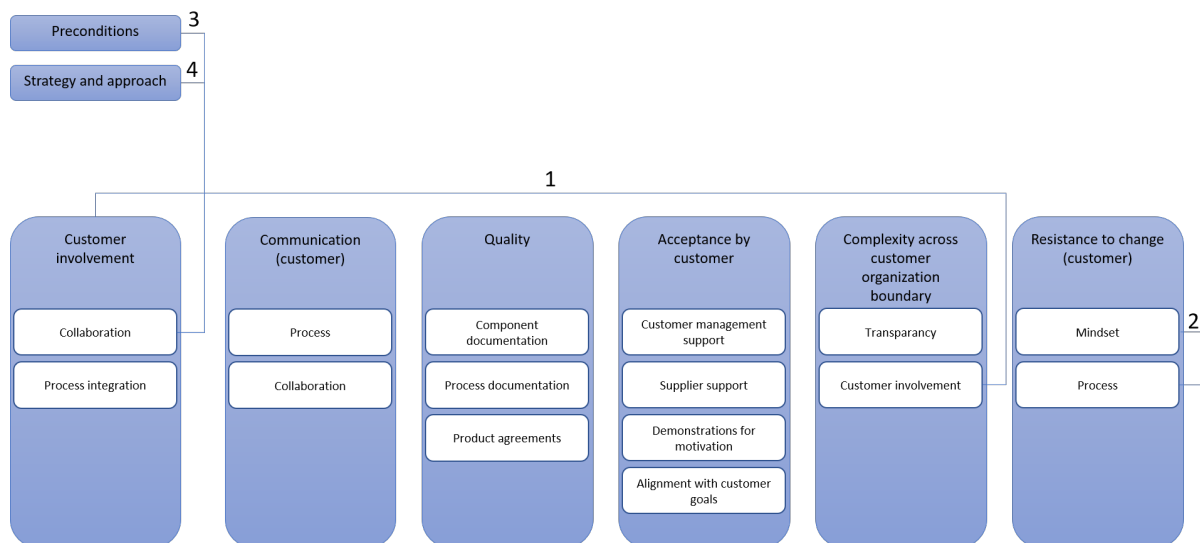


Figure 3: Model that indicates possible relations between measures and CSF's.

As shown in figure 3, four relationships are suggested. Relationship 1 is a relation between a measure in the CSF Complexity across customer organisation boundary and customer involvement. The measure identified uses customer involvement as a measure to contribute to the CSF Complexity across customer organisation boundary. Relationship 2 shows a relationship between two measure topics. One measure that was identified covered both topics whereas the other measures covered only mindset of process. Relationship 3 and 4 show a relation between measures within the topic collaboration and the CSF Preconditions and Strategy and Approach. It seems that the measure collaboration not only contributes to the CSF Customer Involvement but also to the CSF's Preconditions and Strategy and Approach.

For all CSF's within the scope of this research we at least found one measure. However, for answering 'RQ5: What measure(s) contribute to the CSF "Sales and intermediaries" from a customer perspective?' we were unable to find measures. Interestingly, we would actually expect to find measures for this specific CSF as this CSF has been described in the reviewed literature. The literature that describes this CSF also does not provide an indication of a measure that contributes to this CSF. Follow-up research is required to find answers to this question.

Worth mentioning is that the measures we found on the CSF "Complexity across customer organisation boundary" closely related to transparency and involving the customer. As the description of the CSF indicated other aspects, like no access or control on a production environment or complexity of customer sides we had expected to find measures that would specifically address these aspects. Follow-up research is needed to acquire more insight in measures related to these aspects of the CSF.

We have combined our results with the results from another research that focussed on the Process control/Management/Governance perspective. The results are included in Attachment G - Measures per CSF totaal Framework.docx and Attachment H - Conceptueel model v5.jpg.

2.5. Objective of the follow-up research

The results of the literature research provides useful insight on measures that contribute CSF's from a customer perspective. From this insight we were able to construct a theoretical framework that contains measures based on examples from literature related to CSF's and we were partially able to answer our research questions. However, one research question (RQ5) remained fully unanswered and the foundation of our framework was entirely based on a SLR.

The list below indicates possible goals of performing follow-up research:

- Validate measures that were identified during the SLR;
- Enrich the framework with new insight/measures;
 - o Determine differences in impact of measures;
 - o Identify measures that cover aspects of CSF's that were not found during the SLR;
 - o Challenges in applying measures;
 - o Disadvantages or side effects of applying a measure;
 - o Establish new relations between measures and CSF's;
 - o Difference in level of difficulty implementing a measure;
- Operationalise the framework (by making it measurable).

Our main objective for follow-up research is to focus on the first item in the list, to empirically validate our theoretical framework. To achieve this and to substantiate our answers to the research questions we opt for conducting a case study at an organisation that applies CI/CD. Doing so will allow us to test the framework against a real business and provide insight on how CI/CD is applied in practice.

3. Methodology

This section provides insight in the methodology used during this research. Section 3.1. describes enhancements made to the theoretical framework after completion of chapter 2. In section 3.2. the conceptual design of the research and selected method is described. Section 3.3. elaborates on the technical design and provides in detail how the research will be conducted. In section 3.4. the method of data analysis is described and section 3.5. provides a reflection on validity, reliability and ethical aspects of the research.

3.1. Theoretical framework enhancements

After the completion of the theoretical framework as presented in the results of chapter 2 additional literature research was conducted by our supervisor. This was aimed at finding measures in the context of the process of the CI/CD-process. During this research new measures were also discovered on CSF's part of this research. Together with two Master students and two supervisors we setup two additional metaplan sessions, as also described in section 2.4., to review and incorporate these new measures to the framework.

During the sessions we further refined the descriptions of the measures and some measures were merged and new ones were formed. This resulted in a new framework that will be used for this research. The results of the framework are included in attachment I.

3.2. Conceptual design: select the research method(s)

The goal of this research is to aid in the adoption of CI/CD by identifying measures that contribute to CSF's in CI/CD processes. In the previous chapter a SLR was performed that resulted in a theoretical framework. The objective of this part of the research is to empirically validate and possibly extend the theoretical framework. We want to do this by conducting research at an organisation that has been working with CI/CD for some time. Doing so will provide insight in how CI/CD-processes with its CSF's and related measures are actually applied in practice.

Given the data that we are dealing with (non-numeric) this research can be classified as qualitative. Saunders et al. (2019) indicates eight strategies for qualitative research:

- Experiment;
- Survey;
- Archival and documentary research;
- Case study;
- Ethnography;
- Action Research;
- Grounded Theory;
- Narrative Inquiry.

Our research closely aligns to the definition Yin provides for a Case study; "A case study is an in-depth inquiry into a topic or phenomenon within its real-life setting" (Yin, 2018). Saunders et al. (2019) indicates the most frequently used research method for evaluating a theoretical framework is a case study. Due to limited time and resources we will conduct a qualitative case study using a single organisation (single case study) that applies CI/CD.

To collect data and validate our framework we identified two types of resources for gathering data:

1. Stakeholders of the process of CI/CD

2. Documentation/artifacts related to the process of CI/CD

Given the nature of our framework/data, that has room for interpretation, we think it is more relevant to collect data from stakeholders than from documentation. Stakeholders (experts) are able to relate information that we have collected with their own practice and experiences. On top of that they can make it more concrete by giving examples.

For collecting data from stakeholders we will conduct interviews. The interviewed parties will be customers and other key-stakeholders in the context of the CI/CD-processes within the case organisation.

3.3. Technical design: elaboration of the method

In this section the method of research will be described in detail. The goal of this section is to show how the research will be implemented and why this is appropriate.

3.3.1. Case organisation

The goal is to validate and possibly extend our theoretical framework. Doing so will allow us to substantiate our answers to the research questions from both a theoretical and practical point of view. We want achieve this by verifying the framework at one sample case organisation. This allows for extracting as much information as possible from the case organisation.

We have setup the following criteria for the case organisation:

1. Provides IT services and software development;
2. Has at least 500 employees;
3. Has dedicated IT teams for software development/production (f.i. DevOps teams, SCRUM teams);
4. Has continuous practices embedded in their business and delivery for at least 2 years;
5. Is willing to provide insight and invest time by allowing a minimum of 5 respondents to participate in the interviews.

Table 4 indicates why these criteria were set.

Criteria	Reason
1	In order to answer the research question we need to select an organisation that provides IT services and software delivery, because the CI/CD-processes that we are looking at during this research are intended for IT integration and IT delivery. An organisation that does not provide these services will not work with continues practices for software delivery.
2	This criteria was set to not include smaller organisations as they might have less dependencies and fewer teams. This might result in a multitude of measures that are not applicable to them. Larger organisations tend to have more standards in place and multiple teams to verify our framework.
3	The case organisation should in some way have dedicated IT teams for IT delivery and development as many of the continuous concepts relate to teams.
4	This criteria was set to a minimum of 2 years of experience as we are also looking for results of the measures. If the organisation just started recently with continuous practices these results might not be known yet. Also, we want our interview participants to have experience in continuous practices which seems to be more likely in an organisation with more experience in continuous practices.

- 5 The case organisation should be willing to provide insight and invest time by means of allowing employees participate in the interview. We have set a number of minimal 5 participants as this could provide enough detail from different roles and teams to verify our measures.

Table 4: Criteria case organisation

3.3.2. Interview participants

In section 3.2. we have indicated two resources that could be used for data collection. For the first one, stakeholders of the CI/CD process, we will conduct interviews. In regard to the CI/CD-process we are focussing on the customer aspect. Therefore, we want to interview customers or customer representatives. However, in regard to the measures in the framework we are also interested in other aspects of CSF's. To get a good perspective on these aspects we also want to interview respondents in other roles as we expect their views and experiences with CI/CD might differ from one another. Also, their diverse background, views and experiences might lead to new insight.

The following criteria were set for the participants of the interviews:

1. The participant of the interview has one of the roles as shown in table 5;

Developer (DEV)	This would be someone in the team that is developing software. This person could provide detailed information on software delivery as they have hands-on experience delivering software.
Product Owner	This person would be a representative for the customer and acts between the IT team(s) and customer. This person could give insight in many of the customer aspects of the process and probably also many aspects of the CSF's.
Scrum Master	This person would have insight in initiatives within the team to improve but also on reporting, communication, knowledge sharing etc.
End-user (Customer)	This would be a customer of the CI/CD-process. This person would know first-hand how things are delivered from the IT team.
Business line owner / Manager	This role is a person that the IT team(s) report to. This person could give insight on strategies and how the IT team is managed.
Security officer	Security is often an important stakeholder for setting and guarding boundaries in IT development. This person could provide information in some of the CSF aspects.
Architect	Architecture is often an important stakeholder for setting and guarding boundaries in IT development. This person could provide information in some of the CSF aspects.
(Business) Information Analyst	This would be someone in the team that is making software designs, gathering requirements, interacts with the customer and works closely with the developer(s).
Functional Manager (OPS)	This would be someone in the team that is responsible for the operations side of software. This person could provide in detail information on software delivery as they have hands-on experience delivering software.

Table 5: Roles in organisation

2. Has a minimum of 2 years of working experience in the current role;
3. Works at least for 2 years at the case organisation;
4. Has permission to participate.

Table 6 provides clarity on why these criteria were set.

#	Reason
1	To answer our research questions, we want to interview participants that are knowledge holders of the CI/CD-process. Persons in the functions specified are likely to have experience in CI/CD.
2	We want to interview participants that work at least two years in their current role as we want to interview experts on the subject.
3	We want to interview participants that work at least two years at the case organisation as we want to interview experts that are also knowledgeable about the case organisation.
4	A person should be permitted to participate else this person is unsuitable.

Table 6: Participant criteria reasons

3.3.3. Interview type

The main goal of the interview is to validate the measures that we have in our framework substantiated by examples and results. This means we would have a predefined list of primarily open questions that we would ask participants.

Saunders et al. (2019) identifies three types of research interviews:

- Structured (Standardised);
- Semi-structured (Non-standardised);
- In-depth (Non-Standardised).

Structured interviews are conducted using researcher completed questionnaires and are based on pre-determined set of identical questions (Saunders et al. (2019)). As the nature of our questions will be complex, open ended and the order may vary, a standardised interview is not meeting our goals. Besides Saunders et al.(2019) indicates employees and managers are more likely to agree to be interviewed rather than complete a questionnaire, especially where the interview topic is seen to be interesting and relevant to their current work.

In-depth interviews are mostly used to explore a general area of interest. This type of interview is exploratory and emergent. A semi-structured interview will consist of a predetermined list of themes and maybe some key questions related to the theme. Saunders et al. (2019) indicates this type of interview is often used for testing theory. Given the nature of our questions and our research purpose is exploratory (we want to validate and extend our framework) a semi-structured interview is most suitable for our research.

3.3.4. Pilot interview

The first interview that will be conducted will be considered a pilot interview. The goal of the pilot interview is to increase quality of the interview material and overall interview quality which will lead to higher quality data. According to Saunders et al. (2019) elements that should be tested during the pilot interview are:

- Interview schedule
- Style of interviewing

- Researcher bias

The pilot interview will be done with a person that holds strong knowledge regarding CI/CD-processes within the case organisation and is willing to participate in the pilot interview.

3.3.5. Interview approach

The interviews will be conducted in either Dutch or English based on the language proficiency of the participants. Data collection will be done by means of audio-recording the interview and taking notes during the interview. As Saunders et al. (2019) indicates, taking notes will function as a backup in case of audio-recording failure but more importantly it will allow for easier summarization and follow-up questions during the interview.

The semi-structured interview will consist of primarily specific open questions that will ask for confirmation, examples and results. Asking for confirmation will help validating the measures found during the SLR. To further enhance these measures will ask for examples and results of the measures. This will allow us to substantiate our answers to the research questions. The full interview protocol with exact questioning including introduction and closing is included in attachment W. The list below shows the questions we will ask per CSF.

- Welke geïdentificeerde maatregelen worden toegepast?
- Hoe wordt maatregel 1 (2, 3, etc.) toegepast? Kun je voorbeelden noemen?
- Wat zijn de resultaten van maatregel 1 (2, 3, etc.) in de context van de bijbehorende CSF(s)? En waaruit (bijv. meetgegevens) blijken die resultaten?
- Waarom zijn dat de resultaten van maatregel 1 (2, 3, etc.)?
- Is er nog een maatregel die mist binnen deze CSF?

We will use specific questions as they result in specific information that we are looking for which will help in validating our framework. Open questions leave more room for an interviewee to elaborate on their answers. This type of questions might lead to new insight.

As the main focus of our research is to validate our framework, we will start each theme with specific questions that will validate the usage of measures that we have identified. Per CSF we will close with a more open question to validate if the participant is missing any measures in the framework that the case organisation is using. This method of questioning might provide new insight as the participant is open to come up with new elements that are not (yet) included in the framework.

We have created an interview action plan (Attachment J – Interview Action Plan.docx) that consist of four phases (table 7).

Phase	Name	Description
1	Preparation	During the preparation phase the artifacts and interview is prepared.
2	Pilot	The pilot phase will consist of a pilot interview to test the interview material and interview.
3	Implementation	During the implantation phase the invitations will be send and interviews will be conducted.
4	Transcription	The transcription phase will consist of transcribing the interviews and allowing participants to review the transcribed interview.

Table 7: Phases interview action plan

For the first phase we have created the following artifacts:

- Invitation emails (Attachment K)

The invitation emails document contains two email templates for reaching out to potential participants. The first email is to provide general information about the research by including the Participant Information Sheet and asking for willingness to participate. The second email provides the details of the measures that we will ask about during the interview. This email also has the consent form as attachment that participants need to agree to in order to participate.

- Theoretical framework to be shared with participants (Attachment L)

To provide some context and examples to the participants we will provide a version of the theoretical framework that consists of the CSF's, measures and some examples. The goal is to create a better understanding of the measures for the participants.

- Participant information Sheet (Attachment M)

The goal of the participant information sheet is to have an overview of all the important information about participating in this research. It also contains contact information of the researcher and supervisors.

- Consent form (Attachment N)

In order to participate in the research, the participant has to agree to the terms stated in the consent form.

3.3.1. Transcribe interview

Saunders et al. (2019) is clear on data analyses of interviews and advises to transcribe the interview in full, including non-verbal communication. We will transcribe in full what was said but will not transcribe the non-verbal communication as we are more interested at what was said instead of all communication around it. However, during the interviews we will take notes and also the audio-recordings will reflect the way something was said.

3.3.2. Validate transcription

The transcribed interview will be shared with the interviewee for a final check. The goal of this check is both to check factual accuracy and provide insight to the interviewee on the data that will be used for the research. It also allows for participants to supplement the data in case they left something out during the interview. This check is not intended to improve grammar or syntax.

3.4. Data analysis

In this section the method of data analysis is described. The input for the data analysis consists of three elements extracted during the semi-structured interviews:

- Audio recordings of the interviews;
- Written notes;
- Transcriptions of the interviews.

The data analysis will primarily be performed on the interview transcriptions. The written notes and recordings are only used as back-up in case of unclarity in the transcriptions.

For the analysis of the transcriptions we will use a deductive approach. We will compare our theoretical framework against the findings of the interviews. We will use coding to categorize our data and will use Atlas.TI as coding tool. For the coding we will use an established method to ensure a structured and systematic approach. We will code the interview based on the three stages described in Strauss and Corbin (1998). It consists of the following stages:

1. Open coding;
2. Axial coding;
3. Selective coding.

During the first stage we will categorize data fragments from the interview into codes and groups. This will be done by reading the full interview transcripts and assigning codes and groups to text fragments that relate to those codes and groups. As the semi-structured interviews were primarily aimed at validating our framework we will start with an initial set of codes shown in table 8.

Name	Type	Description
CSF	Group	The goal of the analysis is to be able to answer the research questions. During the interview we will go over all the CSF's and measures we have in the theoretical framework (Attachment I). For each CSF we will create a group, these groups (CSF's) are in accordance with RQ2 – RQ8. The groups can be used to link to measures, confirmations, examples and results.
Measure	Code	For all measures in the theoretical framework (Attachment I) a code will be created. In case new measures are mentioned a new code will be created. This code should always be applied together with a confirmation, example or result code.
Confirmation	Code	We will ask for confirmation on the measures that are in our theoretical framework (Attachment I). To indicate a confirmation we introduced a code that indicates a confirmation. This code should always be used in combination with a measure code.
Example	Code	We will ask for examples on the measures that are in our theoretical framework (Attachment I). To indicate an example we introduced a code that indicates an example. This code should always be used in combination with a measure code.
Result	Code	We will ask for results on the measures that are in our theoretical framework (Attachment I). To indicate a result we introduced a code that indicates a result. This code should always be used in combination with a measure code.

Table 8: Codes and groups

During the interview we have asked for confirmation of measures, examples and results. So in case we find a confirmation of a measure we will assign the code of the specific measure combined with the confirmation code tag. The same goes for examples and results. This allows us to create specific overviews on, for instance, examples of a measure.

During the second stage, axial coding, we will look for relations between the codes by identifying similarities. This might lead to organizing the codes in a hierarchical way and the emerging of new codes.

The third stage, selective coding, will result in a structured output of the interviews. At this point the results will be compared with the theoretical framework which will substantiate the answers to our research questions. Especially what we are looking for is confirmation in the use of measures as

indicated in the framework. Furthermore, we will indicate newly identified examples, new measures, newly discovered relations and highlights.

3.5. Reflection w.r.t. validity, reliability and ethical aspects

This section will identify risks on validity and reliability of this research (3.5.1. & 3.5.2.). It will indicate how these risks were addressed using counter measures. The ethical aspects and how this research dealt with it is described in section 3.5.3.

3.5.1. Validity

According to Saunders et al. (2019) validity can be grouped into internal validity and external validity.

Internal validity refers to the extent findings can be attributed to the research rather than flaws in the design (Saunders et al. (2019)). Cook and Campbell (1979) indicate the six most frequent threats to internal validity. We have included these potential threats in table 9 and described applicability and counter measures.

Threat	Counter measure
Past or recent events	This threat is not deemed applicable for this research as we will only conduct the interviews around the same time and only conduct one interview per respondent.
Testing	To make the respondents feel safe and free to talk it is important to create a safe environment (Saunders et al. (2019)). To ensure this the respondents could choose the location of the interview and day and time of their liking. To increase the respondents to talk open and honest we will anonymise the transcripts.
Instrumentation	This threat is not deemed applicable for this research as we will only conduct the interviews around the same time and only conduct one interview per respondent.
Mortality	We will contact respondents about the research and include all details using a Participant Information Sheet (Attachment M). The interviews will be planned shortly after approval and consent strongly reducing the chance of respondents dropping out.
Maturation	Not applicable for this research as will use one moment in time for the interviews.
Ambiguity about causal directions	Not applicable for this research. This research is exploratory and does not aim to find causal directions.

Table 9: Threats to validity and counter measures

Furthermore Saunders et al. (2019) emphasize it is important to reduce bias. We have identified respondent bias and researchers bias for this research. To reduce the impact of respondent bias we will use several respondents from different teams in different roles. This is described by Saunders et al. (2019) as triangulation. Using a variety in data sources will ensure the data is telling us what we think it is telling us (Saunders et al. (2019)).

Another measure we will use is sharing a for the respondent tailored version of the framework (Attachment L) prior to the interview with the respondent. This will allow them to read into the topic

before taking the interview. During the interview we will also be able to explain and clarify questions during the interview if needed, reducing respondent bias.

To address researchers bias we will use participant validation as described by Saunders et al. (2019). In practice this means we will be summarizing answers of participants and allowing them to check if the interpretation of the researcher is correct. After the interview, the interviewee will be able to review the transcriptions for correctness allowing them to correct researchers bias in the data. The second measure is using a pilot interview. One of the goals of this interview is to test and reduce researchers bias.

The external validity is about whether results can be generalised to other relevant contexts (Saunders et al. (2019)). The results of this research should not be generalised as the results come only from a single case organisation.

However, to increase the external validity of this study we will provide full disclosure on interview protocols and methods used for analysis. This allows readers to interpret the generalisation of this research as much as possible.

3.5.2. Reliability

Besides validity Saunders et al. (2019) indicates reliability is a key characteristic of research quality and refers to the replication and consistency of the research. Saunders et al. (2019) indicates semi-constructed interviews are not intended to be repeatable as they reflect reality at the time they were collected. Therefore, it is deemed not to be realistic or feasible to reproduce non-standardized research as it would undermine its strength. However, by explaining our research design in detail, having an interview protocol in place, provide insight in the data analysis methods used we ensure transparency in how the results should be interpreted.

3.5.3. Ethical aspects

This section describes the ethical aspects of this research. Saunders et al. (2019) provides ten ethical principles that can be applied to most research approaches. We have outlined the ethical principles and implementation for this research in table 10.

Ethical principle	Implementation
Integrity, fairness and open-mindedness of the researcher	We will be communicating openly about the goal of the research, its findings and methods used. Participants will be explicitly asked for their consent for the use of gathered data in our study. The collected data is only used for this research and not used for secondary purposes without getting explicit consent for the participants.
Respect for others	To gain trust and respect of thesis supervisors, fellow student, interview respondents and gatekeepers at the case organisation we will be open and clear about the research. We will inform participants of the interviews up-front on the topics below: <ul style="list-style-type: none"> - Right to privacy - Right to confidentially - Right to withdraw

Avoidance of harm (non-maleficence)	This principle is deemed not applicable for this research.
Privacy of those taking part	Personal data of participants will be anonymised as well as data of the case organisation. This allows for participants to communicate open and freely. Participants are informed about their privacy in the Participant Information Sheet (PIS) (Attachment M) explaining how their privacy is protected.
Voluntary nature of participation and right of withdraw	The nature of participation is voluntary. Participants are not forced in any way to participate. Their rights are stated in the Participant Information Sheet (PIS) (Attachment M) indicating participation is voluntarily and they can withdraw at any moment.
Informed consent of those taking part	Respondents will be informed about the research and what it entails to take part by the Participant Information Sheet (PIS) (Attachment M). To take part in the interview they have to agree in writing to the terms as stated in the consent form (Attachment N).
Ensuring confidentiality of data and maintenance of anonymity of those taking part	The research is designed to answer the research questions stated in section 1.3. To answer these questions participants and the case organisation can remain anonymous.
Responsibility in the analysis of data and reporting of findings	This research will provide full disclosure of collected data (anonymised), methods used for analysis and results.
Compliance in the management of data	Management of the data collected during the research will be compliant to European privacy laws.
Ensuring the safety of the researcher	This principle is deemed not applicable for this research.

Table 10: Ethical principles and implementation

4. Results

This section describes the implementation of the research and contains the results. Section 4.1. describes the way the research was implemented and how it relates to the research questions. The research context is provided in section 4.2. In section 4.3. the execution of the interviews is described and section 4.4 provide the interview results. In section 4.5 the observations during the interviews and analyses are shared. The final results are presented in section 4.6.

4.1. Research implementation

In chapter 1 we defined the following 8 research questions which we want to answer.

- *RQ2: What measure(s) contribute to the CSF “Resistance to change” from a customer perspective?*
- *RQ3: What measure(s) contribute to the CSF “Complexity across customer organisation boundary” from a customer perspective?*
- *RQ4: What measure(s) contribute to the CSF “Acceptance by customer” from a customer perspective?*
- *RQ5: What measure(s) contribute to the CSF “Sales and intermediaries” from a customer perspective?*
- *RQ6: What measure(s) contribute to the CSF “Quality” from a customer perspective?*
- *RQ7: What measure(s) contribute to the CSF “Customer involvement” from a customer perspective?*
- *RQ8: What measure(s) contribute to the CSF “Communication” from a customer perspective?*

In chapter 2 we provided a theoretical framework to substantiate the answers to our research questions. In chapter 3 we established the methodology for the research at a case organisation.

For this research we have interviewed 6 participants working at the case organisation. Three of them had the role of Product Owner and were representing the customers interest. The other interviewees were part of different DevOps teams and worked on the delivery of IT solutions. The case organisation approved cooperating and all participants agreed to the terms in the consent forms by means of confirming by email.

All interviews were conducted in Q1 2021. The participants were asked their preference in terms of the moment and location of the interview. Half of the interviews were held on location, face-to-face and the other half was done through Microsoft Teams. The table 9 below shows the interview schedule and method used.

Participant	Date time	Method
Participant 1 – Business Information Analyst / Scrum Master Automation team	5 februari 2021, 08:30uur	Digital
Participant 2 – Lead Developer Customer team	17 februari 2021, 16:00uur	Face-to-face
Participant 3 – Product Owner Bank team	19 Februari 2021, 14:00uur	Face-to-face
Participant 4 – Functional Manager Bank team	24 februari 2021, 13:00uur	Digital
Participant 5 – Product Owner Pensions	25 februari 2021, 16:00uur	Digital
Participant 6 – Product Owner Software Factory Team	1 maart 2021, 17:00uur	Face-to-face

Table 11: Participant overview

4.2. Research context

This section provides insight in the case organisation and interview participants.

4.2.1. Case organisation

The case organisation is a multinational in the financial services industry. This research was conducted at the Dutch part of the company. In the Netherlands it's a leading provider of life insurances, pensions, banking services, mortgages and general insurances and has around 3500 employees by the end of 2020.

Each of these business units have their own IT teams that develop IT solutions for internal and external customers. They also house a centralized IT department to provide companywide generic IT services, in example a customer portal.

The company interacts with customers through a range of distribution channels. In general, most business lines use the intermediary channel but in recent years the direct online channels have become increasingly popular.

Table 12 provides an overview of the criteria that were set in section 3.3.1. and if the case organisation met the criteria.

#	Criteria	Criteria met
1	Provides IT services and software development	Yes, the case organisation provides IT services for internal customers and end-customers.
2	Has at least 500 employees	Yes, the case organisation houses around 3500 employees in the Netherlands.
3	Has dedicated IT teams for software development/production (f.i. DevOps teams, SCRUM teams)	Yes, the case organisation has many dedicated IT teams for software development spread over multiple business units.
4	Has continuous practices embedded in their business and delivery for at least 2 years	Yes, the case organisation has embedded continuous practices in their business and delivery for more than 2 years.
5	Is willing to provide insight and invest time by allowing a minimum of 5 respondents to participate in the interviews	Yes, the organisation has agreed to cooperate.

Table 12: Criteria met by case organisation

4.2.2. Participants

Participant 1 – Business Information Analyst / Scrum Master Automation team

Participant 1 is a Business Information Analyst (BIA) and has been working in IT since 1998. He started his career as a software developer. In his role as BIA he is closely and actively involved in development of software solutions delivered to other DevOps teams in the organisation. CI/CD is something that he uses in his day-to-day work to deliver software.

Participant 2 – Lead Developer Customer team

Participant 2 is a lead developer in DevOps team that focusses on delivery of customer solutions that are generic and used by the various business units. He started his career over 10 years ago in IT as a front-end developer. In the team they actively working with CI/CD and use best practices on quick and secure ways of delivering new software.

Participant 3 – Product Owner Bank team

Participant 3 is a product owner of two DevOps team within the Bank business unit. As Product Owner she is a representative for the customer. Her teams cover front-end and back-end development and support a whole range of banking products. Her teams work with CI/CD for delivering solutions to the internal and external customers. She has been working at the case organisation for about 15 years.

Participant 4 – Functional Manager Bank team

Participant 4 is a functional manager within one of the bank DevOps teams. His Product Owner is participant 3. As functional manager he is involved in the CI/CD process of delivering software to their customers. He has been working at the case organisation for more than 15 years.

Participant 5 – Product Owner Pensions

Participant 5 is a Product Owner for a pensions team. He has been working at the case organisation for over 5 years and has always been active in the digital domain. His teams focusses on the delivery of BPM solutions and portals for intermediaries. His team uses CI/CD for delivering its solutions to the customer.

Participant 6 – Product Owner Software Factory Team

Participant 6 is the product owner of the Software Factory (SWF) team and she is responsible for CI/CD within the case organisation. She is also owner of the software delivery management DevOps process which CI/CD is part of. Her DevOps team delivers software for other DevOps teams to deploy and enable them to apply CI/CD. The team delivers a range of tools for deployments, collaboration and documentation. They use CI/CD to deliver these tools to about 50 DevOps teams in the case organisation.

As shown in table 13 all participants met the criteria set in chapter 3.

	Criteria 1	Criteria 2	Criteria 3	Criteria 4
Participant 1	Yes	Yes	Yes	Yes
Participant 2	Yes	Yes	Yes	Yes
Participant 3	Yes	Yes	Yes	Yes
Participant 4	Yes	Yes	Yes	Yes
Participant 5	Yes	Yes	Yes	Yes
Participant 6	Yes	Yes	Yes	Yes

Table 13: Criteria met by participants

4.3. Execution of the interviews

This section describes the execution of the interviews.

4.3.1. Pilot interview results

Initially an appointment was made for the pilot interview after all the interview material was finalized. The goal of this interview was to test the protocol and enhance the quality of the remaining interviews.

The pilot interview led to some small improvements in the interview material as well as in the interview protocol. For example, initially the framework that was shared with the respondent had a different order of CSF's compared to the questioning in the interview protocol. This caused some confusion during the interview. The improvement was to align the shared framework and interview protocol.

Another improvement was the questioning during the interview. During the pilot interview the respondent was asked if he recognized and applied measures in the CSF. This led to a too open discussion and not focussed discussion on the measures. This made it hard to track what examples belong to what measures. In the follow up interviews we would go from measure to measure to ask confirmation, examples and results, making the answers more specific and tailored to the specific measures. Another question that we initially had in the interview protocol was to ask the respondent for missing measures. This question was removed due to time constraints. Going through the measures already took the reserved time for the interviews.

4.3.2. Interviews

After the enhancements made the other respondents were contacted and appointments were made. An appointment was always for 90 minutes and the goal was to go through all the CSF's and measures in 60 minutes. The 30 minutes would give time for an introduction, some explanation and some spare time if needed. All interviews were finished within the time scheduled.

Short after the interview took place it was transcribed and shared with the interviewee for verification. All verified the correct transcription of the interview.

All respondents explicitly agreed to the terms in the consent form. They agreed by responding to the email that contained the consent form.

4.4. Interview results

After the transcripts were completed and verified the coding process started. For coding Atlas.TI was used. First the CSF's were created as groups and the measures were created as codes and linked to the appropriate CSF groups. Then 3 codes were created for coding confirmations, examples and results.

During the coding we saw respondents sometimes mentioning the negative results of not applying certain measures. As the code result was to indicate a result of applying a certain measure we could not use this and decided to introduce a new code, reverse results. This code was used for indicating results when not applying a measure, so the negative effects of that.

This resulted in the codes and code groups in Atlas.TI as shown in figure 4.

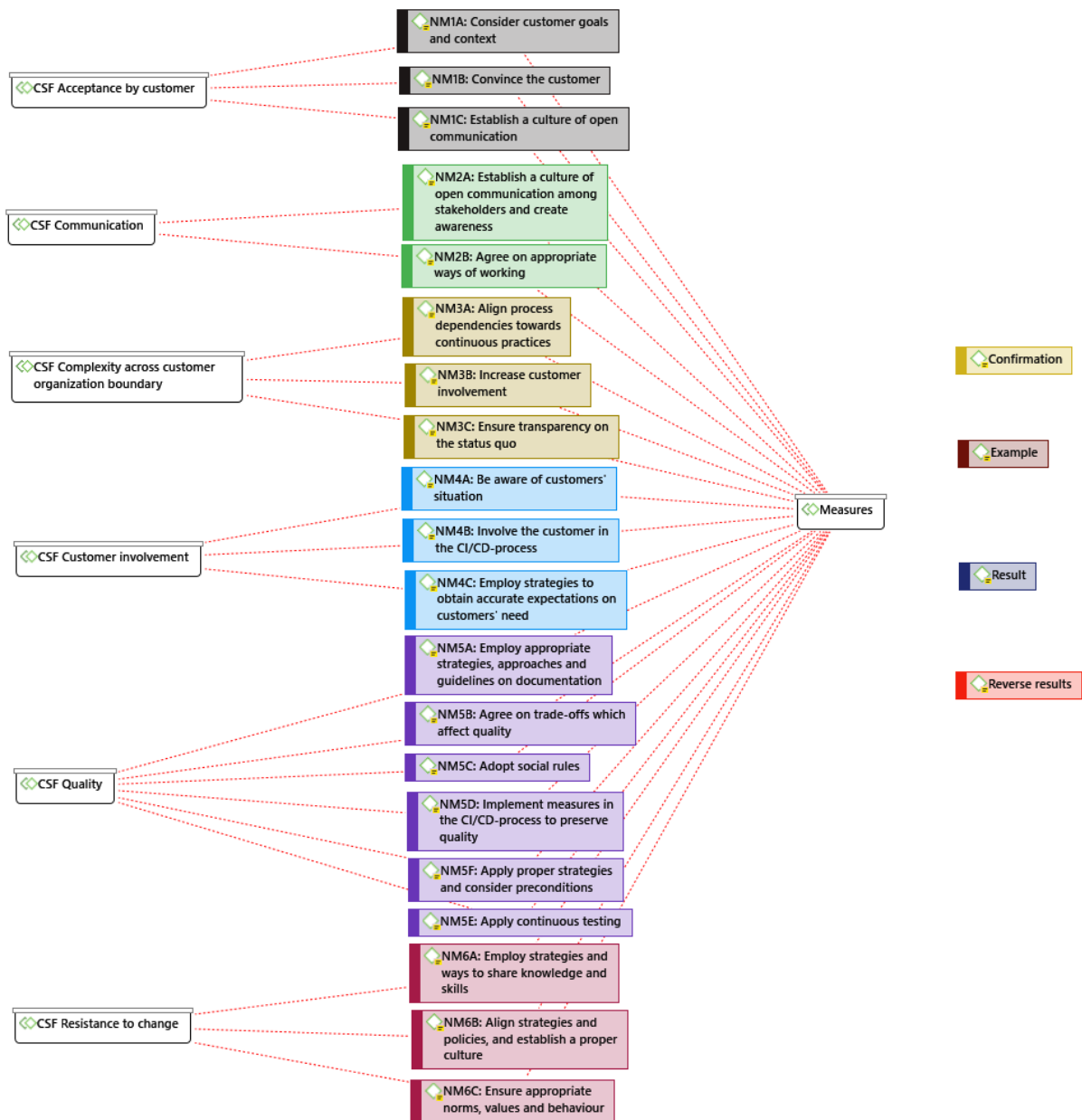


Figure 4: Codes, groups and relations in Atlas.TI

After the coding we did some first quantitative analysis on the results. The results of the coding are shown in attachment U and in figure 5.

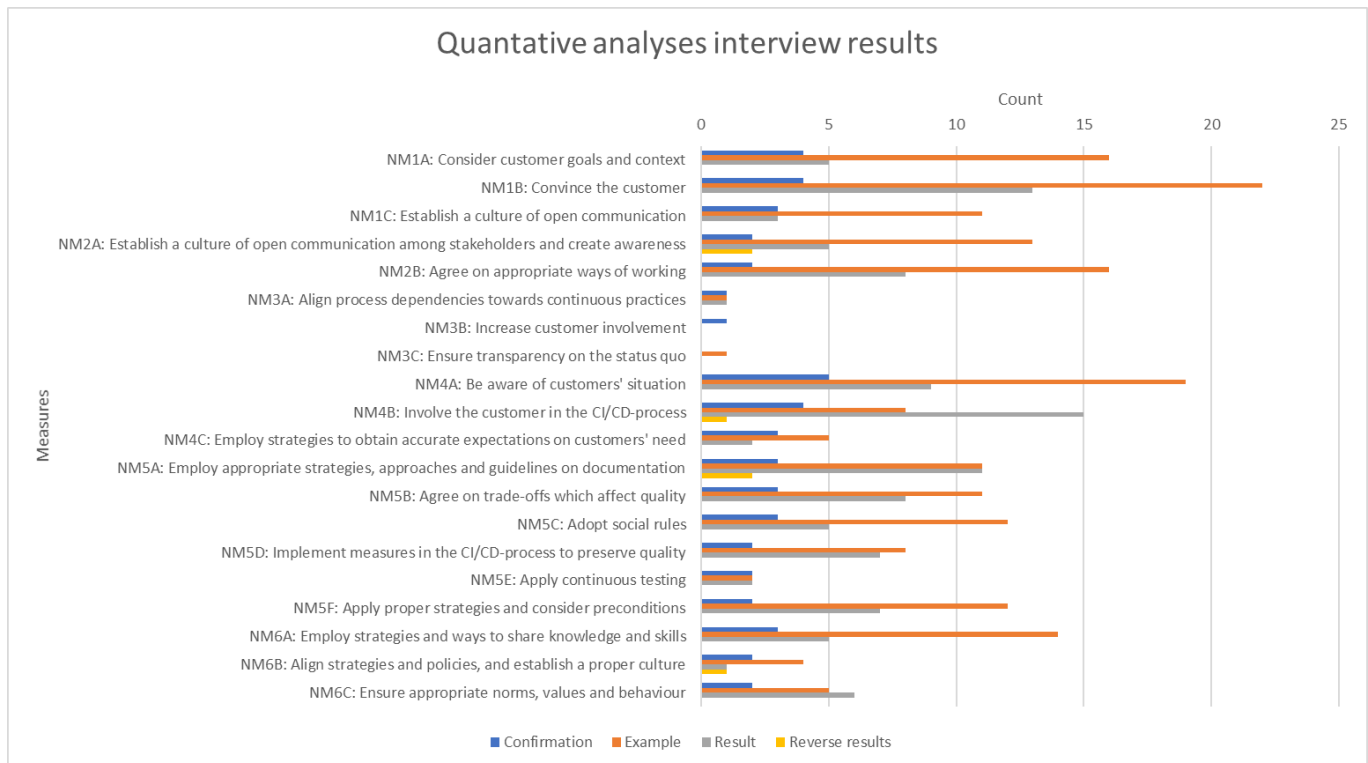


Figure 5: Quantitative analysis of interview results

What stands out is the little response on measures within the CSF Complexity across customer organisation boundary. Most respondents did not recognize this CSF and measures. This might be due to the fact that our case organisation works for internal customers and therefore experience no or limited complexity across customer organisation boundaries.

Moreover, we see that a large number of measures have been substantiated with more than five examples. For the measure convince the customer even more than twenty examples were provided.

The full and raw results of the coding can be found in attachment V.

In the sections below we will substantiate the answers to our research questions RQ2 – RQ8. For RQ5 we didn't find any measures during the literature research. For the case organisation this measure is not applicable as the teams of the respondents did not work with intermediaries.

4.4.1. CSF Acceptance by customer

NM1A: Consider customer goals and context

Confirmation: This measure was strongly confirmed by 4 respondents. They indicated this is an important measure and that you have to consider the goals and context of the customer in your approach.

Examples: Many of the examples that were mentioned related to the approach in involving the customer. It strongly depends on the type of customer, how the customer interacts and how often the customer interacts with the software. One respondent said for instance that for corporate customers it is important to not release too often so you can provide more context to a release:

“Dus dat je er ook gewoon veel meer context aan kan meegeven en uit kunt leggen waarom er een verandering is, wat er dan verandert is, waar de oude dingen staan waar, de nieuwe dingen staan.”

In general respondents indicated that they closely align with their customers on release frequency, sprint duration and size of releases.

Results: In general, the result of this measure was better customer satisfaction.

NM1B: Convince the customer

Confirmation: This measure was recognized by the respondents as something that is used within their teams.

Examples: A lot of examples were given to substantiate this measure. Examples that were given: Giving demo's, workshops, showing quality tests, blogs, examples, onboarding sessions, newsletters, sneak previews and demonstrating advantages for the customer.

Results: The customer gets the feeling of involvement and influence resulting in more support for changes. A quote by one of the respondents that reflects these results:

“Maar op het moment dat je ze dingen laat zien en je ze er ook echt bij betrekt en dus ook fysiek de interactie opzoekt. Ja, dan krijg je mensen zo veel makkelijker mee in de aankomende verandering, die er gaat zijn.”

NM1C: Establish a culture of open communication

Confirmation: This measure was confirmed by the respondents and found to be an important one.

Examples: The examples given were diverse. Some respondents said they provided insight and an open culture by showing their team results. Or even dashboards that monitor team performance. Others said the way of communicating with the customer was important. For instance, allowing developers to directly interact with the customer.

Results: Not much was said on the results. The results that were mentioned were a better feeling of involvement on the customer end. Easier and faster communication resulting in a better product for the customer.

4.4.2. CSF Communication

NM2A: Establish a culture of open communication among stakeholders and create awareness

Confirmation: Not many respondents directly confirmed recognizing and applying this measure. However, some explanation and providing some of the examples we found the respondents came up with 13 examples.

Examples: Examples that were given are setting up an internal community for knowledge sharing and a Microsoft Teams channel. What also was mentioned is using the demo's not only for new releases but also to share progress and what is in scope for the next sprint.

Another interesting measure that was mentioned was an IT maturity dashboard on which stakeholders can see the performance of the team.

Results: Only limited results were provided which varied between the respondents. Examples of results are better quality releases, better alignment with the customer and a feeling of involvement

from the customer. Also, communication with the customer becomes more accessible making it easier to align and discuss things.

NM2B: Agree on appropriate ways of working

Confirmation: Although not all respondents directly responded with a positive confirmation, we collected many examples on this measure.

Examples: Examples for this measure: Definition of Ready, Definition of Done, clear communication protocols, tools used for documentation, tools used for agile way of working.

Results: Increased quality, impact of the team in the organisation is bigger if you keep stakeholders updated, being predictable, being more efficient and being compliant were given as results for this measure.

4.4.3. CSF Complexity across customer organisation boundary

This CSF turned out to be limited applicable for the case organisation. The teams at the case organisation work for the internal customer and have in general access to all environments. Almost all respondents indicated this CSF was not applicable.

NM3A: Align process dependencies towards continuous practices

Confirmation: There was one confirmation for a very specific example.

Examples: One specific example was given by one respondent. They provide best practices. If the customer adopts the best practices they are fully supported. If not, they lose support.

Results: No results were provided.

NM3B: Increase customer involvement

Confirmation: One responded confirmed this measure. However, he indicated they do increase customer involvement but not to contribute to the success of this CSF.

Examples: No examples were provided.

Results: No results were provided.

NM3C: Ensure transparency on the status quo

Confirmation: No confirmation was provided.

Examples: One example was given, being open about upcoming projects. However, this was not intended for contributing to this CSF.

Results: No results were provided.

4.4.4. CSF Customer involvement

NM4A: Be aware of customers' situation

Confirmation: Respondents recognized and confirmed this measure.

Examples: Various examples were given and one respondent pointed out that the way of collecting data from the customer depends on the type of customer. Multiple respondents said they have monitoring or active logging on their application to collect feedback. But also small rooms, 1 on 1 talks and demos are methods used for getting more insight.

Results: Based on acquired insight the strategic direction is influenced. The service towards customers can be more tailored.

NM4B: Involve the customer in the CI/CD-process

Confirmation: Respondents strongly recognized this measure and indicated this is something they do.

Examples: One respondent said they use so called key-users. Key-users are involved in the CI/CD-process and perform formal business acceptance approvals. During the end-to-end process they are involved to verify ongoing work.

Other examples that were given: involve the customer for testing, train the customer, update user manuals and process descriptions.

Remarkable for this measure is that we interviewed 3 Product Owners and none of them recognized having a Product Owner as a measure.

Results: In general the respondents indicated that the feeling of involvement of the customer increased. They said this improved the adoption of releases, resulted in better quality releases and strengthen the relation with the customer.

One respondent said the more he involved the customer the better the result is:

“Ik merk dat hoe meer ik de business betrek bij iedere stap die we doen in ontwikkeling, hoe beter het resultaat uiteindelijk is in de applicaties die we voor hen maken.”

NM4C: Employ strategies to obtain accurate expectations on customers' need

Confirmation: Some respondents confirmed that this measure was applied.

Examples: Only a few examples were given by the respondents. Mostly about standard monitoring and tooling that was used by most teams in the case organisation. Also the way of working at the case organisation that applied on all teams was mentioned as an example.

Results: The monitoring resulted in the ability to measure and score customer satisfaction. This could be compared to the goals that were set upfront to see if goals were met.

4.4.5. CSF Quality

NM5A: Employ appropriate strategies, approaches and guidelines on documentation

Confirmation: This measure was confirmed by most respondents.

Examples: Agreements on documentation are made within the teams. There is no overarching strategy at the case organisation. Examples that were given, were agreements for documentation are part of the Definition of Done. Some teams don't deliver documentation, instead the customer is responsible for the documentation. Overall they said the agreements on documentation depend a lot on the type of software and the customer.

Results: Improves the overall quality of releases, works more efficient, transferability of work improves, creates traceability.

NM5B: Agree on trade-offs which affect quality

Confirmation: Respondents indicated they have to make trade-offs that effect quality from time to time.

Examples: Respondents experience pressure of releasing because of deadlines. Most respondents indicated that in case a release could not be delivered on time, parts of the release were placed out of scope or other functionalities were dropped based on priorities of the customer. It also happens sometimes that releases are not delivered according to architecture or security best practices or guidelines. However, these trade-offs are always tailored to a specific release.

Results: On one hand it enables the teams to deliver faster and meeting the deadline.

“Ja, je bent wel in staat om te leveren en soms gebeurt dat ten goede van de klant, denk ik. Want ik vind dat de klant beter iets kan zien dan niks.”

On the other hand these trade-offs also result in technical debt and re-work. In the worst case these trade-offs even cause incidents in production.

NM5C: Adopt social rules

Confirmation: This measure was recognized based on the examples by most respondents. However, they indicated that the case organisation had agreements and SLA's in place.

Examples: Have an IT framework in place for handling incidents, have an officer of duty for picking up incidents, have support available 24x7.

Results: It stimulates customers trust. They become more confident in allowing releases to go to production as they know this can also be easily fixed.

NM5D: Implement measures in the CI/CD-process to preserve quality

Confirmation: Respondents confirmed the usage of measures in the CI/CD-process to preserve quality.

Examples: 4-eyes principles, CMDB identifiers, SonarCube, use Gitflow for code reviews, static code analyses and automated tests were examples given by the respondents.

Results: It provides insight in the quality of releases and reduces the number of incidents. One respondent stated the following:

“Ja, het is een beetje een soort van selffulfilling prophecy. Als je het niet doet, heb je daar alleen maar last van. Maar als je het wel doet dan wordt eigenlijk alles er beter van.”

NM5E: Apply continuous testing

Confirmation: One respondent said they use automated testing. Others said it is something they are looking for and could be a possible improvement for the future.

Examples: Using an automated testing tool for automated functionality testing.

Results: Clarity towards customer and small amount to no incidents on production.

NM5F: Apply proper strategies and consider preconditions

Confirmation: Most respondents needed some content and examples before recognizing this measure. After showing some examples most recognized the measure and came up with some examples.

Examples: Making transparent what features are initiated by the team to decrease technical debt or upgrades. Promote building reusable components and sharing components that are available. Schedule a fixed amount of time for resolving technical debt. Putting technical debt in the backlog to make it visible.

Results: Keeping up to date with the latest developments, being compliant with rules and regulations within the organisation.

Specifically, for reserving time for cleaning up technical debt a result was that it's good for the wellbeing of the team knowing there is time reserved.

4.4.6. CSF Resistance to change

NM6A: Employ strategies and ways to share knowledge and skills

Confirmation: This measure was recognized and is applied by the respondents.

Examples: Looking forward to adopt future capability requirements. Having community of practices for knowledge sharing and organizing community meetings. Collective trainings, involve agile coaches in teams and onboarding sessions.

Results: Without the right knowledge and know how teams would not be able to deliver. Eventually it is about creating and maintaining the right skills in the teams required for delivering features to the customer.

NM6B: Align strategies and policies, and establish a proper culture

Confirmation: This measure was confirmed but not many examples were given. Respondents indicated this was arranged on a high level in the organisation outside of their sphere of influence.

Examples: Having an organisation wide standard way of working and policies and strategies in place.

Results: One result was given, being aligned on the strategy.

NM6C: Ensure appropriate norms, values and behaviour

Confirmation: This was also a measure that was recognized but respondents expected it to come from the top management.

Examples: Mostly examples were given that higher management is determining the direction and pushing work down towards the teams. For instance, management should make sure that the organisations stay compliant. Another example is the way of working that management determines, the whole organisation has to comply to this.

One respondent however, also said they promoted the DevOps culture actively:

“In onze demo’s proberen we ook echt wel de soort van DevOps cultuur; “you build it, you own it, you run it, you love it” te benadrukken.”

Results: When work is pushed from management down towards the teams your IT delivery process is DNB proof. As indicated by the respondent quoted below it creates a flow where the teams are continuously producing rather than also interacting with the customers and have ownership in the work that is picked up.

“Wat doe je nu nog als Product Owner en wat bepaalt een team nog zelf als er al allerlei analyse sessies zijn geweest om uit te denken wat er precies moet gebeuren, dan ben je dus alleen nog maar aan het produceren.”

4.5. Observations

During the analysis we observed that respondents reported overlap and relations between measures and CSF’s. One example is for instance measures that contribute to the CSF customer involvement. Several measures were mentioned by the respondents but they also mention these measures contribute to a better quality and improved customer acceptance. Also, a measure like giving demo’s was said to contribute to multiple CSF’s.

Another observation is that the CSF’s complexity across customer organisation boundary and sales and intermediaries are not applicable for the case organisation. In regards to sales and intermediaries this was expected as the case organisation, or at least the teams of the respondents, did not work with intermediaries. For complexity across customer organisation boundary we expected to find more confirmation as we had also find some measures during our literature research. However, the teams in the case organisation had no issues on customer environments and had all access needed for monitoring and deployments. Although the CSF was not applicable some respondents still recognized the measures that we found. Interestingly is that these measures were used to contribute to other CSF’s.

4.6. Final results

In this section an overview of the final results are provided. The overview, shown in table 16, shows whether a measure was confirmed and how strongly it was substantiated with examples from the case organisation. We have used three levels for indicating this. The tables below show the criteria used for the indicators.

The criteria as shown in table 14 are used for indicating the level of confirmation.

Indication	Criteria
	At least two respondents confidently confirmed the measure and more than 5 examples were provided
	At least two respondents confirmed the measure and more than 2 examples were provided
	Less than two respondents confirmed the measure and less than 3 examples were provided

Table 14: Criteria level of confirmation

The criteria as shown in table 15 are used for indicating the level of substantiation.

Indication	Criteria
	More than 10 examples were provided
	Between 5 and 10 examples were provided
	Less than 5 examples were provided

Table 15: Criteria level of substantiation

CSF: Acceptance by customer			
Nr.	Measure	Confirmed	Substantiated
1A	Consider customer goals and context		
1B	Convince the customer		
1C	Establish a culture of open communication		

CSF: Communication			
Nr.	Measure	Confirmed	Substantiated
2A	Establish a culture of open communication among stakeholders and create awareness		
2B	Agree on appropriate ways of working		

CSF: Complexity across customer organisation boundary			
Nr.	Measure	Confirmed	Substantiated
3A	Align process dependencies towards continuous practices		
3B	Increase customer involvement		
3C	Ensure transparency on the status quo		

CSF: Customer involvement			
Nr.	Measure	Confirmed	Substantiated
4A	Be aware of customers' situation		
4B	Involve the customer in the CI/CD-process		
4C	Employ strategies to obtain accurate expectations on customers' need		

CSF: Quality			
Nr.	Measure	Confirmed	Substantiated
5A	Employ appropriate strategies, approaches and guidelines on documentation		
5B	Agree on trade-offs which affect quality		
5C	Adopt social rules		
5D	Implement measures in the CI/CD-process to preserve quality		

5E	Apply continuous testing		
5F	Apply proper strategies and consider preconditions		

CSF: Resistance to change			
Nr.	Measure	Confirmed	Substantiated
6A	Employ strategies and ways to share knowledge and skills		
6B	Align strategies and policies, and establish a proper culture		
6C	Ensure appropriate norms, values and behaviour		

Table 16: Measure confirmation and substantiation

The result shows that we were able to confirm 14 out of 20 measures. All confirmed measures were substantiated with examples except for one; Employ strategies to obtain accurate expectations on customers' need. This measure was recognized by the respondents and said it is applied within the case organisation, however they were only able to give a small number of examples.

In table 17 we have enriched the theoretical framework (Attachment I) with new examples we found during the case study. New examples are examples that we did not find during the SLR. Also results that were mentioned by respondents are included in this table.

CSF: Acceptance by customer				
Nr.	Measure	Description	New examples	Results of the measure
1A	Consider customer goals and context	Consider customer goals and context when making trade-offs on speed, release frequency, security, learning curve of end-users etc.	<ul style="list-style-type: none"> Determine customer approach based on type of customer Provide (more) context to release Align closely on release frequency, sprint duration and release size 	<ul style="list-style-type: none"> Better customer satisfaction
1B	Convince the customer	Convince the customer of the benefits of continuous practices through effective communication (e.g. blogs, materials, workshops, demonstrations), high quality releases, right behaviour etc.	<ul style="list-style-type: none"> Giving demo's of releases Showing quality tests Provide onboarding sessions Sneak previews 	<ul style="list-style-type: none"> Improved support for changes Customer has feeling of involvement Customer has feeling of having influence
1C	Establish a culture of open communication	Establish a culture of open communication, for example seek permission to gather information.	<ul style="list-style-type: none"> Showing team results Dashboards that show team performance Allowing developers to interact with customer directly 	<ul style="list-style-type: none"> Improved feeling of involvement by the customer Easier and faster communication resulting in better product for the customer

CSF: Communication				
Nr.	Measure	Description	New examples	Results of the measure
2A	Establish a culture of open communication among stakeholders and create awareness	Share information and knowledge, make activities transparent, communicate frequent, involve stakeholders and create awareness.	<ul style="list-style-type: none"> Setup a community for knowledge sharing Use MS Teams channels for communication Demo progress and scope of next sprint Have an IT Maturity dashboard on which stakeholders can see team performance 	<ul style="list-style-type: none"> Better quality releases Better alignment with customer making communication more accessible
2B	Agree on appropriate ways of working	Agree on appropriate ways of working among team members and with the customer, make right decisions and trade-offs during the design of the CI/CD process, and be transparent.	<ul style="list-style-type: none"> Agree on a Definition of Ready Agree on a Definition of Done 	<ul style="list-style-type: none"> Impact of the team in the organisation is bigger if you keep stakeholders updated Being predictable Being more efficient

			<ul style="list-style-type: none"> • Have clear communication protocols • Agree on tools used for documentation • Agree on tools used for agile way of working. 	<ul style="list-style-type: none"> • Being compliant with rules and regulation
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CSF: Complexity across customer organisation boundary				
Nr.	Measure	Description	New examples	Results of the measure
3A	Align process dependencies towards continuous practices	Convince all actors in the process to adopt continuous practices and customize updating mechanisms of involved systems and devices.	None	None
3B	Increase customer involvement	Involve organisational units which are the interface towards customers.	None	None
3C	Ensure transparency on the status quo	Be transparent on the status of development projects.	None	None

CSF: Customer involvement				
Nr.	Measure	Description	New examples	Results of the measure
4A	Be aware of customers' situation	Use feedback mechanisms, be aware of possible barriers and even assume the role of a customer.	<ul style="list-style-type: none"> • Active logging on customers applications • Small rooms (customer discussion groups) • 1 on 1 talks with customers • Demo's for collecting feedback 	<ul style="list-style-type: none"> • Influence on strategic directions • More tailored service offering towards customers
4B	Involve the customer in the CI/CD-process	Involve the customer as actor in the CI/CD-process, take measures to get feedback, take into account customers' needs and prepare the receiving end.	<ul style="list-style-type: none"> • Introduce key-users on customer side • Involve the customer in training instructions • Involve the customer in updating user manuals and process descriptions 	<ul style="list-style-type: none"> • Improved feeling of involvement on customers end • Improved adoption of releases • Stronger relation with customer • Better quality releases
4C	Employ strategies to obtain accurate expectations on customers' need	Apply different measures to get feedback quickly, develop an appropriate engagement model with customers and enable other continuous practices (e.g. continuous improvement, continuous planning).	<ul style="list-style-type: none"> • Apply standard monitoring and tooling • Have a uniform way of working 	<ul style="list-style-type: none"> • Ability to measure customer satisfaction

CSF: Quality				
Nr.	Measure	Description	New examples	Results of the measure
5A	Employ appropriate strategies, approaches and guidelines on documentation	Employ appropriate strategies, approaches and guidelines on documentation of software products. Consider the level of detail, frequency and automation. Ensure traceability, verification and validation.	<ul style="list-style-type: none"> • Agree on documentation within team • Include documentation agreements in Definition of Done 	<ul style="list-style-type: none"> • Improves quality of releases • Works more efficient • Improved traceability • Improved transferability when team members leave/join
5B	Agree on trade-offs which affect quality	Consider trade-offs on integration frequency, security, certainty, size of increments, quality gates and involvement of stakeholders.	<ul style="list-style-type: none"> • Agree on dropping functionality or parts of a release to meet deadlines based on priorities of customer • Tailor trade-offs per release 	<ul style="list-style-type: none"> • Enables team to delivery within deadline • Introduction of technical debt and re-work • Incidents
5C	Adopt social rules	Act cooperatively to fulfill customer expectations, such as apply customer feedback, react on warnings, broken builds and bugs, ensure compatibility and roll back if necessary. Think about the complete system.	<ul style="list-style-type: none"> • Have an IT Framework in place for handling incidents • Have an officer of duty for picking up incidents • Have 24x7 support 	<ul style="list-style-type: none"> • Improved customer trust • More confidence with customer to release to production

5D	Implement measures in the CI/CD-process to preserve quality	Ensure rapid feedback and code reviews, manage artifacts and system configuration, integrate quality checks and fool proofing mechanisms.	<ul style="list-style-type: none"> • 4-eyes principles on releasing to production • Usage of CMDB identifiers • Usage of SonarQube for static code analysis • Automated tests 	<ul style="list-style-type: none"> • Insight in quality of releases • Reduces amount of incidents
5E	Apply continuous testing	Automatically test immediately after a code commit, test new features in real use, involve the customer in testing and assess changes in testing.	None	<ul style="list-style-type: none"> • Clarity on quality towards customer
5F	Apply proper strategies and consider preconditions	Apply continuous strategies on refactoring, improvement, monitoring, measurement, compliance, security, use, innovation etc. Consider preconditions, such as strategies to decrease technical debt, modularisation of development, reliable test environments. And take care with top-down imposition of a metric-based evaluation.	<ul style="list-style-type: none"> • Be transparent in what technical debt needs to be resolved • Promote reusable components • Have a fixed amount of time for resolving technical debt • Put technical debt in the backlog to make it visible 	<ul style="list-style-type: none"> • Being compliant with rules and regulations • Improved wellbeing of the team

CSF: Resistance to change				
Nr.	Measure	Description	New examples	Results of the measure
6A	Employ strategies and ways to share knowledge and skills	Support the change with strategies, such as more planning how to organize the work, low learning curve, training, colocation and adding experience/coach to the team. Apply ways to share knowledge and skills via communities, demonstrations, templates etc.	<ul style="list-style-type: none"> • Have community in practice(s) in place for knowledge sharing and organizing community meetings • Collective trainings on way of working • Onboarding sessions 	<ul style="list-style-type: none"> • The right knowledge and skills are prerequisites for delivery
6B	Align strategies and policies, and establish a proper culture	Align rules, regulations, policies and strategies and establish a culture of open communication.	None	None
6C	Ensure appropriate norms, values and behaviour	Ensure top management support and leadership on continuous improvement, budgetting and tooling. Give the development team ownership and trust. Create awareness, the right culture and mindset.	<ul style="list-style-type: none"> • Promote DevOps culture: "you build it, you own it, you run it" • Have top management decide the way of working 	<ul style="list-style-type: none"> • Compliant IT delivery process

CSF: Sales and intermediaries				
Nr.	Measure	Description	New examples	Results of the measure
-	-	-	None	None

Table 17: New examples and results compared to theoretical framework

5. Discussion, conclusions and recommendations

This chapter contains a discussion of the outcomes. In 5.1 the conclusions of the research are shared and the main research question is answered. In section 5.2 a discussion on the research is provided. 5.3 provides recommendations on using the outcomes of this research in practice. In section 5.4 recommendation for future research on this topic are given. Section 5.5 contains a reflection on the process and lessons learned.

5.1. Conclusions

In this section we will answer the main research question: What are measures of Critical Success Factors from a customer perspective of the CI/CD-processes?

The SLR resulted in a theoretical framework that contained 20 measures in total. During our research we were able to confirm 14 out of these 20 measures that contribute to CSF's from a customer perspective of the CI/CD-processes. The answer to the research question is not unambiguous and will be given per CSF.

CSF Acceptance by customer

The measures that we found in the CSF acceptance by customer were all confirmed and substantiated with examples by the respondents. Especially for the measure convince the customer respondents provided a lot of examples. Moreover, we have collected 10 new examples that could be added to the framework. We also have collected 6 results of these measures.

CSF Communication

The measures that we found in the CSF communication were all confirmed and substantiated with examples by the respondents. We have found 9 new examples and 6 results for the measures in this CSF.

CSF Complexity across customer organisation boundary

The CSF complexity across customer organisation boundary was not recognized as teams had full access to environments to monitor and perform deployments. This does not mean these measures are not valid but can simply not be confirmed by this research.

CSF Customer involvement

All measures in this CSF were confirmed and substantiated with examples. Only the measure employ strategies to obtain accurate expectations on customers' need was poorly substantiated. We have collected 9 new examples and 7 results of the measures in this CSF.

CSF Quality

For the measures in the CSF quality one measure was not strongly confirmed and substantiated with examples. This is about the measure apply continuous testing. The other measures within this CSF were confirmed and provided with examples. We have discovered 15 new examples and 14 results.

CSF Resistance to change

Only one of the measures within the CSF resistance to change was confidently confirmed and substantiated. The other measures were not strongly confirmed and backed by examples. Especially measures related to organisational changes, like strategies on organisational level, culture and norms were not strongly confirmed. We did however find 5 new examples and found 3 results of the measures within this CSF.

CSF Sales and intermediaries

We were not able to find any measures during the SLR, so we did not have any measures that could

be confirmed. After consulting with the gatekeeper at the case organisation this CSF was deemed not relevant as the DevOps teams only work for the internal customer.

5.2. Discussion

The results of this research are discussed in this section. It gives insight in how the results should be interpreted, what the implications are and the limitations of the research.

The research demonstrates that 14 of the 20 measures that we identified in our framework are applied by the case organisation. These results substantiate about 75% of the measures in our framework and allow us to answer the research question.

However not all measures are confirmed by the respondents of the case organisation. One reason is that certain measures are not applicable to the case organisation. This is the case for the CSF complexity across customer organisation boundary. Since the IT teams deliver software to an internal customer they didn't face issues in this regards. This does not mean the measures are wrong but could simply not be confirmed.

While previous research focussed on identifying the CSF's for successfully adopting continuous practices this research further established the CSF's and extended it by giving insight in measures that contribute to these CSF's. The results we found are in line with what we have found in other studies during the literature research. Our findings further enhance an operation framework for adopting continuous practices.

The results that we found does not match with one specific CSF, Sales and intermediaries. During the literature research we were not able to find any measure that contributed to this CSF. For the case organisation this CSF was not applicable as teams were directly working for internal customers without intermediaries. So we were not able to further substantiate this CSF. It could mean that this CSF is too specific and therefore can not be generalised.

To address respondent bias six respondents with different roles and from different teams and business units were interviewed. Two respondents were in the same team but had different roles. However, six respondents is still a small number as for many roles we only had one respondent and for most teams we only had one respondent. Due to the variety in how teams operate and their type of customers using more respondents with a wider variety of roles could potentially even further address respondent bias and increase the quality of the research.

Researchers bias was addressed by summarizing answers during the interview to validate answers were understood correctly. Also a full transcript of the interview was provided to the respondents after the interviews allowing them to correct researchers bias. It should be noted that although all of them approved the transcripts none of the respondents used this to correct the transcripts. This can either be explained by the fact that there was no researchers bias found in the transcripts or by the fact the respondents did not use this opportunity to correct the transcripts.

Although semi-structured interviews are not intended to be repeatable, we have increased the reliability of the research by describing all steps in our process in detail. Artifacts of these steps are included as attachments. Doing so allows the reader to interpret the results of this research.

The generalizability of the results is limited by the fact that this study has been conducted at one case organisation. To increase the generalizability we have selected participants from different departments and teams. Due to time constraints we have not validated the completeness of the

measures in the framework. Although most of the measures we found were confirmed it could be that we are missing some.

5.3. Recommendations for practice

This research can be used as a reference when organisations plan to implement continuous practices. Organisations could analyse the research results to get a better understanding of CSF's involved in continuous practices and measures they can take that contribute to these CSF's.

Although more research is needed the framework and the results can be used as topics to discuss and think about when introducing continuous practices within an organisation. It can be used as guidance and can be tailored to the organisation that adopts continuous practices.

5.4. Recommendations for further research

For this research respondents from multiple teams and in multiple roles have been interviewed. However not all roles that you would typically see in a DevOps team were accounted for in this research. Also senior management and supporting roles like architects or security officers have not been interviewed. To cover all aspects of the measures from multiple perspectives it is recommended to also cover this in follow up research.

This research has been conducted at a single case organisation. To increase the validity of the results a multi case study should be executed. This could also give insight in applicability of measures between different organisations. As we have seen during this research not all CSF's and measures that we found during our literature research were applicable. Therefore, we were unable to verify and substantiate the results. When performing the study on a variety of organisations the results could be more generalised.

Already during the literature research we saw indications of relationships between CSF's and measures. This was further reinforced during the analysis of the interviews. Although we didn't explicitly ask for relations between CSF's and measures, we still had respondents saying some measures contributed to multiple CSF's for instance. That makes it interesting to perform follow-up research on these relationships to gain a better understanding of how the CSF's and measures interact and influence each other. It could mean that one measure, that we now have listed under one specific CSF, could in reality contribute to multiple CSF's. Such a measure would have a bigger overall impact and therefore it is interesting to know.

The results of this research could be enhanced by also gathering insight in the value or weight of the measures. In the current results we have no insight in how much a measure contributes to a CSF relatively to the other measures. Without this knowledge it's difficult to predict the results of a measure. With this information added the framework would become more powerful as it would also guide in priority of measure and therefore provide more guidance in what measures to apply for better results.

Besides the value or weight of the measure it would also be interesting to know what the ease of implementation of a measure is. For instance, giving a demo every sprint is much easier to implement than establishing a new culture. The first could be implemented by just making an agreement and start doing it while the second could take months to achieve.

During the research the focus was to verify the measures in our framework and to substantiate them with examples from the case organisation. As this was an already pre-defined list of measures that we would verify we possible missed measures that we didn't find or are not described in the literature. Therefore follow-up research on missing measures could further enhance the framework.

To make the framework more suitable to use in practice it would be helpful to be able to classify the maturity level in continuous practices of an organisation. This could help organisations identify on what level they are and what is needed to grow in maturity. Follow-up research could aid in the setup of such a model when collecting data from multiple case organisation that vary in maturity level.

5.5. Reflection

This section reflects on how the research was conducted and what are lessons learned. This will provide insight that can be taken into account by other researchers and Master students.

For this research we have performed semi-structured interviews which were scripted. For the first interview, which was the pilot interview, I prepared by reading literature about interviews. After the first interview I learned I was not leading the interview strong enough causing me to lose time over discussing topics irrelevant for this study. I noticed I was growing and getting better at leading and steering the interviews with every interview I conducted. Doing more interviews will give you more time to practice your interview skills resulting in better interviews. Two key lessons learned are; dare to intervene when the interview tends to go off topic and provide sufficient guidance and context during the interview.

Another takeaway I would like to give is about the way to pose questions. During the interviews I would ask the respondents for confirmation and examples in the same question. During the coding of the transcripts it becomes difficult to differentiate if something was merely an example or confirmation or both. Asking this separately would make clear what the response to a single question was.

Something else I noticed during the interviews was that respondents would identify CI/CD with only the tooling they use for deployments. Even further explaining the respondents upfront could have helped clarify this prior to the interviews.

I have in total interviewed six participants in various teams with various functions. However, I have not interviewed higher management due to availability for an interview. The lack of interviewing higher management is reflected in the research results, I think. When looking at the measures related to organisation strategy, norms, values and culture we saw little confirmation and examples. This could be due to the fact that this is something established on a higher level that teams feel they have little influence on.

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Attachment A - CSFs 2018-August 2020_v03.xlsx

Attachment B - Potential CSFs CI+CD+CDE_Classified_v1.3.xlsx

Attachment C - Measure definition - Boris Buis - v1.0.docx

Attachment D - Measures Customer Perspective - Boris Buis - v1.0.docx

Attachment E - Identified measures customer perspective - metaplan session input.xlsx

Attachment F - Measures Metaplan Session Results.docx

Attachment G - Measures per CSF totaal Framework.docx

Attachment H - Conceptueel model v5.jpg

Attachment I - Conceptual model Customer perspective.xlsx

Attachment J - Interview Action Plan.docx

Attachment L - Theoretical Framework Interviews.docx

Attachment M - Participant Information Sheet.docx

Attachment N - Consent Form.docx

Attachment O - Transcriptie - Sub1.docx

Attachment P - Transcriptie - Sub2.docx

Attachment Q - Transcriptie - Sub3.docx

Attachment R - Transcriptie - Sub4.docx

Attachment S - Transcriptie - Sub5.docx

Attachment T - Transcriptie - Sub6.docx

Attachment U - Analysis code results.xlsx

Attachment V - Interview transcriptions - coding results raw.xlsx

Attachment W - Interview protocol.docx