

**Augmenting Standards in Engineering Education and Windows and Doors  
Manufacturing**

by

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## **ABSTRACT**

This thesis studies integrative augmentation with customer satisfaction (CS) standards in a service and a manufacturing organization.

Case study organization 1 (CSO 1) is an engineering course operated in a Western Canadian university. In this course, surveys were undertaken that addressed student satisfaction with elements of the course management system (MS) based upon standards of the international organization for standardization (ISO) CS series. The course e-class site established with ISO 10008 guidance, as well as sub-systems following ISO 10001/2/4 are the subject of interest in this research. The survey results form the basis for investigating student satisfaction through two different statistical methods. On one hand, descriptive statistics show comparisons from midterm to survey results, as well as developments over two different years of undertaking the surveys. The second method was structural equation modelling (SEM) that illustrates the effects of multiple characteristics of the MS elements on e-class site satisfaction.

The second analysis presents the results of an augmentative integration performed in a windows and doors manufacturer (CSO 2). The integrated management system (IMS) that is operated in CSO 2 enables the demonstration of how integration with ISO 10001/2/3/4 MSs into an existing organizational system can be approached. The research project is divided into four phases. A gap analysis for the QMS is performed on which suggestions for the transition from ISO 9001:2008 to ISO 9001:2015 are based upon (Phase 1). Furthermore, the IMS is studied with ISO 9001, ISO 14001 and Occupational Health and Safety Assessment Series (OHSAS) 18001/ISO 45001 MSSs and reveals in how far the three sub-systems for quality, environment and occupational health and safety are related (Phase 2). The QMS, as the core of the IMS, forms the basis for the integration with four augmentative MSs. The currently operated CS associated programs (CSAPs) are compared to ISO 10001/2/3/4 requirements. Results on the CSAPs study and methods for potential standardization of the programs are explained (Phase 3). Finally, a three-step approach for the integration of an ISO 10001/2/3/4 MS into the existing IMS is detailed, which includes results and suggestions for the integration (Phase 4).

## **PREFACE**

This thesis is an original work by Katharina Astleitner. The research project conducted with a case study organization, received research ethics approval from the University of Alberta Research Ethics Board, Project Name “Integration of Standardized Customer Satisfaction Systems in Windows Manufacturing”, ID No. “Pro00068356”, April 11, 2017.

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## **GLOSSARY OF ABBREVIATIONS AND TERMINOLOGY**

<b>AIMS</b>	Auditing and Integration of Management Systems
<b>BBB</b>	Better Business Bureau
<b>CH</b>	Complaints Handling
<b>CS</b>	Customer Satisfaction
<b>CSAPs</b>	Customer Satisfaction Association Programs
<b>CSCS</b>	Customer Satisfaction and Complaints Handling System
<b>CSO</b>	Case Study Organization
<b>EDR</b>	External Dispute Resolution
<b>EI</b>	Emerald Insight
<b>EMS</b>	Environmental Management System
<b>GS</b>	Google Scholar
<b>HLS</b>	High Level Structure
<b>IACSS</b>	Integrated Augmentative Customer Satisfaction System
<b>IHS</b>	Information Handling Services
<b>IMS</b>	Integrated Management System
<b>IMS</b>	Integrated Management System
<b>ISO</b>	International Organization for Standardization
<b>MS</b>	Management System
<b>MSS</b>	Management System Standard
<b>OHS</b>	Occupational Health and Safety
<b>OHSAS</b>	Occupational Health and Safety Assessment Series
<b>PBC</b>	ProQuest Business College
<b>QMS</b>	Quality Management System
<b>SD</b>	Science Direct
<b>SEM</b>	Structural Equation Modelling
<b>TF</b>	Taylor and Francis

# 1. Introduction

## 1.1. General

Customer satisfaction (CS) is of paramount importance for providers of services and products. Management system standards (MSSs) of the ISO 10000 series provide guidance in setting customer related sub-systems. The MSSs can be used by any type of organization (Karapetrovic, et al., 2012; Nowicki, et al., 2014; Ramphal, 2015). The consolidation of an organization's management system (MS) with these sub-systems is referred to as an integrative augmentation. This thesis addresses integrative augmentation with CS standards in a service case study organization (CSO 1) and a manufacturing case study organization (CSO 2).

CSO 1 offered the possibility to analyze the satisfaction with augmentative MSs. This analysis is based on surveys that were previously performed by the "Auditing and Integration of Management Systems (AIMS)" laboratory with undergraduate university students in two sections of an engineering course. The course MS included sub-systems based upon ISO 10001/2/4 and an e-class site established with ISO 10008 guidance. Information on satisfaction with the MSs is studied through survey results. Two statistical methods are used to perform the analysis: descriptive statistics and structural equation modelling (SEM).

In CSO 2, the integrative augmentation of MSs based upon ISO 10000 standards into an existing IMS is detailed. The CSO is a windows and doors manufacturer in Western Canada that already had an integrated management system (IMS) in place including MSs for quality, environment and occupational health and safety. The transition to the new version of the quality MSS (ISO 9001:2015) was in progress in CSO 2. Therefore, it was possible to show how an IMS that is largely based upon its QMS can be used to drive the integration of MSs based upon ISO 10001/2/3/4.

## 1.2. Organization of the thesis

Chapter 2 shows the literature review divided into six sub-chapters. Sub-chapter 2.1 details the methodology used to search for, and review, the literature. In Sub-chapter 2.2, the literature on augmentative standards and student satisfaction is presented. SEM studies, as well as the usage of ISO 10000 standards are included, as they were the major area related to the research within

CSO 1. Within Sub-chapter 2.3, literature on major changes from ISO 9001:2008 and ISO 9001:2015 are shown. This is related to the analysis of the quality management system (QMS) update in CSO 2. Moreover, basics of MSs and a discussion on MSSs are given. The ISO 10000 series on CS is presented in Sub-chapter 2.4, including studies on the awareness and satisfaction with the standards and details on ISO 10001/2/3/4. ISO 10000 standards and integrative augmentation were discussed as they were the common topic addressed in both case studies. Sub-chapter 2.5 includes the review of literature on customer satisfaction associated programs (CSAPs) operated in manufacturing. The areas presented are product guarantees, complaint handling (CH), external dispute resolution (EDR) and CS measurements. The motivation for the research and its objectives in Sub-chapters 2.6 and 2.7, respectively, conclude the literature review.

Chapter 3 outlines the methodologies used for the research and background on both CSOs. The statistical methods used to analyze student surveys conducted in CSO 1 are explained. Furthermore, methods used to conduct augmentative integration with an existing IMS in CSO 2 are presented.

Chapter 4 presents the findings from the statistical analysis in CSO 1. Student satisfaction with elements of an MS based upon ISO 10001/2/3/4 is revealed based on midterm and final survey results. The surveys address the major elements of the MS, such as student satisfaction codes, the feedback process and surveys, as well as the e-class site. SEM and correlations demonstrate how the characteristics of elements in the MS are related. Furthermore, trends are studied through surveys of two consecutive years and comparisons are made between midterm and final survey results.

Chapter 5 presents two of the four phases of the research project conducted in CSO 2. In the first phase, a gap analysis regarding the transition of the QMS from ISO 9001:2008 to ISO 9001:2015 is shown. This analysis provides the basis for gap closure suggestions. The second phase shows an IMS analysis, which was based upon ISO 9001, ISO 14001 and Occupational Health and Safety Assessment Series (OHSAS) 18001/ISO 45001. Furthermore, the integration status of the IMS and suggestions for integration of MS processes, documents and objectives are included.

In Chapter 6, the third and fourth phase of the research project in CSO 2 include the analysis of CSAPs with ISO 10001/2/3/4 and the integration of an augmentative CS MS into the existing IMS, respectively. The analysis of CSAPs included a presentation of the current processes and sample suggestions for standardization of CSAPs with augmenting standards. A three-step tabular approach on how integrative augmentation can be performed with an IMS is detailed in the fourth phase. It includes the presentation of suggestions for setting up an integrated augmentative CS system (IACSS) using the example of CSO 2.

Chapter 7 details the main contributions, limitations, challenges and the scope for further research.

## 2. Literature Review

In this chapter, the current literature for topics related to the thesis is presented. The methodology for the literature review is detailed first in Sub-chapter 2.1. In the following Sub-chapter 2.2, findings from a review of university students' satisfaction with e-learning platforms are presented. Sub-chapter 2.3 analyzes the new ISO QMS standard ISO 9001:2015, focusing on the changes to its predecessor. Sub-chapter 2.4 addresses augmenting standards of the ISO 10000 series, focusing on the ISO 10001/2/3/4 CS standards. The literature review regarding CSAPs in manufacturing is illustrated in Sub-chapter 2.5. The motivation for the research (Sub-chapter 2.6) and the research objectives (Sub-chapter 2.7) conclude this chapter.

### 2.1. Methodology

This sub-chapter presents how the literature review was carried out within a time span of nine months. Six different databases were searched and in total 134 articles were included in the thesis. The Google Scholar (GS) database was a special case, as the search could not be restricted to peer-reviewed articles only. Additionally, many articles found could not be opened because of the missing accessing rights. This is why the number of articles illustrated in the search tables is high compared to the articles that were actually used. All MSSs cited in the literature review were obtained from the Information Handling Services (IHS) Standards Expert database. The full search tables showing the detailed breakdown of the search trails for each topic are included in the Appendix A1-A9.

#### 2.1.1. Augmenting standards and student satisfaction in e-learning

Three topics were covered in the literature review regarding ISO 10001/2/4/8 augmentative systems in education: student satisfaction with e-learning platforms, SEM and augmentative standards. The most important topic was student satisfaction with e-learning platform as it was related to all MS elements studied in the surveys. SEM was investigated as one of the statistical methods used in the analysis. Augmentative standards were the underlying focus of the thesis. In total, thirteen articles from four different databases were used for the review and are shown in Table 1. However, the literature on augmentative standards in education was very limited. Only two master theses from the "Auditing and Integration of Management Systems (AIMS)" laboratory were, as well as three articles from GS that addressed other MSSs.

Table 1: Literature review table SEM (excerpt A.1.)

Database	Searching Criteria	Articles used
Scopus	Structural equation modelling "e-learning" university	1
Emerald Insight (EI)	Structural equation modelling "e-learning" + university + "student satisfaction"	1
Science Direct (SD)	"Structural equation modelling " "e-learning" university "satisfaction" <u>From:</u> 2006-2017	5
GS	"Structural equation modelling " "e-learning" university "Student satisfaction" <u>From:</u> 2006-2017 <u>Languages:</u> English/German	6
	"E-learning" satisfaction "ISO 10001"	1
	"E-learning" satisfaction "ISO 10002"	2

### 2.1.2. ISO 9001:2015, MSs and MSSs

Articles on ISO 9001:2015 and its changes compared to ISO 9001:2008 were limited in the search to the last five years. This decision was made as the committee draft of ISO 9001:2015 was published in June 2013 and only then was the development process open to the participating countries (Palmes, 2014). The articles used from GS were cross-checked with other databases: Emerald Insight, Taylor & Francis (TF) and ProQuest Business Collection (PBC). Many of the same articles appeared in the same databases and therefore were considered redundant for the review. For specific topics on the ISO 9001 update, keywords like "knowledge management" and "risk management" helped to narrow down the results. In total, 14 articles were used from GS, five from EI, one from PBC and five from the ISO website. There was a vast number of articles on MSS and MS, which is why only articles from the last 15 years were considered. Ten articles were used from GS, three from TF, six from EI and six from SD. Three articles were discovered through a reference within another journal article. The book "The integrated use of management system standards" further referred to as IUMSS handbook was an additional source. In total, 28 articles were included to form the literature on MSS and MS. A detailed table of the searching trail is included in Appendix A.2.



### 2.1.3. ISO 10000 series

The total number of articles used to form the ISO 10000 literature was 29. From these articles, twelve were also used for the individual sections of ISO 10001/2/3/4.

Five references were ISO standards, namely ISO 10001:2007, ISO 10002:2014, ISO 10003:2007, ISO 10004:2012 and ISO 9001:2015. The keyword "ISO 10000" was used to screen articles in GS. The initial output was 147 articles.

Twelve articles were used from GS, eight from Emerald Insight and one from ProQuest Business Collection (PBC). One article was discovered through a reference within another thesis. One web link and one reference were found in other journal articles' citations. A full table of the searching trail is illustrated in Appendix A.3.

The literature on the individual standards, ISO 10001/2/3/4, was limited, which made the establishment of searching criteria easier. For specific articles on ISO 10001/2/3/4, the keywords "ISO 1000X" were sufficient. The number of used articles for each MSS and the corresponding database are shown in Table 2.

**Table 2: Literature review table for ISO 10001/2/3/4 (excerpts from A.4 – A.7)**

Search topic	Database	Searching Criteria	Articles used
ISO 10001	GS	"ISO 10000" <u>Languages</u> : English/German	7
	EI	"ISO 10001"	1
ISO 10002	GS	"ISO 10002" + Complaint <u>Languages</u> : English/German	1
		"ISO 10001" <u>Languages</u> : English/German	2
	EI	"ISO 10002"	1
		transition "ISO 9001" 2015 <u>From</u> : 2012-2017	1
		manufacturing + customer satisfaction + ISO 9001	1
	PBC	"ISO 10002"	1

Table 2 (continued): Literature review table for ISO 10001/2/3/4 (excerpts from A.4 – A.7)

ISO 10003	GS	"ISO 10001"	2
		"ISO 10003"	1
ISO 10004	EI	"ISO 10004"	3
	SD	"ISO 10004"	2
	GS	"ISO 10004"	2

In total, eight articles have been incorporated for the ISO 10001 literature. Furthermore, two Master theses from the AIMS laboratory were included. ISO 10002 literature was presented through eight articles in total. In comparison to the other ISO 10000 standards, most case studies were found for ISO 10002. Literature on ISO 10003 was limited and not described in depth. Only articles that also addressed other ISO 10000 standards were found. From three databases searched, only three articles were additionally included for the ISO 10003 literature review.

#### 2.1.4. Manufacturing and CSAPs

The four CSAPs studied were guarantees, CH, EDR and CS measurements. Table 3 presents the articles that were incorporated in the literature review for each.

Table 3: Literature review table manufacturing and CSAPs (excerpt A.8 – A.10)

Search topic	Database	Keywords	Articles used
Guarantees in manufacturing	EI	Product Promise	1
		manufacturing "product guarantees"	3
	GS	manufacturing "product guarantees" "customer satisfaction"	2
	TF	manufacturing "product guarantees"	1
CH in manufacturing	GS	manufacturing "complaint handling" + "customer satisfaction" <u>From</u> 2000-2017 <u>Languages:</u> English/German	2
	EI	manufacturing "complaints handling"	6
		manufacturing "complaint handling" <u>From:</u> 2000-2017	1
	SD	manufacturing "complaint handling" <u>From:</u> 2000-2017	1

Table 3 (continued): Literature review table manufacturing and CSAPs (excerpt A.8 – A.10)

EDR in manufacturing	GS	manufacturing "dispute resolution" "complaints handling" "customer satisfaction"	6
CS measurement in manufacturing	ES	manufacturing "customer satisfaction" measurements <u>From:</u> 2000-2017	2
	GS	manufacturing "customer satisfaction" measurements <u>From:</u> 2000-2017	1

Searching articles on manufacturing and product guarantees was difficult, because authors refer to product guarantees in different ways, such as. “customer promise”, “service guarantee” or “manufacturer guarantee”. As CS in manufacturing was a focus of interest in the research, the term "customer satisfaction" was included. Furthermore, only articles that addressed voluntary guarantees were included in the literature.

In total, 15 articles formed the literature on CH in manufacturing. Five were used from the results of the ISO 10000 triad analysis. The search revealed a vast number of articles for manufacturing and complaints handling within GS. Therefore, the addition of “customer satisfaction” as a keyword helped to limit the output to a relevant number.

Only four results with the keywords “windows and doors” in connection with EDR were found. Therefore, the keyword was changed to manufacturing. This resulted in a higher number of outputs. However, many articles focused on dispute resolution for e-commerce only. Furthermore, information from the Better Business Bureau website on EDR numbers were used.

## 2.2. Augmenting standards and student satisfaction in e-learning

This sub-chapter discusses literature on e-learning, case studies that investigated factors related to student satisfaction in university courses, and course characteristics that may lead to the improvement of satisfaction.

CS leads to an organization's success. This is not different for a university environment, where according to Headar, et al. (2013) students are the customers and the university and their staff the provider of services or courses respectively (Headar, et al., 2013).

Courses nowadays often rely on the support of different e-learning platforms. "[...] *E-learning extends beyond the classroom and consists of material and communication*" delivered to the

student through the internet (Mitchell & Honore, 2007). A blended-learning environment is one with both aspects of the traditional classroom as well as content delivered online (Garrison & Kanuka, 2004; Mitchell & Honore, 2007). Wu et al. (2010) see online learning platforms as the *"[...] most prominent instructional delivery alternative when employed in e-learning systems"*.

Williams et al. (2007) explain that it is vital to understand *"[...] the perspective of the learner"* when developing such e-*"[...] learning environments"*, especially because the learner could *"[...] over-rely on the traditional face-to-face component of the course"* (Williams, et al., 2007).

### 2.2.1. SEM studies on student satisfaction

Within the recent literature, ten SEM studies on the effects of e-learning platforms on university students' satisfaction were found. A summary of major findings from these studies is given in Table 4. An overview of all factors analyzed in each study is included in Appendix B.1a.

**Table 4: Findings from SEM Studies on student satisfaction with e-learning platforms**

Author(s)	Findings
Moreno et al. (2017)	Social groups showed to have a weak impact on perceived usefulness of e-learning platforms. More experienced users were seen to rely less <i>"strongly on peers' advice and opinions"</i> .
Headar et al. (2013)	<i>"[...] Familiarity affects behavioural intentions directly and indirectly through satisfaction"</i> . Satisfaction showed to be a significant link to the behavioural intentions or user retention. Students' satisfaction with the e-service might have to be present before the <i>"[...] behavioural intentions can be formed"</i> . <i>"[...] service quality, interactivity, and student comfort"</i> are factors that influence the intention to use e-learning.
Wu et al. (2010)	Students with more experience <i>become " [...] more confident and capable"</i> when using e-learning and also contribute to a positive learning culture. Furthermore, these students were more satisfied.  Perceived e-learning satisfaction was <i>" [...] directly and indirectly"</i> facilitated <i>" [...] by the performance expectations and learning climate"</i> .  E-learning satisfaction in a blended learning environment is <i>" [...] affected by the interaction among cognitive, technological environment, and social environment factors"</i> (Wu, et al., 2010).
Al Azawei et al. (2016)	The study revealed no relationship between satisfaction and student's gender or their actual academic achievement. <i>The " [...] processing dimension"</i> was the only relationship that <i>" [...] showed a strong correlation with perceived satisfaction"</i> . Active learners were more satisfied in the blended courses than the reflective learners were.

**Table 4 (continued): Findings from SEM Studies on student satisfaction with e-learning platforms**

Eom & Ashill (2016)	Studies revealed that course design and intrinsic motivation influences the
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and Aktir, et al., (2017)	learning outcomes positively.
Mohammadi (2015)	Most significant factor for "[...] <i>user satisfaction and intention to use e-learning</i> " was the system quality. the quality of provided information, as Study also found that educational and service quality positively affected student satisfaction. However, education quality did not seem to be related to the intention of use.

As can be seen in Table 4, some overlapping findings were observed. Headar et al. (2013), Mohammadi (2015) and Eom & Ashill (2016) revealed similar findings for the influence of students' intention to use e-learning on e-learning platform satisfaction. As the platform usage increases, the experience of users and its influence on the usefulness and perceived ease of use changes (Williams, et al., 2007; Martins & Kellermanns, 2004; Moreno, et al., 2017). The interested reader may refer to Appendix B.1c related to the perceived usefulness of e-learning platforms and B.22 for more details on student satisfaction with e-learning platforms.

Multiple studies found that easily accessible, aesthetically appealing and reliable systems increase student satisfaction (Headar, et al., 2013; Mohammadi, 2015; Wu, et al., 2010).. Furthermore, monitoring students' expectations and taking into account the students' perspective was seen by Headar, et al. (2013) and Mohammadi (2015) as important for educational institutions in order to satisfactorily establish e-learning platforms. This included social and human factors (Headar, et al., 2013; Mohammadi, 2015). More details on studies are provided in Appendix B.1b.

### 2.2.1. ISO 10000 in engineering education

Several studies were performed that show the application of ISO 10001/2/4/8 in engineering education (Vargas-Villarroel, 2015; Karapetrovic, 2010; Karapetrovic & Doucette, 2009; Honarkhah, 2010). These studies revealed that students regarded the implementation of "[...] *codes to be useful*" (Karapetrovic, 2010; Karapetrovic & Doucette, 2009; Honarkhah, 2010). Students "[...] *would recommend the use of*" the implemented codes in other courses, based on the surveys performed (Karapetrovic & Doucette, 2009). Vargas-Villarroel (2015) presented a generic model for the application of the ISO 10008 in a university course. The model included subsystems for codes of conduct (ISO 10001), feedback handling (10002), and CS measurement (ISO 10004) (Vargas-Villarroel, 2015).

## 2.3. ISO 9001:2015, MSs and MSSs

This sub-chapter addresses the new ISO 9001:2015 and the major changes from the former version of the standard, ISO 9001:2008. Subsequent to that, an explanation of the basics of MSs, as well as a detailed discussion of management system standards (MSSs) and their usage are given.

### 2.3.1. ISO 9001:2015

This section explains the reasons for developing the new version of ISO 9001, followed by the structural changes in the standard and a detailed analysis of new and changed requirements.

ISO standards undergo a review process in a five year cycle “[...] *to establish if a revision is required to keep it current and relevant for the marketplace*” (ISO, 2017a), besides from the initial review that takes place after three years (West, 2008). An ISO survey among present and potential ISO 9001 users in 2011 showed what topics should be addressed within the next revision according to the surveyed organizations (Fonseca, 2014; Wilson & Campbell, 2016). These included resource management, “*voice of customers*” and risk management (Wilson & Campbell, 2016). More information on the results of the 2011 ISO survey, sector specific versions of ISO 9001, group representatives and different types of organizations using the standards are given in Appendix B.2a.

Authors had different views on the prescriptiveness of the standard (Hampton, 2014; Murray, 2016), as can be seen in Appendix B.2c. Multiple authors agreed that the standard needs easily understandable and more business-oriented language (ISO, 2015a; Militaru & Zanfir, 2016; Zgodavova, et al., 2016; Merrill, 2014). Freeman & Drown (2015) explain that transition challenges vary depending “[...] *on how much the organization's management system mirrors ISO 9001:2008* ”.

The literature review indicated that more emphasis in ISO 9001:2015 was put on the process approach than when it was initially introduced in 2000 to ISO 9001 (Hampton, 2014; McKewen, 2015; Murray, 2016; ISO, 2015a). McKewen (2015) explains that the process approach was seen as “[...] *highly successful in guiding quality management implementation* ” (McKewen, 2015). The standard’s main objectives remain, namely to “[...] *continually [improve] quality and*

*ensure that products and services consistently meet customers' requirements*" (Murray, 2016; ISO, 2015a). A clarification of differences between the process approach and the PDCA approach and the revised quality principles is given in Appendix B.2b.

The main areas of changes in ISO 9001:2015 that authors addressed are summarized in Table 5.

**Table 5: Main findings from the literature on the ISO 9001:2015 update**

Clause	Main Changes in ISO 9001:2015
4	<p>Introduction of “[...] <i>opportunity thinking</i> and “ incorporation of “[...] <i>internal and external issues</i> “ on the strategic level (Merrill, 2015).</p> <p>Interested parties replaced the term customer, but the most important interested party to serve and satisfy is the customer (Reid, 2015; Merrill, 2015).</p> <p><i>“interested party needs and expectations</i> “, have to be considered as an input for scoping the QMS, which could lead to a scope expansion (Reid, 2015).</p> <p>Appendix B.2d presents additional findings on interested parties, setting objectives, as well as opinions on innovation and strategic planning.</p>

Table 5 (continued): Main findings from the literature on the ISO 9001:2015 update

5	<p>A significant shift in terms of leadership and commitment within Clause 5 (ISO, 2015b; Palmes, 2016; Zgodavova, et al., 2016).</p> <p>The need for a "[...] <i>single management representative</i> " was removed (ISO, 2015; Hampton, 2014).</p> <p>The new requirement requires top management is required "[...] <i>to assign responsibilities and authority to relevant persons to ensure</i> " the requirements of the QMS are "[...] <i>communicated and understood</i> ".</p> <p>Fonesca's (2014) and Palmes' (2016) agree that the clause remains the same, if management chooses to assign "[...] <i>each of these QMS responsibilities</i> " (Palmes, 2016) to a single person as required in ISO 9001:2008.</p> <p>It might be beneficial to ensure "[...] <i>a host of activities in the QMS are carried out and regularly reported among top management</i> " (Palmes, 2016). More details regarding the changes in Clause 5 are shown in Appendix B.2e.</p>
6	<p>"[...] <i>6.1 actions to address risks and opportunities</i> "[...] brought major changes to strategic planning requirements. (Reid, 2014; Palmes, 2014; Merrill, 2015; ISO, 2015).</p> <p>Inclusion of risks and opportunities is an addition that could make the MSS more realistic as companies have to deal with these two topics in one way or another. It will help to understand and manage the system better, as well as to bring higher levels of awareness.</p>
7	<p>All supporting processes in one place. Little discussion was present considering requirements related to the MSS sections for people, competence, training and awareness, but the requirements are more detailed.</p> <p>Changed documentation requirement have been extensively discussed (Freeman &amp; Drown, 2015; Barouch &amp; Kleinhans, 2015; Zgodavova, et al., 2016; Murray, 2016; Yasenachak, 2016; Fonseca, 2014; Merrill, 2014; Ramphal, 2015; Fisher, 2016). The requirements showed a less prescriptive manner and more decision for the individual organization on how to address documentation. A table presented in Appendix B.2h gives an overview about the main topics that were discussed.</p> <p>Knowledge management is a new addition and important for an organization (Reid, 2015; Palmes, 2014; Fonesca, 2014). Created knowledge vital to the business operations need to be captured (Reid, 2015) and accessed by the right people (Palmes, 2014) also because of the fast paced business environment nowadays. Knowledge is "[...] <i>fuel of the innovation process</i> ", and the requirement to access "[...] <i>necessary additional knowledge</i> ", is a key for addressing "[...] <i>the creative steps</i> " (Merrill, 2014).</p>

Table 5 (continued): Main findings from the literature on the ISO 9001:2015 update

8	<p>Clause 8 addresses the operations and has changed in its structure. It is logically sequenced, as well as focused on customer requirements.</p>
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	<p>Articles discussed the importance of addressing risk internally within the design and development as well as the production and the control of external providers (West &amp; Cianfrani, 2015; Reid, 2015; Hampton, 2014). . Reid (2015) states that the “[...] <i>level of control expected for the design and development process</i>“ will be affected by the ” <i>relevant interested parties</i>“. Ramu (2016) points out the new emphasis on external controls within the clause.</p> <p>More information on mistake-proofing in the production, external controls’ requirements, and outsourcing can be found in Appendix B.2f.</p>
9	<p>CS measurement need to investigate the perceptions of the customer, including feedback, views and perceptions on the organization's outputs.</p> <p>An expansion of nonconformity requirements, organization are required to react to detected nonconformities (Hampton, 2014).</p> <p>Little discussion about the changing audit requirements. However authors described that there will be alterations for auditors, respectively the audit criteria, the information or documents an audit will be based on (Fisher, 2016; Murray, 2016).</p> <p>Self-assessments have been discussed within the literature (Klute-Wenig &amp; Refflinghaus (2015); West &amp; Cianfrani, 2016a), including the discussion of benefits compared to internal audits (West &amp; Cianfrani, 2016a) shown in Appendix B.2g.</p> <p>“[...] <i>feedback from relevant interested parties</i>“ needs to be considered “[...] <i>in the management review process</i> “ (Reid, 2015). Details on internal audits, changing measuring requirements and relationships to planning processes are represented in the Appendix B.2i.</p>
10	<p>Fonseca (2014) claims the clause overarching term was changed to improvement “[...] <i>as there are several types of improvement e.g., breakthrough and continuous improvement</i>“. On the other hand, Hampton (2014) states the change is because “[...] <i>improvement is never finished</i> “, so the adding of continual is redundant. She also sees nonconformity requirements extended to not only the production processes but the entire systems’ processes and it is necessary to “[...] <i>address and react to this type of nonconformity</i> “.</p>

### 2.3.2. MSs and MSSs

This section presents the basics of MSs, followed by a discussion of ISO MSSs and their implementation.

Authors agree that modern organizations face different expectations from numerous stakeholders (Asif, et al., 2011; Karapetrovic & Jonker, 2003; Asif & Searcy, 2014; Asif, et al., 2010a; Asif, et al., 2010b; Wilkinson & Dale, 1999). Karapetrovic & Jonker (2003), Karapetrovic (2003) and Wilkinson & Dale (1999) explain that the number of people who are interested in the company's

operations stem from the many aspects organization include in their "*bottom-line performance*" such as natural environment or "*corporate social responsibility*" (Karapetrovic & Jonker, 2003).

It is not surprising that Rebelo et al. (2016) and Karapetrovic (2003) grant the IMS foremost importance in meeting and excelling the needs of various interested parties. For example, in manufacturing the major stakeholder "[...] *may still be*" the customer, but also the local community, investors or employees need to be satisfied (Karapetrovic & Jonker, 2003).

An organization naturally has different MSs in place. To address all the different interested parties' requirements, the necessity for "[...] *a systematic approach*" towards MSs became apparent (Asif & Searcy, 2014; Asif, et al., 2011). Karapetrovic & Willborn (1998a & 1998b) describe a MS "[...] *as sets of processes that function harmoniously, using various resources to achieve management objectives*". The MS regulates "[...] *the behavior of a system and provide a systematic way*" to consistently operate an organizational function (Asif & Searcy, 2014).

When establishing MSs, organizations use documents called MSSs that specify the necessary system elements and provide organizations guidance in order to set up and operate a MS (Karapetrovic, 2003; Asif, et al., 2010a; Bernardo & Simon, 2014)

The most well known body to publish MSSs is the "*International Organization for Standardization (ISO)*" (Karapetrovic & Jonker, 2003; Bernardo & Simon, 2014; Anon., 2008), with the highest certification numbers for QMSs (ISO 9001) and EMSs (ISO 14001) worldwide (Karapetrovic & Jonker, 2003; Karapetrovic & Jonker, 2004; Asif, et al., 2010a; Bernardo & Simon, 2014). In addition, the usage of MSSs that were published more recently is rising according to Bernardo et al. (2012).

The integration of MSs is addressed in the following sub-section.

#### 2.3.2.1. *Integration of MSs*

Companies nowadays can choose from "[...] *numerous management systems and certifiable standards*", which are most suitable for their needs (Bernardo & Simon, 2014). However, they also face difficulties when using multiple MSSs and operating multiple MSs (Karapetrovic & Jonker, 2004; Garengo & Biazzo, 2013; Wilkinson & Dale, 1999).

Asif et al, (2010a) explain that due to the increasing number of MSSs and their usage within organizations, “[...] their integration with existing MSs becomes a necessity”. Integration is the amalgamation of MSs for “[...] combining or merging the elements of individual management systems” (Asif, et al., 2010a).

When establishing an IMS, the organization has to try to identify the commonalities of different MSs’ processes, resources and objectives, in order to align them. The goal is to reach a more efficient and effective performance compared to having multiple separate systems (ISO, 2008).

Karapetrovic (2002) emphasizes the advantages of the systems approach, as its flexibility “[...] allows for the amalgamation of elements at different organizational levels”. The integration degree “[...] represents the extent to which integration of MSs takes place” (Asif, et al., 2010b). It is measured by the “[...] degree of integration of the system goals, resources and processes” (Kafel & Casadesus, 2016). Generally, the literature sees three different integration degrees described in the following table:

**Table 6: Degrees of MSs integration**

Degree of integration	Definition	Author(s)
Full	<i>"[...] Total harmony and alignment of policy and purpose throughout the organization"</i>	Garvin (1991) from Wilkinson & Dale (1999)
Partial	<i>"[...] Integration of some common procedures"</i>	Jørgensen, et al. (2006)
None	<i>"[...] the individual standardized management systems coexist completely differently from each other"</i>	Kafel & Casadesus (2016)

Karapetrovic (2002) explains that the level of integration also depends on the hierarchy level in the organization. The next sub-section shows methods for integrating the existing MSs.

#### 2.3.2.2. MSs integration methods

Organization decide to include new standardized MSs in order to enhance their existing MS. In which order implementation of MS takes place depends on the needs of a company as well as the current MS in place (Karapetrovic, 2002). An overview of the different types of MSSs can be found in Appendix B.3a.

Examples of the methodologies for the integration of multiple MSs have been presented in Karapetrovic & Willborn (1998b), Wilkinson & Dale (2001) and Karapetrovic (2003). Karapetrovic & Willborn (1998b) suggest the usage of a systems approach, which is based on restructuring the guidelines from ISO 9001 and 14001 and connecting them to build an IMS. Wilkinson & Dale (2001) recommend the implementation of an IMS in which all individual MSs lose their independence (QMS, EMS and OHSAS). Karapetrovic (2003) proposes a "[...] *generic process for the integration of internal management systems*" showing a ten step framework for implementation and improvement of an IMS. Appendix B.9 presents the three authors' models in more detail. In addition, ISO published a "*Handbook for the Integrated Use of Management System Standards*" (ISO, 2008), which provides "[...] *methodologies and examples of integration*" (Karapetrovic, 2005).

Various case studies that studied the effects of the implementation of IMSs are presented in the following sub-section.

#### 2.3.2.3. *Case studies on MSs integration*

A benefit that both Karapetrovic et al. (2010) and López-Fresno (2010) found was the positive image that organizations show to their stakeholders. López-Fresno (2010) additionally adds "[...] *improved decision making, better utilization of resources, enhanced communication, [...] cultural change*". Authors also agree on decreased costs for management (Zeng, et al., 2011; Casadesús, et al., 2011) and audits (Rebelo, et al., 2014). A further major advantage was related to the manageability of the IMS. This resulted from:

- "[...] *Elimination of conflicts between individual systems with optimization of resources*" (Rebelo, et al., 2014),
- "[...] *Improvement at the level of the coordinated and Integrated Management*" of the various MSs (Rebelo, et al., 2014),
- "*Simplification of the certification process itself, decrease in paperwork*" (Zeng, et al., 2011)
- *Synergy effects and improvement of the processes and procedures* (Casadesús, et al., 2011).

Casadesús, et al. (2011) and López-Fresno (2010) explain that social factors also improved, as for example employee motivation, better customer relationships and satisfaction.

A major factor for leaving the standards separate were problems encountered during "[...] *the integration of internal MSs*" (Karapetrovic et al., 2010). Pheng & Kwang (2005) found that companies encountered problems with employees' resistance to change and the lack of knowledge about other MSSs.

Most authors agree that management commitment is one of the enablers for a successful integration, as well as internal communication throughout the process (Pheng & Kwang, 2005; Garengo & Biazzo, 2013; Manzanera et al., 2014).

A table with additional information on the case studies like the locations and number of surveyed organization as well as difficulties, benefits and enablers are included in the Appendix B.3d.

However, looking at the benefits that the studies revealed, "[...] *application of multiple MSSs*" is preferred (Casadesús, et al., 2011)

#### 2.3.2.4. *High Level Structure of ISO MSSs*

To improve compatibility among ISO MSSs, ISO introduced the High Level Structure (HLS) in 2012 (ISO, 2017c). The goal was to provide consistency that should lead to easier integration for users (ISO, 2017c). One major change to ISO 9001:2015 is the new common structure of MSSs called "*High-Level Structure*" (HLS) (Militaru & Zafir, 2016; Fonseca, 2014; Murray, 2016). This HLS is presented in the "*Annex SL of ISO/IEC Directives Part 1*", which are the "*rules for developing ISO standards*" (ISO, 2015a). The common structure consist out of ten clauses (Militaru & Zafir, 2016) and "[...] *a set of common requirements*" (Murray, 2016). This structure should make the integration of several standards in a common IMS easier (Militaru & Zafir, 2016; Fonseca, 2014; Murray, 2016). The ISO website (www.iso.org) shows all MSSs that are based on the HLS. Further discussion on the HLS is provided in Appendix B.3e.

## 2.4. ISO 10000 CS standards

This sub-chapter presents the development and purpose of the ISO 10001/2/3/4 MSSs, as well as augmentative integration of MS with ISO 10000 standards. Studies that investigated awareness and satisfaction with these augmenting standards in organizations are debated. Furthermore, reasons for non-implementation are discussed. The sub-chapter is concluded by a discussion on the content and usage of each standard.

#### 2.4.1. Development of the ISO 10001/2/3/4 standards

The standards of the ISO 10000 series belong to the group of augmenting standards. These standards “[...] are used to enhance the existing quality management system of an organisation” (Asif, et al., 2010b)

As part of ISO, the “Technical Committee (TC) for Quality Assurance and Management, specifically Subcommittee (SC) on Supporting Technologies” is in charge of publishing and updating the ISO 10000 standards (West, 2008; Karapetrovic, 2005). The first three standards for establishing a “*Customer Satisfaction Complaint System (CSCS)*” follow “[...] the life of a product related complaint” as follows: (Karapetrovic, 2005; West, 2008):

1. ISO 10001:2007 - Customer related codes of conduct
2. ISO 10002:2014 - Internal customer complaints handling
3. ISO 10003:2007 - External dispute resolution

As more augmented standards are developed, this triad “[...] can and should be” supplemented with its related systems, like ISO 10004:2012 for “*monitoring and measuring*” of CS (Karapetrovic, 2012). Tranchard (2010) and Nowicki, et al. (2014) both explain that the four standards mentioned are guidelines and “[...] not intended for certification”. Nowicki, et al. (2014) additionally clarify that companies use them for internal reasons in order “[...] to improve customer satisfaction processes”.

Details on the revision of the ISO 10000 standards are given in Appendix B.4a.

#### 2.4.2. Purpose of the ISO 10001/2/3/4 standards

The usage of any of the four standards is independent of a company’s “[...] type, size and product provided” (Nowicki, et al., 2014; Ramphal, 2016). Karapetrovic (2008) and Karapetrovic & Doucette (2009) point out that the narrow scope and “[...] focus on a single component of a QMS” in comparison to MSSs like ISO 9001 is advantageous. Karapetrovic (2012) adds that the benefits arising from an augmentative standard are often showing immediate effects, “[...] which may or may not be the case with an overall ISO 9001 system”.

The four standards guide a company in setting up a “[...] *system and processes for effective complaint management*” (Dee, et al., 2004). However, the scope of these MSSs exceeds solely complaint management. Dimkov & Ivanova (2012) describe that the intention of the triad is to provide guidance for the development of codes (ISO 10001), as well as internal (ISO 10002) and external (10003) CH processes. Furthermore, it is an effort towards getting “[...] *the best of the international good practices for development of ethical codes, handling complaints from the organization and outside*” (Dimkov & Ivanova, 2012).

Although most articles have not included ISO 10004 yet, the standard smoothly blends into this framework. The three standards aim to enhance CS, whereas ISO 10004 can provide the guidelines to constantly monitor and measure this CS.

How a company can implement one or more augmenting standards or integrate them into an existing IMS is presented in the following section.

#### 2.4.3. Augmentative integration with the ISO 10000 series

The section discusses commonalities of ISO 10001/2/3/4 and different ways MS based on the standards can be implemented in an organization.

Dee, et al (2004), Karapetrovic (2005), Karapetrovic (2012) explain that the three standards have the same structure in order to make them more compatible. A flowchart within ISO 10004 shows the interrelations of the four standards. Therefore, the standards support the setup of an MS that is integrated in order to “[...] *augment each other*” (Karapetrovic, et al., 2012). A table that shows the commonalities of ISO 10001/2/3/4 is presented in Appendix B.4b.

Karapetrovic, et al. (2012) describe three different ways in which an augmenting standard can be used to establish a MS.

1. One standard used to form a stand-alone MS (Karapetrovic, et al., 2012).
2. MSSs augmenting each other in order to form an MS (Dee, et al., 2004 ; Karapetrovic, 2007; Schnoll, 2015)
3. Integration into a “[...] *function-specific or cross-functional*” overarching MS, for example a QMS or IMS (Karapetrovic, 2012).

A detailed discussion on the three different integrative augmentation scenarios is given in Appendix B.4c.

#### 2.4.4. Awareness of standards from the ISO 10000 series

Karapetrovic et al. (2006) found that only half of respondents were aware of ISO 10001 and ISO 10003. However, they were unsure about a future implementation of the standards. Similar findings were shown in a survey seven years later in Serbia, as *[...] half of respondents indicating that they are “not aware” or “aware and not sure” of 10001, 10002, 10003*” (Karapetrovic & Spasojevic-Brkic, 2014). ISO 10002 was the standard with the highest awareness and implementation rate in Spanish spa companies (Simon, et al., 2015) compared to Serbian organization, where ISO 10004 was the standard with the highest awareness (Karapetrovic & Spasojevic-Brkic, 2014). More details on the case studies analyzed is presented in Appendix B.4d.

#### 2.4.5. Satisfaction and ISO 10000

Seven case studies were found on the satisfaction of organizations when implementing MSs based upon standards of the ISO 10000 series (Hughes & Karapetrovic, 2006; Ang & Buttle, 2012; Karapetrovic & Doucette, 2009; Karapetrovic, 2010; Dimkov & Ivanova, 2012; Khan & Karapetrovic, 2013; Vargas-Villarroel, 2015). Six of those included ISO 10002, while ISO 10004 and ISO 10008 were only studied once. Findings from the studies are summarized within Appendix B.4e.

#### 2.4.6. Reasons for non-implementation

Several publications discussed the reasons for non-implementation of ISO 10000 standards. One reason all authors agreed on was that internal factors are predominately responsible (Karapetrovic & Spasojevic-Brkic, 2014; Salerno-Kochan & Salerno-Kochan, 2014; Nowicki, et al., 2014; Simon, et al., 2015). Nowicki, et al. (2014) add: *“[...] cost of implementation, lack of time to prepare it and then maintain it as well as bureaucracy”* (Nowicki, et al., 2014). Problems with standards were less of an issue (Karapetrovic & Spasojevic-Brkic, 2014)

Simon et al. (2015) explained that *“[...] top management commitment and resources allocation”* are crucial for *“[...] evolution of managerial practices related to customer complaints”* and



should relate to the overall objectives of the organization. Similarly, Hughes & Karapetrovic (2006) pointed out the importance of availability of resources to improve a company's "[...] *CHS and other associated systems and processes*".

#### 2.4.7. ISO 10001

ISO 10001 is a globally acknowledged guidance "[...] *for developing and implementing a set of commitments*", so called "codes of conduct", to a customer about a company's provided outcomes and "[...] *a complaint prevention technique*" (Dee, et al., 2004). The standard offers a structured method for promises to "[...] *be designed, developed, implemented, maintained and improved*" (Khan & Karapetrovic, 2015). Furthermore, ISO 10001 "[...] *facilitates the implementation of a simple framework for creating a code as well as making integration with other MSs straightforward*" (Karapetrovic, 2012).

Schnoll (2015) describes the potential benefit as decreasing the likelihood of complications arising and the ability "[...] *eliminate causes of complaints and disputes that can decrease customer satisfaction*". This view was accentuated by studies of ISO 10001 applications in the fields of health care, education and telecommunications, which all see positive relations with CS and an ISO 10001 based promise (Dimkov & Ivanova, 2012; Karapetrovic, 2010; Khan & Karapetrovic, 2015; Khan & Karapetrovic, 2013; Karapetrovic & Doucette, 2009).

#### 2.4.8. ISO 10002

As the first published standard in the triad, ISO 10002 is an "[...] *effective approach for addressing complaints using resources and expertise within the organization*" (Dee, et al., 2004). It guides organizations in setting up and implementing an effective process for internal product-related complaints handling (Ang & Buttle, 2012; Hughes & Karapetrovic, 2006; Dee, et al., 2004)

Schnoll (2015) and Ramphal (2016) agree that the objective is to help companies increase CS, further leading to customers' "[...] *loyalty by helping organizations resolve complaints effectively and efficiently*" (Schnoll, 2015). Ang & Buttle (2006) note that it will help companies to "[...] *audit and improve their complaints-handling processes*". Dee, et al. (2004) similarly see the standard as a possibility for serving as a benchmark and confidence tool for customers,

especially in non-commercial areas of operation, as well as “[...] improved customer understanding of the manner in which complaints are handled and resolved”.

The standard should guide companies in both the individual process for CH and in improving the product or service from the data gained in this process (Dee, et al., 2004). This can be seen as a strength of the standard, because it incorporates the concept of system-thinking, which is also embraced by the new ISO 9001:2015 (Merrill, 2015).

Hughes & Karapetrovic (2006) explain the possibility to integrate ISO 10002 “[...] as a subsystem into an ISO 9001 based QMS“. Both Ang & Buttle (2006 and 2012) and Dee, et al, (2004) in particular explain that it “[...] was designed to be flexible from two specific perspectives: application and structure.”

Ang & Buttle (2006) revealed that the usage of ISO 10002 could lead to improvement of processes and higher levels in customer advocacy. In a study six years later, they found a strong positive relationship of companies having a “[...] documented complaints-handling process” and superiority in customer retention. More details on the latter study is given in Appendix 4f.

#### 2.4.9. ISO 10003

ISO 10003 guides organizations to set up a framework in cases when they are not able to resolve a complaint with a customer internally (Dee, et al., 2004; Ramphal, 2016; Grigore, 2009).

In order to prevent a lawsuit that incorporates high costs and complications, an organization works with an EDR provider. This provider helps to “[...] resolve the problem” between the organization and the complainant (Dee, et al., 2004). Different types of EDR providers a complainant can “[...] escalate their complaint to” are for example ombudsmen or legal representatives (Ramphal, 2016).

ISO 10003 offers plans for both the company and their chosen EDR provider (Hughes & Karapetrovic, 2006). Guidance is offered “[...] on the drafting and implementation of effective processes to resolve external conflicts, such as mediation, arbitration or services of judge proximity” (Grigore, 2009). Busch & Reinhold (2015) suggest a company should offer “[...] as many channels of communications for the initiation of the dispute resolution procedure as

*possible*” for their customers. They further argue that the formulation in ISO stating that the procedures should be “[...] *as informal as appropriate to the circumstances of the dispute*” (ISO, 2007b) is vague and propose for a future standard to include more specifications for the format of communication between the parties. Karapetrovic (2012) points out that the standard is “[...] *the most detailed guidance, especially in the annexes*” compared to ISO 10001 and ISO 10002.

#### 2.4.10. ISO 10004

ISO 10004 supplements ISO 10001/2/3 as it can provide guidance to set up a MS for measuring CS. Unawareness about this standard was still high in recent years (Karapetrovic & Spasojevic-Brkic, 2014; Selakovic, 2016). However, Selakovic (2016) and Karapetrovic & Spasojević-Brkić (2014) also found that there was reasonable interest in implementing ISO 10004 in the future among the surveyed companies. There are only few case studies available on the usage of ISO 10004. However, some studies showed that it could aid companies in setting up a system for CS measurements (Khan, 2016; Khan & Karapetrovic, 2013; Selakovic, 2016)

### 2.5. Manufacturing and CSAPs

This sub-chapter reviews CSAPs within manufacturing firms. These programs are related to product guarantees, complaints handling, EDR and CS measurements. The CSAPs were chosen because each of them is related to one of the MSSs addressed in the research.

#### 2.5.1. Product guarantees in manufacturing

McDougall, et al. (1998) describe a guarantee as a statement, which explains customers what they can expect and what actions are taken if the stated promises are not met. Baker and Collier (2005) explain that the customer can expect “*an economic and/or noneconomic payout*”.

Steinhart (2012), Donaldson (1995) and McDougall, et al. (1998) agree that it is a marketing strategy utilized by companies resulting in multiple benefits. In line with that, Rudawska (2014) suggested companies go beyond the traditional focus, which are the functional benefits of their products and their production process. Purohit & Srivastava (2001) explain that a promise can be changed quicker compared to long built and hard to change factors such as reputation.

Nevertheless, it is important to design guarantees carefully as the features of the promise need to match the company needs (McDougall, et al., 1998; Steinhart, 2012).

Promises were categorized by their different features in the literature as shown in Table 7. Details on both studies mentioned in the table are discussed in Appendix B.5a.

**Table 7: Categorization of promises**

Author	Categorization of promises
Steinhart (2012)	Explicit or implicit
McDougall (1998)	<i>“Pure conditional”, “Unconditional”, “Pure specific” or “Specific”</i>

### 2.5.2. CH in manufacturing

Complaints are inevitable but they can be seen as an opportunity *“[...] to improve performance and raise profitability”* with the right strategy in place (Petnji-Yaya, et al., 2013). A definition of the term complaint satisfaction is presented in Appendix B.5b.

Recovery actions are designed processes, which are taken to reduce impacts of negative incidents, when companies become aware of failures (Bhandari, et al., 2007). There have been numerous studies showing that successful dealing with complaints can be used in a way to recover a customer’s satisfaction (Hughes & Karapetrovic, 2006; Nyer, 2000; Ang & Buttle, 2012; Schnoll, 2015; Urdziková, 2012; Petnji-Yaya, et al., 2013) and a criterion for customer retention (Strauss, 2002; Dee, et al., 2004; Petnji-Yaya, et al., 2013; Karatepe, 2006). Karatepe (2006) explains that complainants expect a form of atonement, such as refunds or replacements, to perceive justice. Both Karatepe (2006) and Bhandari, et al. (2007) discussed three forms of justice perceptions shown in Appendix B.5c.

Nyer (2000) found that if customers were asked explicitly to talk about their *“[...] feelings and thoughts experienced,”* they were more satisfied and evaluated the products better *“[...] compared to consumers who were not explicitly asked to complain”*. A summary of aspects authors recommend for successful CH are summarized in Table 8.

**Table 8: Findings on success factors for CH**

Author(s)	Success factors for CH
Petnji-Yaya, et al. (2013)	"[...] encourage and educate customers" on filing complaints.
Urdziková (2012), Yaya, et al. (2014)	Encouragement of customer communication
Petnji-Yaya, et al. (2013) and Karatepe (2006)	training employees in customer CH
Vos, et al. (2008).	Usage of complaint information for "[...] analysis, improvement or even the elimination of particular organisational practices that may have led to these complaints" (Vos, et al., 2008)

### 2.5.3. EDR in manufacturing

EDR comes into effect when a customer complaint cannot be solved internally, usually because the manufacturer rejects the customer's claim or if the customer is not satisfied with the rectification by the manufacturer (Murthy & Blischke, 1992). Murthy & Blischke (1992) point out that customers have the option to take no further actions, complain to a "public or private institution" or take legal actions. As this is costly, companies seek other formalized ways to deal with disputes (Vandeputte, 2015; Avgar, 2016). A neutral third party in negotiations could avoid that a party with less negotiation power feels intimidated by the superior (Department of Justice Canada, 2017). Two of the most common methods involving such a third party in solving disputes are mediation and arbitration (Department of Justice Canada, 2017; Larivet & Brouard, n.d.; Vandeputte, 2015). Better Business Bureau (BBB) is one of the providers for EDR. Numbers of complaints in windows and doors manufacturing and more details on the BBB are provided in Appendix B.5d.

### 2.5.4. CS measurement in manufacturing

Fernández-González & Prado Prado (2007) performed a study with 300 manufacturing companies that had a standardized QMS in place revealed that 70 % of these companies applied „[...] some kind of rigorous measuring of customer satisfaction“. Written surveys were considered to be the most useful method (Fernández-González & Prado Prado, 2007). Fernández-González & Prado Prado (2007) claim that CS measurements may be the „[...] most reliable feedback system“ for an organization. Kapuge and Smith (2007) explain that in a

competitive industry CS has become increasingly important to gain an advantage and survive on the markets in the end.

## 2.6. Motivation for the proposed research

The motivation for conducting the research presented in this thesis relates to CS and applicability of augmenting standards of the ISO 10000 series in servicing and manufacturing. Two CSOs provide the basis to analyze the satisfaction with augmenting standards through surveys (CSO 1) and to study the integrative augmentation with ISO 10001/2/3/4 (CSO 2).

CSO 1 offered the unique possibility to analyze student surveys that revealed information about satisfaction with MSs based on ISO 10001/2/4/8 in engineering education. The chance to use surveys from different years enabled the empirical research on trends of CS with ISO 10001/2/4/8. An analysis of relationships between the characteristics of MS elements based on ISO 10001/2/4/8 through the usage of SEM was not addressed in the literature before.

CSO 2 was a subject of interest as it was currently undergoing the transition process from ISO 9001:2008 to ISO 9001:2015. This transition is used to show how the ISO 9001:2015 MSS addresses customer-related areas within an organization. Further, it can be used as a basis to integrate a MS based upon four different ISO 10000 standards as the literature review showed. However, no studies have been found that show the integration of an MS based upon ISO 10001/2/3/4 when simultaneously transitioning to ISO 9001:2015.

In addition, no literature has been found that studied the analysis of interrelationships between ISO 10001/2/3/4 with ISO 9001:2015 requirements or an application of an ISO 10001/2/3/4 MS within manufacturing. The findings in the literature also showed a lack of studies addressing ISO 10001/2/3/4 augmentative integration connected to an existing IMS.

The literature review also found a lack of usage of augmentative standards with the IUMSS Handbook methodology in general and in manufacturing.

## 2.7. Objectives of the proposed research

With respect to the first goal related to CSO 1 the following objectives are identified:

- Show relationships of surveyed elements of the CS system and their influence on satisfaction through the means of SEM and correlation analysis.
- Analyze student satisfaction with the elements of an integrated CS framework based upon ISO 10001/2/4/8 standards.
- Investigate the changes of the survey results from different points of time in the course, as well as changes from two consecutive years.
- Identify improvement of satisfaction over time.

These objectives are addressed in Chapter 4.

Regarding the second goal of the research connected to CSO 2 the following objectives were formulated:

- Providing transition suggestions from ISO 9001:2008 to ISO 9001:2015,
- Providing suggestions for the sustainability of the IMS,
- Perform an analysis of the gaps between the CSAPs of an ISO 9001 based system to requirements of ISO 10001/2/3/4,
- Providing suggestion on how to set up an ISO 10001/2/3/4 framework, and
- Demonstrate a path to integrate ISO 10001/2/3/4 with an existing IMS in a Windows Doors manufacturing setting

These objectives are tackled in Chapters 5 and 6.

### 3. Methodology

This chapter presents the methodology used in the research.

Sub-chapter 3.1 illustrates the methods of analysis used for comparing the results of surveys regarding augmentative standards in a university (CSO 1) that are presented in Chapter 4. An explanation of the context of the surveys, as well as the statistical methods used for the analysis of these surveys are provided.

The methodology for research on integrative augmentation in manufacturing related to Chapters 5 and 6 is shown in Sub-chapter 3.2. Details on CSO 2 and the methods used for the analysis are presented.

#### 3.1. Augmentative system analysis with ISO 10001/2/4/8 in education

The data used in the analysis stems from surveys performed with students of an undergraduate engineering course. The course was held at a university in Western Canada, which will be considered as CSO 1. These surveys were undertaken as a part of a project called “Implementation of ISO 10008 in Engineering Courses” by the AIMS laboratory.

Collection of the surveys was performed in 2016 and 2017 within two sections (Section 1 and 2) of the course. As demonstrated in Table 8, Section 1, taught in 2016, was excluded from the analysis, because a different professor offered the course that year.

**Table 9: Excluded and used course sections in survey analysis**

Course 2016		Course 2017	
Section 1	Section 2	Section 1	Section 2
Professor 2	Professor 1	Professor 1	Professor 1
<b>Excluded</b>	<b>Used</b>	<b>Used</b>	<b>Used</b>

Surveys were conducted three times throughout the course:

1. Initial Survey at the beginning of the term
2. Midterm Survey during the term
3. Final Survey at the end of the term.



Quantitative data analysis was performed with the following two methods:

1. Descriptive statistics, and
2. Structural equation modeling (SEM)

Descriptive statistics included the calculation of means, standard deviations and variances with Microsoft Excel. SPSS was used for the creation of correlation matrices. The matrices were further used to create covariance matrices, needed in the SEM analysis.

SEM was used to establish theoretical models visualizing the influences of MS elements on student's e-learning platform satisfaction. LISREL, a SEM computer software, was used to calculate the effects of the established relationships based on covariance matrices. Program syntaxes were created that described the models through their structural equations.

### 3.2. IMS analysis with ISO 9001/14001/45001 and OHSAS 18001 in manufacturing

CSO 2 is a manufacturer of windows based in Western Canada. The research was undertaken within this organization because it already operated an IMS and was interested in the usage of ISO 10001/2/3/4. The CSO's IMS covered three different areas: Quality (ISO 9001:2008), Environment (ISO 14001:2004) and Occupational Health and Safety (OHSAS 18001:2007).

The research was conducted through a project funded by NSERC. It included two parts: namely project preparation and undertaking. For both parts, Chapter 3 of the IUMSS Handbook was used to establish the analysis steps, as this chapter provides tools and guidance for the *"integration of management system standard requirements"* into the MS.

The project preparation included four steps illustrated in Table 5. Each of the steps relates to a sub-chapter of the IUMSS Handbook.

**Table 10: Project preparation**

<b>Project preparation step</b>	<b>IUMSS Handbook reference</b>
1) Self analysis of changes between ISO 9001:2008 and ISO 9001:2015	Sub-chapter 3.3
2) Literature review on the changes in ISO 9001:2015 from ISO 9001:2008	Sub-chapter 3.3
3) Setup of questionnaires for ISO 9001 update and ISO 10001/2/3/4	Sub-chapter 3.3
4) Research ethics application	Sub-chapters 3.1 and 3.3

Step 1 included an analysis of changes between the ISO 9001:2008 and ISO 9001:2015 standards. The analysis consisted of the mapping of elements from ISO 9001:2008 to the elements of ISO 9001:2015 in a tabular form. The self-analysis was performed before reviewing literature on the ISO 9001:2015 revision. This helped conduct the analysis without biases. The full self-analysis table is presented in Appendix C.6.

Step 2 was a literature review on the ISO 9001:2015 update. It was performed in order to compare authors' views with the self-analysis from Step 1. It also helped clarify new or changed requirements of the standard, such as risk-based thinking or change management.

Step 3 in the preparation phase was the set up of questionnaires for undertaking the research project. Five questionnaires were created in total:

The ISO 9001 questionnaire (Appendix C.1.) included questions regarding changed and new requirements of ISO 9001:2015, as well as the identification of customer-related processes related to ISO 9001:2015

The four questionnaires for ISO 10000, specifically ISO 10001/2/3/4 (Appendix C.2. – C.5.), addressed the requirements related to each MSSs, as well as CSAPs in the CSO.

All questionnaires were divided into two parts:

- Part 1 (“Status Quo” in the questionnaire) was aimed at gaining information on the current status of the QMS, IMS and CSAPs.

- Part 2 (“Potential” in the questionnaire) was used to gather information on potential changes related to the MSSs requirements.

Whenever possible, specific elements of the MSSs relating to the questions were given in brackets beside the questions. For example, Question 1b) from the ISO 10001 questionnaire stated:

- *“Which remedies do you offer to the customer if the promise or codes of conduct were not fulfilled?”*  
[ISO 10001, 6.8]

Step 4 was the preparation of the application for research ethics approval by the University of Alberta Research Ethics Board. The five questionnaires used throughout the research project were included within the application.

Between the preparation and undertaking the research project, a kick-off meeting was held at the CSO 2 in order to reconfirm the objectives and organizational aspects with CSO managers. These aspects included the scheduling of interviews with employees, the frequency of interviews and meetings, as well as access to internal documentation. Throughout the research project, fifteen interviews were conducted with ten employees of the CSO. Furthermore, around ten meetings were held, including interim presentations. The objectives and phases are shown in Table 4.

**Table 11: Research project phases and objectives**

Phase	Name	Objective
1	ISO 9001	Provide suggestions for transitioning from ISO 9001:2008 to ISO 9001:2015
2	IMS analysis	Analyse the current IMS and its sustainability
3	CSAPs	Analyse how the CSAPs could be enhanced with the help from ISO 10001/2/3/4
4	IMS augmentation	Providing suggestions on how a system based on ISO 10001/2/3/4 could be integrated into the current IMS

A breakdown of each phase, including the analysis steps undertaken is shown in Table 6. Each of the phases relates to one or more sections of the IUMSS Handbook.

**Table 12: Detailed steps and actual research project phases**

Phase	Analysis step	IUMSS Handbook reference
Phase 1	1) Gap Analysis ISO 9001:2008 to ISO 9001:2015	Sections 3.4.1, 3.4.2, 3.4.3, 3.5.1
	2) Suggestion of actions for transition to ISO 9001:2015	Section 3.5.2
Phase 2	3) Analysis of IMS and its sustainability	Sections 3.4.1, 3.4.2, 3.6
	4) Results of IMS analysis	
Phase 3	5) Analysis of CSAPs	Sections 3.4.1, 3.4.2, 3.4.3
	6) Individual suggestions for augmentation with ISO 10001/2/3/4	Sections 3.5.1, 3.5.2
Phase 4	7) Analysis of potentials for integration of a framework based on ISO 10001/2/3/4 into the IMS	Sections 3.4.2, 3.5.1
	8) Suggestions for integration	Section 3.5.2

Phase 1 included the identification of gaps between the ISO 9001:2008 registered QMS of CSO 2 compared to the ISO 9001:2015 requirements. Furthermore, processes mentioned in ISO 9001:2015 that are related to CSAPs, such as measurement of CS, were identified. The table used for the gap analysis was built upon the self-analysis table set up in the preparation process. Three streams of information were used to perform the gap analysis and formulate suggestions based on the gaps identified:

1. Findings from the ISO 9001 self-analysis.
2. Interviews conducted with the ISO 9001 questionnaire, and
3. Meetings at the CSO 2.

In Phase 2, an IMS analysis was performed, in which an IMS matrix was created to study the current integration status of the IMS (Step 3). The table was based on examples and methods presented in the IUMSS handbook, Section 3.4.3. It included the mapping of requirements related to the three MSSs (ISO 9001:2015, ISO 14001:2015 and OHSAS 45001), as well as the identification of interrelated requirements. The integration status of MS elements in the CSO was determined by comparing these elements with the interrelated requirements of the three MSSs. Suggestions for the integration of MS elements were formulated, based on the findings gained through the IMS analysis (Step 4).

In Phase 3 of the research project, current CSAPs in CSO 2 were studied through interviews conducted with the ISO 10001/2/3/4 questionnaires and information stemming from meetings in the CSO. All information gained through questionnaires on the current CSAPs was entered within an electronic version of the questionnaire. Because the questionnaires were related to each clause of the MSS studied, it was possible to identify requirements that have not been addressed by a CSAP operated in the CSO. Through the identification of these unaddressed requirements and the information gained in interviews and meetings, suggestions on the standardization for each of the four CSAPs were formulated.

Phase 4 of the research project related to the integration of an ISO 10001/2/3/4 based MS into the existing IMS. This was performed through three tables, in which color-coding was used to show the integration possibilities for the MSs studied. The tables, which will be shown in Chapters 5 and 6, were added onto one another. They were established in the following sequence:

**1. Interrelationships of ISO 10001/2/3/4**

Requirements of each MSS were analyzed for their interrelationships with one another

**2. Interrelationship of ISO 10001/2/3/4 with ISO 9001:2015**

The table established for the interrelationships of ISO 10001/2/3/4 was expanded by a column for ISO 9001:2015 requirements. This made it possible to connect the ISO 10001/2/3/4 requirements with elements of ISO 9001:2015.

**3. Integration of an ISO 10001/2/3/4 based MS into the CSO's IMS**

Five more columns were included to the former table. Two columns were added to identify how many of the ISO 10000 standards could be integrated into the IMS based on the MSSs requirements. The last three columns were added to insert data on how the current MS elements in the CSO address the ISO 10000 requirements, as well as the details on these elements and how integration actions could be performed.

Some sections or sub-clauses from Chapter 3 of the IUMSS Handbook were not used. These steps can only be applied after an actual implementations takes place, which was out of scope of the research project. The excluded section and sub-clauses are:

- “3.5.3 *Confirm Gap Closure*”

- “3.6 *Maintain and improve integration*”
- “3.7 *Apply lessons learned in the organization*”

### 3.3. Summary

The methodology used in the research in the two CSOs was presented. The next chapter illustrates the results from the statistical analysis regarding augmentative standards in CSO 1.

## 4. Augmentative system analysis with ISO 10001/2/4/8 in education

This chapter presents the statistical analysis of surveys with 306 university students in an engineering course taught at CSO 1. The courses operated four standardized MSs established in accordance with the requirements of ISO 10001/2/4/8. Two different statistical methods were used to identify the satisfaction with the MS elements related to the ISO 10000 standards:

- 1) Descriptive statistics presented in Sub-Chapter 4.2, and
- 2) SEM presented in Sub-chapter 4.3.

Sub-chapter 4.1 will give an overview of the survey analysis.

### 4.1. Survey analyses overview

Descriptive statistics were used to analyze four different comparisons of survey results. Table 7 presents an overview of the compared surveys and the common MS element characteristics related to ISO 10001/2/4/8. The third column in the table shows the thesis section in which the results are presented.

Table 13: Survey analyses overview

Comparison	MS element characteristic	Thesis section
Midterm surveys 2016 to midterm surveys 2017	<ul style="list-style-type: none"><li>- Response code usefulness</li><li>- Typo code usefulness</li><li>- E-class site satisfaction</li></ul>	4.2.1
Final surveys 2016 to final surveys 2017	<ul style="list-style-type: none"><li>- Response code effectiveness</li><li>- Typo code effectiveness</li><li>- Addition of codes</li><li>- Feedback process appropriateness</li><li>- Survey frequency adequacy</li><li>- Course satisfaction improvement</li><li>- Course quality improvement</li><li>- E-class site satisfaction</li></ul>	4.2.2
Midterm surveys 2016 to final surveys 2016	<ul style="list-style-type: none"><li>- E-class site satisfaction</li></ul>	4.2.3
Midterm surveys 2017 to final surveys 2017	<ul style="list-style-type: none"><li>- E-class site satisfaction</li></ul>	4.2.4

In addition to the comparisons presented in Table 9, a correlation analysis for the final surveys from 2016 and 2017 is included in Section 4.2.2.

The midterm and final surveys had one common characteristic analyzed, which was e-class site satisfaction. Each survey also included questions related to the two satisfaction codes, the surveys and the feedback process. However, the questions on those three MS elements differ, as shown in Table 10. These MS element characteristics will still be analyzed, but not directly compared to each other.

**Table 14: Difference between midterm and final survey question**

MS element	Midterm survey question	Final survey question
Satisfaction codes	Typo code usefulness Response Code Usefulness	Typo code effectiveness Response code effectiveness
Surveys	Survey usefulness	Survey frequency adequacy
Feedback process	Feedback forms usefulness	Feedback process appropriateness

Following the descriptive statistics results, SEM was used to study the effects that MS elements' characteristics may have on student satisfaction with the e-class site. One valid model for eight characteristics of the MS elements is presented in Sub-chapter 4.3.

## 4.2. Descriptive statistics

The analysis included means, standard deviations, variances and correlation analyses. The four different comparisons that were carried out will be presented in the following sections.

### 4.2.1. Analysis of 2016 and 2017 midterm survey results

In total, 47 midterm surveys from 2016 and 107 midterm surveys from 2017 were analyzed. The midterm surveys from 2016 and 2017 had three common characteristics, which were included in the comparisons.

The midterm surveys from 2017 additionally included questions regarding the:

- Adequacy of the feedback process, and



- Adequacy of the survey frequency.

Results for these two elements can be found in Annex D.6.

The questions used a 1-5 Likert scale. For example, the usefulness of the MS elements ranged from 1 “Not Useful” to 5 “Extremely Useful”. The results for the midterm survey comparisons are shown in Figure 1.

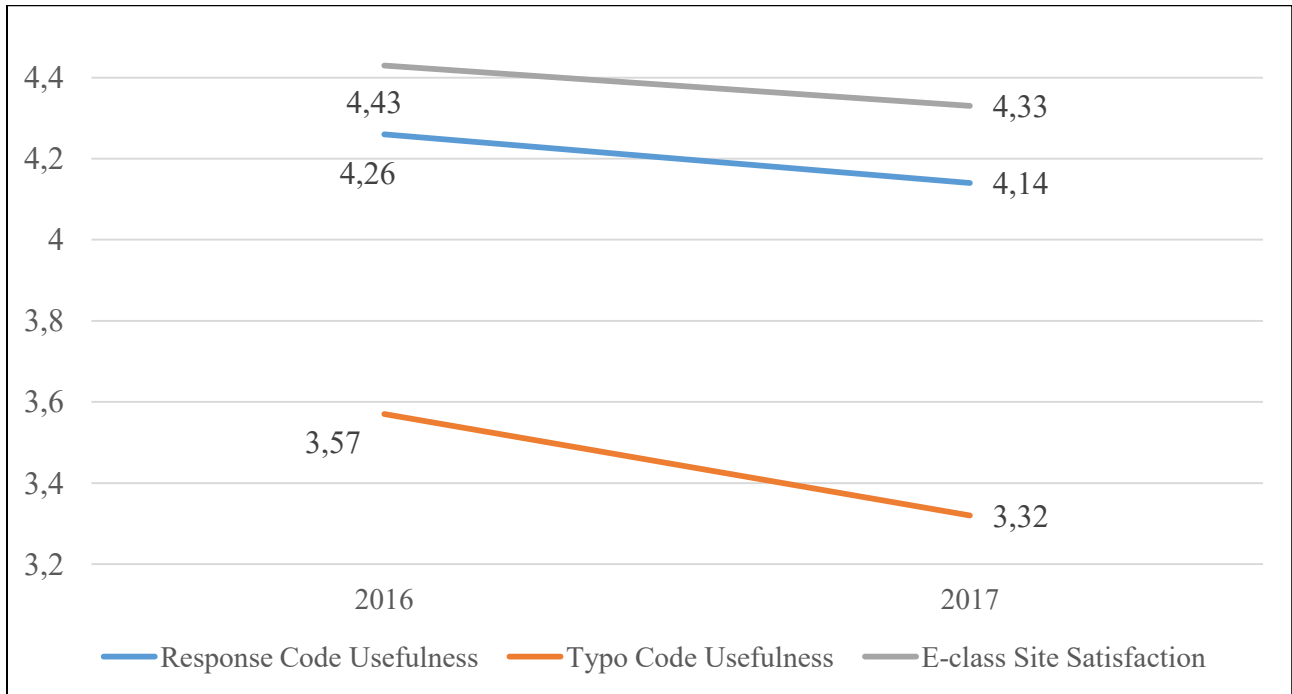


Figure 1: Comparison of midterm survey results

Students satisfaction with the e-class site was consistently high for both years with the means of 4.43 ( $\sigma=0.45$ ) in 2016 and 4.33 ( $\sigma=0.724$ ) in 2017, i.e. between “satisfied” and “highly satisfied”.

Both codes, which are ISO 10001 MS elements, decreased in their effectiveness according to the means of responses given by students. The response code was rated with an average of 4.14 ( $\sigma=1.24$ ) in 2017 compared to 4.26 ( $\sigma=0.89$ ) in 2016. For the typo code, the numbers declined from an average rating of 3.57 ( $\sigma=0.972$ ) in 2016 to 3.32 ( $\sigma=1.22$ ) in 2017.

Students considered the response code's effectiveness significantly higher than the typo code's effectiveness by 19 % in 2016 and 25 % in 2017. This can also be observed in Figure 1, as the line for the typo code is much lower than for the response code.

The reason that the response code was considered more useful as the typo code might have been a result of the students' involvement in the response code process. The response code offered the possibility to directly ask questions to the professor and receive answers in 24 hours. This information might have helped them in improving the understanding of class material, as well as their performance. The typo code in contrast did not affect the student's course performance. Additionally, the typos in the course materials were limited and students with low class attendance might not have been impacted as much by the typo code. Furthermore, the usefulness of the typo code may have decreased towards the end of the semester as most of the slides have already been checked for typos.

The standard deviations and variances were larger for all three characteristics of the MS elements in 2017 than 2016 due to the larger number of surveys analyzed in 2017. Additional details of the analysis are given in Appendix D.6.

#### 4.2.2. Analysis of 2016 and 2017 final survey results

The analysis for the final surveys included the comparison of results from 37 surveys from 2016 and 75 surveys from 2017. Eight common characteristics of the MS elements were used within the analysis.

The questions also used a 1-5 Likert scale. For example, the agreement with the statements related to the MS elements ranged from 1 "Strongly Disagree" to 5 "Strongly Agree".

The means of responses for the effectiveness of the two satisfaction codes were compared. The results are shown in Figure 2.

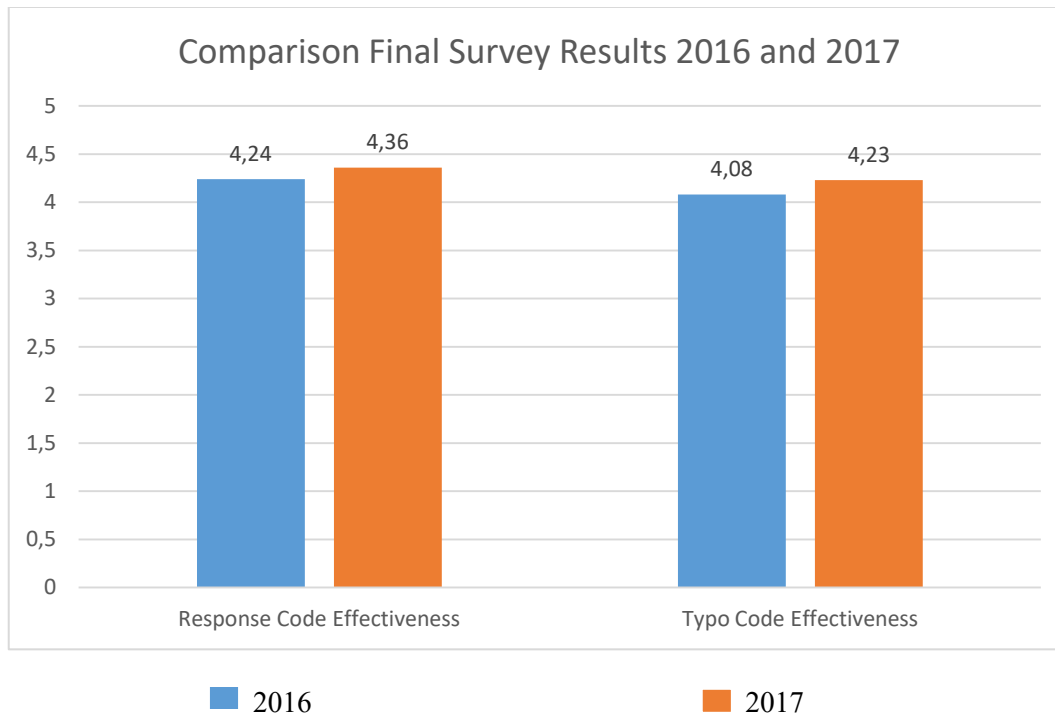


Figure 2: Comparison of the means for the codes' effectiveness for final surveys 2016 to 2017

Out of the two codes, the response code was seen as more effective by the students with means of 4.24 ( $\sigma=0.89$ ) in 2016 and 4.36 ( $\sigma=0.88$ ) in 2017. The typo code's effectiveness was rated with an average of 4.08 ( $\sigma=0.89$ ) in 2016 and 4.23 ( $\sigma=0.91$ ) in 2017. In both cases, the averages increased slightly. Furthermore, both the response code and the typo code (ISO 10001 MS elements) were seen as effective by the students. All means achieved results over 4 out of 5. However this result was more prominent for the response code for both 2016 and 2017. These findings match with those from Honarkhah (2010), who found the response code to be the most effective compared to two other codes in a university course. The MS established for the codes, based on ISO 10001 could have contributed to the high results for the codes' effectiveness, because these provide a structured approach for the operation of the codes. Furthermore, both codes were used throughout the whole semester so students were able to judge if the codes were effective and evaluate better.

The suggestion to include additional codes had a mean of 3.05 ( $\sigma=0.7$ ) in 2016 and a marginally higher number in 2017, with 3.19 ( $\sigma=0.85$ ). The addition of more codes received an average rating and therefore it could indicate that no more codes should be added. Students were not

strongly supporting the addition of codes. This might have been the case as they were already satisfied with the two codes in place.

Students found the feedback process appropriate with a consistent high mean of 4.43 (out of 5) in both years. Therefore, it can be concluded that students found the feedback process (ISO 10002 MS element) to be appropriate.

Further details including the minimums, maximums, means, standard deviations and variances can be found in Appendix D.5.

A correlation analysis was conducted for eight MS elements of the final surveys of 2016 and 2017 (112 cases).

The strongest relationships between the characteristics were:

- Course satisfaction improvement and course quality improvement ( $r = 0.886$ )
- Response code effectiveness and typo code effectiveness ( $r = 0.753$ )
- Response code effectiveness and feedback process adequacy ( $r = 0.624$ )
- Typo code effectiveness and feedback process adequacy ( $r = 0.608$ )

Three findings can be observed from these high correlations. First, the strongest correlation was shown for course satisfaction improvement and course quality improvement ( $r=0.886$ ).

Therefore, the quality of the course may directly contribute to student's satisfaction with the course. Secondly, the effectiveness of both codes was correlated significantly. ISO 10001 was used for setting up the MS for both codes. This could have contributed to a high correlation.

Thirdly, the effectiveness of both codes were significantly correlated with the feedback process adequacy. The feedback process was used to obtain feedback on the codes, which could indicate that it helped in improving the codes' effectiveness.

Furthermore, it is interesting to identify the characteristics of the MS elements that were highly correlated with the course quality improvement. Those elements are indirectly related to the course satisfaction improvement due to the high correlation of the satisfaction and quality improvement items in the survey ( $r = 0.886$ ). The characteristics of three MS elements were significantly correlated with course quality improvement:

- Feedback process appropriateness ( $r=0.536$ )
- Survey frequency adequacy ( $r=0.550$ ), and
- Typo code effectiveness ( $r=0.429$ ).

The addition of codes was least correlated with the e-class site satisfaction ( $r = 0.03$ ), This was expected because the addition of codes to the course received low ratings in the surveys, whereas e-class site satisfaction received high ratings. None of characteristics of the MS elements analyzed were significantly correlated with the addition of codes. These findings could support the previous conclusion that no additional codes needed to be established according to student responses.

The results of the correlations obtained were compared with the results of the SEM analysis in Sub-chapter 4.3. The full correlation table is given in Appendix D.4.

#### 4.2.1. Analysis of 2016 midterm and final surveys results

In total, 47 cases were analyzed from the 2017 midterm surveys and 37 cases from the 2016 final surveys.

The satisfaction with the e-class site was the common characteristic analyzed in both surveys (Figure 3).

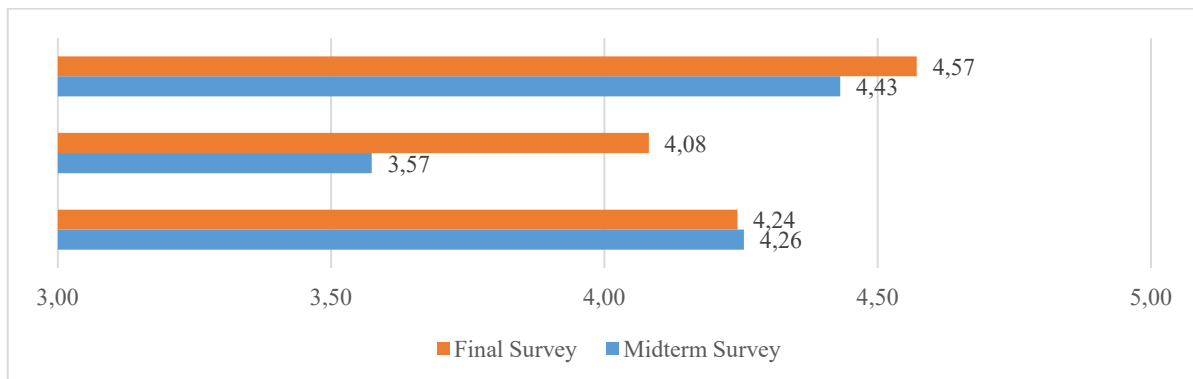


Figure 3: Comparison of the means of e-Class site satisfaction for 2016 midterm surveys and final surveys

A high satisfaction with the e-class site was observed, with an average rating of 4.43 ( $\sigma=0.85$ ) in the midterm survey. This satisfaction further increased to 4.57 ( $\sigma=0.78$ ) in the final survey.

Students agreed strongly that the response code was useful with means of responses of 4.26 ( $\sigma=0.94$ ). Additionally, the final survey showed that the effectiveness of the response code also reached a strong agreement with a mean of 4.24 ( $\sigma=0.89$ ). Looking at these results, the response code, as an ISO 10001 MS element, was useful and effective according to students.

The results for the typo code were different. In the midterm survey, the typo code usefulness reached a score between “Useful” and “Very Useful” ( $\mu = 3.57$  and  $\sigma = 0.97$ ). However, the students agreed more strongly on the typo code’s effectiveness ( $\mu = 4.08$  and  $\sigma = 0.89$ ).

The high satisfaction with the e-class site could be a result of the standardized MSs operated in the course. The students saw both codes, which were MS elements of ISO 10001, as having contributed to the high satisfaction with the e-class site as well.

#### 4.2.2. Analysis of 2017 midterm and final surveys results

The comparison included 112 midterm surveys and 105 final surveys from 2017. Figure 4 illustrates the comparison of the mean responses for e-class site satisfaction from midterm surveys to final surveys 2017.

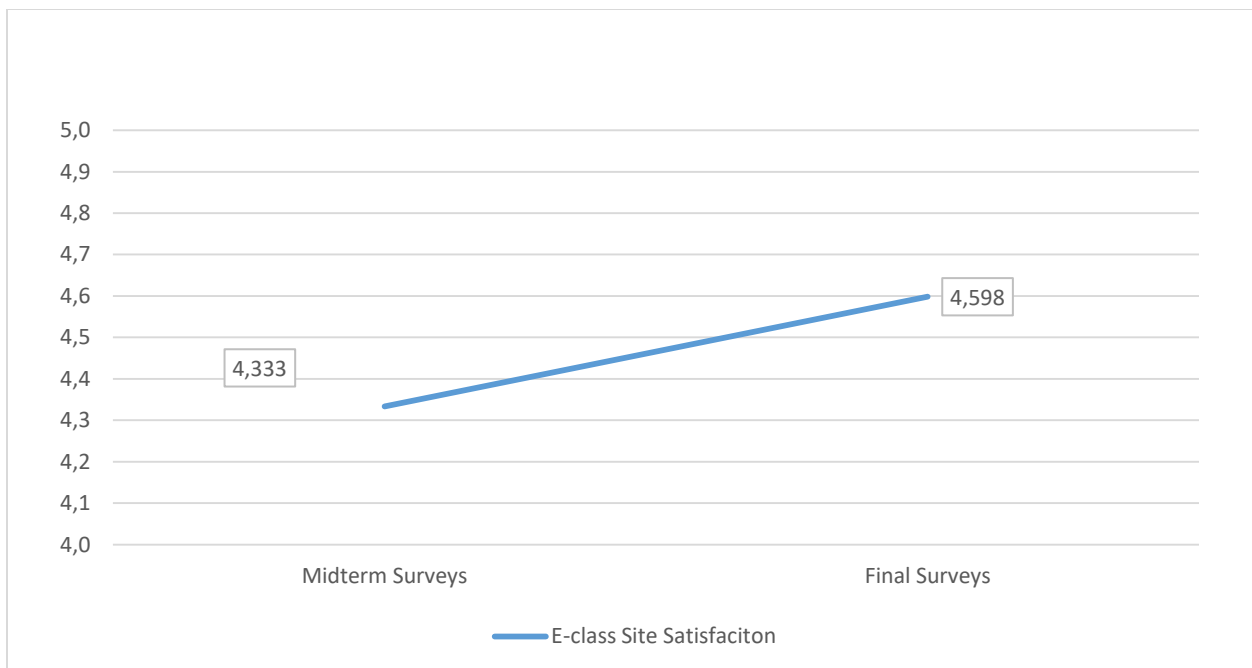
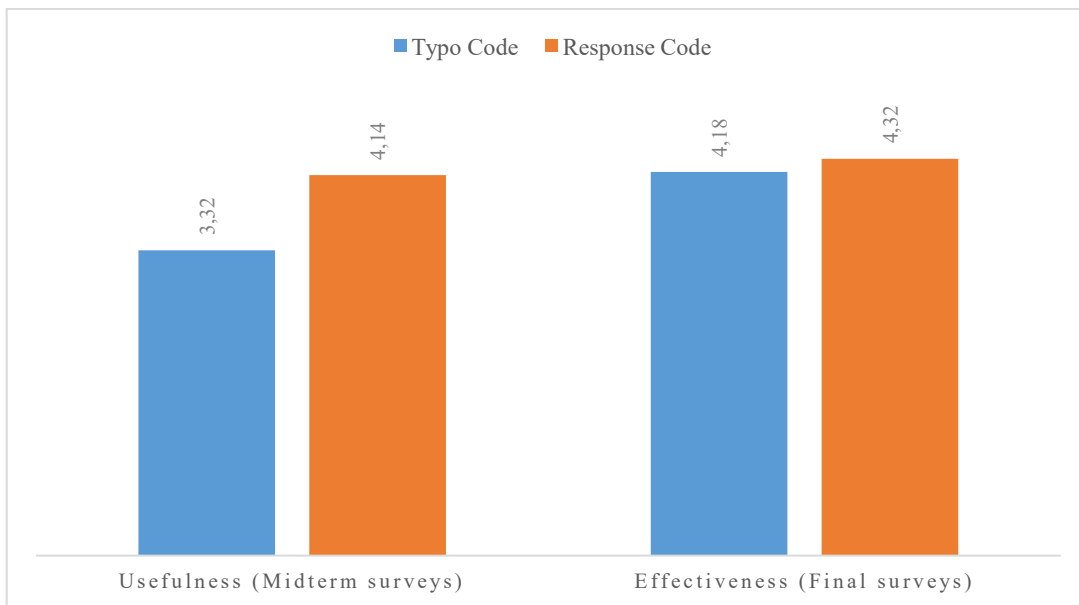


Figure 4: E-class site satisfaction development for midterms and finals 2017

As Figure 4 shows, students satisfaction with the e-class site increased slightly (0.27) from midterm surveys ( $\mu = 4.33$  and  $\sigma=0.85$ ) to final surveys ( $\mu =4.60$  and  $\sigma=0.712$ ). These results, i.e. between “Satisfied” and “Very Satisfied”, indicate that the e-class site satisfied the needs of the students.

Even though the questions on the two codes differed, it is still interesting to investigate the means for their usefulness and effectiveness. These results are shown in Figure 5.



**Figure 5: Usefulness and effectiveness of codes of 2017 midterm and final surveys results**

A significant difference can be observed between the students’ ratings of typo code usefulness in the midterms, with an average of 3.32 ( $\sigma=1.22$ ) and typo code effectiveness in the final surveys, with a mean of 4.18 ( $\sigma=0.90$ ). Concerning the response code, the results were more consistent for both, the code’s effectiveness ( $\mu = 4.14$ ) and usefulness ( $\mu = 4.32$ ).

These results could indicate that even though students found the typo code effective, they did not perceive it as useful compared to the response code. One reason might be that the response code helped students in clarifying questions and therefore may lead to a better understanding of the course material. The typo code does not affect their grades and students could therefore see the code as less useful. However, the operation of the codes, which was based on ISO 10001

guidance, could have led to high ratings for both codes. Therefore, the operation of the code is most likely not the issue, but its scope or content.

Regarding the ISO 10002 based feedback process, one specific document from the MS was addressed in the midterm surveys, namely the feedback form. The form was rated with an average of 3.28 ( $\sigma=1.06$ ) and therefore seen as useful by the students, which is a significantly lower rating compared to the response code (0.86 lower) or the e-class site satisfaction (1.05 lower). Compared to the feedback forms, the adequacy of the feedback handling procedure achieved a high agreement of 4.36 ( $\sigma=0.68$ ) in the final surveys.

This might indicate that students support the feedback process, but the feedback forms used could be improved or another way to give feedback could be established.

Additional details of the analysis are given in Appendices D.5 and D.6.

After the study of surveys through descriptive statistics, SEM was used to reveal information about the relationship of MS elements addressed within the surveys.

### 4.3. SEM analysis

Three different models have been considered in the analysis of the survey data. The following relationships were tested with the models:

- 1) Relationship between eight characteristics of the MS elements from the final surveys (2016 and 2017)
- 2) Relationships between five characteristics of the MS elements from the midterm surveys (2017)
- 3) Relationships between eleven characteristics of the MS elements from the midterm surveys (2016 and 2017) and the final surveys (2016 and 2017)

The values for Chi-square, p-values and RMSEA were used to decide on the validity of a model. These values were valid for the first model for the final surveys 2016 and 2017. The second and third model failed. They are presented in Appendix D.5 and D.6.



The model for the 2016 and 2017 final surveys is presented in the following sections, including the covariance matrix, the syntax created for LISREL, the LISREL output and the analysis of the output.

#### 4.3.1. SEM model







The model contains seven measured variables and one latent variable, which represent the eight elements from the surveys analyzed (Table 11). It visualizes how the characteristics of the MS elements were assumed to be related to the e-class site satisfaction. Figure 6 shows the model established. In the top part of the models, the seven factors (x's) potentially contributing to the student's satisfaction ( $\eta$  1) are represented:

- The usefulness of the typo (x2) and response code (x1)
- The addition of further codes in the course (x3),
- The adequacy of the feedback handling process (x4) and the surveys (x5), and
- The improvement of satisfaction (x6) and quality of the course (x7).

Furthermore, it was assumed that there is a relation between all variables in the survey, given their similarity and appearance on the same E-Class website. This relationship is expressed through the inclusion of correlations in the syntax.

The symbols in the model are described in Table 15.

Table 15: SEM model symbols

	Measurement errors on the x's		Y measurements of the exogenous latent variables
	Measurement errors on the y's		exogenous latent variables
	Y measurements of the endogenous latent variables		endogenous latent variables

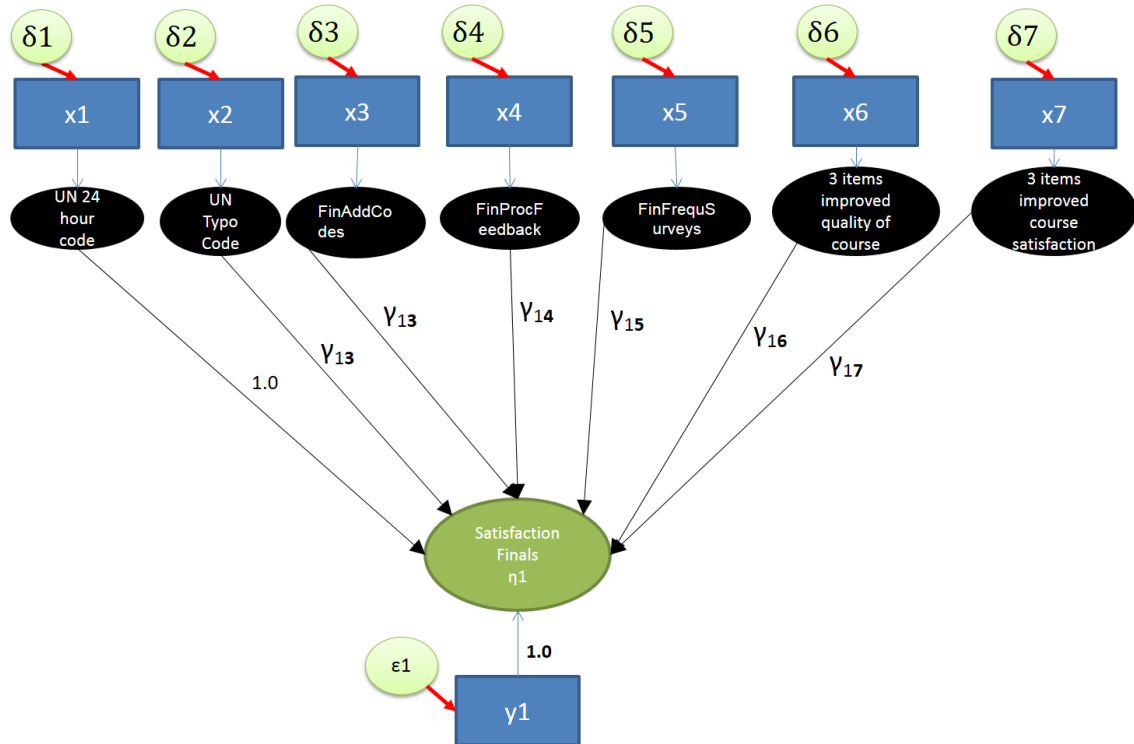


Figure 6: SEM model for 2016 and 2017 final surveys

The next section will show the created syntax and the covariance matrix, needed for the LISREL program and a description of the error variables.

#### 4.3.2. SEM model syntax

The syntax representing the model, which is needed for the calculation performed in LISREL consists out of the equations and matrices presented in this section. All equations are given in a matrix notation.

- 1) The first equation encapsulates all postulated direct effects among the concepts.

$$\eta_1 = 0 + [\gamma_{11} + \gamma_{12} + \gamma_{13} + \gamma_{13} + \gamma_{12} + \gamma_{13} + \gamma_{13}] \zeta_4 + \zeta_1$$

2) The second equation links the endogenous concepts to the endogenous indicators:

$$y = [1.0]*\eta_1 + [\varepsilon_1]$$

3) The third equation links the exogenous concepts to the exogenous indicators:

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{bmatrix} = \begin{bmatrix} 1.0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1.0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1.0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1.0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.0 \end{bmatrix} \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \\ \xi_4 \\ \xi_5 \\ \xi_6 \\ \xi_7 \end{bmatrix} + \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \\ \delta_5 \\ \delta_6 \\ \delta_7 \end{bmatrix}$$

4) The  $\Phi$  Matrix, presents the error covariances of the endogenous concepts by conceptual level variables (contained in  $\Phi$ ).

$$[\Phi] = \begin{bmatrix} \varphi_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ \varphi_{21} & \varphi_{22} & 0 & 0 & 0 & 0 & 0 \\ \varphi_{31} & \varphi_{32} & \varphi_{33} & 0 & 0 & 0 & 0 \\ \varphi_{41} & \varphi_{42} & \varphi_{43} & \varphi_{44} & 0 & 0 & 0 \\ \varphi_{51} & \varphi_{52} & \varphi_{53} & \varphi_{54} & \varphi_{55} & 0 & 0 \\ \varphi_{61} & \varphi_{62} & \varphi_{63} & \varphi_{64} & \varphi_{65} & \varphi_{66} & 0 \\ \varphi_{71} & \varphi_{72} & \varphi_{73} & \varphi_{74} & \varphi_{75} & \varphi_{76} & \varphi_{77} \end{bmatrix} \theta_{\delta}$$

5) The  $\theta$  Matrix, presents the error covariances of the exogenous concepts by conceptual level variables (contained in  $\theta$ ). The matrix is symmetric.

$$\theta = \begin{bmatrix} \theta_{\delta_{11}} \text{fixed} & & & & & & & & \\ 0 & \theta_{\delta_{22}} \text{fixed} & & & & & & & \\ 0 & 0 & \theta_{\delta_{33}} \text{fixed} & & & & & & \\ 0 & 0 & 0 & \theta_{\delta_{44}} \text{fixed} & & & & & \\ 0 & 0 & 0 & 0 & \theta_{\delta_{55}} \text{fixed} & & & & \\ 0 & 0 & 0 & 0 & 0 & \theta_{\delta_{66}} \text{fixed} & & & \\ 0 & 0 & 0 & 0 & 0 & 0 & \theta_{\delta_{77}} \text{fixed} & & \end{bmatrix}$$

LISREL bases its calculations on a covariance matrix for the elements used in the model. The created covariance matrix is presented in Appendix D.4.

Furthermore, the error variables needed to be estimated. These small error percentages were added in the model shown as  $\epsilon$  and  $\delta$  in Figure 6. Calculation of the error is the factor's variance multiplied with the percentage estimated for the error and this will give the amount of variance estimated to be an error. These need to be included, because factors, like the student's condition on the survey day, could lead to biased answers. A table for all error variances and their justification is given in the Appendix D.3.

#### 4.3.3. LISREL output

After running the syntax with LISREL, an output, including a graphical model and a full report on the estimations, was produced. A part of the output is the graphical model displayed in Figure 7. It shows the x-variables to the left, representing the seven characteristics of the MS elements. The arrows represent their influence on the e-class site satisfaction on the right side of the model. In addition, the error variables on the x-variables are given on each of the elements.

The model represents which of the elements describes most of the satisfaction with the e-class site (ETA 1). It also shows the major indices for the validity of the: Chi-Square, p-value and RMSEA value.

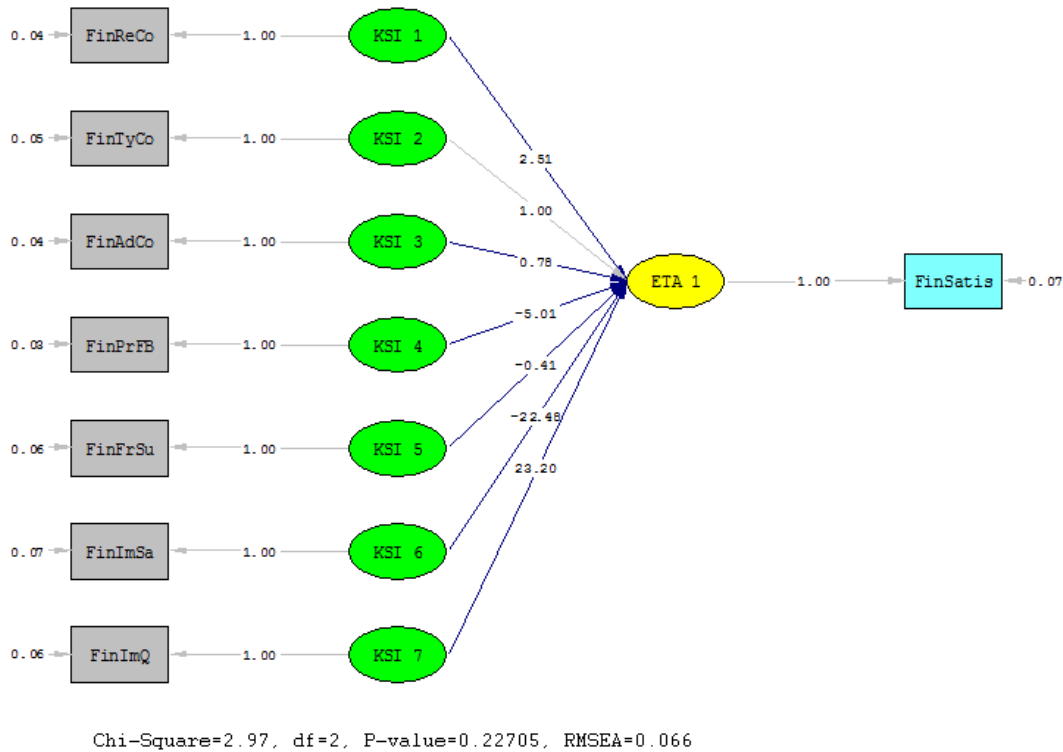


Figure 7: LISREL output for 2016 and 2017 final surveys

#### 4.3.4. LISREL output analysis

The outputs of LISREL are used to analyze the validity of the model and the effect of the seven characteristics of the MS elements on e-class site satisfaction. P-Values larger than 0.05 show a good fit. However, a few problems were found during the analysis of the indices given in the full report, for example Q plot, Residuals, ASMQ value.

Later on in the output analysis, a correction was made to the  $\eta_1$  (student satisfaction with the e-class site) variable, as the error variable was not included. Therefore, some of the indices that show if the model is valid could not be included in the analysis. This change, however, did not affect the possibility to show the effect the seven elements have on the satisfaction with the e-class site.

The three characteristics with the most significant effect on the satisfaction with the e-class site were the response code usefulness (2.51), the course quality improvement (23.2) and course satisfaction improvement (-22.5).

The response code usefulness showed a significant positive effect on the e-class site satisfaction. These findings match with those obtained in the correlation analysis, as the response code correlated strongly with e-class site satisfaction ( $r = 0.399$ ).

However the effects of the last two characteristics seemed unrealistic. For example, if the students rated the improvement of the satisfaction with the course low, then the satisfaction with the e-class site would increase by 22.5, which seems unrealistic because the Likert scale does not allow ratings higher than 5.

#### 4.4. Summary

Chapter 4 presents the analysis of survey data from 2016 and 2017 stemming from a larger scale study addressing integrative augmentation in an undergraduate engineering course at CSO 1. The survey analysis was performed to study integrative augmentation in engineering education with standards ISO 10001/2/4/8.

The survey data was used to reveal the acceptance of the two satisfaction codes, established based upon ISO 10001, the feedback system with ISO 10002 and the e-class site satisfaction, built upon the requirements of ISO 10008.

Two methods were chosen for conducting statistical analyses, namely SEM and descriptive statistics. The SEM analysis was performed to show how the characteristics of the MS elements were related based upon their impact on the student's satisfaction with the e-class site. This was supplemented by a correlation analysis within the descriptive statistics.

Furthermore, descriptive statistical results identified developments of midterm survey results to final surveys' results. Data available from two consecutive years made it possible to compare the findings over a one-year span.

## 5. IMS analysis with ISO 9001/14001/45001 and OHSAS 18001 in manufacturing

Chapter 5 illustrates the first two phases for undertaking the research project within CSO 2, specifically the analyses regarding:

- The transition of the QMS from ISO 9001:2008 to ISO 9001:2015 (Phase 1)
- The IMS based upon ISO 9001, ISO 14001 and OHSAS 18001/ISO 45001 (Phase 2)

Sub-chapter 5.1 shows how the gap analysis of the QMS against ISO 9001:2015 was conducted in CSO 2, as well as a presentation of gap closure suggestions. The analysis and suggestions regarding the IMS and its integration status are detailed in Sub-chapter 5.2.

### 5.1. ISO 9001:2008 to ISO 9001:2015 gap analysis

In CSO 2, the transition process to the new ISO 9001:2015 standard was in progress during the research. The IMS was majorly built upon the QMS, as it was the first MS implemented. It was also the first of the three MSs in the CSO's IMS that were chosen to be updated, possibly followed by the EMS (ISO 14001:2015) and OHS MS (ISO 45001:2018). Therefore, the QMS was the basis for future updates of the IMS, such as a potential integration of new MSs into the IMS. Quality-related sub-systems, like those based on ISO 10000 standards, are one example.

A gap analysis was performed based on the methodology presented in the IUMSS Handbook within "*Chapter 3.4 Connect MSS requirements and the MS*". The process described was adapted in order to compare the ISO 9001:2015 requirements to the CSO's existing QMS. The steps in the gap analysis included:

- Creation of a self-analysis table (Appendix C.6) to analyze changes between ISO 9001:2008 compared to ISO 9001:2015.
- Gathering of information on the QMS of the CSO, through the analysis of internal documentation, interviews with employees and meetings.
- Extension of the self-analysis table with the CSO specific information.

The first step is presented in Section 5.1.1, while the second and third steps are shown in Section 5.1.2.

Types and examples of gap closure suggestions for the QMS are illustrated in sections 5.1.3 and 5.1.4, respectively.

### 5.1.1. Analysis of changes between ISO 9001:2008 and ISO 9001:2015

The requirements of ISO 9001:2015 were used as the basis for the self-analysis table (Appendix C.6.). The term “element” mentioned in columns 1 and 2 of the table includes clauses, sub-clauses and sections of the ISO 9001 standards. All elements of ISO 9001:2015 were added into column 1. Only the element(s) from ISO 9001:2008 with overlapping requirements were included in column 2. In column 3, explanations on the changes that were identified between the requirements of the versions were added. Color-coding in column 1 helped to visualize which elements changed and which remained the same. Red indicates a new requirement, green stands for no changes between the requirements, white shows changed requirements and dark grey is used for an element without requirements (e.g. heading). An extract of the self-analysis is presented in Table 16:

**Table 16: Self-analysis of changes from ISO 9001:2008 to 2015**

1) ISO 9001:2015 element	2) ISO 9001:2008 element(S)	3) Changes 2008 to 2015 version)
5.2.1	5.3	The policy does not have to be a printed document. It has to be established related to Clause 4. The commitment to satisfy the applicable requirements and continual improvement of the QMS needs to be shown.
7.5.2	/	Includes detailed requirements as to how the documented information shall be created and updated.
9.1.2	8.2.1	Monitoring should reveal information on customer’s perceptions of the degree of fulfilment of needs and expectations.
9.3	5.6	N/A

The self-analysis revealed that some of the elements’ requirements remained the same. For example, only some wording changes were identified for the measurement of CS within Section 9.1.2 of ISO 9001:2015. Other requirements of ISO 9001:2008 were included in different elements of ISO 9001:2015, or were amalgamated. One example is Clause 7 that now includes



requirements of all supporting resources for the product realization (PR) process in one place. However, new requirements were also introduced, such as Sub-clauses 4.1 and 4.2.

### 5.1.2. CSO gap analysis for ISO 9001:2015

The self-analysis provided understanding of the changes between the two versions' requirements. Furthermore, it helped in the gap analysis between the CSO's QMS and the ISO 9001:2015 presented in this section. One reason was that the documents and processes in CSO 2 were based on the old version of the standard. For example, if a process in the CSO 2 had addressed two different elements of ISO 9001:2008 before this analysis and the requirements were merged into one element, the new requirement could be more easily related to the existing IMS documentation and/or process.

In order to perform an analysis between the CSO 2's QMS and the ISO 9001:2015 requirements, two more columns were added (Table 17):

- “Case study organization's IMS gap” (Column 4), and
- “Suggested actions”. (Column 5).

Column 4 was used for the identification of the gaps found. As proposed in an example within page 115 and 116 of the IUMSS Handbook, color-coding was applied to illustrate different gap types. Three different colors were chosen based on a traffic light color scheme:

- **Red** = Requirement not fulfilled
- **Yellow** = Requirement partially fulfilled, e.g. a process/document is in place, but it does not completely address the requirement
- **Green** = Requirement fulfilled through a process/document

After the identification of the gaps, the proposal of suggestions as described within Section 3.5.2 in the IUMSS Handbook followed. Column 5 was used to add suggested actions based on the gap identified in column 4. The suggestions pointed out possibilities on how to address the identified gaps and meet the requirements of the ISO 9001:2015 standard. Examples on how to address identified gaps based on the gap analysis in CSO 2 are presented in Sub-chapter 5.2.

Three different types of suggestions were:

- “New Process/Document/Flowchart” was suggested if:
  - A requirement had not been fulfilled, or
  - A requirement had been completely fulfilled but there was a possibility to introduce a new process/document/flowchart in order to improve the system.
- “Add/Change current Process/Document/Flowchart” was suggested if a requirement had been partially fulfilled.
- “Do Nothing” was suggested if a requirement had been completely fulfilled and no improvements were identified.

The major input for the new columns in Table 17 were the reviewed internal documentation of the CSO, as well as meetings and interviews with employees. Any IMS documents related to an ISO 9001:2015 element were added within column 4 of the table.

Table 17: CSO gap analysis

1) ISO 9001:2015 element	2) ISO 9001:2008 element(s)	3) Changes 2008 to 2015 version	4) Case study organization’s IMS Gap	5) Suggested actions
4.2	N/A	New requirement	Currently no process/document (ISO 9001 questionnaire questions three and four, no IMS document)	Implementation of a <b>new</b> process for identification of relevant interested parties to the QMS (IMS) and analysis of their requirements.
6.2		Includes details on how quality objectives need to be planned and how to achieve them	IMS document in CSO shows that a process is in place in order to establish quality objectives. (IMS document)	<b>Add</b> details on the planning of IMS objectives for example with a flowchart, as well as details on how to achieve the objectives
7.1.3	6.3	minor wording changes	Described in IMS manual	<b>Do Nothing</b>

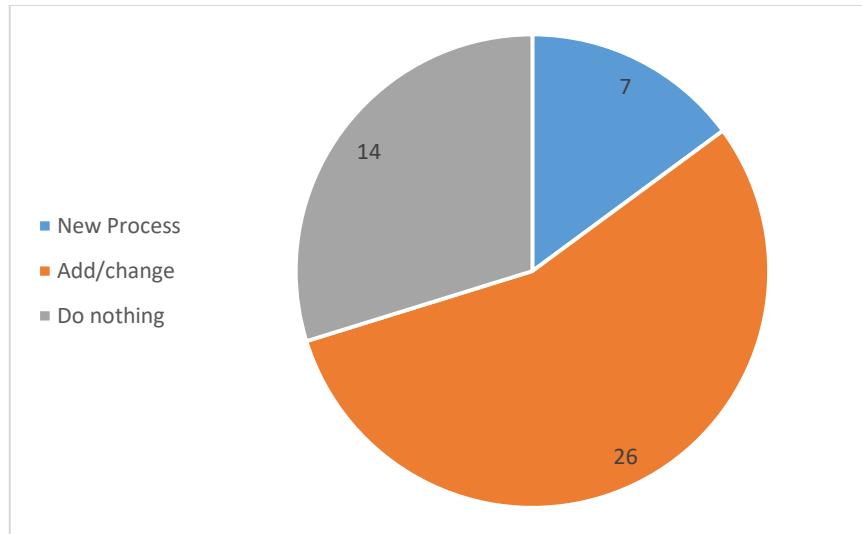
Table 17 (continued): CSO gap analysis

7.5.2		More requirements as to how the documented information shall be created and updated [7.5.2], including format and proper identification, review and approval for suitability and adequacy	Two IMS documents shows how documents and records are created	<b>Do Nothing</b> (Possibility of having one IMS document for both records and documents)
8.2.4	7.2.2	8.2.4 is an own clause, but was already included within 7.2.2	Included in IMS document	<b>Do Nothing</b>
8.5.2	7.5.3	minor wording changes	Described in IMS manual	<b>Do Nothing</b>
9.3	5.6.1	More inputs for management review require namely trends in CS, monitoring and measuring as well as the performance from external providers, adequacy of resources, and effectiveness of actions taken to address risks and opportunities.	Current management review inputs do not cover all new requirements	Update current management review process, by <b>adding</b> the new requirements

As anticipated, the gap analysis revealed that the majority of the newly introduced requirements in ISO 9001:2015 were not documented and addressed by CSO 2 at that time (i.e. Sub-clause 4.2 presented in Table 17).

### 5.1.3. Gap closure suggestions, distribution and examples

In total, 47 suggestions were made for the QMS. For each of the requirements addressed in the gap analysis, at least one suggestion was given. These were related to the type of the gap identified. Figure 8 shows the distribution of suggestions according to the type.



**Figure 8: Distribution of ISO 9001:2015 suggestion types**

For eleven ISO 9001:2015 elements multiple suggestions were provided. All of them were of the “add or change” type. Alternative suggestions were given when a requirement was stricter in the former version of the standard. This resulted in opening up different options for addressing a changed requirement. One example is the requirement for the management representative shown in Sub-section 5.3.1.1. The most frequent suggestion type (26) was “Add or Change”. New suggestions made up the least of the total. In addition, 30 % of the 47 suggestions were to “Do Nothing”.

#### 5.1.4. Sample suggestions of gap closures within CSO

Even though the gap closure suggestions focused on the QMS part of the IMS, a suggestion may also address the requirements of other standards related to the EMS and OHS MS parts. One example is Sub-clause 4.2 included in Table 17, as the expectations of interested parties may be considering three MSs’ interested parties, instead of QMS-related parties only.

Two different examples are chosen for demonstrating possible gap closure suggestions:

- “Context of the CSO” is represented in Sub-section 5.1.4.1. The two related sub-clauses (4.1 and 4.2) were chosen as they were newly incorporated in ISO 9001:2015.
- “Management representative” is shown in Sub-section 5.1.4.2. It is related to Section 5.1.1 of ISO 9001:2015. The requirement changed from ISO 9001:2008, as a

management representative is not explicitly required anymore. Three different possibilities are presented on how this requirement can be addressed.

#### 5.1.4.1. *Context of the CSO*

One new requirement of ISO 9001:2015 was Clause 4, addressing the “*context of the organization*”. Sub-Clause 4.1 requires the understanding of “[...]the organization and its context”, which includes the “*internal and external issues*” relevant to CSO 2. Sub-clause 4.2 requires the understanding of “[...] the needs and expectations of interested parties”, relevant to the QMS.

Information on Sub-Clauses 4.1 and 4.2 was gained through questions one, three and four in the ISO 9001 questionnaire (Appendix C.1). Interviews showed that neither of the requirements were currently addressed in CSO 2. For that reason, a new process was suggested. The process had two steps in order to meet both requirements that form the “context of the CSO” together.

Internal and external issues were analyzed in the first step of the process. The second step considered the interested parties. The joint review of interested parties and internal and external issues was suggested because the two processes impact one another. For example, if environmental laws changed (external issue) or the owners wanted to enforce stricter environmental policies (internal issue), there would be new governmental bodies or interest groups CSO 2 needed to consider in addition.

Whenever a change in the context occurs, there might be other processes in an IMS that require review. ISO 9001:2015 specifically refers to the following:

- Establishment of the scope (ISO 9001:2015 Sub-clause 4.3 a and b)
- Determination of opportunities and risks (ISO 900:2015 Section 6.1.1)

Both the information on the context of the CSO, as well as the needs and expectations of the interested parties had to be monitored and reviewed. However, as the standard details within Annex A.6, no physical document needed to be maintained.

The presented process allows CSO 2 to perform recurring analyses of the context, as well as to support continuous improvement.

#### 5.1.4.2. *Management representative*

The gap analysis revealed that ISO 9001:2015 does not specifically require one single person to perform the tasks of the management representative (ISO 9001:2008 Section 5.5.2). This offered more possibilities for CSO 2 to address the requirement. Therefore, the current operations in the CSO and the complexity of the QMS were important for gap closure suggestions. Two different internal documents (IMS manual and organizational chart) revealed that the CSO currently had a management representative for the QMS. Three different suggestions are presented in the following paragraphs.

The first suggestion was to maintain one management representative solely responsible for the tasks described in Section 5.1.1, as interviews showed that there were no issues with the current arrangement. One more requirement (ISO 9001:2015 Section 5.1.1 d) had to be included in the management representative's responsibility. This was why the suggestion type "Add/Change" addressed the gap closure. The additional task required to promote "[...] *the use of the process approach and risk-based thinking*" (ISO 9001:2015 Section 5.1.1 d).

The second suggestion was to address tasks in Section 5.1.1 of ISO 9001:2015 without a management representative for the QMS or the IMS. Aston (2016) recommended that key responsibility should be kept within the top management.

Finally, it would be possible to spread the responsibilities on a team of management representatives, as a growing IMS could be more easily managed by a team. An advantage of this solution was that multiple employees were responsible for the tasks. Therefore, if one employee was not available the responsibilities could simply be delegated to another person within the team of management representatives.

The presentation of three different suggestions showed that the requirements of ISO 9001:2015 within Section 5.1.1 could be tailored to the individual needs of the CSO. In general, a smaller organization could have a single person responsible for the tasks detailed within Section 5.1.1. However, one possibility was to spread the responsibilities for the QMS or the IMS within the organization, because expertise from multiple people could be needed for performing the tasks

related to the different MSs, e.g. EMS and OHS MS. For larger and more complex organizations, this would be recommendable.

## 5.2. Analysis of the IMS

The second phase of the research project studied the IMS. An IMS matrix (Table 18) was established to reveal the interrelationships of the three different MSs operated in the CSO. The IMS matrix was created using ISO 9001:2015, ISO 14001:2015 and OHS MS documentation, as well as methodology presented in the IUMSS handbook Section 3.4.3. The decision to use the new versions of ISO 9001 and ISO 14001 was based on the following considerations:

- Phase 1 of the research project addressed the transition to an ISO 9001:2015 based QMS
- The two ISO MSSs that are included in the IMS matrix are following the same high level structure (HLS)
- The CSO showed interest in transitioning to ISO 14001:2015.

The interrelated processes of the MSSs, as well as the current extent of the integration, i.e. how many processes of the three MSs are integrated, were identified within the IMS matrix (Table 18). After the presentation of the IMS matrix, Section 5.2.1 explains the findings on the IMS integration, followed by suggestions for addressing the integration of sample IMS processes.

Internal documentation from the CSO and information obtained through interviews on ISO 9001 (Phase 1 of the research project) helped to:

- Understand the current integration status of the IMS, as well as
- Formulate suggestions for possible integration of processes.

One example for an internal document used in the analysis was the IMS manual. It included three policies for each MS. It showed top management commitment for the all three MSs as well as an integrated mission statement. The OHS MS in the CSO was studied through internal documents, as the OHSAS standard was not available.

The IMS matrix was built upon the common HLS of ISO 9001:2015 and ISO 14001:2015 (see Column 1 in Table 19). The IUMSS handbook showed examples on tabular approaches to

identify commonalities between “MSS requirements impacted by the same MS process” (IUMSS handbook, Section 3.4.3). The next step was the identification of the impacted processes that related to the HLS Clauses. The third, fourth and fifth column present the requirements of each MSSs and how they related to the process(es) within the CSO (Column 2), whenever a corresponding requirement was present. If there was no information on a related requirement of a MSS available, “N/A” was added, as it was the case for the “Context of the CSO”. The sixth column explains the integration status of the IMS in the CSO. Three results were possible:

1. “No integration”, if none of the processes related to the MSS requirement were integrated with at least one other,
2. “Partial integration”, if one of the processes related to the MSS requirement was integrated with another process, and
3. “Full integration”, if all three processes related to the MSS requirement were integrated.

Based upon the information gained, suggestions were made in Column 7. Parts of the IMS matrix are shown in Table 18.

Table 18: IMS matrix (Examples from Clause 4, 6 and 7)

HLS[1]	Process within CSO [2]	ISO 9001 related element [3]	ISO 14001 related element [4]	OHSAS 18001 related element [5]	Integration status of IMS [6]	Suggestion [7]
Clause 4	“Context of the” CSO	4.1 and 4.2	4.1 and 4.2	N/A	No	Include environmental criteria (ISO 14001:2015 Sub-Clause 4.1) and interested parties for all MSs (ISO 14001:2015 Sub-Clause 4.1 and OHS)
Clause 6	“Establishing of Objectives”	6.2.1	6..2.1	4.3.3	No	Integration of establishment of objectives



Table 18 (continued): IMS matrix (Examples from Clause 4 and 6)

Clause 6	“Addressing Risks and Opportunities”	6.1.1	6.1	4.3.1	Partial (Risk management table does not cover all requirements of ISO 14001)	Address all risks and opportunities in risk management table, including the ISO 14001 requirements
Clause 7	“Training”	7.2	7.2	4.4.2	Partial (OHS training is provided and stored separately)	Include all training information in one database

More details on the results follow in Section 5.2.1, as well as suggestions on how to address the integration of processes in Section 5.2.2.

### 5.2.1. IMS status

This section shows the details on the integration status of the CSO’s IMS, based on the information gained through the IMS matrix. Secondly, integration possibilities corresponding to ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018 are demonstrated.

Even though the QMS and EMS were not certified to either of the new versions of ISO 9001 or ISO 14001 yet, some changes have already been made due to the upcoming certification audits. As a result, new processes and documents required by ISO 9001:2015 and ISO 14001:2015 were already partially integrated, for example risk management. Audits and management reviews were already fully integrated for all MSs. The full analysis revealed that, from the ten processes studied:

- One process was integrated for all three MSs, namely top management commitment.
- Five processes were partially integrated for all three MSs, meaning not all requirements of the clause in a standard were addressed. One example was the policy (HLS, Clause 5), as the policies themselves were established separately (ISO 9001:2015, Section 5.2.1 and ISO 14001:2015, Sub-Clause 5.2), but the communication of the policies was done in a joint IMS manual (ISO 9001:2015, Section 5.2.2 and ISO 14001:2015, Sub-Clause 5.2). Another example was the risk management presented in Section 5.4.2.
- One processes was not integrated between any of the MSs’ processes. This was the establishment of objectives.

- Three processes could only be analyzed for EMS and the QMS (no information on the OHS MS) and showed the following integration status:
  - Monitoring and measurement was a partially integrated process (ISO 9001:2015 and ISO 14001:2015, Clause 9), as not all requirements were addressed from sub-clause 9.1 within ISO 14001:2015.
  - Two of the process were not integrated related, namely to the establishment of product requirements in ISO 9001:2015 Clause 8 and the Context of the CSO related to ISO 9001:2015 and ISO 14001:2015 Clause 4.

The results showed that the operational areas like training of employees (ISO 9001 and 14001 Clause 7) or the definition of product requirement (ISO 9001 and 14001 Clause 8) were not integrated or were only partially integrated. Training was separated into general training for all employees (fully integrated) and a specialized training (not integrated), tailored to the position of the employees. Examples are special safety training and environmental emergency training.

Table 19 shows an extract from the analysis of the interrelationships of elements from ISO 9001, ISO 14001 and ISO 45001. Even though they follow the HLS with the same clause structure, some elements differ within the level of sub-clauses (e.g. 4.2), section (e.g. 8.2.1) and sub-sections (e.g. 7.1.5.1). The number of MSSs with the same elements is visualized through three different colors: red for one MSS, yellow equals two MSSs, and green for all three MSSs.

**Table 19: Integration of requirements from ISO 9001, ISO 14001 and ISO 18001**

ISO 9001	ISO 14001	ISO 45001			
6.1	x	6.1	x	x	8.1.2
x	6.1.1- 6.1.4	6.1.1 - 6.1.4	x	x	8.1.3
6.2	6.2	6.2	x	x	8.1.4
x	6.2.1	6.2.1	9	9	9
x	6.2.2	6.2.2	9.1 – 9.1.2	9.1 – 9.1.2	9.1 – 9.1.2
6.3	x	x	9.1.3	x	x
7.1	7.1	7.1	9.2	9.2	9.2
7.1.1 - 7.1.6	x	x	x	9.2.1	9.2.1
7.2 – 7.4	7.2	7.2	x	9.2.2	9.2.2
x	7.4.1 – 7.4.3	7.4.1 – 7.4.3	9.3	9.3	9.3
7.5	7.5	7.5	9.3.1	x	x
8.1	8.1	8.1	9.3.2	x	x
x	x	8.1.1	9.3.3	x	x
			10	10	10

For the elements not included in Table 19, the following findings were shown. All elements from Clause 4 have overlapping requirements: Sub-clauses 4.1, 4.2, 4.3 and 4.4. In Clause 5, Sub-clause 5.4 is not included in ISO 14001. Clause 8 has a lot more requirements included in ISO 9001. For example, Sub-clause 8.2 includes four sections, whereas ISO 14001 and ISO 45001 include no sections on this sub-clause. Sub-clauses 8.3, 8.4 and 8.5 are not included in ISO 14001 and ISO 45001 at all.

This table could be used by the CSO when deciding what processes described in the MSSs should be integrated. A decision on the integration, for example for the “Context of the CSO”, could be different if the CSO knew that ISO 45001 had an overlapping requirement. For example, CSO 2 might integrate the process fully so a further transition to ISO 45001 would already be partially addressed. Same applied to the risk management tool, in which the requirements of ISO 45001 could be included, even though it might not be required by OHSAS 18001.

#### 5.2.2. Example suggestions for IMS integration

In the following section, two example suggestions on the integration of processes based on the finding from the IMS matrix are presented. Furthermore, an improvement of a currently partially integrated IMS process in the CSO is shown.

No change was suggested for special training of individual employees, based on two considerations:

1. It would not be economical to train all employees on specific tasks, if their position was not related to the certain area. For example, a receptionist is not working within the assembly line and therefore training on safety procedures for transporting glass would not be required.
2. Certain areas, e.g. special safety procedures or response actions for environmental emergencies, required specialized departments or employees who are experts in their field and had the required knowledge to provide adequate training. The appointment of employees with the needed competences was also related to requirements in Sub-Clause 7.2 of ISO 9001:2015 and ISO 14001:2015.

Additional suggestions regarding the integration of training were provided to CSO 2.

A second example was the establishment of objectives (ISO 9001:2015 and ISO 14001:2015 Section 6.2.1). The process in CSO 2 was not integrated, as it was conducted for each MS separately. The integration of the process was suggested, because the different MSs relate to each other, which could be seen in the IMS matrix. Furthermore, the establishment of any MS objective, for either a certain MS or the entire IMS, could be influenced from all MSs operated in the CSO.

In the third example, the improvement of a risk management table is presented. This table was in its development stage at the CSO, while the research project was conducted. It included assessment of risks related to the QMS and EMS. The risks incorporated in the table had to be rated for their severity and response actions needed to be identified. Sub-clause 6.1 of ISO 9001:2015 and ISO 14001:2015 was used to check compliance with the requirements of the standards. The parts of the sub-clauses that were not met can be addressed through the following changes to the risk management table:

- Consideration of risks and opportunities instead of identifying risks alone (ISO 9001:2015 and ISO 14001:2015 Sub-Clause 6.1)
- Addition of OHS related risks, and
- Inclusion of environmental compliance obligations in the ratings (ISO 14001:2015 Section 6.1.3)

This section gave examples on the possible integration of partially, as well as not integrated processes in a CSO. Furthermore, the enhancement of an existing tool in order to fulfill both the requirements of ISO 9001:2015 and ISO 14001:2015, as well as additionally including the OHS risks and opportunities is shown.

### 5.3. Summary

Sub-chapter 5.1, 5.2 and 5.3 addressed Phase 1 of the research project. A gap analysis was presented that shows the analysis of the changes from ISO 9001:2008 to ISO 9001 (Sub-chapter 5.1). Color-coding was used to show the changed requirements of the standards, as well as the identification of the different types of gaps. The created self-analysis table was then extended to

enable a gap analysis for any organization that intends to transition from ISO 9001:2008 to ISO 9001:2015. This was achieved through the inclusion of a column for adding company specific information on the status of the IMS, as well as a column for the formulation of gap closure suggestions. The usage of the table for the analysis of a CSO in windows and doors manufacturing made it possible to present results on the distribution of the gap closure suggestion types used for the gap analysis. Two different examples of gap closure suggestions suggested for the CSO were presented.

Phase 2 of the research project was detailed in Sub-chapter 5.2. An IMS matrix was created based upon the requirements of ISO 9001:2015, ISO 14001:2015 and the OHS MS documentation. Findings from the research project related to the IMS integration status of the IMS are given. Additionally, sample suggestion are shown on how to address processes that were not or only partially integrated. In addition, a table was established to show the interrelationships of ISO 9001:2015, ISO 14001:2015 and ISO 18001:2018.

The following chapter shows the implementation of augmenting standards (ISO 10001/2/3/4) based upon current CSAPs within the CSO. Furthermore, an integration methodology for a MS based upon ISO 10001/2/3/4 into an existing IMS are detailed.

## 6. CSAPs analysis with ISO 10001/2/3/4 in manufacturing

Chapter 6 presents findings related to Phase 3 and Phase 4 of the research project within CSO 2 addressing:

- Analysis of CSAPs with ISO 10001/2/3/4 (Phase 3)
- Integration of an ISO 10001/2/3/4 MS into the existing IMS (Phase 4)

Sub-chapter 6.1 presents the analysis of the CSAPs in CSO 2, as well as suggestions for their standardization. In Sub-chapter 6.2, a tabular approach is presented on how integrative augmentation can be performed with an existing IMS.

### 6.1. Analysis of current CSAPs within the CSO

This sub-chapter presents the analysis of CSAPs within CSO 2 including the presentation of how data on CSAPs was gathered and analyzed (Sections 6.1.1 and 6.1.2), as well as suggestions for standardizing CSAPs through the usage of ISO 10001/2/3/4 guidance (Section 6.1.3).

#### 6.1.1. Gathering of information on CSAPs

The initial step in the CSAP analysis was the identification of requirements in ISO 9001:2015 that were related to CSAPs operated in the QMS of CSO 2. These findings were then used in the second step for the identification of:

- The IMS documentation on the CSAPs, and
- Potential employees and departments that could provide knowledge of CSAPs.

Following this identification, the third step included the analysis of the available documentation and conducting interviews. The fourth step was the establishment of the relationships between CSAPs in CSO 2 and ISO 10001/2/3/4.

Table 20 shows the customer-related ISO 9001:2015 elements connected to the CSO's IMS. Elements in bold were included in Column 1 as suggested in Appendix B.1 of ISO 9001:2015. All other elements from Column 1 were incorporated through the analysis in CSO 2, because they were related to areas such as customer focus, customer communication and post-delivery

activities. This analysis could be used as a generic representation of elements from ISO 9001:2015 that relate to CSAPs in any organization.

**Table 20: ISO 9001:2015 clauses related to CSAPs within CSO 2**

ISO 9001:2015 elements	Relationship to CSAPs within CSO 2
5.1.2	Customer focus of top management
5.3	Responsibilities related to CS defined in the IMS manual
7.2	Customer communication training
8.2.1	Procedures for scheduling of customer appointments Procedures specifying how to approach customer
8.2.2	Customer requests and communication of requirements
8.4.2	Customer’s feedback on performance of an external provider
8.5.5 & 8.7	Follow-up phone calls, email surveys recently established, no IMS document
9.1.2	Customer surveys through follow-up phone calls
9.1.3	Analysis of customer comments
9.3	Analysis of customer concerns and continuous improvement

After the identification of eleven ISO 9001:2015 elements shown in Table 20, interviews were scheduled. Employees were interviewed through the ISO 10000 questionnaires. These interviews helped to obtain information that:

- Described current processes, documents or flowcharts from the IMS that related to elements of ISO 10001/2/3/, and
- Aided with the provision of suggestions on augmenting the current IMS through the guidelines of ISO 10001/2/3/4.

The IMS documentation additionally helped to verify information received through interviews, for example, when employees mentioned a customer guarantee but did not know about internal documentation describing it.

### 6.1.2. Analysis of information

Within the analysis of questionnaires, it was not always possible to analyse each CSAP separately, for example, if employees provided information related to elements of another ISO 10000 standard. This is because the standards are addressing closely related topics and are interrelated (shown later in Section 6.2.1).

The ISO 10000 questionnaires were used to summarize and sort the relevant information gathered in interviews and internal documentation, because the majority of questions were related to an ISO 10001/2/3/4 element. After the information was structured, a gap analysis was performed that compared the CSAPs with the guidance provided in ISO 10001/2/3/4. Furthermore, the gap analysis was the basis for suggestions on the establishment of ISO 10001/2/3/4 related MSs.

### 6.1.3. Individual augmentation suggestions for ISO 10001/2/3/4

The suggestions for ISO 10001/2/3/4 were provided separately for each MS in this stage as opposed to an integrated augmentative CS system (IACSS). This decision was made to allow an individual look at the different ISO 10001/2/3/4 MSs. CSO 2 would also be able to understand what the different MSs include and make a decision on how many should be implemented.

There were no standardized operations for the CSAPs investigated, which resulted in a lack of internal documentation. The identified areas in the IMS that already addressed certain elements of the standards were shown in Table 20. Therefore, this part of the study relied mostly on interviews conducted with the questionnaires (Appendix C.2-C.5).

Another consideration was that, if standards were to be implemented in sequence, the better-established CSAPs in CSO 2 could be implemented first and more quickly. Those MSs could later be used as the basis for the integration of more ISO 10001/2/3/4 MSs.

For each of the four ISO 10000 standards, the related CSAPs in the CSO were identified. Sections 6.1.4 to 6.1.7 first show the status of each CSAPs, followed by the potential suggestions for the standardization with ISO 10001/2/3/4 guidance.



### 6.1.3.1. ISO 10001

The ISO 10001 questionnaire (Appendix C.1) was used to gain information on the current state of CS guarantees. Two CS codes were present (Table 21). One of them was included in the internal documentation. Interviews showed that CS codes were known by certain interviewees only. No common knowledge was present for either the customer response code or the resolution of complaints code.

**Table 21: Promises in CSO 2**

CS code	Details on CSAPs
Customer response code	Responding by emails or fax within a certain time, for internal and external customers inside business hours. IMS document is present and includes the promise and details on the responsibilities.
Resolution of complaints	Guaranteed resolution of a complaint in a specified amount of time for customers with high purchase volume. Recently established and therefore no IMS documentation. Top management is committed to this customer code.

To show how elements of ISO 10001 were addressed by an unstandardized CS code the CSO had in place, the first example from Table 21 will be used. Details on the three requirements of ISO 10001 that have been addressed and related suggestions for addressing Clause 6 are shown in Table 22.

**Table 22: Customer response code conformance related to ISO 10001**

ISO 10001 elements	Addressed in CSO	Actions needed	Source
6.1	Yes	No action needed, the objective is stated in the IMS document.	IMS document
6.2 – 6.3	No	Gather information necessary for code establishment including those from interested parties.	Interviews

Table 22 (continued): Customer response code conformance related to ISO 10001

6.4	Partially	Code does not meet all requirements. It states the purpose and scope of the course, as well as limitations and key terms used in the code.  However, there is no explanation on who is responsible when complaints about the code arise or what actions will be taken.	IMS document  Interviews
6.5	No	Performance indicators have to be established for the code.	
6.6	Partially	The code itself is prepared and included in the documentation.  Details on code procedures should be expanded and included in the IMS document.	
6.7	No	Establishment of internal or external communication plan	
6.8	No	Determination of resources for the code.	

Only three elements from Clause 6 of ISO 10001 have been addressed or partially addressed (Figure 9). All other elements related to Clauses 4, 5, 7 and 8.

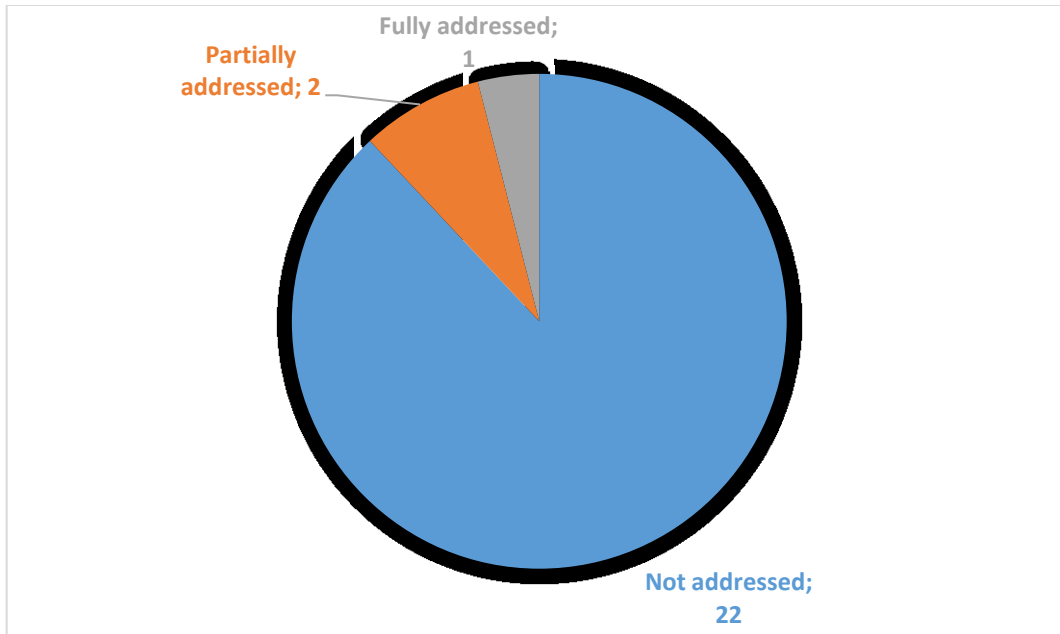


Figure 9: ISO 10001 elements addressed through customer response code

This analysis showed that the usage of ISO 10001 leads to a more structured approach when establishing a CS code, as only three sub-clauses of ISO 10002 were addressed by CSO 2. The code analyzed did not cover core parts for supporting the framework around the CS codes. One example is external and internal communication, which is a process ISO 10001 demonstrates, but that was not established in CSO 2. Furthermore, the code did not include details on actions for when the code was not fulfilled or CS measurements related to the code performance.

#### 6.1.3.2. ISO 10002

The investigation for CSAPs related to feedback and complaint handling (FCH) was performed with the developed ISO 10002 questionnaire (Appendix C.3) and internal documentation. As there was no FCH documentation found in the analysis, three processes related to FCH were identified through interviews: follow-up survey calls, follow-up emails and meetings. The results of the analysis of one such element, the meeting with customers are detailed.

The implementation process for MS based on ISO 10002 is presented in Clause 7 of ISO 10002. It specifies the receiving, tracking, assessing, investigating, responding and closing of complaints. This process will be referred to as “core process”. The meetings addressed the elements 7.1, 7.2 and 7.7 partially. No elements related to the core process were addressed.

Figure 9 presents how a FCH process for meetings could be structured. The core process suggested is generic and could be used by any organization interested in the standardization of meetings or discussion with customer related to FCH.



**Figure 10: FCH process based upon ISO 10002 Clause 7**

The support processes in Clauses 4, 5, 6 and 8 were largely not addressed. From the nine guiding principles in Clause 4, six could be studied. No information related to compliance with Sub-clauses 4.4, 4.5 and 4.7 could be found. An overview of all 33 sub-clauses from ISO 10002 that were addressed by the meetings are shown in Figure 11.

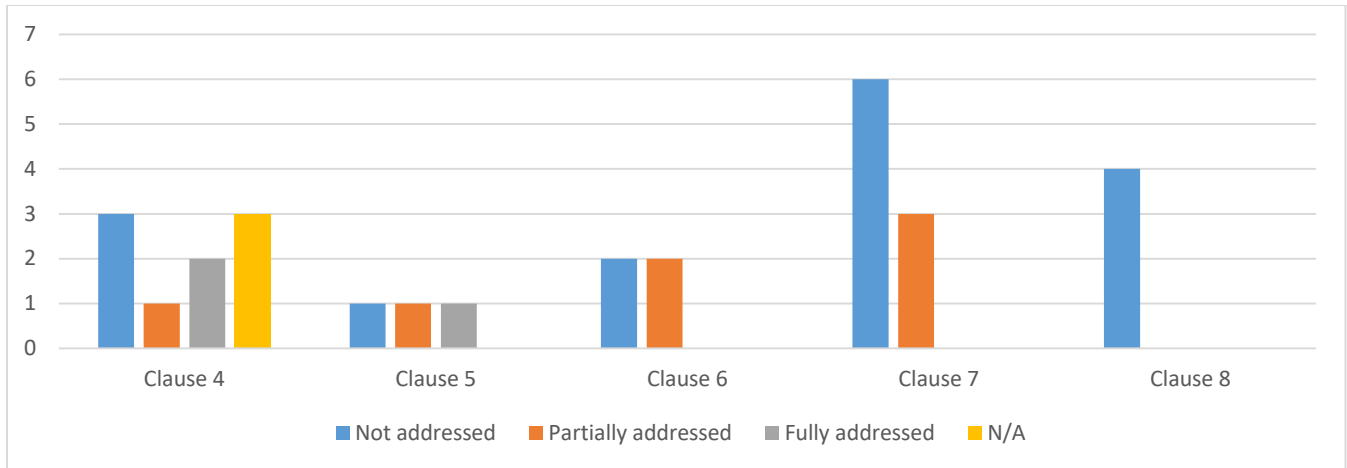


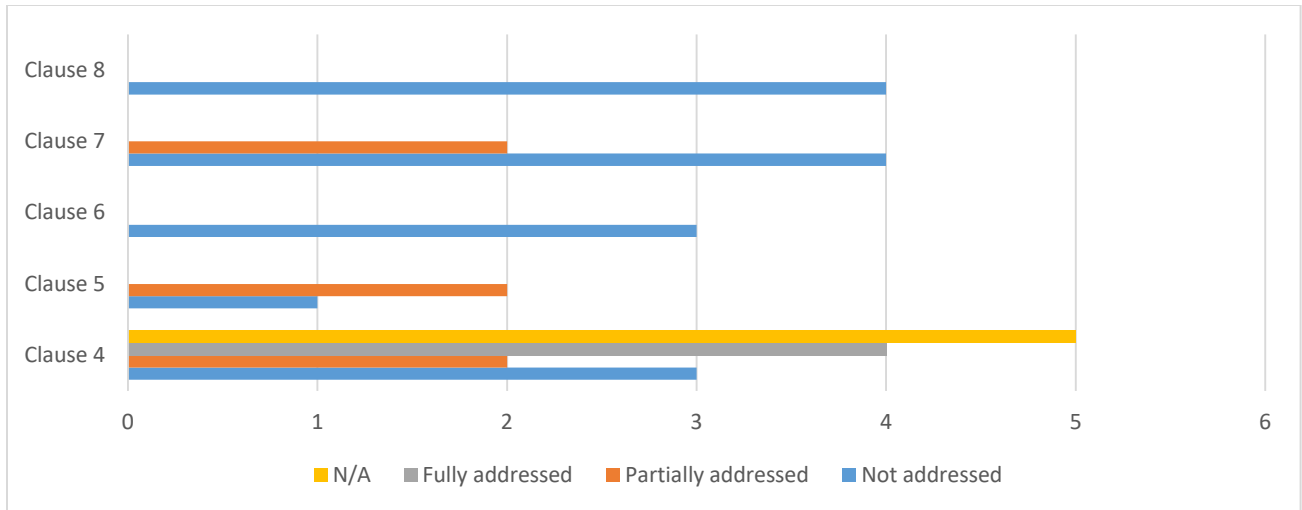
Figure 11: ISO 10002 elements addressed through meetings in CSO 2

Figure 10 shows that Clause 8 for maintaining and improving the meetings was not addressed at all. From all other clauses, half of the sub-clauses were not addressed. The addressed requirement in Clause 5 was the commitment to the meetings.

Suggestions on the supporting processes were provided to CSO 2 in a report and relied on the identification of the gaps from the current CSAPs compared to the ISO 10002 requirements. However, it is obvious that many new elements had to be considered for the standardization of the meetings as a FCH process.

#### 6.1.3.3. ISO 10003

The investigation for CSAPs related to EDR was conducted with the ISO 10003 questionnaire (Appendix C.4). Only two interviewees were able to provide information on how EDR was carried out at the CSO and no internal documentation was present. The interviews revealed that CSO 2 had an EDR provider selected (ISO 10003 questionnaire, Question 1), which partially addressed requirements of Sub-clause 6.4. From 29 sub-clause elements of ISO 10003, eight were addressed. Four of these were guiding principles (Clause 4). The other four were partially addressed elements from Clauses 5 and 7 (Figure 12)



**Figure 12: ISO 10003 elements addressed through EDR process**

An example process that could guide any organization that already has an EDR provider, just like CSO 2, in the establishment of an ISO 10003 MS, is visualized in Figure 13. Step 1 includes the collection of information related to the existing EDR process. Step 2 shows the structuring of the information related to the ISO 10003 elements. In Step 3, the elements of ISO 10003, which CSO 2 did not address as an example, are indicated in brackets. Lastly, the identified gaps should be addressed with actions to conform to ISO 10003.

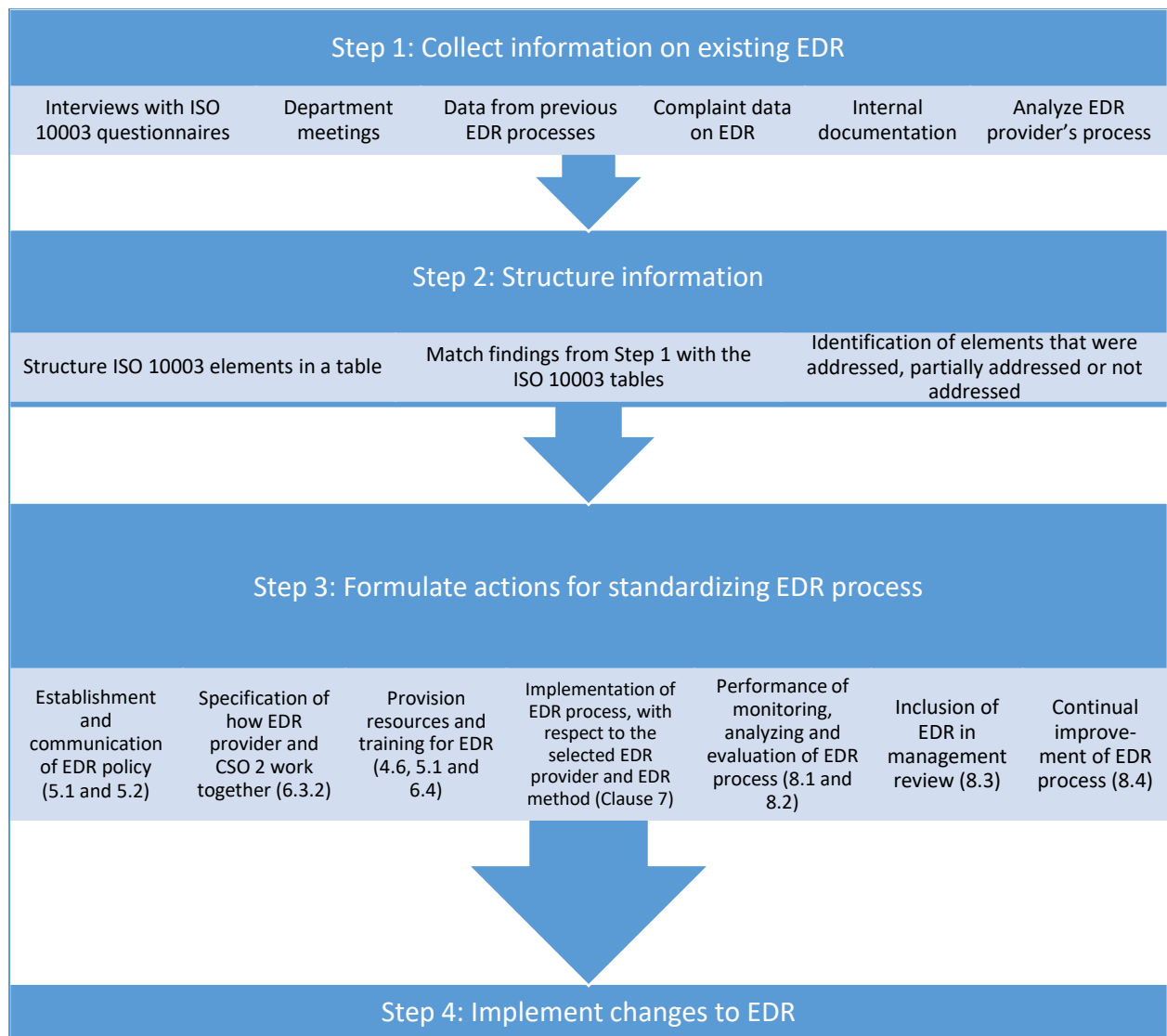


Figure 13: Process for analysis of a current EDR process with ISO 10003

Based on this analysis, an organization could implement changes to the current EDR process in order to establish an MS based upon ISO 10003.

#### 6.1.3.4. ISO 10004

CS measurements were analyzed through the ISO 10004 questionnaire (Appendix C.5.), as no corresponding procedure was found in the analysis of IMS documentation. Interviews revealed that CS measurement were introduced within the CSO shortly before conducting the research. Table 23 shows, which elements of Clause 6 and 7 of ISO 10004 were addressed by follow-up survey calls.

Table 23: Follow-up survey calls conformance with Clause 6 and 7 of ISO 10004

ISO 10004 sub-clauses	Addressed by follow-up survey calls in CSO	Details on CSAPs
6.1	No	Formulation of objectives and the purpose of the CS measurements
6.2	Fully	The sampling period is one month. A list for completed services is printed according to which the customers are called.
6.3 and 6.4	Partially	Resources are provided for conducting measurements, but “planning, monitoring and measuring” (ISO 10003, Sub-clause 6.4) resources also need to be considered.
7.1 and 7.2	No	The processes in Sub-clause 7.1 that were not addressed are described in detail in Sub-clauses 7.3–7.6. Sub-clause 7.1 of ISO 10004 gives an overview.  CS data is gathered, but the expectations of the customer need to be identified.
7.3, 7.4	Partially	Follow-up survey calls are performed for customer within a month after sale or service.  Data is collected in electronic document and presented to top management. No standardized analysis of the data.
7.5 – 7.6	No	Data on CS should be available to relevant functions of CSO 2.

The feedback calls partially addressed five elements of ISO 10004. This analysis was conducted for all methods the organization used for the purpose of CS measurement. The feedback calls was the most structured approach. The measurement methods, including feedback calls, should be continued and carried out alongside each other.

Within Sub-chapter 6.2, a methodology and suggestions for the integration of a MS based upon the ISO 10001/2/3/4 standards into an existing IMS will be shown.



## 6.2. Integration of ISO 10001/2/3/4 MS into the existing IMS

In Phase 4 of the research project, augmentative integration with four MSs is explained based upon ISO 10001/2/3/4 and information on the existing IMS. The integrative augmentation analysis is conducted through three different steps:

1. Analysis of the interrelationships of ISO 10001/2/3/4 requirements (Section 6.2.1)
2. Interrelations of ISO 10001/2/3/4 with ISO 9001:2015 (Section 6.2.2)
3. Integration possibilities for an ISO 10001/2/3/4 based MS into the CSO's IMS (6.2.3)

The first step of the integrative augmentation analysis is presented in the following section.

### 6.2.1. Interrelationships of ISO 10001/2/3/4

In order to connect requirements of the ISO 10001/2/3/4 augmenting CS standards Table 24 was created. This was done within step 3 of the preparation process and therefore prior to the start of the research project process (Chapter 3, Section 3.2.1, Table 9).

**Table 24: Interrelationships of ISO 10001/2/3/4**

Requirement	ISO 10001 element(s)	ISO 10002 element(s)	ISO 10003 element(s)	ISO 10004 element(s)
Policy		5.2	5.2	
Provision of resources	4.3 and 6.8	6.4	6.4	6.4
Process Audit		8.5		

The requirements analyzed for its interrelationships are shown in the first column of Table 24. The light grey shadings in Columns 2-4 indicate an ISO 10001/2/3/4 requirement described in the standard that was related to another ISO 10001/2/3/4 processes within a row. All shaded columns in a row therefore illustrate processes that could be integrated. For example in the second row of Table 24, the common requirement analyzed was “*provision of resources*”. As the provision of resources is required by all four ISO 10000 standards, all four boxes in a row (ISO 10001/2/3/4) were shaded grey.

Table 24 helped to demonstrate the interrelationships and various integration possibilities to the CSO when using MSs based upon ISO 10001/2/3/4. The extent of the integration, i.e. how many of the related ISO 10001/2/3/4 processes should be integrated, can be decided within the CSO. Some factors that influence the extent of integration might be the departmental structure, management commitment, current operations and current needs of the CSO. Within the next section, the interrelationships of requirements from ISO 10001/2/3/4 and ISO 9001:2015 are analyzed.

### 6.2.2. Integration of ISO 10001/2/3/4 with ISO 9001:2015

In order to analyze the interrelationships of ISO 10001/2/3/4 with an IMS that was based upon ISO 9001:2015, Table 25 was created. The table was based upon Table 24 presented in Section 6.2.1. ISO 9001:2015 requirements were chosen to form the basis for the integrative augmentation. This decision was made based on the following considerations:

- Phase 1 and 2 of the research study in the organization showed that the IMS was largely built upon the QMS.
- ISO 10001/2/3/4 are QM-related standards.
- CSO 2 will seek certification to the 2015 version of ISO 9001 out of the first of all updates.

ISO 9001:2015 clauses were added through a new column (column 1) within Table 23. This helped to connect the requirements of ISO 10001/2/3/4 to the QMS processes, based upon ISO 9001:2015 clauses, of the IMS.

Table 25: Integration table for related elements of ISO 10001/2/3/4 and ISO 9001:2015

ISO 9001:2015 element	ISO 10001 element	Comment	ISO 10002 element	Comment	ISO 10003 element	Comment	ISO 10004 element	Comment
Section 5.1.2 (Policy)			5.2		5.2			
Section 9.1.2 (Monitoring of CS)	8.3		8.3		7.6			Entire standard is related to CS measurement

Table 25 provides an example of two ISO 9001:2015 requirements and their overlaps with the guidance provided in ISO 10001/2/3/4. For example, in row two the “monitoring of CS” was identified as a process related to all four ISO 10000 standards. The grey shading visualized the overlaps of requirements from the ISO 10001/2/3/4 standards with ISO 9001:2015. Columns for comments on each overlap were included for ISO 10000 elements, where additional information was needed to explain the overlap. Within Section 6.2.3, this table is further developed in order to analyze how a current IMS could be augmented with the ISO 10000 standards at any type of organization.

### 6.2.3. Connecting ISO 10001/2/3/4 MSs to the CSO’s IMS

Table 25 was used as the base for the analysis of the ISO 10000 integration to the existing IMS of the CSO. In order to show the possibly extent of the integration, i.e. how many processes were chosen to be integrated to the existing MS, column 10 and 11 were added. Up to column 11 the data entered within Table 26 could be used by any organization, as it is not specific to a company, compared to the last three columns.

The expansion of the table with column 11 and 12, as well as the inclusion of three company specific columns (columns 12-14) enabled to:

- Show the possible extent of the integration (column 10 and 11)
- Identify gaps when comparing the requirements of ISO 10001/2/3/4 to the processes in the CSO (column 12)

- Include details of the current CSAPs (column 13), and
- Formulate suggestions on how to perform IACSS integration, based on the integration extent.

Table 26 shows the added columns (12, 13 and 14) that are organization specific. Examples from findings in CSO 2 are given in Table 27 in Sub-chapter 6.3.

Table 26: Gap analysis table for ISO 10001/2/3/4 and a CSO IMS

1. ISO 9001:2015	2. ISO 10001	3. Details of Overlap	4. ISO 10002	5. Details of Overlap	6. ISO 10003	7. Details of Overlap	8. ISO 10004	9. Details of Overlap	10. Integration possibilities (min)*	11. Integration possibilities (max)	12. Addressed in CSO	13. Details of current CSAPs	14. Suggested for IACSS integration
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“Integration possibilities (min)” means that only ISO 10000 standards with the specific requirement are included. “Integration possibilities (max)” also considered the standards that were applicable but do not have the specific requirement Color-coding was used to identify the integration possibilities within Column 2-9. Five colors were chosen to indicate the relations between the clauses of the augmenting standards with ISO 9001:2015.

- **Yellow** = Augmenting standard is directly related to the ISO 9001:2015 clause
- **Orange** = Augmenting standard has less/more requirements but is related to the ISO 9001:2015 clause
- **Red** = not required by the standard
- **Pink** = indirectly related to the ISO 9001:2015 clause
- **Black** = not related to the ISO 9001:2015 clause

It was important to differentiate between “required” and “related” clauses when showing the possibilities of integration. A clause that is not related does not have potential to be integrated, compared to a clause that is not required. When a clause is not required it can still be additionally be considered for integration. One example is the policy, which is not required by ISO 10001 and ISO 10004 but it can be included in a common IACSS policy. Black was chosen for “not

related” requirements, as it would make it visible that this clause is not used for any integration in the table. Green, orange and red were used as they are commonly known from an ample scheme, green indicating a requirement that is directly related, red a color for “alarm or stop”, therefore used for a requirement that was “not required by the standard” and orange when the ISO 10000 standard has less or more requirements for the process.

Columns 10-14 were separated from the universal table through a thick line, as they addressed the possibilities for integration of the ISO 10000 standards within a specific organization. The first column “Integration possibilities (min)” indicates, which clauses of the standards that was required, could be integrated, therefore the minimum. The second column “Integration possibilities (max)” shows the possibilities for integration whenever a standard did not specifically state a requirement, but it could be part of the IACSS. One example was training, as a training is required by ISO 10001, 10002 and 10003, therefore the minimum integration could be a training based on the requirements of these three standards. However, if CSO 2 chose to go over the requirements of ISO 10004 it could include a training for CS measurements in this integrated training process. Therefore, a maximum of four MSs could be suggested for integration.

In Column 12, color-coding was used to show how far the company is addressing the ISO 10001/2/3/4 requirements. The analysis performed for the ISO 10001/2/3/4 individually in Sub-chapter 6.1, was the basis for entering the colors. Red was not “not addressed”, orange is “partially addressed and yellow is “fully addressed” the ISO 10001/2/3/4 requirements.

The CSAPs comparison to requirements of ISO 10001/2/3/4 in Sub-chapter 6.1 helped to formulate suggestions for the integration into the existing IMS.

### 6.3. Results of the integration suggestions

The results of the integrative augmentation based upon table 26 showed that 20 elements out of all addressed ISO 9001:2015 elements could be connected with at least one ISO 10001/2/3/4 element.

Half of the integration suggestions were on the integration of all four MSs. The other half suggested the integration of the IMS with one single MS process based upon ISO 10001/2/3/4. The elements from ISO 10001/2/3/4 that were not in the table did not relate to the existing IMS.

For seven of the interrelated elements identified in Table 24, the current IMS did not address elements from the ISO 10001/2/3/4 standards. The other thirteen times the current IMS partially addressed, i.e. not to the full extent, ISO 10001/2/3/4 guidance.

When relating the integration suggestions to the gaps in Column 12, it showed that sixteen out of twenty addressed processes could be integrated with the existing IMS. For the rest a new process or document was suggested.

Figure 14 shows the relation of the gap between the IMS and the requirements for ISO 10001/2/3/4 and the given suggestion to address the integration.

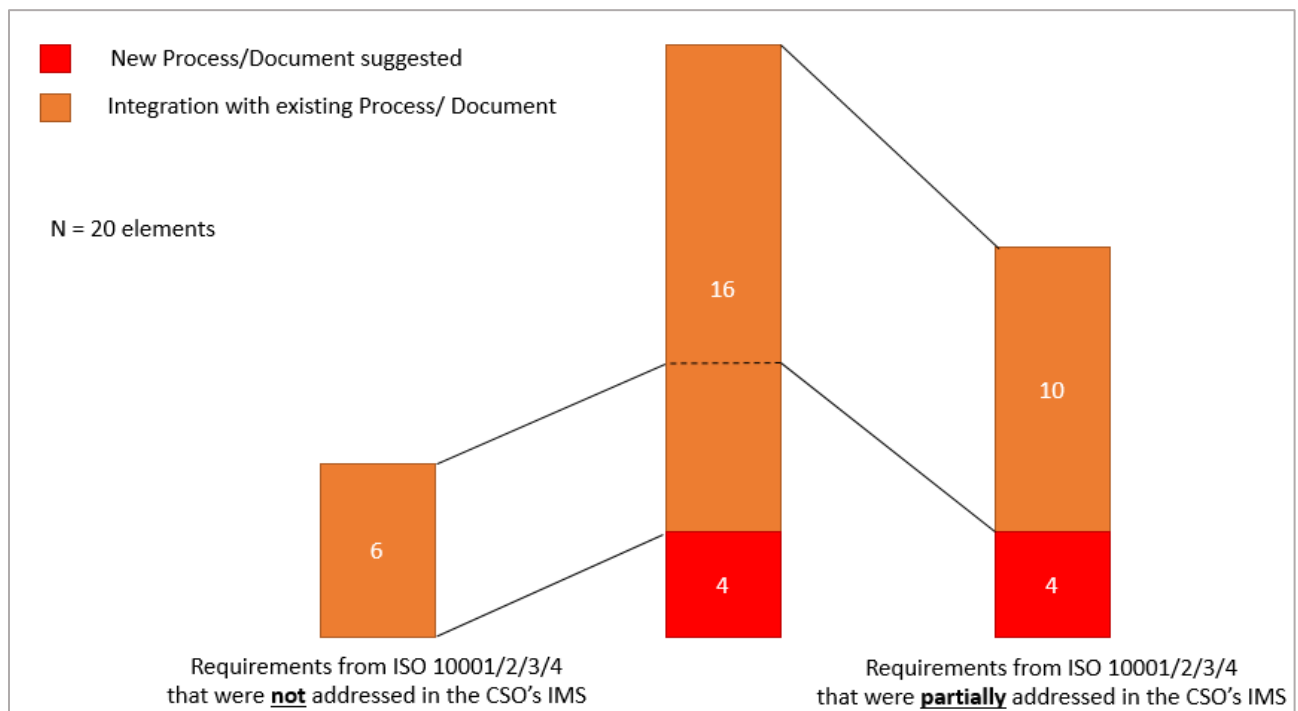


Figure 14: Relationship between IMS and ISO 10001/2/3/4 gap and integration suggestion

Within Table 28, the supporting processes for the IACSS will be detailed. This table was related to the existing processes of the IMS in CSO 2. Therefore, Table 28 was used to base the suggestions for the integration of the processes.

Clause 7 was addressed separately as it differed from the other clauses. It forms the core process of the ISO 10001/2/3/4 standards, similarly to the product realization process in ISO 9001:2015 and only related to Section 9.1.2 of ISO 9001:2015. Figure 15 illustrates a flowchart, which shows how an IACSS could be set up according to the requirements of ISO 10001/2/3/4.

Table 28 shows the results for augmenting the existing IMS with an IACSS based upon the requirements of ISO 10001/2/3/4. The complete table with the detailed clauses and comments can be found in the Appendix F.

**Table 27: Supporting processes for IACSS integration into the CSO IMS**

Process in CSO 2 and corresponding IMS MSS	Related ISO 10001/2/3/4 MSSs	Additional ISO 10000 MSSs with integration potential	ISO 10001/2/3/4 elements addressed	Suggestion for integration of IACSS supporting processes into the CSO 2 IMS
IMS Policy (ISO 9001/ISO 14001/OHSAS 18001)	10002 10003	10001/ 4	No	<ul style="list-style-type: none"> <li>• Joint policy for IACSS, addressing ISO 10001/2/3/4. Inclusion of the policy into existing IMS policy.</li> <li>• The policy could cover the whole system, even though ISO 10001 and ISO 10004 do not specifically require a policy.</li> <li>• The policy review could be performed within the management review.</li> </ul>
Customer focus, Top Management Commitment (ISO 9001/ISO 14001)	10001 10002 10003 10004	10001/ 2/3/4	Partially	<ul style="list-style-type: none"> <li>• Top management commitment to the IACSS could be shown through the IMS manual.</li> <li>• Additionally, inclusion of commitment on the homepage or other media channels for customers</li> </ul>

Table 28 (continued): Supporting processes for IACSS integration into the CSO IMS

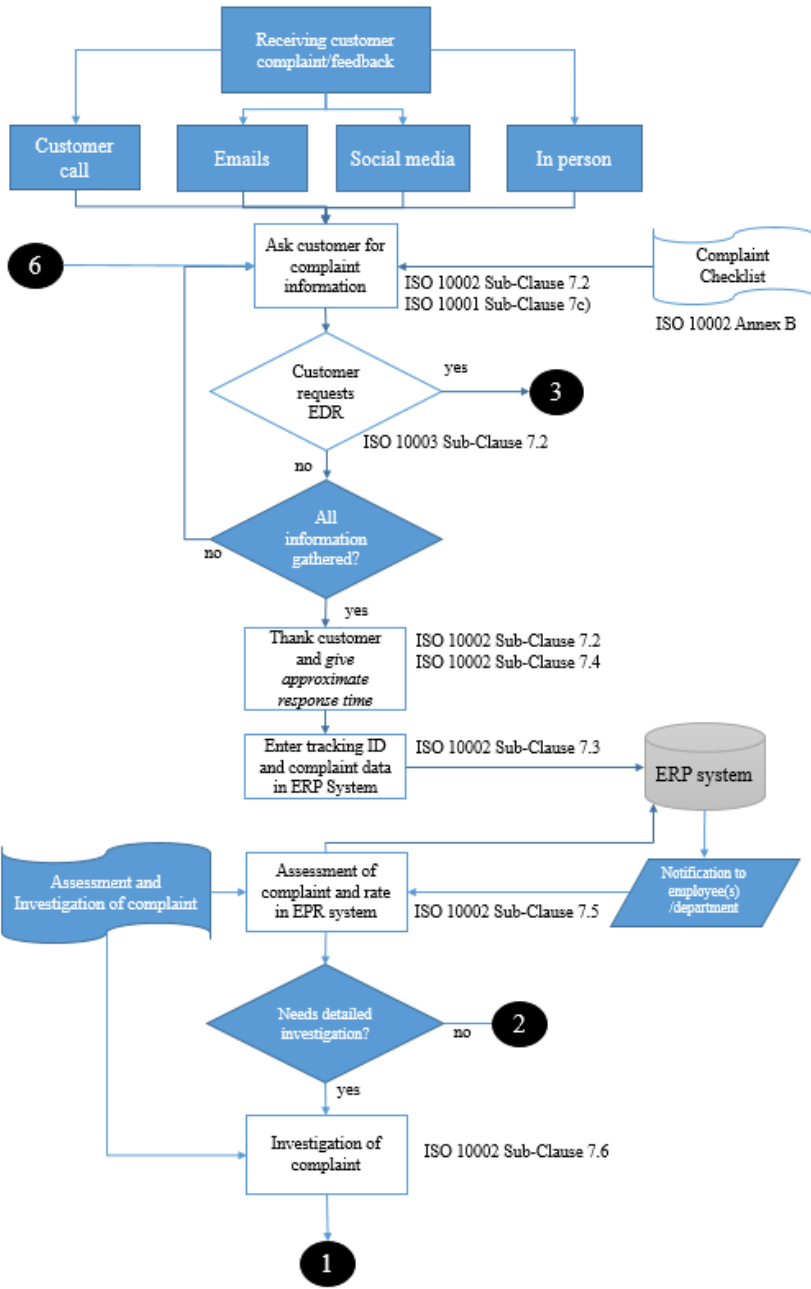
Training (ISO 9001/ISO 14001/OHSAS 18001)	10002 10003	10001/ 2/3/4	Partially	<ul style="list-style-type: none"> <li>• Integrated training for all people involved with customers addressing basics of skills involved for processes of IACSS.</li> <li>• Specific training, if needed for a certain position could be provided additionally.</li> <li>• All training information should be added to the same database.</li> </ul>
Resource Allocation (ISO 9001/ ISO 14001/OHSAS 18001)	10001 10002 10003 10004	10001/ 2/3/4	partially	Resource allocation for the IACSS processes should be included to the current IMS resource allocation
Customer communication (ISO 9001/ISO 14001)	10001 10002 10003 10004	10001/ 2/3/4	Partially	Set up a customer communication plan with specifications on which platforms the customer is informed about the IACSS. For example, the IACSS policy could be used as the medium for passing on the relevant information. Figure 10 shows when the customer would be informed throughout the entire process suggested.
Requirements for products and services (ISO 9001/ISO 14001)	10001	10001/ 2/3	No	<ul style="list-style-type: none"> <li>• During the establishment of product requirements promises made to the customers should be considered.</li> <li>• A promise should only be establish, when knowing that the product is able to fulfill the promise in most of the cases.</li> <li>• In addition, the CH and EDR process could be considered in establishing requirements.</li> </ul>
External provider control and provision of information (ISO 9001/ISO 14001)	10003	10003	Partially	<ul style="list-style-type: none"> <li>• Provide information needed for settling disputes and on the complaint case to EDR provider</li> <li>• EDR process and provider should be monitored and measured in order to validate the effective operation. If needed a switch to another provider can be based upon this monitoring process.</li> </ul>



Table 28 (continued): Supporting processes for IACSS integration into the CSO IMS

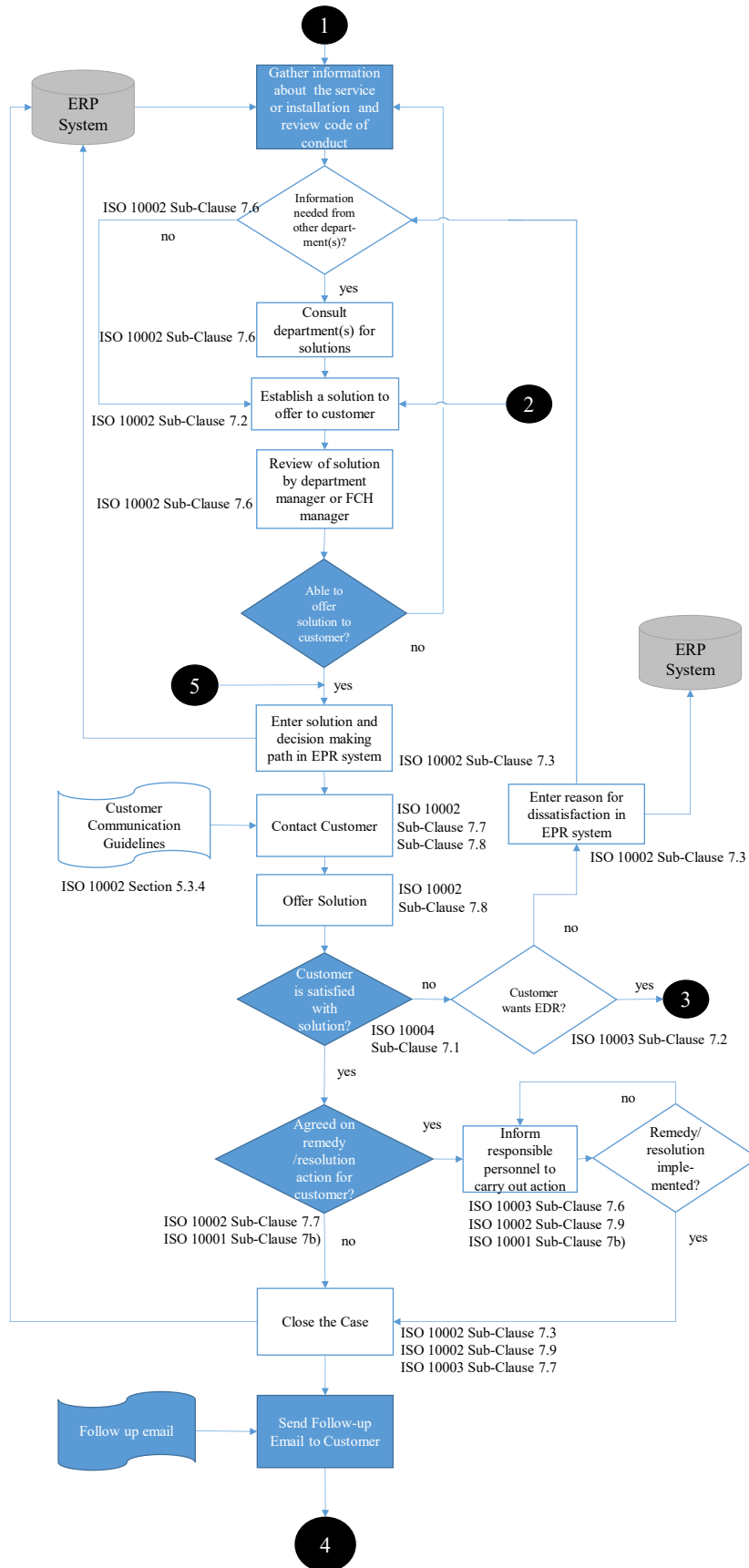
Audit (ISO 9001/ISO 14001/OHSAS 18001)	10002	10001/ 2/3/4	No	<ul style="list-style-type: none"> <li>Integration of IACSS audit with the current audit process. Only ISO 10002 specifically requires an audit, but including the whole IACSS is recommended.</li> </ul>
Management Review (ISO 9001/ISO 14001/OHSAS 18001)	10002 10003	10001/ 2/3/4	No	Inclusion of IACSS in the management review. Only ISO 10002 and 10003 require a management review of the MSs, but inclusion of the whole IACSS is suggested.
CS (measurement) (ISO 9001)	10001 10002 10003 10004	10001/ 2/3/4	Partially	<ul style="list-style-type: none"> <li>CS should be measured for all processes involved in the IACSS.</li> <li>Satisfaction with the promises, the complaints and feedback handling as well as the dispute resolution process can be measured with a process for CS measurement based on the guidelines from ISO 10004.</li> </ul>
Monitoring, measurement, analysis and evaluation (ISO 9001/ ISO 14001/ OHSAS 18001)	10001 10002 10003 10004	10001/ 2/3/4	No	The process for monitoring and measurement for the current IMS should include IACSS performance.
Control of production and service provision (ISO 9001/ISO 14001/OHSAS 18001)	10001	10001	No	The promises made for the products could be made available as a document in the production line and service departments, in order for the employees to know what is promised to customers.
Control of non-conforming output (ISO 9001)	10002	10001 10002	Partially	The process currently used for the control of nonconformities should be integrated with the suggested IACSS system (Figure 14).

Figure 15 presents the suggested core process of the IACSS based on Clause 7 of ISO 10001/2/3/4. The related clauses from the ISO 10000 standards were included beside the symbols in the flowchart. Clause 7 from ISO 10002 and 10004 were chosen to build the basis for the creation of the core process. This decision was made after the investigation of CSAPs at CSO 2. The CSAPs related to ISO 10002 and ISO 10004 were the two most developed processes compared to the ISO 10001 and 10003. Furthermore, the MSSs for ISO 10002 and ISO 10004 provide more detailed guidance compared to ISO 10001. The explanation of the IACSS core process is given subsequent to the flowchart.



Comments
Includes feedback on customer satisfaction code, EDR, FCH, CS measurement process
Complaint checklist could be based on the Annex B of ISO 10002 provided checklist and should be tailored to the needs of the CSO
A tracking ID can be included for feedback on the customer satisfaction codes, FCH, EDR and CS Measurement Process
The document for assessing and investigating the complaint should explain the criteria on how a complaint is rated and details on when a thorough investigation is needed.

Figure 15: IACSS core process



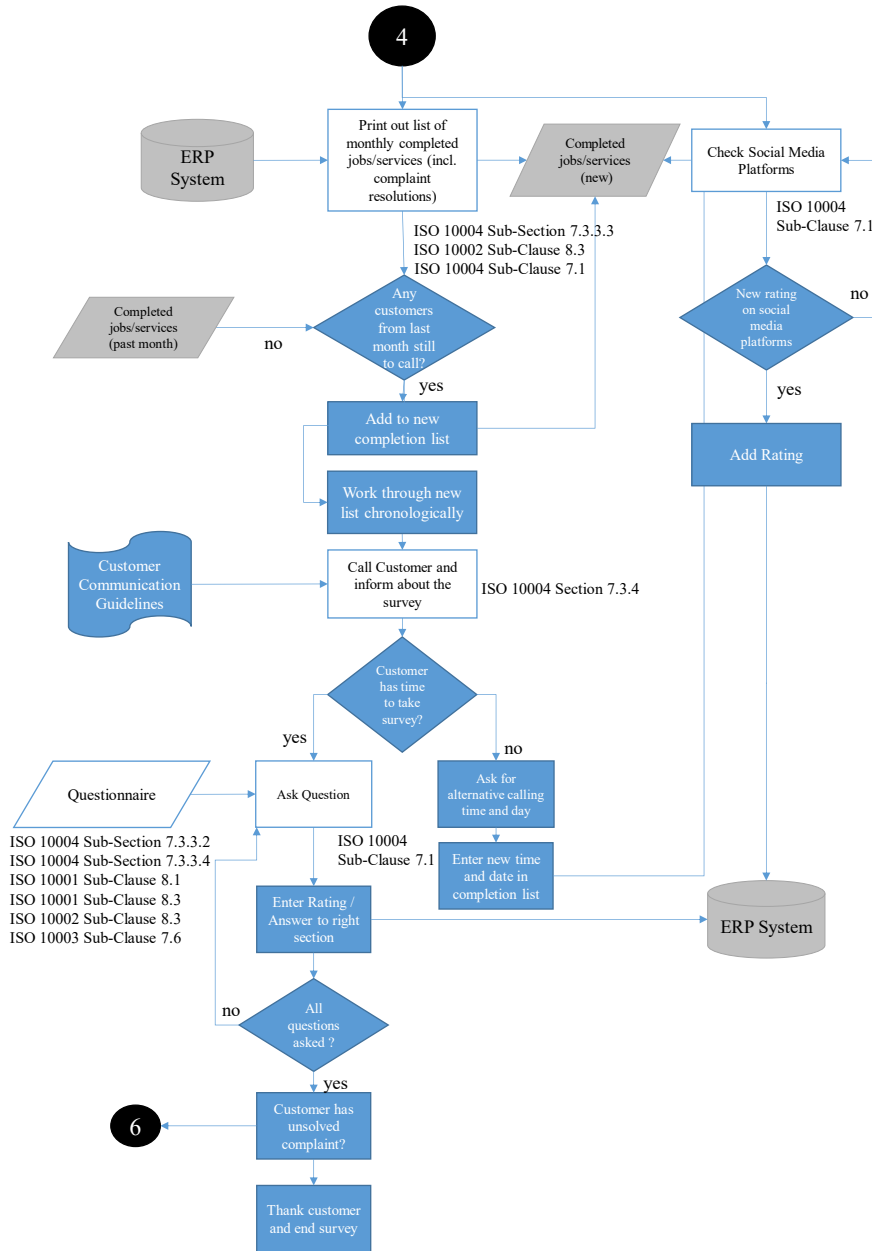
**Comments**

A unique ID can be included for feedback on the customer satisfaction code, FCH, EDR and CS measurement Process

The document on customer communication guidelines should summarize what is important to consider when talking with complaining customers. Moreover, the information and remedies that are able to be offered to the customer should be explained.

Follow up email should inform customer about a follow-up survey and a link to social media platforms on which satisfaction ratings can be made.

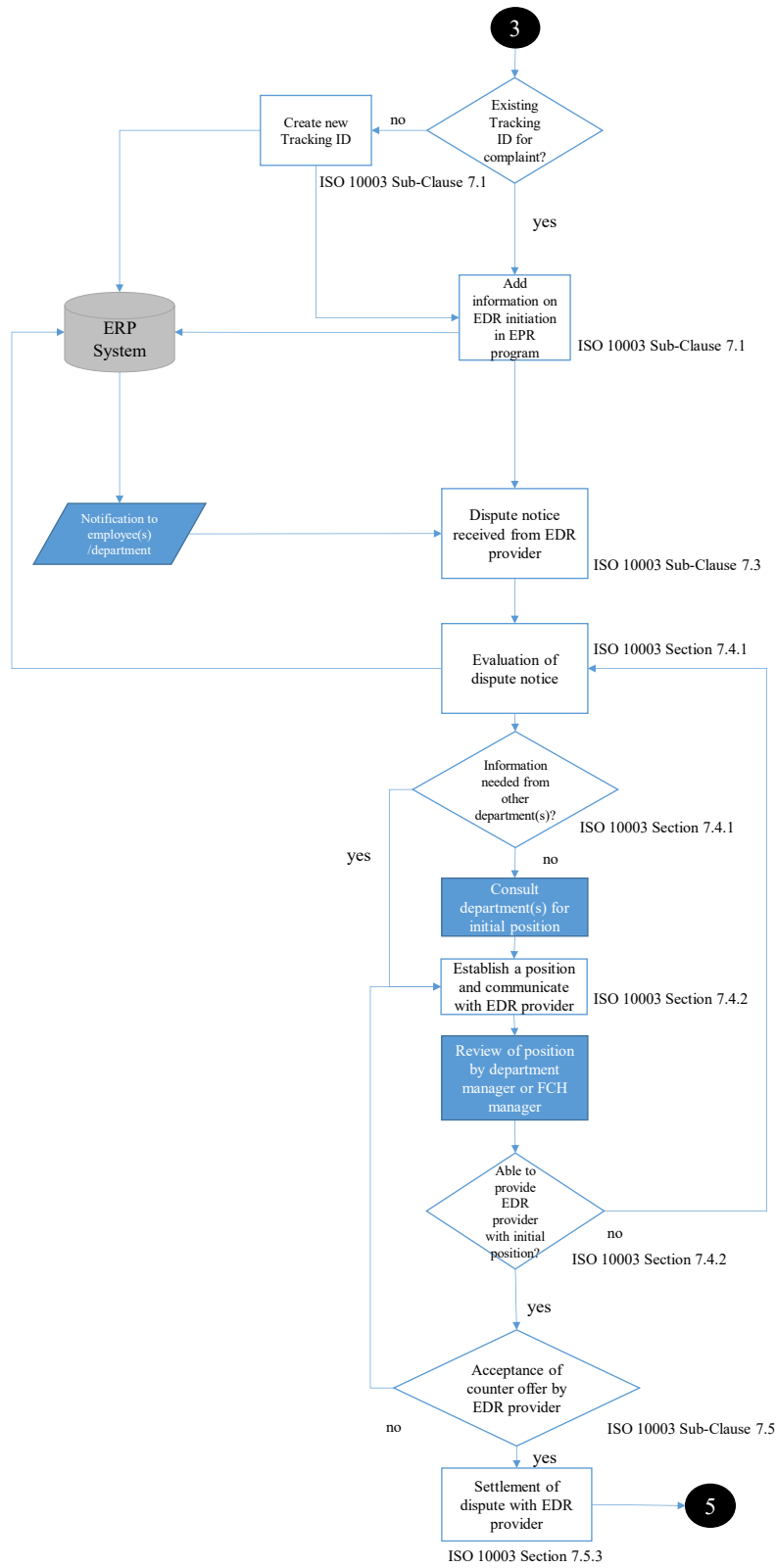
Figure 15 (continued): IACSS core process



**Comments**

The questionnaire can cover, if relevant, satisfaction with the customer satisfaction code, FCH resolution, EDR resolution and the CS measurement process itself

Figure 15 (continued): IACSS core process



**Figure 15 (continued): IACSS core process**

The process recommended started with the receipt of customer feedback and complaints (ISO 10002) through four different channels. These were based on channels that were already operated in the CSO:

- “Customer call”,
- “E-mails” and
- “Social media”, and
- “In person”.

Following the customer input, a new checklist stored in the ERP system was suggested, in order to gain necessary information from the customer. In course of asking the customer for information, also codes of conduct (ISO 10001) related complains are suggested to be included. The possibility for EDR (ISO 10003) should be added and communicated to a customer when receiving a complaint.

The customer complaint should be tracked throughout the IACSS, for all types of complaints. This data was suggested to be stored in a centralized ERP system, in order to make it accessible for all employees. The complaint could then be rated and assessed the complaint in the ERP system.

The proposed start of feedback and complaints investigation was a notification sent automatically through the ERP system. This employee was identified as responsible for the complaint-related issue. The analysis of the severity and the decision if a detailed investigation is needed was based on the new document included in the process. This document should specify standard criteria for rating the complaint and making a decision accordingly.

Whenever no detailed investigation is needed four steps suggested in the IACSS flowchart are skipped. These four steps would be done for detailed investigations only and start with gathering detailed information about the background and reviewing of the code of conduct, if applicable. Other departments could be involved if needed and a possible solution for the customer should be established. Any solution developed needs to be reviewed by the department or related manager. After the acceptance of the solution internally, it should be presented to the customer, while also tracking the decision-making path in the ERP.

The customer should be contacted according to specified guidelines, and should further be informed about the possibility of EDR. If the customer accepted the solution, the remedy actions could be performed. The realization process for the remedy action was suggested to be done in the same way for the ISO 10001/2/3 related requirements.

The case should be closed within the ERP system and a follow up e-mail sent to the customer, informing them about an upcoming survey. The survey process was largely based upon ISO 10004 requirements but addresses requirements of all four ISO 10000 standards' requirements as well as one requirement of ISO 9001:2015. The surveys were the part of the presented flowchart that already existed in CSO 2. A print out from the ERP system detailed all the fulfilled services and product deliveries. The completed jobs or services were printed for the specific month and any customers that had not been called from previous months were added to the new calling list. When customers were called and informed about the survey, they are be asked if they are able to take the survey.

The questionnaire suggested in the IACSS core process should include questions related to ISO 10001/2/3/4, depending on what service or job the customer received. The customer should be asked if any unsolved complaints were present and if so the process would lead back to the start of the IACSS core process on the first page of Figure 15. Asking for any unsolved complaints and thanking the customer for the feedback concluded the process of CS measurements.

The CS measurement process shown on page three of the flowchart also included the current social media ratings. It was also suggested to include the rating by customers into the ERP system.

The flowchart addressed the entire clause seven from ISO 10002 and ISO 10003, parts of ISO 10001 and ISO 10004. ISO 10001 had all the requirements for implementation in one clause (Clause 7), whereas the other standards divided the requirements in different elements. For ISO 10004 the elements 7.2, 7.5 and 7.6 were not included, because those parts present supporting processes, for example the identification of customer expectations or the communication of the satisfaction data to the relevant departments. The possibilities of integrating supporting processes to the existing parts of the IMS was shown in the Table 28.

## 6.4. Summary

Within Phase 3 of the research project CSAPs in the CSO were analyzed and suggestions for the implementation of individual MS based upon ISO 10001/2/3/4 requirements were given. Questionnaires were the main input of information and were used to structure the information gained from the interviews. Furthermore, internal documentation was used to study the CSAPs. This data enabled the identification of gaps related to the guidance provided by ISO 10001/2/3/4. Methods on how to structure the data, as well as suggestions for the standardization of the CSAPs were given for ISO 10001/2/3/4

Phase 4 of the research project presents an integrative augmentation analysis. Three steps were shown on how the integration of an ISO 10001/2/3/4 MS can be performed on the example of the existing IMS in the CSO. The first step was the analysis of the interrelationships between ISO 10001/2/3/4. Secondly, the requirements of ISO 10001/2/3/4 are related to the requirements of ISO 9001:2015. Last step is the presentation of a comprehensive table that addresses the integration of the IACSS into an existing MS based on ISO 9001:2015. Suggestion for the implementation of an IACSS were divided into core and supporting processes. The integration suggestions addressing the supporting processes were given in tabular form, while the core process was shown in an IACSS flowchart, based on Clause 7 of ISO 10001/2/3/4.



## 7. Conclusion

This chapter finalizes the thesis by presenting the main contributions of the research, challenges, the research limitations, and lastly giving recommendations for future research.

### 7.1. Contributions

The presented research has provided insight on students' satisfaction with a MS in a university course (CSO 1). The course MS was established based on the requirements of ISO 10001/2/4/8. The analysis included SEM and descriptive statistics of surveys from two consecutive years. In a second case study performed within a windows and doors manufacturer (CSO 2), augmentative integration was performed with four ISO 10000 standards into an existing IMS.

The application of ISO 10000 standards in engineering courses has been studied previously. This research contributed an analysis of student surveys that showed the satisfaction of students with a course MS implemented in a research project from Vargas-Villaruel (2015) and the AIMS laboratory.

The statistical analysis enabled to show trends and improvements of students' satisfaction with ISO 10001/2/4/8 MS elements. The availability of surveys from two consecutive years enabled this unique possibility. These results could contribute to the improvement of the MS in the course. Furthermore, they showed if the MSs related to ISO 10001/2/4/8 were implemented to student needs.

There was no previous research that showed a SEM model that established relationships between characteristics of ISO 10000 standards. Therefore, this research presented the first model that used seven characteristics of the MSs based on ISO 10001/2/4 and their effect on satisfaction with the e-class site (ISO 10008).

CSO 2 provided the unique possibility to present an analysis of how a QMS based upon ISO 9001:2015 could be used for augmentative integration with ISO 10001/2/3/4. A gap analysis was provided in which the update of the QMS from ISO 9001:2008 to ISO 9001:2015 was studied. It was important to investigate the existing MS first, as for example CSO 2 based its IMS largely on the QMS therefore requirements of ISO 9001:2008. This resulted in the decision of using the QMS as the basis for further integration of MSs.

The integration status of the IMS was analyzed through an IMS matrix, which helped to connect the requirements of the MSs operated. Additionally, a table was included for the relationship of ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018. This was not presented in the former literature, because ISO 45001:2018 was published recently. The additional table made it possible to gain insight in how far the ISO standards, which follow the same HLS could be integrated. For CSO 2 it would additionally help to make decisions on the extent of integration, because a later integration of MS based on the new MSSs could be simplified.

A gap analysis was performed between the CSAPs of CSO 2 and the QMS operated. ISO 10001/2/3/4 questionnaires were created for the study of CSAPs within organizations. The information from interviews and internal documentation was used to show how current unstandardized CSAPs in an organization could be analyzed and enhanced with the requirements of the augmenting standards.

A tabular approach was presented that showed a path to integrate an integrated ISO 10001/2/3/4 MS into the existing IMS. A three-step analysis was established in order to connect the augmentative MS to the existing operations. This analysis was performed with three tables that built upon one another. The first table was used to analyze the interrelationships of the ISO 10000 standards, secondly their interrelationships with ISO 9001:2015 and the third table was used to connect the requirements of the augmentative MS into an IMS.

The suggestions made for CSO 2 served as examples on how organizations could perform an integration process. A separation of core and support processes was visualized for the four standards. This could help organizations to integrate the support system around their individual core process.

## 7.2. Limitations

Limitations for the survey analysis of the augmenting standards in engineering education were:

- The comparison of midterm survey results and final survey results was limited to specific elements of the MS. The reason was that the surveys only had one common question that could be directly compared.
- The measurement errors added to the SEM model were assumed, as there was no real data, therefore there could be wrong assumptions in the model.

- The LISREL output for the SEM model presented showed two unrealistic values of effects. This showed that there were some problems with the model, which influenced the model analysis.
- The surveys reveal no demographic data on the students, which could have helped the create a better model.

The limitations present for the study on integrative augmentation in CSO 2 were:

- The gap analysis table was addressed to companies with an existing MS certified to either ISO 9001:2008, ISO 9001:2015 or any other standard with the ISO's HLS only.
- The suggested framework for the integration of ISO 10001/2/3/4 MSs could not be implemented, because it was out of scope of the research project.
- The analysis was performed in one Canadian windows and doors manufacturing company only.
- The results were not compared with another similar study, as there was no previous analysis of an integration of ISO 10001/2/3/4 into an existing IMS.
- The time commitment from employees was limited, therefore only one or two interviews with each of the ten interviewees were performed.
- Observations were not conducted and therefore only interviews and documentation were used as information inputs.
- The OHSAS 18001 standard was not available. Therefore, the majority of information on OHS was used from internal documentation and the OHSAS outline.

### 7.3. Challenges

For SEM no demographic data on the surveyed students was available, making it difficult to create a valid model. Therefore, many models that were created also failed.

The initial outline of the research project was adjusted, because it was more logical to start with the analysis of the IMS to reveal current areas of CSAPs and after that perform the study on integrative augmentation with the ISO 10000 CS standards.

The integration table for ISO 10001/2/3/4 and ISO 9001 was very comprehensive, because three MSs were operated and four additional ones were related to the current operations.

#### 7.4. Future research

The possibilities for further research on the survey analysis of the augmenting standards in engineering education could include the following:

- In order to enable an analysis with SEM, demographic data on the students could be included in surveys, to reveal more detailed information on relationships between characteristics of the MS elements.
- The surveys used in the midterm surveys and final surveys can be designed to address the same characteristics of the MSs elements, therefore additional comparison can be made.
- Survey results of engineering education courses should be compared with other courses that use augmenting CS standards.
- A comparison of survey results in a university course prior to the implementation of ISO 10000 standards and after their implementation could be undertaken. This may show the impact of the ISO 10000 based MSs on students' satisfaction.

Future research for study on integration of augmenting standards in windows and doors manufacturing could address:

- Application of the integration framework within a CSO of a different industry or country.
- Inclusion of more ISO standards within the three-step analysis.
- Application of the methods presented in the research in a CSO and study the challenges and applicability of suggestions.

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## Appendix A. Literature review methodology

Within the tables, the term “articles used” means that the articles are actually used within the literature survey. Many more articles have been read and sorted out due to not being relevant. Google Scholar cannot be limited to peer-reviewed articles only, making the output number a lot higher compared to the accessible and/or useable articles

Table A1 shows the databases searched and articles that were used for blended learning and user satisfaction within the literature review.

Table A.1: Database search: SEM, e-learning at university and student satisfaction

Database	Searching Criteria	Articles found	Articles used
Scopus	Structural equation modelling "ISO 10008"	0	
	Structural equation modelling "e-learning"	247	
	Structural equation modelling "e-learning" university	78	1
Emerald Insight	Structural equation modelling "e-learning" university <u>From: 2006-2017</u>	2198	
	"Structural equation modelling " "e-learning" university <u>From: 2006-2017</u>	1305	
	structural equation modelling "e-learning" + university + "student satisfaction"	28	1
Science Direct	"Structural equation modelling " "e-learning" university <u>From: 2006-2017</u>	406	
	"Structural equation modelling " "e-learning" university “satisfaction” <u>From: 2006-2017</u>	34	5
Google Scholar	"Structural equation modelling " "e-learning" university "Student satisfaction" <u>From: 2006-2017</u> <u>Languages: English/German</u>	252	6
	“e-learning” satisfaction "ISO 10001"	2	1
	“e-learning” satisfaction "ISO 10002"	12	
	“e-learning” satisfaction "ISO 10003"	1	
	“e-learning” satisfaction "ISO 10004"	2	

Table A2 shows the databases searched and articles that were used for ISO 9001:2008 to ISO 9001:2015 transition within the literature review.

Table A.2: Database search for ISO 9001:2015 update, MSs and MSSs

Database	Keywords	Articles found	Articles used
GS	"ISO 9001:2015" transition since 2012 <u>Languages:</u> English/German	255	6
	"ISO 9001:2015" <u>From:</u> 2012-2017 <u>Languages:</u> English/German	983*	2
	"ISO 9001:2015" revision <u>From:</u> 2012-2017 <u>Languages:</u> English/German	621*	4
	"ISO 9001:2015" revision "risk management" <u>From:</u> 2012-2017 <u>Languages:</u> English/German	208	1
	"ISO 9001:2015" revision "knowledge management" <u>From:</u> 2012-2017 <u>Languages:</u> English/German	81	1
EI	"ISO 9001:2015" transition since 2012	52	4
	ISO 26000 + integration Note: This articles stems from an earlier search on articles for ISO 26000	210	1
TF	transition "ISO 9001" 2015	4	-
PBC	"ISO 9001:2015"	284	3
GS	"Integrated Management System" ISO <u>Languages:</u> English/German	131	6
	" Management System" ISO <u>Languages:</u> English/German <u>From:</u> 2000-2017	2200	4
TF	"standardized management systems" ISO	16	2
	standardized "management systems" integrated ISO <u>Restriction:</u> Only articles with full access	3	1
SD	"standardized management systems" ISO	39	4
	"Integrated Management System" ISO <u>From:</u> 2000-2017	281	2
EI	"Integrated Management System" ISO <u>From:</u> 2000-2017	86	5
	"Standardized Management System"	8	1

Table A.3: ISO 10000 series

Table A3 shows the databases searched and articles that were used for the overview about the ISO 10000 series within the literature review.

Database	Keywords	Articles found	Articles used
GS	"ISO 10000" <u>Languages</u> : English/German	147	7
	"ISO 10001" <u>Languages</u> : English/German	125	4
	transition "ISO 9001:2015" <u>From</u> : 2012-2017	316	1
EI	"ISO 10001"	5	6
	"ISO 10000"	3	1
	"manufacturing customer satisfaction ISO 9001"	473	1
PBC	"ISO 10000"	1	1

Table A4 shows the databases searched and articles that were used for ISO 10001 within the literature review.

Table A.4: Database search ISO 10001

Database	Keywords	Articles found	Articles used
EI	"ISO 10001"	5	1
GS	"ISO 10001" Languages: German & English	125	7
PBC	"ISO 10003"	6	

Table A5 shows the databases searched and articles that were used for ISO 10002 within the literature review.

Table A.5: Database search ISO 10002

Database	Keywords	Articles found	Articles used
GS	"ISO 10002" <u>Languages:</u> English/German	402	
	"ISO 10002" + Complaint <u>Languages:</u> English/German	294	1
	"ISO 10001" <u>Languages:</u> English/German	125	2
EI	"ISO 10002"	9	1
	Transition "ISO 9001" 2015 <u>From:</u> 2012-2017	52	1
	Manufacturing customer satisfaction ISO 9001		1
PBC	"ISO 10002"	20	1

Table A6 shows the databases searched and articles that were used for ISO 10002 within the literature review.

Table A.6: Database search ISO 10003

Database	Keywords	Articles found	Articles used
GS	"ISO 10001"	125	2
	"ISO 10003"	95	1
PBC	"ISO 10003"	1	
EI	"ISO 10003"	1	

Table A7 shows the databases searched and articles that were used for ISO 10004 within the literature review.

Table A.7: Database search ISO 10004

Database	Keywords	Articles found	Articles used
EI	"ISO 10004"	3	0
SD	"ISO 10004"	2	0
GS	"ISO 10004"	2	0

Table A.8: Database search manufacturing and product promises

Database	Keywords	Articles found	Articles used
EI	Product Promise	7	1
	manufacturing "product guarantee"	9	
	manufacturing "product guarantees"	24	3
GS	manufacturing "customer satisfaction" "manufacturing guarantee"	7	
	manufacturing "customer satisfaction" "product guarantee"	145	
	manufacturing "product guarantees" "customer satisfaction"	190	2
TF	manufacturing "product guarantee"	17	
	manufacturing "product guarantees"	31	1

Table A.9: Database search manufacturing and complaint handling

Table A.9 shows the databases searched and articles that were used for manufacturing and complaints handling within the literature review.

Database	Keywords	Articles found	Articles used
GS	manufacturing "complaint handling" "customer satisfaction" 2000 English/German	3070	
	manufacturing "complaints handling" "customer satisfaction" 2000 English/German	945	
	manufacturing "complaint handling" "complaint satisfaction" 2000 English/German	173	2
EI	manufacturing "complaints handling"	61	
	manufacturing "complaints handling" <u>From:</u> 2000-2017	34	6

Database search manufacturing and complaint handling (continued)

TF	manufacturing "complaints	20	
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	handling" 2000		
	manufacturing "complaint handling" <u>From:</u> 2000-2017	100	1
SD	manufacturing "complaints handling" 2000	29	1

Table A9 shows the databases searched and articles that were used for dispute resolution in manufacturing within the literature review.

Table A.10: Database search for dispute resolution in manufacturing

Database	Keywords	Articles found	Articles used
GS	windows doors "dispute resolution" "complaints handling" "customer satisfaction"	4	
	manufacturing "dispute resolution" "complaints handling" "customer satisfaction"	116	6
SD	manufacturing "complaints handling" "dispute resolution"	11	
EI	manufacturing "complaints handling" "dispute resolution"	2	

## Appendix B. Literature review

### B.1 Blended learning and student satisfaction

#### a) SEM studies and factors used

Table 10 shows the variety of factors used within the various models, whereas four of them specifically include the variable "student satisfaction".

Study	Factors used in SEM															
Author(s)	E-course Quality, Course Design	Perceived Ease of Use	Perceived Usefulness	Satisfaction	Intention to use	Actual Use	Social influences / Peers	Cognitive absorption	Self-Efficacy	Facilitating Conditions	Prior Experience / Familiarity with E-learning	Attitude / Interactivity	Learning styles	Learner Performance	Gender	Behavioural Intentions (customer retention)
Mohammadi, H. (2015)	X	X	X	X	X	X										
Al-Azawei, Al-Bermani, & Lundqvist, (2016)				X									X	X	X	
Moreno et al (2017)	X	X	X				X	X	X	X	X	X				
Headar (2013)	X			X							X	X				X

SEM studies and factors used (continued)

Aktir, Munira, & Amin (2017)		<b>X</b>	<b>X</b>						<b>X</b>			<b>X</b>				<b>X</b>	
Williams (2007)		<b>X</b>	<b>X</b>		<b>X</b>		<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>					
Fryer & Bovee (2016)									<b>X</b>		<b>X</b>			<b>X</b>	<b>X</b>		
Eom & Ashill (2016)	<b>X</b>			<b>X</b>			<b>X</b>		<b>X</b>			<b>X</b>		<b>X</b>			
Ali Tarhini et al. (2013)		<b>X</b>	<b>X</b>				<b>X</b>		<b>X</b>	<b>X</b>							<b>X</b>
Wu et al. (2010)	<b>X</b>			<b>X</b>	<b>X</b>		<b>X</b>		<b>X</b>					<b>X</b>			

### a) SEM Studies on Satisfaction with E-Learning

Attitude is positively affected with perceived usefulness, ease of use and peer encouragement. Furthermore, student's attitude had a positive influence on the intention to use. The students also perceive the platform as more useful if they have the intention to use and receive peer encouragement (Williams, et al., 2007).

Interestingly, Headar et al. (2013), studied how satisfaction can be a mediator between familiarity, hence experience, and the behavioural intentions. They found that "*[...] familiarity affects behavioural intentions directly and indirectly through satisfaction*". Therefore, according to the authors, students that used the e-service before and are familiar with it will base their decision additionally on satisfaction with it (Headar, et al., 2013).

Headar et al. (2013) tested the effects of "*[...] e-service quality, interactivity, student comfort with e-learning, and student familiarity with e-learning on behavioural intentions in the e-learning context*" and how satisfaction can be a mediator within those relationships. They found that "*[...] student-content interaction*" is most important for the interactivity, which they expected as the students enter the websites for retrieving their material.

Al-Azawei et al. (2016) conducted their research in blended engineering courses in Iraq. They specifically focused their research on different groups of learners namely active and reflective learners. The study showed that the "*[...] processing dimension is the only one that showed a strong correlation with perceived satisfaction*". Active learners were more satisfied in the blended courses than the reflective learners were.

Eom & Ashill (2016) (Aktir, et al., 2017) also showed in their study that the course design and intrinsic motivation influences the learning outcomes positively.

Al Azawei et al. (2016) explain that the e-learning platform alongside with the traditional classroom makes an interaction of instructor to students and students among each other easier and more frequent, which is a preference of active learners. There was no relationship found between satisfaction and student's gender or their actual academic achievement, hence performance, in the study from Al-Azawei et al.

## b) Relationship of student satisfaction with e-learning platforms with perceived usefulness and ease of use

Williams et al. (2007) investigated the influence of perceived usefulness and ease of use on the attitude toward the system as well as the intention to use e-learning in their SEM. His model was based on the study of Martins & Kellermanns (2004). Four contradicting results were shown, as Martins & Kellermanns (2004) supported the following relationships, while Williams et al. (2007) did not:

- Faculty encouragement will be positively related to the perceived usefulness of the system
- "*Prior experience*" is positively related to "*Ease of use*"
- "*Perceived ease of use*" would be positively related to "*perceived usefulness*";
- "*Intention to use*" is positively related to "*actual use*"

In a later study from Moreno et al. (2017) experience was also "*[...] not significantly associated with*" perceived ease of use. Both studies were performed later compared to Martins & Kellermanns (2004), this might be because students have higher experience with the technology and therefore their ease of use is not highly influenced by prior usage. This also explains that "*[...]students' beliefs regarding their ability with computer systems*" compared to experience is from higher importance (Moreno, et al., 2017).

## B.2 ISO 9001:2015

### a) Reasons for a new standard

ISO explains the revision should make the standard more accessible for different types of enterprises, including service companies. They state is a response to the increased globalization and the more complex supply chains, as well as the increased expectations from customers who have more access to information and a stronger voice (ISO, 2015a; ISO, 2015b).

The ISO survey conducted in 2011 revealed following concepts to be from importance to those polled:

- "*[...]Resource management 75 per cent*
- *Voice of customers 74 per cent.*
- *Integration of risk management 73 per cent.*

- *Systematic problem solving and learning 73 per cent.*
- *Measures (e.g. Performance, return on investment, satisfaction) 72 per cent.*
- *Knowledge management 72 per cent.*" (Wilson & Campbell, 2016)

Palmes (2014) explains that further input came from group representatives of sectors using ISO 9001 as a basis of their standards, so called "[...] *sector-specific standards*". He credits these representatives a high influence on the incorporation of risk management in the standard (Palmes, 2014).

Looking at sector-specific groups ISO tries to minimize these specific versions of standards. Predominately through the new Annex SL's High-Level-Structure (HLS). The included general principles aim to "[...] *minimize the need for sector-specific variances*", as well as the applicability of MSS for "[...] *all relevant sectors and cultures of every size*". The reason being could be an easier update of the standards, better comparison of companies certified to ISO 9001 and better auditing.

Hampton (2014) also mentions risk management as requirement previously implied, similarly to other concepts "[...] such as mistake-proofing, change management", "[...] and the issuance of nonconformities when planned arrangements aren't followed ". She claims that this explicitness leaves less room for interpretation, but therefore offers an outlined plan. This in turn helps to improved understanding "[...] of meeting customer expectations and protecting of its efforts" (Hampton, 2014).

## b) Structure and PDCA

To clarify the difference between the process approach in the standard and the PDCA model the author refers to the ISO explanation in the standard, which shows the difference between the three concepts Plan-Do-Check-Act (PDCA) and process approach, as well as Risk Based Thinking (RBT). Together they are essential for the ISO 9001:2015 standard. (ISO, 2017b) The process approach is the overarching way to enable for an organization "[...] *to plan its processes and their interactions*", incorporating PDCA and RBT (ISO, 2015).

The standard shows a diagram where clauses are connected to the PDCA cycle:

- Plan Clause 6 – Planning
- Do Clause 7 and 8 – Support and Operation
- Check Clause 9 – Performance evaluation

- Act Clause 10– Improvement (ISO, 2015; Fonseca, 2014)

In ISO 9001:2015's introduction there is paragraph mentioning the “[...] *challenge for organizations in an increasingly dynamic and complex environment*”, which require to think beyond the classic continual improvement and corrections and consider “[...] *breakthrough change, innovation and re-organization*” (ISO, 2015).

### c) Prescriptiveness of ISO 9001:2015

There are striking opinions on the prescriptive manner of the standard (Hampton, 2014; Murray, 2016). While Murray (2016) sees the entire standard as “[...] *less prescriptive than its predecessors*”, Hampton (2014) points out that some areas like the “[...] *monitoring and measuring devices, are less prescriptive*” while “[...] *others are more prescriptive*”.

Hampton (2014) sees the process approach as a key focus of the new standards, which was “[...] *moved from being hidden in the shadows of ISO 9001:2008*”.

### d) Clause 4

ISO 9000 (2015) defines “[...] *relevant interested parties are those that provide a significant risk to organizational sustainability if their needs and expectations are not met*”. Merrill (2015) explains that interested parties are introduced in this section and sees it as a vital part of the strategy to think “[...] *about social responsibility*”. Ramu (2016) points out. “[...] *also external providers are interested parties to consider*”. Fonseca (2014) and Reid (2015) interpret that the standard intends to make an organization determine interested party of relevance to the organization, i.e. those who have “[...] *some actual or future impact on quality of products and services*” (Fonseca, 2014).

West and Cianfrani (2016a) claim that the standard actually states no definite “[...] *need for strategic planning*” although some requirements in “[...] *Clause 4 Context of the organization*” (ISO, 2015) and “[...] *Clause 6 Planning*” (ISO, 2015) allude to it.

However, an implementation of the standard is dependent on strategic planning and top management's involvement. Organizations without a strategic plan could face difficulties in their operations, due to the lack of management's support for the MS, difficulties in understanding the interrelated processes and creating of common objectives. Thinking about ISO 9001 and its application, it can be argued that the MSS itself is also a risk management

tool. A standard serves *“the organization’s ability to satisfy its stakeholders, and to meet its goals and objectives”*, which help the company to achieve risk prevention when these major objectives are not met (ISO, 2008).

*“[...] The process of setting objectives and”* passing them on” *[...] to relevant levels and functions”* is key value and factor *“[...] of continual improvement in the standard”* (Reid, 2014). Strategic objectives that are deployed and aligned with more specific objectives at *“[...] relevant levels and functions“* is maintained from past versions of the standard, Reid (2014) examined.

The organization should also go beyond the standard's requirements concerning innovation as there is no actual process required, being a shortcoming of the standard. (West & Cianfrani, 2016a; Merrill, 2015) Top management should have *“[...] processes defined and deployed to consider innovation in its products and processes”* as it is *“[...] less effective and sporadic “* without a framework (West & Cianfrani, 2016a).

#### e) Clause 5

Merrill (2015) explains, leadership's decisions should include risks and opportunities the business faces and continually evaluate them to stay competitive. Opportunities, also addressed in clause 4, become especially important when setting *“[...] objectives compatible with the strategic direction and context of the organization “*(Merrill, 2015).

Palmes (2016) describes, if the requirements of the two clauses 5.1.1 and 5.3 are connected and work alongside each other, it helps the system to function. This is due to the fact that processes need to work, in order to make the whole system operate smoothly. He gives more details, by explaining that it might be beneficial to ensure *“[...] a host of activities in the QMS are carried out and regularly reported among top management “*(Palmes, 2016). Assigning *“[...] effectiveness of the QMS”* (ISO, 2015) to top management will result in *“[...] shared responsibility of both top management and the quality department”* (Palmes, 2016). Thinking about linkages and systems, this is a goal for the organization to work on, because without commitment of the top management it is difficult to get the information exchange needed for decisions and motivate employees to commit to the QMS.

Aston (2016) stresses importance on communication within the company when management establishes changes, as people often naturally dislike change. For success it is important to involve *“[...] all management, process owners and employees “* and also *“[...] top*



*management's involvement, leadership and commitment* “ has to take place” (Aston, 2016). This is related to Merrill's (2015) point of view, as he sees opposition to changes “[...] when you try to innovate ”, referring also to clause “[...] 6.3 Planning of changes”.

As mentioned in the former section considering clause 4.2, the policy is driving “[...] conformance with specified requirements ”, along with “[...] continual improvement of the QMS ” (Reid, 2014). This continual improvement is not obligatory “[...] for products and services” because industries, which are in a highly regulated environment, have a hard time meeting this requirement (Reid, 2014). Ramu (2016) stresses the importance to set the quality expectations for suppliers. He thinks it is important to make the policy “[...] available to relevant interested parties” as required by the standard, and additionally include it in the “[...] supplier agreement” and publish it on the website (Ramu, 2016).

#### f) Clause 8

Hampton (2014) sees “[...] mistake-proof production of goods and provision of services ” as an area organizations have to get knowledgeable about also in terms of the related “[...] tools and methods ”.

“[...] Emphasis should be on error-proofing processes to prevent problems from occurring” contrary to the less effective detection of errors (Reid, 2014).

Palmes (2014) sees a clearer picture considering “[...] what goods or services are ” outsourced compared to former versions of ISO 9001. He mentions that “[...] regardless of what is obtained through outsourcing ”, a risk-based approach has to be taken, and he refers to the Annex A as a helpful tool in understanding *this* “[...] new structure, terminology and concepts”.

#### g) Clause 9

Reid (2014) connects planning and measurement and explains; after the proper plans are established on a strategic level, the metrics must be in place “[...] to monitor progress in achieving the objectives and specified requirements ”. Just like the objectives are broken down to “[...] relevant levels and functions ” and are in place for the “[...] products and processes that can affect quality or delivery ”, this has to be done with the monitoring indicators. (Reid, 2014)"

Fisher (2016) and Murray (2016) agree that there is less documentation throughout the standard, so auditors are challenged to get the needed information. However, Fisher (2016) argues there is still documentation, but in different formats, so the auditors need to invest more time in planning their audits. She points out that processes are serving as evidence to check if the system works, whether they are “[...] *written down in documentation* “ or not.

Murray (2016) adds this is especially true for system evaluation on “[...] *metrics/key performance indicators for quality objectives* “. For areas without specified documented information the auditor should focus on the processes, as requirements in ISO should always be fulfilled by the companies’ QMS processes (Fisher, 2016).

It is also important for the right people to participate in an audit. Should questions come up about the processes and their description, the right people will make it easier and more visible to check for conformity.

Hampton (2014) sees a strengthening for the “[...] *monitoring and measurement* “ requirements. Both Hampton (2014) and Ramphal (2015) similarly explain that additionally requirements on “[...] *what to monitor, measure, methods, when to perform, when to analyze and evaluate* “ have to be addressed. Furthermore, analysis in the former version did not require evaluation and the documented information will help the organization in becoming data driven (Hampton, 2014).

#### h) Documentation requirements

Authors	Changes in the documentation requirements
Barouch and Kleinhans (2015), Freeman and Drown (2015)	Documented information has been a difficulty for organizations since the 2000 version of the standard.
Zgodavova, et al. (2016); Murray (2016); Freeman & Drown (2015); Yasenchak (2016); Fonseca (2014)	More flexibility of documentation requirements
Fonseca (2014), Freeman & Drown (2015), Zgodavova, et al (2016) and Fisher (2016)	A quality manual is no formal necessity in ISO 9001:2015 compared to ISO 9001:2008.
Ramphal (2015); Fisher (2016), Zgodavova, et al. (2016)	The terms “documented procedure” and “record” were substituted by “documented information” and can be in any media and format (ISO, 2015).

Considering the quality manual Merrill (2014) states, only if organizations find “[...] a better tool against which” they can prove their QMS' effectiveness against, they should stop using a quality manual. Similarly Fisher (2016) says working “[...] quality manual and procedures “ shall not be abandoned.

Murray (2016) sees the change within documentation two-sided, he agrees there is more flexibility with less rigid requirements, but the documentation planning “[...] and the application of appropriate risk measures at the management level as part of that documentation” is required more carefully.

#### i) Clause 10

West and Cianfrani (2016a) compare ISO's requirements for internal audits and self-assessment. They regard self-assessment as to being able in helping process improvement through gaining “ richer data “ compared to internal audits, as audits are a “[...] binary, yes-or-no determination “. Klute-Wenig & Refflinghaus (2015) explain “[...] analysis of self-assessment occurs automatically and also shows the extent of requirement realization, so that the need for action becomes obvious “.

They are right in terms of usefulness for a company, because an organization can get better insight in areas they need to improve through self-assessments. Nevertheless, for the purpose of (re-)certification, the company needs to meet the requirements fully to confirm. Of course a company can do audits for other purposes, with different audit types existing, but an audit in general is stricter and has exact criteria to be met.

Therefore, it is important within the self-assessment, to consider continually the “[...] interaction between QMS processes and other processes of the organization“ and “[...] not only the processes and elements of the QMS“ alone (West & Cianfrani, 2016a).

### B.3 MSSs and MSs

#### a) Types of MSSs

Regarding the different types of integration, according to Karapetrovic (2005) and Karapetrovic, et al. (2012), a management system compliant with “[...] a seed MSS can be expanded” in three different ways summarized in the table below:

MSSs	Description
Augmentation	<p>Inclusion of supplementary processes, “[...] which are developed according to different guidance standards and are subsequently built into the MS itself” (Karapetrovic, 2005)</p> <p>The augmenting standards offer “[...] models for specific subsystems of a function-focused or an overall MSs in the organization” (Karapetrovic, et al., 2012)</p>
Ascension	<p>This type of integration is an “[...] extension of virtually all components of the corresponding MS” (Karapetrovic, et al., 2012).</p> <p>For example, the application of “[...] suggested concepts and techniques” of another quality standard in order to enhance the existing QMS. (Karapetrovic, 2005)</p>
Assimilation	<p>Assimilating standards, as for example the integration of ISO 9001 and ISO 140001, provide models that are “[...] minimal frameworks for [...] function-specific or stakeholder-oriented MSs” (Karapetrovic, et al., 2012)</p>

#### b) Methodology for IMS implementation

Author	Brief Model Description
Karapetrovic & Willborn (1998b)	<p>Approach was to first use system dynamics in order to describe the linkages in the organization and “[...] interrelationships of objectives, resources and processes”. They suggest to use the systems approach to restructure the guidelines from ISO 9001 and ISO 14001 and based on that “[...] be connected to form an integrated management system”</p>
Wilkinson & Dale (2001)	<ul style="list-style-type: none"> <li>• The model suggests elements needed for implementing an IMS (“[...] quality, environmental, and health and safety”)</li> <li>• degree of integration of elements is up to the company</li> <li>• In the model the individual MS loses their independence all same boundaries, resources, work for common output</li> </ul>

Methodology for IMS implementation (Continued)

Karapetrovic (2003)	Propose a "[...] <i>generic process for the integration of internal management systems</i> " showing a ten step framework for implementation and improvement of IMS
Jonker and Karapetrovic (2003) and Jonker & Karapetrovic (2004)	Systems thinking and looking at the whole picture using a "[...] <i>two-prong approach</i> ": <ul style="list-style-type: none"> <li>• "[...] <i>First prong is focused on</i>" applying a system model in order to have a "[...] <i>flexible basis for the integration efforts</i>"</li> <li>• "[...] <i>Second prong involves the development of a contingency-based, but systematic methodology to guide an organization towards an integrated management system.</i>"</li> </ul>
Rocha et al. (2007)	Built upon Jonker and Karapetrovic (2007) including sustainable development within the integration process and "[...] <i>every level of the organization</i> "
Leopoulos et al. (2010)	They propose a "[...] <i>set of control tables that relate every step of the procedure to the related requirements</i> " for the integration of "[...] <i>function specific sub-systems with respect to the organization/decision view</i> ".
Asif and Searcy (2014)	Developed a MS based upon the PDCA cycle including sustainability issues.
Rebelo et al. (2016)	An enhanced IMS model and its feasibility, including PDCA approach and adopts the " <i>lean philosophies</i> " to reduce overlapping functions, management burden and duplications of procedures and information.  Further it shall help the company to "[...] <i>rationalize, standardize and optimize the way to: how; when; where and by whom the right and needed things have to be efficiently and systematically well done, without wasting resources</i> "

c) IMS integration benefits and difficulties

The basis for the categorization of benefits is a study from Simon et al. (2012), which specifically studied the "[...] *difficulties and benefits*" of IMS over 76 companies. The grouping is more general and therefore a good basis for adding findings from other studies:

Difficulties	Author(s)
Lack of resources for integration	(Satalo, et al., 2013; Simon, et al., 2012; Bernardo & Simon, 2014; Karapetrovic & Willborn, 1998c; Zeng, et al., 2007; Asif, et al., 2009; Rebelo, et al., 2014)
Difficulties with the standards implementation and certification	(Wilkinson & Dale, 2001; Simon, et al., 2012; Santos, 2011; Rebelo, et al., 2014)
Organizational internal difficulties	(Karapetrovic & Willborn, 1998b; Jonker & Karapetrovic, 2004; Karapetrovic, 2003; Simon, et al., 2012; Zeng, et al., 2007; Asif, et al., 2009; Santos, 2011; Rebelo, et al., 2014)
Difficulties with the people working with the standards	(Karapetrovic & Willborn, 1998b; Simon, et al., 2012; Zeng, et al., 2007; Asif, et al., 2009; Santos, 2011; Rebelo, et al., 2014; Pheng & Kwang, 2005)
Benefits	Author(s)
Less costs	(Karapetrovic & Willborn, 1998b; Simon, et al., 2012; Zeng, et al., 2011; Zeng, et al., 2011; Asif, et al., 2009; Jørgensen, et al., 2006; Santos, 2011; Pheng & Kwang, 2005)
Joint audits	(Karapetrovic & Willborn, 1998b; Simon, et al., 2012; Casadesús, et al., 2011; Zeng, et al., 2011; Jørgensen, et al., 2006; Santos, 2011; Rebelo, et al., 2014; Pheng & Kwang, 2005)
System performance benefits	(Simon, et al., 2012; Zeng, et al., 2011; Casadesús, et al., 2011; Asif, et al., 2009; Jørgensen, et al., 2006; Santos, 2011; Rebelo, et al., 2014)
Organizational strategic benefits	(Simon, et al., 2012; Zeng, et al., 2011; Casadesús, et al., 2011; Zeng, et al., 2011; Asif, et al., 2009; Jørgensen, et al., 2006; Santos, 2011; Pheng & Kwang, 2005)

d) Case studies of IMS implementation and their findings

Author	Case study or Surveyed organization(s)	Findings
Karapetrovic et al. (2010)	298 organizations in Catalonia and Basque Country in Spain <i>"[...] At least two MSS certificates"</i> ISO 9001 and ISO 14001	<ul style="list-style-type: none"> <li>• Many ISO 9001 and ISO 14001 registered companies <i>"[...] are largely not familiar with many MSSs"</i></li> <li>• Reasons for implementing additional MSs: <i>"Improvement of image and social impact"</i></li> <li>• High integration levels <i>"[...] of internal MS audits"</i></li> <li>• Major reason to leave the standards separate were problems encountered during <i>"[...] the integration of internal MSs"</i></li> </ul>
Bernardo et al. (2010)	<i>"[...] 435 Spanish organizations registered to" at least "ISO 9001:2000 and ISO 14001:2004"</i>	<p>The study surveyed the <i>"[...] degree of integration of"</i> internal and external audits, most important findings:</p> <ul style="list-style-type: none"> <li>• Companies with non-integrated MSs <i>"[...] still integrated their internal"</i> and external audits to some extent</li> <li>• The <i>"[...] level of integration of internal"</i> audits increases with the <i>"[...] level of integration of standardized MSs"</i>, but this was not clear for external audits.</li> <li>• <i>"[...] internal audits are more integrated than external audits in the majority"</i> of studied organizations</li> </ul>
López-Fresno (2010)	Spanish airline ISO 9001 ISO 14001 Other Airline Specific standards	<i>"Number of quantifiable and unquantifiable benefits resulting from integration such as improved decision making, better utilization of resources, enhanced communication, improved people motivation, stronger customer orientation, cultural change and enhanced positive corporate image."</i>

Case studies of IMS implementation and their findings (continued)

<p>Casadesus et al. (2011)</p>	<p>500 companies in Spain</p> <p>Study of benefits organizations obtain when implementing ISO 9001 and ISO 14001 instead of only ISO 9001</p>	<p>Better results for:</p> <ul style="list-style-type: none"> <li>• synergy effects</li> <li>• customer satisfaction</li> <li>• nonconformities</li> <li>• higher satisfaction with the ISO 9001 implementation</li> <li>• improvement of processes and procedures</li> <li>• financial numbers</li> <li>• <i>"[...] employee related and operational results"</i></li> </ul>
<p>Simon et al (2012)</p>	<p>76 companies in Spain</p>	<p>Revealed 4 major groups of benefits and difficulties found among the studied organizations. (See Appendix B.3c)</p>
<p>Garengo &amp; Biazzo (2013)</p>	<p>Research <i>"[...] of how to implement an effective IMS in SME"</i> through studying a case study in a furniture manufacturing company</p>	<p>They found five enablers to overcome barriers against IMS implementation:</p> <ul style="list-style-type: none"> <li>• <i>"[...] Commitment of the management team [...]"</i></li> <li>• <i>Effective adoption of the TQM approach [...]"</i></li> <li>• <i>External facilitators [...]"</i></li> <li>• <i>Communication to the whole organization [...]"</i></li> <li>• <i>Simple software solution"</i></li> </ul>
<p>Rebelo et al. (2014)</p>	<p>Organization Portugal</p> <p>ISO 9001</p> <p>ISO 14001</p> <p>OHSAS 18001</p> <p>ISO 17025</p>	<p>Result of the integration was an IMS-QES, which added value in present and future for organizations and stakeholders.</p> <p>Companies responding to the survey showed:</p> <ul style="list-style-type: none"> <li>• <i>"[...] elimination of conflicts between individual systems with optimization of resources"</i></li> <li>• <i>"[...] improvement at the level of the coordinated and Integrated Management" of the various MSs</i></li> <li>• <i>"[...] reduction of the number of internal and/or external audits" and supplier audits, cost and time</i></li> <li>• <i>"[...] elimination of several types of waste" and therefore added value for the companies</i></li> </ul>



Case studies of IMS implementation and their findings (continued)

Manzanera et al. (2014)	Public Health Organization in Spain  Medium sized government run	Suggestions derived from the case study for similar organizations when implementing an IMS were top management commitment, necessary resources, and training " <i>[...] techniques, group work and peer review</i> " to overcome change resistance, establish plans for " <i>[...] vertical and horizontal communication</i> " and newcomers' integration, using PDCA for continuous improvement, risk awareness, flexibility with the implementation of the IMS model and use integrated audits for " <i>[...] continual improvement of the organization and driver of the model</i> "
Pheng & Kwang (2005)	Construction firms ISO 9001 ISO 14001 OHSAS 18001	<p>The survey considered companies with an IMS certification and the "<i>[...] costs and benefits of implementing IMS and</i>" if the construction companies have experienced significant improvement.</p> <p>Bigger companies only gained slightly more benefits compared to the smaller ones, including cost benefits.</p> <p>Problems were seen with employee resistance to change, maybe due to better documentation showing more of their mistakes.</p> <p>Management commitment was one of the major success factors in the implementation.</p> <p>Concerns were present for the operation of multiple standards, due to missing expertise of people for the various MSs, their stakeholders and objectives.</p>
Zeng et al. (2011)	66 Companies with IMS in China (one third in manufacturing)	<p>Benefits revealed were from most to least significant:</p> <ol style="list-style-type: none"> <li>1) Decrease in paperwork</li> <li>2+3) "<i>[...] Decrease management costs and decrease complexity of internal management</i>"</li> <li>4) Simplification of the certification process</li> <li>5) Facilitation of continuous improvement</li> </ol>

a) HLS

Karapetrovic and Willborn (1998) forecasted the importance of "*[...] harmonized and integrated*" standards in order to use them in conjunction. Twenty years later, Bernardo & Simon (2014) see improvements that resulted from the revisions of ISO standards. For example the adaption to market demands and reaching better equality in "*[...] structure and vocabulary*"

(Bernardo & Simon, 2014). On the other side, Wilkinson & Dale (2001) in a study among British companies in different sectors showed that companies reported the “[...] *compatibility and alignment*” of the standards did not hinder the implementation of an IMS or a second MSS (Wilkinson & Dale, 2001). However, it did not hinder the implementation does not imply that a better alignment would not have made it easier.

## B.4 ISO 10000 CS standards

### a) ISO 10000 revision

However, there are already updated versions of the initially published standards. More specifically ISO 10002 as the first standard developed in 2004 was revised in 2014 and ISO 10004 was updated in 2012, two years after it came out. Only “*ISO 10001 and ISO 10003*”, which “[...] *were added to ISO 10002*” in 2007 (Karapetrovic, 2012) have not been revised yet. According to the ISO website, 2017 all four standards are undergoing a revision process.

West (2008) describes that the revision process is mandatory for all ISO standards. He explains that all standards experience an “[...] *initial systematic reviews*”, which is done “[...] *3 years after publication*”. This allows a validation of the document and the ability to decide about the necessity for a directional change (West, 2008). After this initial review the interval increases to five years for the same purpose (The British Assessment Bureau, 2017).

### b) Commonalities among ISO 10001/2/3/4

Clause	ISO 10001	ISO 10002	ISO 10003	ISO 10004
4	Guiding principles	Guiding principles	Guiding principles	Concept and guiding principles
5	Code framework	Complaints-handling framework	Dispute-resolution framework	Framework for monitoring and measuring CS
6	Planning, design and development	Planning and design	Planning, design and development	Planning
7	Implementation	Operation of complaints-handling process	Operations	Operation
8	Maintenance and Improvement	Maintenance and Improvement	Maintenance and Improvement	Maintenance and Improvement

### c) Integrative augmentation of MSs

An augmenting standard has all elements to build a stand-alone MS and they “[...] *universally-applicable to any organization and illustrate only a minimal framework for the corresponding MS [...] like the ‘assimilating’ standards*” (Karapetrovic, et al., 2012).

Nevertheless, Karapetrovic, et al (2012) also point out that there is a difference between “[...] *real augmenting standards*” and solely guidelines without the content that is necessary for a MS. However, ISO 10001 is missing in the list of AUGS that “[...] *do not have the necessary content or context to be able to form a MS on their own*” (Karapetrovic, et al., 2012).

Dee, et al. (2004), Karapetrovic (2007) and Schnoll (2015) agree that it is possible to use the individually, but they may be used to form a MS for complaints handling, given that the standards are addressing closely related topics and their structural commonalities.

A customer satisfaction and complaints handling system (CSCS) is the second way of using the augmentative standards, described by Dee, et al. (2004). They also address the different possibilities for companies in terms of the integration strength. Dee, et al. (2004) and Karapetrovic, et al. (2012) agree that a company can choose to integrate “[...] *a comprehensive CSCS [...] as a subsystem within the overarching [...]*” MS or simple use one of the elements of the CSCS in alignment. The company is able “[...] *to choose the desired scope of CSCS implementation*”, while keeping their current “[...] *process model structure of ISO 9001*” (Dee, et al., 2004).

Karapetrovic (2007) sees benefits in an integration within augmentative standards. He agrees that the usage of an augmenting standard independently is possible if the company does not have “[...] *an overall standardized management system in place*”. However, the integration into an existing MS is the preferable option should the company already have a MS in “[...] *accordance with an augmenting standard*” (Karapetrovic, 2007).

A QMS established according to ISO 9001 forms an ideal basis to smoothly integrate the CSCS standards (Karapetrovic, 2005; Dee, et al., 2004). For an overview of methods that can be used in the implementation, the reader may refer to subchapter "Methodology for IMS implementation" within Chapter "Management Systems and Management System Standards" of the thesis.

Karapetrovic, et al. (2012) claim that the existing QMS, or IMS, “[...] can be strengthened” through the integration of systems from these augmentative standards. Dee et al. (2004) emphasize the importance to harmonize the QMS with the CSCS in terms of their “[...] related elements (objectives, resources and processes) and linkages between them.” (Dee, et al., 2004)”

Furthermore, the augmenting standards can be integrated in a horizontal or vertical way due their natural focus on one part of the MS (Dee, et al., 2004; Karapetrovic, 2007; Karapetrovic, 2012). Karapetrovic (2012) refers to his paper from 2007 explaining “[...] the real advantage of integrative augmentation rests with the horizontal integration, where systems are used to augment each other and thus are combined much more naturally”.

d) Awareness about standards of the ISO 10000 series

Author	CS standards investigated	Awareness	Location, sector and number of companies
Karapetrovic, et al. (2006)	ISO 10001, 10002, 10003, 10004	Half of the respondents not familiar with 10001 and 10003 or were unsure if they will implement them (standard <u>not published</u> at that time)  1/3 of the organizations planned to implement 10002 or had already implemented it	529 (23% response rate) ISO 9001-registered companies
Karapetrovic & Spasojević-Brkić (2014)	10001, 10002, 10003, 10004, 10005, 10008	<ul style="list-style-type: none"> <li>• Lack of “<i>awareness of customer satisfaction AUG MSSs</i>” and “<i>[...] half of respondents indicating that they are “not aware” or “aware and not sure”</i>” of 10001, 10002, 10003.</li> <li>• 25 % find it “important to implement” or have “already implemented 10001 and/or 10002” and 36% indicated this for ISO 10004</li> <li>• 5 % of organizations use ISO 10001 and/or ISO 10003</li> <li>• 13% use 10002 and/or 10004</li> </ul>	Serbia, 39 companies (half of them manufacturing, 15 % construction, 8 % energy/utilities other sectors all 3% or less)
Salerno-Kochan & Salerno-Kochan (2014)	10001-10008; 10012-10015; 10017-1019	Large number of organization have no awareness of ISO 10000 existence, higher percentage found in small enterprises <ul style="list-style-type: none"> <li>• 10001 + 10002- 1/3 knew</li> <li>• 10003 + 10004 – ¼ knew</li> </ul> From the companies that knew about the standards, 35% also used them.	Poland, 40 organizations ISO 9001:2008 certified, different sizes,
Simon et al. (2015)	ISO 10001, ISO 10002 and ISO 10003	Most companies did not know the ISO 10000 family	Poland and Spain, Spa enterprises (with formal/informal customer promises in place as a prerequisite)

Interestingly Salerno-Kochan & Salerno-Kochan (2014) found that from the companies that knew about the standards, 35% also used them. Multiple authors agree on the fact that there is

less information on standards like those within the 10000 series, in their nature ‘supporting standards’, compared to ISO 9001 (Salerno-Kochan & Salerno-Kochan, 2014; Ang & Buttle, 2012; Karapetrovic, 2012). An interesting finding in a study in Poland conducted by Salerno-Kochan & Salerno-Kochan (2014) revealed that organizations in manufacturing have a higher awareness and usage (77% and 15%) for the CS standards compared to those in services (40% and 7%).

Another point Salerno-Kochan & Salerno-Kochan (2014) make, is the lack of reference to the standard within other MSSs. However, ISO reacted in its revision of ISO 9001 in 2015 to this by adding “Annex B ‘Other International Standards on quality management and quality management systems developed by ISO/TC 176’” (ISO, 2015c).

#### e) Case studies on satisfaction with ISO 10000 standard

Author	Standards investigated	Findings	Company, Location
Hughes & Karapetrovic (2006)	Application of 10002	Opportunity for integration of CHS and QMS  Company failed in complaint closing and follow-up actions, areas for improvement the CH process and performance using feedback	Large electrical utility, Canada,
Ang & Buttle (2012)	Impact of documented complaints-handling processes on customer retention due to the, at that time, upcoming publication of ISO 10002	“[...] Customer retention is strongly associated with the presence of a documented complaints-handling process” and secondly “[...] standard management practices of planning, budgeting and assigning accountability for customer retention are not associated with excellent customer retention performance”	170 companies, Australia, dominant sectors: manufacturing (43 companies); wholesale and retail (24 companies); and health, community services, accommodation, cultural/ recreation, personal and other services (23 companies)
Ang & Buttle (2006)	10002	Survey used two groups of variables namely organizational and complaint handling indices. Outcome was that implementing ISO 10002 generates a range of marketing related outcomes	Australia, 4 sectors, 144 organizations

#### Case studies on satisfaction with ISO 10000 standard (continued)

Karapetrovic & Doucette	Application of ISO 10001 and ISO	Positive results, students would recommend the usage of the	University in Canada, Engineering Management
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(2009)  Karapetrovic (2010)	10002 in Engineering Management Courses	implemented codes of conduct (79% and 94% in two courses)  Usefulness of the codes and feedback forms rated high (ranging from 75 % to 100 %)	courses, 6 course sections
Dimkov & Iavnova (2012)	Model to assess telecommunication companies' performance of the quality of service based on ISO 10001 and ISO 10002	„Customers' satisfaction is strongly dependent on the quality of telecommunication service “and it is “[...] based on three main factors: results of the telecommunication service, process of telecommunication service, organizational image“	Bulgaria
Khan & Karapetrovic, (2013) Khan & Karapetrovic, (2015)	Establishing an ISO-based promise in inpatients care	ISO 10001: „[...] Activities suggested by the standard were further defined, suggesting a potential improvement of the standard“  „[...] integrated use of the ISO 10000 series for the first time in health car	Hospital in Canada
Vargas-Villarroel (2015)	Model for integrative augmentation of ISO 10001/2/4/8 in an undergraduate course online platform	„[...] 65 % students expressed an increase in course quality and satisfaction improved with actions taken because of the implementation of surveys and redesign of the course E-class site“	University in Western Canada

#### a) ISO 10002.

Six years later, Ang & Buttle (2012) formulated their research question, as to whether “[...] the presence of a documented complaints-handling process has a greater impact on customer retention outcomes than customer retention planning process”. They found that there is a strong positive relationship of companies having a “[...] documented complaints-handling process” and superiority in customer retention. The planning of budgeted plans and “[...] control of a responsible manager” has less impact in comparison (Ang & Buttle, 2012). Furthermore, they

describe that the process is able to “[...] identify and act on the problems that motivate customers to take some or all of their business to competitors”.

## B.5 Manufacturing and CSAPs

### a) Types of service guarantees [adapted] from McDougall (1998)

Type of service guarantee	Coverage and payout
“Pure conditional guarantee”	“[...] does not specify either the coverage or the payout (e.g. - 'Satisfaction guaranteed. Period')”
“Unconditional guarantee”	“[...] guarantee does not specify the coverage but does specify the payout (e.g. - Satisfaction guaranteed or you money back')”
“Pure specific guarantee”	“[...] details both the coverage but does specify the payout (e.g. - 'Delivery by 10.00 a.m. or your money back’”
“Specific guarantee”	“[...] might contain a detailed coverage and an unconditional payout (e.g. 'Deliver in 30 minutes. Period.')

McDougall (1998) claims, for companies it is critical to “[...] design a guarantee that is most appropriate for their situation” and also consider matching the particular type of guarantee carefully. The latter is mainly based on the McDougall's investigation of preferences for the different kinds of guarantees. This study showed mixed result; “[...] When consumers considered characteristics regarding invoking the guarantee, the specific guarantee was preferred“, which might be in relation to their clear and manifest nature, whereas when consumers had to choose a firm in regards to the guarantee, “[...] the unconditional guarantee was preferred, probably for its complete coverage”.

According to Steinhart (2012) the validity of a guarantee is related to the information a customer needs to measure the promise. He proves in his study that guarantees are better used when a promise is explicit, respectively can be measured through external information. Further he found, “[...] consumers will find an implicit promise, conveyed through the bundling of a diagnostic kit to the product, to be more appealing” as implicit promises are only able to be measured by the



consumers themselves and therefore it is a subjective judgment. This is why the consumer might even see the product as less reliable, if an explicit promise is attached to it. (Steinhart, 2012)

#### b) Complaint satisfaction

It is important to define the term “*complaint satisfaction*”, which is “[...] *satisfaction of a complainant with a company’s response to her/his complaint*” including both the outcomes of complaints management itself and the way the company is acting within the process (Strauss, 2002). Strauss (2002) explains that the “[...] *outcome complaint satisfaction seems to have a stronger influence on overall complaint satisfaction and process complaint satisfaction*” appears to be more influential on repurchase intention and overall satisfaction. Ang & Buttle (2011) show similar results in their study almost a decade later, explaining that “[...] *customer loyalty after a complaint essentially depends on complaint satisfaction and is largely unaffected by overall customer satisfaction*”. This also means customer satisfaction from previous experiences is no safeguard for a company “[...] *against the consequences of ineffective complaint handling*” (Ang & Buttle, 2012).

c) Forms of Justice and Actions [adapted] from Karatepe (2006)

Form of justice	Actions
Distributive justice	Necessary condition customers expect is a form of atonement, for example [...] "replacement, refund, free gift and coupons by the organization relative to the failures they experienced"
Procedural justice	Swift responses, [...] " <i>facilitation and promptness</i> " [...], where promptness has the stronger effect of the two. Actual time is less important factor than the perceived time of responses.
Interactional justice	Effort and attractiveness have strong effects, than the other two factors, explanation and apology.

Bhandari, et al. (2007) describes procedural justice as the experience of fairness during the "[...] *entire process of dispute resolution*", distributive justice being concerned with receiving a fair resolution and interactional justice is influenced by "[...] *courtesy and respect in terms of management's recovery actions and outcomes*". They further say, one satisfied dimension does not mean all of justice dimensions are satisfied. Karatepe (2006) additionally grants interactional justice the highest importance.

d) Better Business Bureau

In Canada and the USA, BBB publishes results of their inquiry and complaint statistics since 2011. The company has been working in the field of dispute resolution for nearly 100 years (Council of Better Business Bureaus, 2016a). "[...] *A panel of approximately 1,000 professional arbitrators--predominantly attorneys--partner with the BBB system to provide arbitration hearings that are local and yet consistent with overall program mandates*". They offer different model of resolving the complaints depending on the customer (Council of Better Business Bureaus, 2016a).

The results a divided by industries and for the windows and doors category in 2015 the following numbers are published: (Council of Better Business Bureaus, 2016b):

Table 28: Excerpt from the 2015 complaint statistic for Windows and Doors from Better Business Bureaus (2016b)

Year	Inquiries	Rank by inquiries	Complaints	Rank by complaints	Settled
2015	2158	671	2	889	100%

Industries with the highest complaints in the last years are automotive (car dealers), movers, furniture retail and telecommunication (Council of Better Business Bureaus, 2016b).

## Appendix C. Methodology

### C.1 ISO 9001 Questionnaire

#### Objectives:

- *Identifications of current procedures that are new requirements within ISO 9001:2015*
- *Gathering information about the potentials and improvements with current standardized procedures in accordance to ISO 9001:2008*
- *Get information on how to best fit the new requirements into the existing Quality Management Systems (QMS)*
- *Identification of the existing relations to the ISO 10000 series and how the ISO 10000 series guidelines could be integrated in the overall Integrated Management System (IMS)*

#### Target Group

- *Top Management*
- *Functional Management*
- *Staff Members*

#### **Planning the QMS and relation to the IMS and customer related programs**

1. How do you address internal and external issues the company is facing in order to understand customer-related processes and the requirements for doors, windows and related services?  
[ISO 9001, 4.1]
2. Which tools would help you gain understanding internal and external issues regarding the QMS (e.g. Brainstorming, SWOT-Matrix, Benchmarking)?

3. How do you determine relevant interested parties influencing the CSO's ability to provide windows and doors meeting customers' requirements?  
[ISO 9001, 4.2]
  
4. How do you monitor and review information about these relevant parties?  
[ISO 9001, 4.2]  
[ISO 10001, 8.4]
  
5. When planning for your doors and windows and related services how do you gather information on customers' requirements?  
[ISO 9001, 8.2.1]  
[ISO 10001, 8.1]
  - a) How do you establish customer requirements including any codes of conduct and the feedback or complaints handling?  
[ISO 9001, 8.2.2 a]  
[ISO 10004, 7.5]
  - b) How do those requirements contribute to the functioning of the integrated management system and customer satisfaction programs?  
[ISO 10001, 6.3]
  - c) How do you review if customer requirements can be met?  
[ISO 9001, 8.2.3.1 a]
  - d) What evidences of customer requirements are retained?  
[ISO 9001, 8.2.3.2]  
[ISO 10002, 5.2]  
[ISO 10001, 6.4]  
[ISO 10003, 5.2.1]
  
6. When you established the Management System according to the ISO 9001,:2008 standard, did you exclude any parts of the standard's requirements (Clause 7), if so why?

Exclusions

Reason(s) for Exclusion

7. What is the relationship between your quality management system and your integrated management system?
  - a. Which areas of the organization's management system did you choose not to integrate and why?
  - b. What are customer-related processes or procedures in the company you want to emphasize in your integration efforts?

### **Risks and Opportunities**

8. How is your company addressing risks and opportunities when planning for the Quality Management System (e.g. product conformity, customer satisfaction, control of externally provided products and services, external dispute resolution)?

[ISO 9001, 6.1]

[ISO 10003, 6.3.3]

- a. What are the methods used to measure, review and evaluate risks and opportunities that influence

[ISO 9001, 6.1.2]

current methods

potential methods

customer satisfaction?

complaints-handling?

customer communication?

Product conformity?

External products and services

- b. How can an assessment of risks and opportunities within manufacturing contribute to
  - 1) The improvement of your processes?
  - 2) Higher customer satisfaction?
  - 3) The improvement of the doors and windows?

### **Documents**

9. Which information do you document related to

[ISO 9001, 7.5.1 b]

1) Nonconformities?

[ISO 9001, 8.1 e) 1]

2) Customer-feedback?

[ISO 10002, 7]

[ISO 10002, 8.1]

3) Internal feedback?

[ISO 10002, 7]

[ISO 10002, 8.1]

4) Customer satisfaction?

[ISO 9001, :2015 8.7.2]

[ISO 9001, 8.1 e) 2]

a) Which documented information did you create and maintain?

[ISO 9001, 7.5.2]

b) Where do you record and monitor the relevant documented information?

[ISO 9001, 7.5.3]

c) How do you control the adequacy and suitability of documented information including information from customers and external providers?

[ISO 9001, 7.5.3]

d) How is the current documented information integrated for quality, environment, occupational health and safety (e.g. through universal forms)?

e) How would it be easier for you to create documents for the integrated management system?

### **Information and Knowledge Management**

10. How do you organize your information in order to be able to look at all elements of the integrated management system?

a. How do you include customer feedback, complaints and satisfaction information in this information system?

[ISO 9001, 7.1.6]

b. How do you decide which departments or functions will have access to this information?

[ISO 10002, 5.3.3]

[ISO 9001, 7.5.3.2]

c. How can information received from customers be effectively communicated to relevant functions (e.g. detailed problem description, quick forwarding) ?

d. What changes to the current procedures or resources could improve the understanding of

1) Complaints?

2) Customer requirements?

3) Suggestions and feedback?

## **Training**

11. How is the current employee training on customer related topics performed (e.g. customer service, customer communication, complaints handling, measurement):

1) intervals

2) resources

[ISO 9001, 7.2]

[ISO 10002, 5.1]

[ISO 10002, 6.4]

[ISO 10002, 5.3.4]

12. How do you evaluate if the training was effective?

[ISO 10002, 8.1 c]

[ISO 10002, 8.6 3]

## **Design and Development**

13. How do the different stages of the design and development of the doors and windows reflect your customer's requirements, suggestions, feedback and complaints?

**Planning**

[ISO 9001,

8.3.2]

**Inputs**

[ISO 9001,

8.3.3]

**Controls**

[ISO 9001,

8.3.4]

**Outputs**

[ISO 9001,

8.3.5]

**Changes**

[ISO 9001,

8.3.6]

**Measurement**

14. What are the indicators and methods used to measure:

[ISO 9001, 9.1.1]

	Indicators	Measurement Method
a) Customer Satisfaction [ISO 9001,9.1.2]		
b) Performance of guarantees and codes of conduct [ISO 10001, 8.2] [ISO 10001, 8.3] [ISO 10001, 8.4]		
c) Complaints handling process [ISO 10002, 8.4]		
d) Dispute resolution process [ISO 9001, 8.4]		

**Management review**

15. How are the different requirements of the integrated management system addressed within the management review?

[ISO 9001, 9.3]

16. How do the following elements (see table below) influence the

a) inputs of the management review

[ISO 9001, 9.3.2]

b) outputs (e.g. decisions, actions) made after the management review

[ISO 9001, 9.3.3]

	Inputs	Outputs
Guarantees and codes of conduct		
Internal complaints handling		



[ISO 10002, 8.6]

### External dispute resolution

[ISO 10002, 8.3]

### Customer satisfaction measurement

[ISO 10004, 7.5]

[ISO 10004, 8]

## **Auditing**

17. How do you prepare and carry out the auditing of your integrated management system?

[ISO 9001, 9.2]

a. How are codes of conduct, the complaints handling process, external dispute resolution and monitoring and measurement of customer satisfaction included in the auditing process?

[ISO 10002, 8.5]

b. How could the inclusion of additional standardized management systems influence the process?

c. How do you use results of the audit?

## **Improvement**

18. How is the improvement of the following elements conducted within your integrated management system?

### Improvements

Products and related

services

[ISO 9001, 10]

Guarantees and codes of

conducts

[ISO 10001, 8.5]

External dispute  
resolution

[ISO 10001, 8.4]

Customer satisfaction and  
its measurement process

[ISO 10004, 7.5]

Customer-related  
processes

[ISO 9001, 10]

19. Has the integrated management system helped you achieve improvements in the above elements and if so how?

*Production line specific questions*

1. What measurements and monitoring activities do you perform to review the quality of the product in the production line?  
[ISO 9001, 7.1.5.1]
2. How can you give feedback on products or services that were received from a preceding operator or department?  
Please provide some examples.  
[ISO 10002, 7.1]
3. What may be the difficulties of communication between different operators?  
[ISO 9001, 7.4]
4. How do you retrieve or receive information about the different steps in the production (e.g. feedback, non-conformities, complaints, improvements)?  
[ISO 9001, 7.1.6]  
[ISO 9001, 7.4]  
[ISO 9001, 7.5.1]  
[ISO 9001, 8.2.1]
5. How can you suggest new tools or resources (e.g. communication platforms, tablets) for communication or providing feedback?  
[ISO 9001, 8.1 c]  
[ISO 9001, 8.5.1. b]  
[ISO 9001, 9.3.1d]

[ISO 9001, 7.1.5.1]  
[ISO 10002, 8.4]  
[ISO 10002, 6.4]

## C.2 ISO 10001 Questionnaire

### Objectives:

- *Identification of current promises/codes of conducts on doors and windows*
- *Gathering information about the potentials for improvements of the current procedures to suggest a standardized process in accordance with ISO 10001*

### Target groups

- *Top Management*
- *Functional Management*
- *Production Staff*

### Promises – Status Quo

1. What promises or codes of conduct for your doors and windows are currently made to the customers?
- 

- Which remedies do you offer to the customer if the promise or codes of conduct were not fulfilled?

[ISO 10001, 6.8]

2. How are the promises or codes of conduct planned and developed?

[ISO 10001, 6]

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3. How are these promises or codes of conduct operated and administrated?  
[ISO 10001, 7]

Promises

Operated and administrated

a) Are there any differences between promises or codes of conduct for doors and windows, if so which?

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b) How are windows and doors advertised and their characteristics explained to the customer (e.g. Sales Consultants)?

[ISO 10001, 7]

[ISO 9001, 8.2.1]

[ISO 9001, 8.2.2]

[ISO 9001, 8.5.1]

---

4. How do you review if the promise or code of conduct objectives were fulfilled?  
[ISO 10001, 8.2]

- 
- a) Which information do you use for that purpose?  
[ISO 10001, 8.1]
- 

- b) How do you evaluate whether the promises were  
[ISO 10001, 8.3]  
→ Customer friendly?

→ Understood by the customer?

5. Do you evaluate the effectiveness of the promises and the related services?  
[ISO 10001, 8.4]  
[ISO 10001, 8.5]

*Promises – Potential*

1. What additional aspects of your products could be supported with a guarantee or code of conduct and why?  
[ISO 10001, 6.1]
- 
- 

- a) Could you give me an example of a possible promise or code of conduct including limitations and remedies?  
[ISO 10001, 6.4]  
[ISO 10001, 6.8]

- 
2. Where should the information served as an input in the planning of a promise be gathered form (e.g. stakeholders, benchmarking)?

[ISO 10001, 6.2]

[ISO 10001, 6.3]

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3. Which function should be involved in the development of promises and codes of conduct?

[ISO 10001, 6.3]

[ISO 10001, 6.4]

[ISO 10001, 6.5]

[ISO 10001, 6.6]

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4. In which forms could the communication of doors' and windows' characteristics and the results after delivery take place, in order to be easily accessible and understandable to

[ISO 10001, 6.7]

a) Your customers?

b) –relevant functions?

5. Which characteristics of doors and windows and their related services could potentially lead to misunderstandings among customers?

---

---

6. Are there areas where the company wants to establish a promise or guarantee to place more attention on, in order to increase customer satisfaction (e.g. for a competitive edge or for addressing a clustering of complaints arising in the past)?

[ISO 10001, 7.3.1]

[ISO 10001, 7.4.1]

[ISO 10004, 6.4]

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---

7. Which features of doors or windows or resources (e.g. monetary, human) may limit the establishment of promises?

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8. How should the review process of a promise or code of conduct be designed?

[ISO 10001, 8.4]

- a) How often needs the code of conduct go through reviews and why?

[ISO 10001, 8.4]

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### C.3 ISO 10002 Questionnaire

#### Objectives

- *Identification of current complaints/feedback handling operations on doors and windows*
- *Gathering information about the potentials and improvements of the current procedures to suggest a standardized process in accordance with ISO 10002*

#### Target groups

- *Top Management*
- *Functional Management*
- *Production Staff*

#### Customer feedback and complaints handling – Status Quo

1. Which information is offered to the customer on how to:  
[ISO 10002, 7.1]  
[ISO 10002, 5.3.e]
  - 1) Give feedback
  - 2) File a complaint
  - 3) The handling of complaints?

- 
- 
- a. How can the customer get in touch with the company to provide feedback and complaints on doors and windows? [ISO 10002, 7.1]

- 
- 
- b. What channels can customers use to give feedback?  
Traditional (e.g. in person, call):



Internet (e.g. social media, online form, email):

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**2. Target Group: Top Management, Quality/Reclamations/Customer Service Management**

How are feedback and complaints of the features of windows or doors (e.g. sealing, R-value) – received from customers – currently operated?

**a) External Customers:**

**b) Internal Customers:**

	Actions	Department(s)/position responsible [ISO 10001, 5.3.3 f] [ISO 10001, 5.3.3 g] [ISO 10001, 8.1]
Receipt [ISO 10001, 7.2]		
Tracking [ISO 10001, 7.3]		
Assessment and Investigation [ISO 10001, 7.4] [ISO 10001, 7.5] [ISO 10001, 7.6]		
Response [ISO 10001, 7.7]		
Actions [ISO 10001, 7.8] [ISO 10001, 7.9]		

*For individual staff:*

What is your role within the customer feedback and complaints handling process and who are

you usually in contact with during this process? Please provide any existing procedures to review.

---

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*Additional to table above, if not covered already:*

- a) Which information on the complaint/feedback documented and accessible for internal handling and where?

[ISO 10002, 7.3]

[ISO 10002, 7.2]

[ISO 10002, 7.9]

[ISO 10002, 8.1]

---

- b) How do you classify complaints on your windows and doors upon receipt?

[ISO 10002, 7.5]

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---

- c) Who has the authority to make decisions for complaints received from consumers:

- before the delivery

- on the jobsite (e.g. Installation)

- after delivery

- d) Who has the authority to make decisions for complaints received from businesses:

- before the delivery

- on the jobsite (e.g. Installation)

- after delivery

e) Can you give me examples of actions which are taken after identifying that complaints were:

[ISO 10002, 7.1]

[ISO 10002, 8.2]

Single occurrence	
Recurring	
Significant (e.g. high resources usage to recover, important customer, high risk for company and customer) [ISO 10002, 5.3 g]	

f) How often is the customer informed during a complaint-handling process (e.g. decisions concerning the investigation, closing, actions)?

[ISO 10002, 7.3]

[ISO 10002, 7.4]

[ISO 10002, 7.7]

[ISO 10002, 7.8]

[ISO 10002, 7.9]

---

g) How are complaints handled when the investigation reveals that the cause was outside of the company (e.g. suppliers' or customers' unjustified complaints)

---

1. How do you evaluate customer's satisfaction about the complaints resolution and the complaint handling process?  
[ISO 10004, 8.3]
- 
- 
- 

2. How do the feedback and complaints currently contribute to the improvement of doors and windows and quality management processes (e.g. record keeping of complaints)?  
[ISO 10004, 6.1]
- 

3. How are feedback and complaints currently analyzed and evaluated?  
[ISO 10004, 6.1]
- 

- a) Which criteria do you use within the evaluation of complaints and feedback (e.g. severity, risk, customer influence)?

4. Is the complaint and feedback handling currently reviewed through auditing and management reviews?  
[ISO 10002, 8.5]  
[ISO 10002, 8.6]
  - a) If so how often?
  - b) Where is the documented information for the audits and management reviews on the complaint and feedback handling available?

---

*Customer Feedback and Complaints Handling – Potential*

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1. Which type of media do you think would best inform the customers about your (potential) complaints and feedback handling process?  
[ISO 10002, 7.1]
- 
- 

2. Should the current flow diagram of installing doors or windows described at the homepage, be adapted so it includes the process of correction as well, if so which additional elements would be necessary for the customer to understand the diagram?
- 
- 

3. Which departments/personnel do you think should be involved in the following phases of the complaints and feedback handling process?

Please also indicate if it should be an active (e.g. responding to the customer) or passive (e.g. receiving updates/information)

Stage	Department	Resources used
Receipt		
Tracking		
Assessment		

Response		
Actions		

4. What processes or actions may encourage customers to give more feedback and complaints (e.g. After-Installation Surveys, After-Complaints-Resolution Surveys)?

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5. What skills, resources or processes may help you/ the personnel directly in touch with the customer in dealing with customer's feedback and complaints?

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- a) How could regular meetings that include analysis of complaints' root causes and feedback (brainstorming, Ishikawa diagram etc.) benefit the complaints handling process, manufacturing processes and Quality Management processes?

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- b) Which topics would you want to have included in meetings concerning the complaints and feedback from customers?

---

6. How is the choice of whether to involve Top Management within the operational complaint and feedback handling made?

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7. Would a database for collection, analysis and improvement of complaints/feedback and the complaints handling process, could help in the design and development of windows and doors features or the manufacturing process and how?

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8. What means of communication will offer the easiest / most efficient way to track and access the complaint for internal purposes (customer complaint database connected to ERP system)?

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9. *For individual staff*  
*Would you, and how would you benefit, if you had access to a customer complaints/feedback database?*

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10. Which criteria should be used to monitor the performance of the customer complaint and feedback handling process (e.g. number of complaints, time taken to resolve, complaint resolution cost, frequency of type of complaints)  
[ISO 10002, Annex G (G.3.2)]

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11. Would there be benefits, and if so, which, would an anonymous internal complaint and feedback handling system for doors, windows and their according related processes have?

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## C.4 ISO 10003 Questionnaire

### Objectives

- *Identification of current external dispute resolution operations on doors and windows*
- *Gather information about the potentials and improvements of the current procedures to suggest a standardized process in accordance with ISO 10003*

### Target groups

- *Top Management*
- *Functional Management*
- *Production Staff*

### External dispute resolution – Status Quo

1. If the company cannot resolve a complaint concerning windows and doors with a customer, which steps are taken?

Which external parties are involved?

[ISO 10003, 6.3.1]

[ISO 10003, 6.3.2]

Actions	Department involved / notified
<i>Complaint referral</i> [ISO 10003, 7.2]	
<i>Receipt of Dispute Notice</i> [ISO 10003, 7.3]	
<i>Organizational Response</i> [ISO 10003, 7.4]	

<i>Resolution of Dispute</i> [ISO 10003, 7.5]	
<i>Implementation of Resolution</i> [ISO 10003, 7.6]	

*Additional questions if not answered already:*

- a. Does the complainant have to go through internal complaints handling first and which, if any, costs are involved for the customer?  
[ISO 10003, 5.2.1]

- 
- b. If at all, how do you handle different customer groups (e.g. other business or consumers) for the external dispute resolution?  
[ISO 10003, 6.3.2]

- 
- c. What is the company's role after a referral to an external provider and who is responsible for the coordination?  
[ISO 10003, 6.3.2]
-

- d. Where and how do you keep track and update the complaints referred to an external party (e.g. complaints database)?  
[ISO 10003, 7.2]

2. Could you give me specific examples on the most common problems on doors and windows that lead to external dispute resolution and which actions you offered to solve before consulting an external party?  
[ISO 10003, 6.3.2]

Problem	Actions offered to customer before external dispute resolution offered

3. How are providers chosen for external dispute resolution?  
[ISO 10003, 6.4]

4. What actions are taken to analyze the dispute resolution process?  
[ISO 10003, 8.2]

5. How does this evaluation affect:
- a) The windows and doors and their related processes?
  - b) The processes within complaint handling?
- [ISO 10003, 8.4]

External dispute resolution – Potential

1. What are the main goals the dispute resolution process should fulfill at the CSO?  
[ISO 10003, 6.2]

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2. Which sub-goals can it include for your doors and windows manufacturing process, the stakeholders (customers, employees, statutory and regulatory bodies...) and the entire organization?  
[ISO 10003, 6.2]

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3. How should dispute resolution be offered to customers?  
[ISO 10003, 5.2.1]

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- a. Which media and channel can customers be best informed about the procedures for external dispute resolution?  
[ISO 10003, 5.3]

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4. Which criteria of a complaint on doors and windows should lead to the initiation of a dispute-resolution process and why?  
[ISO 10003, 5.2.1]  
[ISO 10003, 7.2]
- 

5. How could you more effectively and efficiently interact with the dispute resolution provider (e.g. receive or send information)?  
[ISO 10003, 6.4]
- 

6. How should a procedure for handling complaints not resolved by the dispute resolution provider include be designed?  
[ISO 10003, 7.6]
- 

7. Which information from dispute resolution should be provided to analyze customer satisfaction and to relevant function (e.g. Quality, Production, Purchasing)?  
[ISO 9001, 9.1.2]  
[ISO 10003, 8.2]  
[ISO 10004, 7.3]
-

## C.5 ISO 10004 Questionnaire

### Objectives:

- *Identification of current practices on customer satisfaction measurement*
- *Gather Information about the potentials and improvements of the current procedures to suggest a standardized process in accordance with ISO 10004 (and 9001)*

### Target groups

- *Top Management*
- *Functional Management*
- *Production Staff*

### Measurement of Customer Satisfaction – Status Quo

1. How do you determine the customers' expectations on
    - your doors and windows
    - the delivery of the doors and windows?[ISO 10004, 4.2]
- 
- 

2. How is the process of gathering customer satisfaction data currently performed?  
[ISO 10004, 7.3.3]
- 
- 

- a. What data or input for the monitoring and measurement of customer satisfaction do you consider (e.g. direct, indirect)?  
[ISO 10004, 7.3.2]  
[ISO 10004, 7.3.3]

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---

b. Which methods, if any, are in place to gather customer satisfaction data (e.g. surveys)?

[ISO 10004, 7.3.3.2]

c. How do you determine how many and which customers are asked to respond to the surveys?

[ISO 10004, 7.3.3.3]

---

---

d. How does the process of analyzing the data obtained from customers performed?

[ISO 10004, 7.4]

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---

3. How is information resulting from the process of measurement and monitoring of customer satisfaction used to improve windows or doors (e.g. functions involved, monitor actions implemented)?

[ISO 10004, 7.8]

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- e. How is data on customer satisfaction used to evaluate if planning was implemented effectively?  
[ISO 9001, 9.1.3]
- 
- 

4. How is the customer satisfaction data stored and reported?  
[ISO 10004, 7.5]
- 
- 

5. What have been difficulties encountered in the process of monitoring and measuring customer satisfaction (e.g. lack of resources, lack of structured approach)?

*Measurement of Customer Satisfaction – Potential*

1. Which objectives within the CSO should monitoring and measurement of customer satisfaction serve?  
[ISO 10004, 6.1]
- 
- 

2. Which business indicators do you think correlate with customer satisfaction information?  
[ISO 10004, 6.1]



3. Which methods and tools for gathering data could provide comprehensive insight in the customer's satisfaction for the purchase of windows and/or doors?  
[ISO 10004, 7.3.3.2]
- 

4. How can a tool, meeting or forum be designed, including the relevant functions involved, to decide on actions based on the results of the analysis of customer satisfaction data?
- 

5. How should information about customer satisfaction be effectively distributed within the company and how should the relevant functions be able to give feedback about the usefulness of the data forwarded?  
[ISO 10004, 7.5]
-

C.6 Table Self-analysis of ISO 9001:2008 compared to ISO 9001:2015

<b>Comparison of ISO 9001:2008 and ISO 9001:2015</b>		
<b>ISO 9001:2015 Clause</b>	<b>ISO 9001:2008 Clause / overlapping</b>	<b>New additions</b>
0	0	
0.1	0.1	In its introduction, the standard already has visible changes. It promotes sustainable development, multiple mentions are granted to customer satisfaction and risk-based thinking and consistently meeting the requirements of interested parties.
0.2		Quality management principles [0.2] is a new clause, explaining again the key principles of the standard. Customer focus, leadership, engagement of people, process approach, improvement, evidence-based decision-making, relationship management.
0.3		
0.3.1	0.2	A few minor wording changes within the process approach [0.3] are managing of interrelated processes to achieve effectiveness and efficiency and interdependency instead of combination and interaction. It seems better structured, with less footnotes and easier language. Moreover, a flow diagram is provided for one process to show the process and its interactions. An addition to the clause is risk based thinking, aiming at taking advantage of opportunities and pre-venting undesirable results within management of processes.

0.3.2	0.2	The Plan-Do-Check-Act cycle [0.3.2] is still the basis for the model but differing in its design, wording and sequencing. Most parts of the model are directly related to clauses of the standard, making it easier to see the relationships. The five internal aspects in the organization are governed by an overarching QMS. The system obtains input from the organization itself, customers' requirements and needs and expectations of relevant interested parties. With the new version of the standard the term stakeholders was replaced by interested parties. This could have been changed due to the fact that stakeholder are mostly related to having solely positive interests in the organization, whereas interested parties are associated to have an interest either for their benefit or detriment. The model is incorporating more aspects and gives a better picture of the processes. The incorporation of continual improvement in the whole cycle is encouraging a more widespread usage of improvement, not solely based on measurement and analysis. A central role is attributed to the leadership of the company, this shows how important the presence and commitment of the top management is, and so encourages employees' understanding what is to be thrived for
0.3.3		Organizations have to plan and implement action to address risks and opportunities, to establish a base to increase effectiveness of the QMS, achieving improved results and preventing negative actions. Within the clause, opportunity and risk are explained as well.
0.4	0.3 / 0.4	expanded , references to Annex
1	1 / 1.1 / 1.2	The scope [1] no longer includes an exclusion, formerly clause 7, for conformity all aspects of the standard have to be met, as it is universally applicable.
2	2	No changes. Except Vocabulary was also updated. 9000:2015
3	3	An update of the terms and definitions [3] ISO 9000 was made when updating ISO 9001.
4		Two sub-clauses are concerned with gaining input for the QMS processes. (4.1 + 4.2)
4.1	4.1	Understanding the processes by analyzing the main inputs (the external and internal organizational issues

4.2		Because of their effect on the organization to provide outputs that meet the requirements the parties and their requirements have to be identified, review and monitor information about those issues
4.3	4.2.2	This clause is mostly new; only the scope was taken from the quality manual. The identified requirements from 4.1+4.2 as well as the products and services shall be considered when determining applicability and boundaries of the QMS, thus defining the scope of the QMS. Requirements determined within the scope of the QMS have to be implemented, the scope has to be made available and maintained as documented information.
4.4	4.1	The QMS and its processes [4.4] formerly only QMS, additionally requires risk and opportunities to be considered, as well as responsibilities and authority assigned. A change has been made in the establishment of the processes. It is focused on which inputs and outputs are expected rather than HOW these are generated.
5	5	Leadership [5] is introduced instead of Management responsibility.
5.1	5.1	
5.1.1		Management has to demonstrate its commitment [5.1.1], which is a guide to more involvement with people throughout the organization. Additionally, this is enforced by not having a clause for a management representative anymore as the only intermediary. Important changes here are the integration of QMS requirements into the organization's business processes, promotion of process-based and risk-based thinking as well as engaging, directing and supporting persons to contribute.
5.1.2		Sub-clause customer focus [5.1.2] has been elaborated more, in regard of risks and opportunities that affect conformity as well as enhancing customer satisfaction. This and the inclusion of risk within leadership shows once more the new emphases of the standard.
5.2	5.3	
5.2.1	5.3	The policy [5.2 / 5.3] itself as mentioned before is not subject to be a printed document but has to be established in context of the organization and support its strategic direction. Another addition is the commitment to satisfy the applicable requirements and continual improvement of the QMS

5.2.2	5.5.2 / 5.5.3	Top management is responsible for communicating and establishing the policy [5.2.2]
5.3	5.5.2	Top management has to assign the roles, responsibilities and authorities(focusing on conformity, processes deliver intended outputs, reporting on conformance and opportunities for improvement to top management, promotion of customer focus and integrity maintained when changes occur). Responsibility and authority was granted a lot more details. As also the organizational knowledge and training of people is much higher valued and its importance understood.
6		
6.1		New is the sub-clause “actions to address risks and opportunities” [6.1]. Risk and opportunities need to be addressed to give assurance QMS achieves intended results, enhance desirable effects, prevent or reduce undesired effects, achieve improvement. The actions to address the risks and opportunities shall be planned, as well as how the integration, implementation, and evaluation of effectiveness is done.
6.2		Quality objectives are granted more details on criteria they have to meet as well as the planning on how to achieve them.
6.3		Planning of changes [6.3] in this early stage is new in this version of the standard. The organization needs to consider the purpose of the changes and consequences, integrity of the QMS, availability of resources and allocation or reallocation of responsibilities and authorities.
7	6	Support (7) is the new clause which has changed some parts of the standards and incorporated new ones, resulting in having all supporting factors and resources in one place
7.1		
7.1.1	6.1	When determining resources, the capabilities of internal existing resources have to be considered as well as what needs to be obtained externally
7.1.2	6.2 / 6.2.2	People are still part of resources but competence has been granted an own sub-clause, as well as training and awareness.
7.1.3	6.3	Minor wording changes.

7.1.4	6.4	Environment for the operation of processes [7.1.4] unlike the former work environment is - also considering the words chosen - promoting a view on the whole organization. Emphasizing the importance of a combination of multiple factors, e.g. Social, psychological, physical, influencing the achieving of conformity.
7.1.5	7.6	Monitoring and measuring resources [7.1.5] were switched and reworded, prior found within product realization and called control of monitoring and measuring equipment. Not many changes have been made to this clause, only in the beginning it was added that the results have to be valid and reliable.
7.1.6		Organizational knowledge has been incorporated in this standard for the first time. Knowledge shall be determined, maintained and be available for achievement of conformity of products and services. To cope with future needs and trends, the organization's knowledge shall be used to address them, and if there is a knowledge gap, additional knowledge required needs to be sourced internally or externally. This change to the standard is progressive and shall cope with fast moving business environments and knowledge being a major factor of success.
7.2	6.2.1 / 6.2.2	Competence has a little terminology difference, now focusing on the people that influence the QMS effectiveness rather than work affecting the conformity to product requirements
7.3		Awareness is granted an own sub-clause, which focuses on making the employees aware of the policy, objective, their contribution to success, as well as implication of not conforming.
7.4		As there is less documented information, the focus is on the involvement of employees, through the presence of leadership and extensive communication.
7.5	4.2	The clause was switched from the former QMS clause to Support. Documented information [7.5] is the term for all documents or records
7.5.1	4.2.1	Needs for a quality manual and quality policy as documented information is not necessary in the new version, quality manual is not mentioned at all. Documented information shall include documents as required by the standard and the ones determined as being necessary for the effectiveness of the QMS.

7.5.2		includes a more practical approach and detailed requirements as to how the documented information shall be created and updated [7.5.2], including format and proper identification, review and approval for suitability and adequacy
7.5.3	4.2.3 / 4.2.4	Control of documents was reduced from two clauses to one as records and documents are both under documented information now. The requirements for documents were expanded in terms of distribution and access, storage and preservation as well as retention and disposition (formerly only records).
8	7	
8.1	7.1	Documentation is required to the extent necessary, and is aimed on being able to provide confidence that processes have been carried out as planned, as well as demonstrate conformity of products and services requirements. Planned changes shall be controlled and consequences of unintended changes reviewed and take necessary actions. Notes: Planned changes were mentioned already in clause 4.4 (QMS and its processes) as well as 6.3 (Planning of changes), so changes are already planned before they occur so that there is less risk and more control if these happen
8.2	7.2	It is no longer called customer-related processes, a possible cause is that all processes of the organization shall work towards customer satisfaction and thereby be customer-related inherently
8.2.1	7.2.3	Standard now starts with customer communication in defining requirements. It additionally includes handling or controlling customer property as well as specifying contingency actions when relevant
8.2.2	7.2.1	Requirements are determined [8.2.2] including the definition of requirements in terms of statutory and regulatory requirements, as well as those the organization considers necessary. The organization needs to make sure the claims for the products offered can be met
8.2.3	7.2.2	Contract or order requirements differing from the previously expressed ones shall be considered and resolved, the customer requirements shall be confirmed by the organization if the customer, this is a new addition to the standard.
8.2.4	7.2.2	Granted an own clause, formerly included in 7.2.2

8.3	7.3	
8.3.2	7.3.1	<p>A few aspects extended Section 8.3.2. The standards required to consider the nature, duration and complexity of the D&amp;D activities, the internal and external resource needs, the involvement of customers and users, requirements for subsequent provision of products and services, the level of control expected for the D&amp;D by customers and other interested parties and the documented information needed to demonstrate that requirements have been met.</p> <p>Notes: The planning of customer involvement and the extent of it is an important incorporation, as it was more focused on the internal interfaces before.</p>
8.3.3	7.3.2	<p>Inputs has two more aspects to consider, namely the standards or codes of practices an organization committed to implement, as well as the potential consequences of failure due to the nature of the products, a clearly risk related point. Documented information is needed of the activities related.</p>
8.3.4	7.3.5 / 7.3.6	<p>Design and development of controls incorporates the old sub-clauses' content for verification and validation, as well as design and development review. Furthermore, a new point is that the results to be achieved need to be defined</p>
8.3.5	7.3.3	<p>Outputs are slightly different. Processes which use the output of the D&amp;D are not restricted to certain functions, it is only 'subsequent' making it broader, as there might not only be three departments making use of it. Documented information on the output has to be retained.</p>
8.3.6	7.3.7	<p>D&amp;D changes requires particular documents to be retained, namely the D&amp;D changes, results of review, authorization of the changes and the actions taken to prevent adverse effects</p>
8.4	7.4	



8.4.1		<p>The clause considers now the different kinds of resources can be obtained externally, which might not be always be a product purchase, but as it is stated now a process, product or service. The clause also requires the determination of controls applied and when there is a need to apply it to external providers. This is the case if a product or service from external providers is incorporated into the own product or service, the external provider delivers a product or service directly to a customer or a (part of) process is provided externally to a customer as decided by the organization. The term supplier is substituted by external provider.</p>
8.4.2	7.4.3	<p>The type and extent of control [8.4.2] is targeted on how the provider's performance will affect the organization's ability to consistently deliver conforming products and services to the customer. The organization shall define controls for the provider itself and the resulting output. Furthermore, the potential impact on the organization's ability to consistently meet requirements (effect on PR or the final product) and the effectiveness of the controls applied need to be considered. Verification activities have been included here, before it had its own sub-clause. The activities the company chooses to verify are more freely determinable.</p>
8.4.3	7.4.2	<p>Information for external provider [8.4.3] in the new version of the standard is additionally requires the communication of the following information to the supplier: approval of the release of products and services, the interaction of the provider with the organization, control and monitoring of the performance to be applied by the organization</p>
8.5	8.5	

8.5.1	7.5.1 / 7.5.2	<p>Control of production and service provision now includes parts of the former validation of processes for production and service provision. Validation does not require documented information or specific methods to use, it is therefore less focused on the specific tools, but on what to achieve. Periodic revalidation was added. Controlled conditions in the new version of the standard were elaborated;• Documented information on the product, service, activity and the results to be achieved need to be provided. This means ‘what and how’ is the first part to consider.• The availability of work instructions (as necessary) was excluded.• For the monitoring and measuring activities, at appropriate stages it is to verify that criteria for control of processes or outputs, and acceptance criteria of products and services have been met. This is again focused on the criteria that were established to meet the customer’s needs.• Instead of focusing on suitable equipment, the new statement is to have suitable infrastructure and environment for the operation of processes. This might be due to the reformulation of clause Environment for the operation of processes [7.1.4].</p> <ul style="list-style-type: none"> <li>• To consider the implementation of actions to prevent human error is a new and again connected to risk management.</li> </ul>
8.5.2	7.5.3	<p>For identification and traceability, the word product has changed to output, as the standard always covers, product, service and process. Additionally, the output has to be identified with the goal to ensure the conformity of products and services, when necessary (this was former throughout the PR). Unique identification still has to be retained as documented information with the little addition ‘necessary to enable traceability’, making it more obvious what the information is needed for.</p>
8.5.3	7.5.4	<p>Property belonging to customer or external providers [8.5.3], formerly only customer property only changed in terms of adding external providers.</p>
8.5.4	7.5.5	<p>Preservation [8.5.4] only changed in the common rewording of product to output and internal processing to production and service provision.</p>
8.5.5		<p>Post-delivery activities [8.5.5] is a new sub-clause, although mentioned in some former section in the old standard. It has a bigger scope and more requirements to fulfill. “The organization shall meet requirements for post-delivery activities associated with the products and services.” It has to consider the following when determining the context of the post-delivery activities: Statutory and regulatory requirements, potential undesired consequences associated with its products and services, nature, use and intended lifetime, customer requirements, customer feedback</p>

.6	8.2.4	Two new requirements in the release of products and services [8.6] are that documented information on the evidence of conformity with the acceptance criteria as well as the traceability to the person authorizing the release.
8.7		<p>Control of nonconforming outputs [8.7] was switched from measurement and analysis to Operations, which makes logically more sense as the non-conformance is occurring often internally already, but also after delivery. Product is substituted by output. The actions taken need to be appropriate for the nature of the non-conformity and its effects on the conformity of products and services, this is comparable to the supplier control and evaluation clause. Regarding the scope, products and services detected after delivery, during and after the provision of service have to be considered as well.</p> <p>Correction is replacing eliminate the detected nonconformity, informing the customer is a new point, while obtaining authorization for acceptance under concession does not state from a relevant party or the customer anymore. The preclusion of the intended use of the product was specified better, so either a segregation, containment, return or suspension of provision of product or service should take place. Need for keeping records was dropped.</p> <p>For the required documented information needed, the standard is listing more specific what shall be included: describe nonconformity, actions taken, any concessions obtained, and identifying the authority deciding the action in respect of the nonconformity.</p>
9	8	Performance evaluation [9] replaced parts of clause 8 measurement, analysis and improvement. Improvement was excluded and has an extra clause now.
9.1		
9.1.1	8.1	For monitoring, measurement, analysis and evaluation [9.1] the requirements compared to the prior version changed. It is outlined that it is necessary to determine what needs to be monitored, which methods are chosen for valid results, when it is performed and when the analysis takes place. This is new and emphasizes more on the way to get the results and leaving less space for interpretation, also documented information has to be retained
9.1.2	8.2.1	CS measurement is still part of this section its new focus lies on customer's perceptions of the degree of fulfilment of needs and expectations.

9.1.3	8.4	<p>This analysis and evaluation additionally includes measuring if planning has been implemented effectively and the effectiveness of actions taken to address risks and opportunities.</p> <p>Notes: The internal audit is placed after measurement and monitoring and the analysis and evaluation clause [9.1.3] is targeted at monitoring and measurement activities for products and services, as well as CS</p>
9.2	8.2.2	<p>The internal audit [9.2] received some slight amendments. When taking the audit the organization also has to consider changes affecting the organization and results of previous audits. As there is no management representative, the corrective actions are undertaken by the person with the authority to do so. Therefore, a new point which requires ensuring that the results of the audits are reported to relevant management was introduced. There is no mentioning of verification of the follow-up activities anymore.</p>
9.3	5.6	See 9.3.1
9.3.1	5.6.1	Management review of the QMS has to be aligned with the strategic direction of the organization
9.3.2	5.6.2	Inputs for the review requires more sources, namely trends in CS, nonconformities (preventive actions not included anymore), monitoring and measuring as well as the performance from external providers, adequacy of resources, and effectiveness of actions taken to address risks and opportunities
9.3.3	5.6.1 / 5.6.3	Review outputs ‘improvement of the effectiveness of the QMS and its processes’ as well as the ‘improvement of product related to customer requirements’ got switched to the clause Improvement [10]. Other requirements stayed the same but were formerly in the General 5.6.1 description
10	8.5	
10.1	5.6.3 a,b	Determining and selecting opportunities for improvement and implementing necessary actions to meet customer requirements and enhance CS (switched from 5.6.3). These actions shall include, improving products and services; correcting, preventing and reducing undesired effects as well as the improvement of the performance and effectiveness of the QMS (former 5.6.3).

10.2	8.5.2 / 8.5.3 / 8.3	<p>Sub-clause nonconformity and corrective action is covering the former corrective and preventive action, and therefore covers a lot more aspects. The requirements are more designed to take opportunities and evaluate the extent of impact a nonconformity will have to the organization. The standard requires to react to a nonconformity as applicable; take action to control and correct and deal with consequences. The organization also has to evaluate the need for an action to eliminate the cause, so it does not happen again. Two new points were added regarding the consideration of risks and opportunities, as well as necessary changes to the QMS, if necessary. Documented information still has to be retained, to have evidence of the nature of the nonconformity and subsequent action, as well as the results of any corrective action.</p> <p>Note: Preventive action is not mentioned anymore</p>
10.3	8.5.1	<p>The continual improvement [10.3] is now all focused on the results of management reviews (it substituted the following parts --&gt; quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review from 2008 version), this is the basis of any decisions for need and opportunities as part of continual improvement.</p>

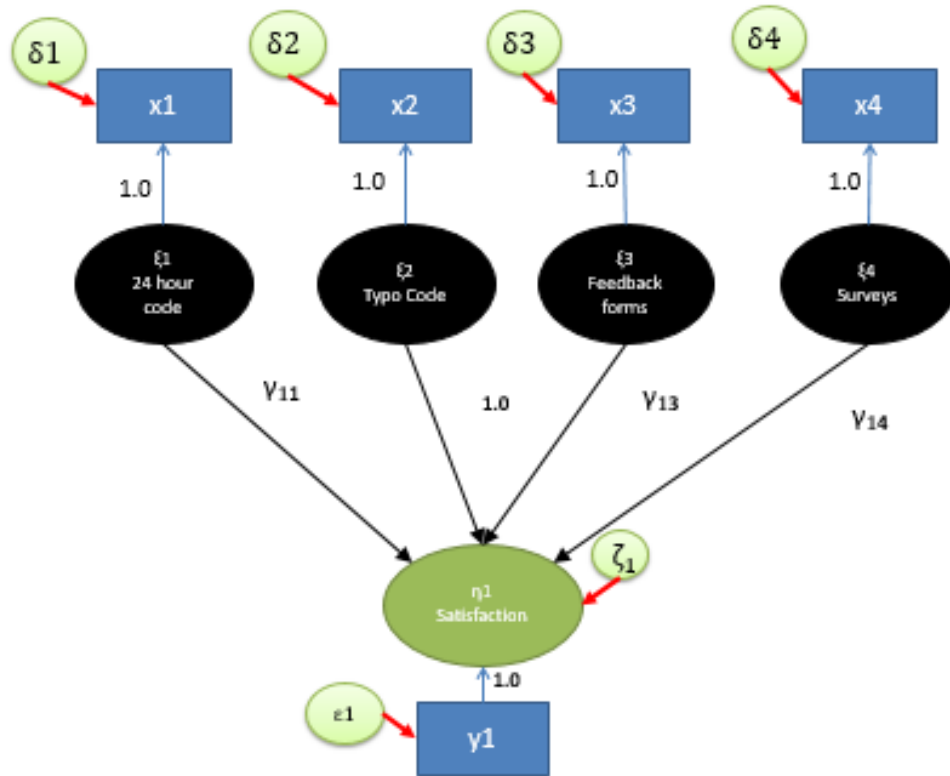
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	New Requirements

## Appendix D Structural Equation Modelling

### D.1 SEM analysis of elements of midterm surveys 2017

#### a) SEM model

Midterm SEM



Year	cases	Cases/section	Sections
2017	106	29+77	B1+B2

b) Structural equations

$$\eta_1 = 0 + [V_{11} V_{12} V_{13} V_{14}] \begin{matrix} \xi_1 \\ \xi_2 \\ \xi_3 \\ \xi_4 \end{matrix} + \zeta_1$$

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 1.0 & 0 & 0 & 0 \\ 0 & 1.0 & 1.0 & 0 \\ 0 & 0 & 1.0 & 0 \\ 0 & 0 & 0 & 1.0 \end{bmatrix} \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \\ \xi_4 \end{bmatrix} + \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix}$$

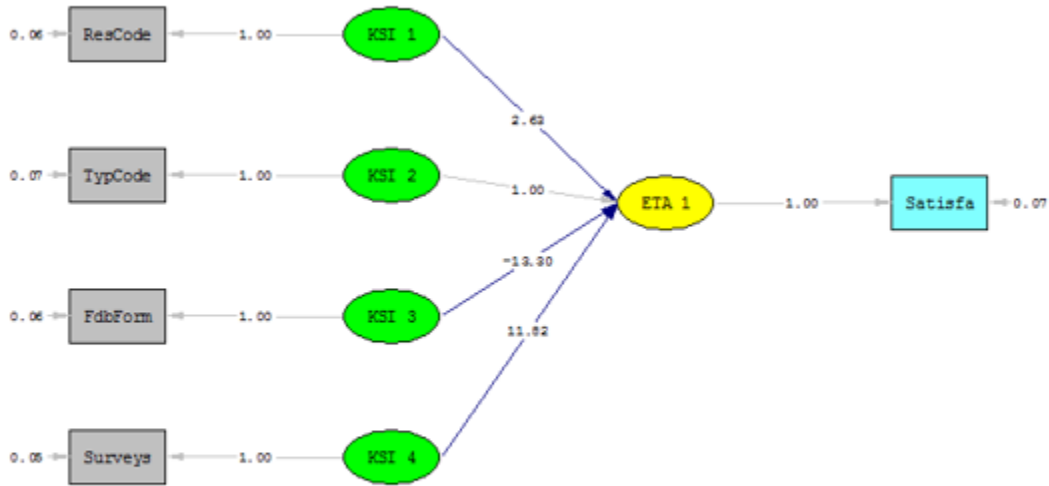
$$y = [1.0] \cdot \eta_1 + [\epsilon_1]$$

$$[\Phi] = \begin{bmatrix} \varphi_{11} & 0 & 0 & 0 \\ \varphi_{21} & \varphi_{22} & 0 & 0 \\ \varphi_{31} & \varphi_{32} & \varphi_{33} & 0 \\ \varphi_{41} & \varphi_{42} & \varphi_{43} & \varphi_{44} \end{bmatrix}$$

$$\Theta_{\delta} = \begin{bmatrix} \theta_{\delta 11} \text{fixed} & \square & \square & \square & \square \\ 0 & \theta_{\delta 22} \text{fixed} & \square & \square & \square \\ 0 & 0 & \theta_{\delta 33} \text{fixed} & \square & \square \\ 0 & 0 & 0 & \theta_{\delta 44} \text{fixed} & \square \end{bmatrix}$$

Year	cases	Cases/section	Sections
2017	106	29+77	81+82

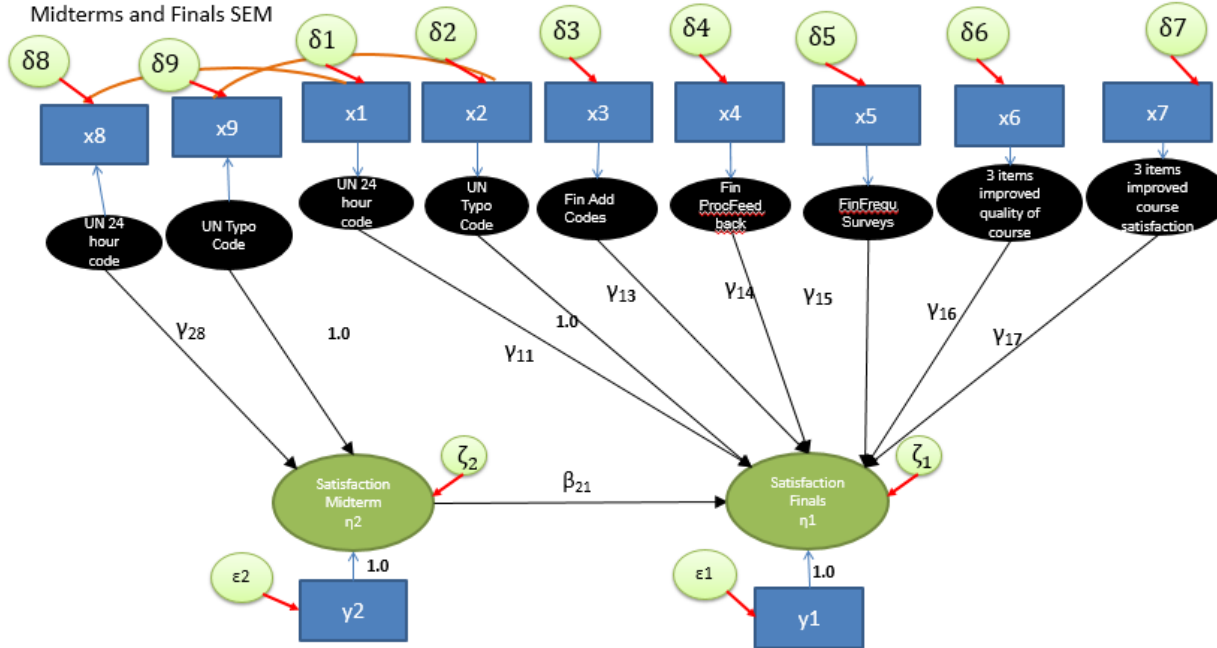
c) LISREL graphical output



Chi-Square=192.72, df=2, P-value=0.00000, RMSEA=0.948

## D.2 SEM analysis of elements of midterm and final surveys 2016 and 2017

### a) SEM Model



### b) Covariance Matrix

	FinResponse Code	FinTypoCode	FinAddCodes	FinProcFeed back	FinFrequSurvey	FinImproveSatisf	FinImproveQuality	FinSatisfactionEClass	MidSatisfactionEClass	MidResponseCode	MidTypoCode
FinResponse Code	0.77864										
FinTypoCode	0.599743	0.814672									
FinAddCodes	0.178893	0.226512	0.646075								
FinProcFeed back	0.37677	0.375483	0.181467	0.468388							
FinFrequSurvey	0.335749	0.290692	0.194833	0.336159	0.690909						
FinImproveSatisf	0.31088	0.324405	0.175886	0.272829	0.358993	0.699263					
FinImproveQuality	0.287812	0.323291	0.163691	0.306039	0.382004	0.618752	0.697248				
FinSatisfactionEClass	0.250713	0.231552	0.017056	0.178603	0.207896	0.137987	0.174293	0.506789			
MidSatisfactionEClass	0.053799	0.013488	-0.18165	-0.06666	-0.11585	-0.09756	-0.09403	0.001261	1.075336		
MidResponseCode	0.16892	0.133155	-0.14508	-0.06872	-0.09265	-0.05563	-0.08952	0.109213	0.570085	1.198214	
MidTypoCode	-0.05665	-0.08348	-0.18151	-0.07391	-0.1614	-0.14236	-0.12603	-0.06427	0.218473	0.216517	0.655528



c) Structural Equations

$$\eta_1 = \begin{bmatrix} 0 & 0 \\ \beta_{21} & 0 \end{bmatrix} * \begin{bmatrix} \eta_1 \\ \eta_2 \end{bmatrix} + \begin{bmatrix} \gamma_{11} & 1 & \gamma_{13} & \gamma_{14} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \gamma_{25} & \gamma_{26} & \gamma_{27} & 1 & \gamma_{29} \end{bmatrix} * \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \\ \xi_4 + \frac{\xi_1}{\xi_2} \\ \xi_5 \\ \xi_6 \\ \xi_7 \end{bmatrix}$$

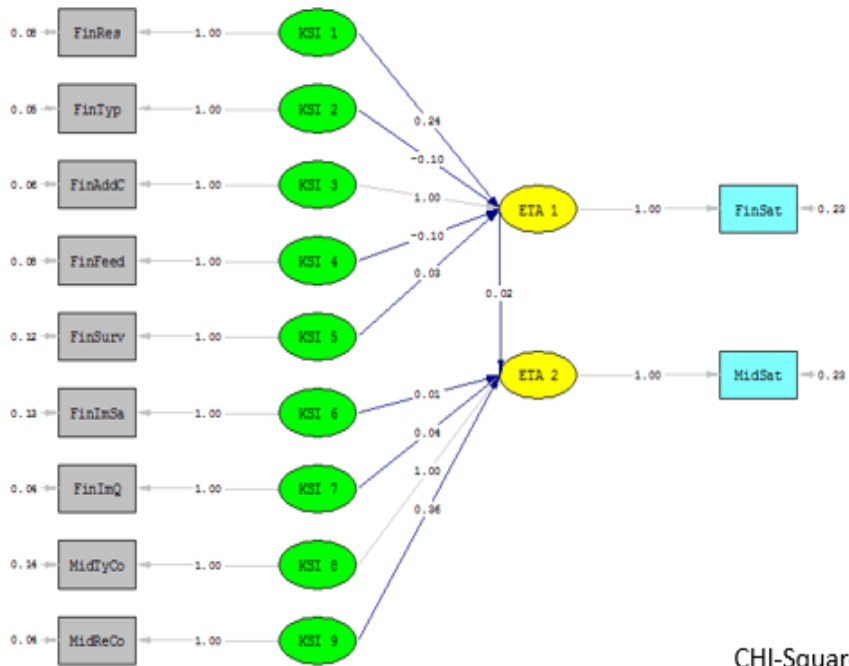
$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{bmatrix} = \begin{bmatrix} 1.0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1.0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1.0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1.0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.0 \end{bmatrix} \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \\ \xi_4 \\ \xi_5 \\ \xi_6 \\ \xi_7 \end{bmatrix} + \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \\ \delta_5 \\ \delta_6 \\ \delta_7 \end{bmatrix}$$

$$\begin{aligned} Y_1 &= [1.0] * \eta_1 + [\varepsilon_1] \\ Y_2 &= [1.0] * \eta_2 + [\varepsilon_2] \end{aligned}$$

$$[\Phi] = \begin{bmatrix} \varphi_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ \varphi_{21} & \varphi_{22} & 0 & 0 & 0 & 0 & 0 \\ \varphi_{31} & \varphi_{32} & \varphi_{33} & 0 & 0 & 0 & 0 \\ \varphi_{41} & \varphi_{42} & \varphi_{43} & \varphi_{44} & 0 & 0 & 0 \\ \varphi_{51} & \varphi_{52} & \varphi_{53} & \varphi_{54} & \varphi_{55} & 0 & 0 \\ \varphi_{61} & \varphi_{62} & \varphi_{63} & \varphi_{64} & \varphi_{65} & \varphi_{66} & 0 \\ \varphi_{71} & \varphi_{72} & \varphi_{73} & \varphi_{74} & \varphi_{75} & \varphi_{76} & \varphi_{77} \end{bmatrix}$$

$$\Theta_{\delta} = \begin{bmatrix} \theta_{\delta 11} fixed & \square & \square & \square & \square & \square & \square \\ 0 & \theta_{\delta 22} fixed & \square & \square & \square & \square & \square \\ 0 & 0 & \theta_{\delta 33} fixed & \square & \square & \square & \square \\ 0 & 0 & 0 & \theta_{\delta 44} fixed & \square & \square & \square \\ 0 & 0 & 0 & 0 & \theta_{\delta 55} fixed & \square & \square \\ 0 & 0 & 0 & 0 & 0 & \theta_{\delta 66} fixed & \square \\ 0 & 0 & 0 & 0 & 0 & 0 & \theta_{\delta 77} fixed \end{bmatrix}$$

d) LISREL graphical output



Chi-Square=628.91, df=45, P-value=0.00000, RMSEA=0.340

CHI-Square indicates very poor fit (Null Hypothesis) as well as the P-Value, RMSEA is ok

### D.3 Error variances for elements of final surveys in structural equation model

SEM element	Errors	Variance	%-Error	Value of error	Why?
x1	Response Code Effectiveness	0.88240	5.00%	0.044120	A student's performance or their condition on the survey day could influence the rating.
x2	Typo Code Effectiveness	0.90259	5%	0.045130	
x3	Addition of Codes	0.80379	5%	0.040189	
x4	Feedback process Adequacy	0.68439	5%	0.034219	
x5	Survey Frequency Adequacy	0.83121	7%	0.058185	
x6	Course satisfaction improvement	0.83622	8%	0.066898	Students could make satisfaction more dependent on their grades when rating the improvement of satisfaction. In addition, the rating could be influenced by the mood a student is on the certain day. Additionally the students might confuse the course satisfaction with the e-class site satisfaction.
x7	Course quality improvement	0.83501	7%	0.058451	Students could not be sure about what to include for the aspect of quality.
y1	e-class site satisfaction	0.71189	10%	0.071189	Students could misunderstand that the question was targeted on the e-class site only

## D.4 Correlations and covariances final surveys results 2016 and 2017

### a) Correlations

Correlations Final Surveys 2016 and 2017 (for SEM)								
	FinResponse Code	FinTypo Code	FinAdd Codes	FinProcFeedback	FinFrequ Survey	FinImproveSatisf	FinImproveQuality	FinSatisfactionEClass
FinResponseCode	1	.753**	.252**	.624**	.458**	.421**	.391**	.399**
FinTypoCode	0.75302	1	.312**	.608**	.387**	.430**	.429**	.360**
FinAddCodes	0.252223	0.31222	1	.330**	.292**	.262**	.244*	0.029807876
FinProcFeedback	0.623887	0.60785	0.32988	1	.591**	.477**	.536**	.367**
FinFrequSurvey	0.457759	0.38746	0.29162	0.590923	1	.516**	.550**	.351**
FinImproveSatisf	0.421314	0.42981	0.26168	0.476725	0.516482	1	.886**	.232*
FinImproveQuality	0.390615	0.42895	0.24389	0.535525	0.550382	0.886141	1	.293**
FinSatisfactionEClass	0.399114	0.36037	0.02981	0.366584	0.351336	0.231795	0.293206	1

### b) Covariances

SPSS Covariance Final Surveys 2016 and 2017 (for SEM)								
	FinResponse Code	FinTypo Code	FinAdd Codes	FinProcFeedback	FinFrequ Survey	FinImproveSatisf	FinImproveQuality	FinSatisfactionEClass
FinResponseCode	0.778635779							
FinTypoCode	0.599742789	0.81467						
FinAddCodes	0.178892945	0.22651	0.64607					
FinProcFeedback	0.376769734	0.37548	0.18147	0.468388031				
FinFrequSurvey	0.335748842	0.29069	0.19483	0.336158612	0.690909			
FinImproveSatisf	0.310880378	0.32441	0.17589	0.272829335	0.358993	0.699263		
FinImproveQuality	0.287812493	0.32329	0.16369	0.306038589	0.382004	0.618752	0.697247706	
FinSatisfactionEClass	0.250713488	0.23155	0.01706	0.178603497	0.207896	0.137987	0.174293005	0.506788926

## D.5 Descriptive statistics final surveys results 2016 and 2017

### a) Final survey results 2017

Descriptive Statistics Finals 2017 (B1+B2)							
	N	Minimum	Maximum	Mean	Std. Deviation	Variance	
Response Code Effectiveness	112	1.00	5.00	4.3214	0.88240	0.779	
Typo Code Effectiveness	112	1.00	5.00	4.1786	0.90259	0.815	
Addition of Codes	112	1.00	5.00	3.1429	0.80379	0.646	
Feedback process Adequacy	112	2.00	5.00	4.3661	0.68439	0.468	
Survey Frequency Adequacy	111	2.00	5.00	4.0000	0.83121	0.691	
Course satisfaction improvement	111	2.00	5.00	3.9730	0.83622	0.699	
Course quality improvement	110	2.00	5.00	4.0000	0.83501	0.697	
E-learning platform satisfaction	107	2.00	5.00	4.5981	0.71189	0.507	
N	112						

### b) Final survey results 2016

Descriptive Statistics - Finals 2016							
	N	Minimum	Maximum	Mean	Std. Deviation	Variance	
Response Code Effectiveness	37	2.00	5.00	4.2432	0.89460	0.800	
Typo Code Effectiveness	37	2.00	5.00	4.0811	0.89376	0.799	
Addition of Codes	37	2.00	5.00	3.0541	0.70498	0.497	
Feedback process Adequacy	37	3.00	5.00	4.4324	0.64724	0.419	
Survey Frequency Adequacy	36	2.00	5.00	4.0000	0.89443	0.800	
Course satisfaction improvement	37	2.00	5.00	3.9459	0.88021	0.775	
Course quality improvement	37	2.00	5.00	4.0541	0.88021	0.775	
E-learning platform satisfaction	35	2.00	5.00	4.5714	0.77784	0.605	
Valid N (listwise)	34						

c) Comparisons final surveys results 2016 and 2017

Comparison Finals 2017 - 2016			
	Mean	Std. Deviation	Variance
<b>FinResponseCode</b>	0.1168	-0.0148	-0.0262
<b>FinTypoCode</b>	0.1456	0.0153	0.0275
<b>FinAddCodes</b>	0.1326	0.1444	0.2244
<b>FinProcFeedback</b>	-0.0991	0.0567	0.0766
<b>FinFrequSurvey</b>	0.0000	-0.0890	-0.1514
<b>FinImproveSatisf</b>	0.0405	-0.0610	-0.1037
<b>FinImproveQuality</b>	-0.0815	-0.0642	-0.1089
<b>FinSatisfactionEClass</b>	0.0397	-0.0949	-0.1387

## D.6 Descriptive statistics midterm surveys results 2016 and 2017

### a) Midterm survey results 2016

	Descriptive Statistics - Midterms 2016					
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
ResponseCode	47	1	5	4.26	0.943	0.890
TypoCode	47	1	5	3.57	0.972	0.945
SatisfactionEclass	51	3	5	4.43	0.671	0.450
Valid N (listwise)	47					

### b) Midterm survey results 2017

	Descriptive Statistics - Midterms 2017					
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
ResponseCode	98	1.00	5.00	4.1429	1.11226	1.237
TypoCode	96	1.00	5.00	3.3229	1.21824	1.484
FeedbackForm	94	1.00	5.00	3.2766	1.06159	1.127
Surveys	98	1.00	5.00	3.1633	1.03240	1.066
SatisfactionEclass	105	1.00	5.00	4.3333	0.85109	0.724
Valid N (listwise)	90					

### c) Comparison Midterm survey results 2016 and 2017

Comparison Midterms 2017 - 2016			
	Mean	Std. Deviation	Variance
ResponseCode	-0.112	0.169	0.347
TypoCode	-0.252	0.246	0.539
SatisfactionEclass	-0.098	0.180	1.066