Learning organisations in interdisciplinary environments

A case study of the Areas of Advance at Chalmers

Master's thesis in Master Programme Learning and Leadership

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Learning organisations in interdisciplinary environments

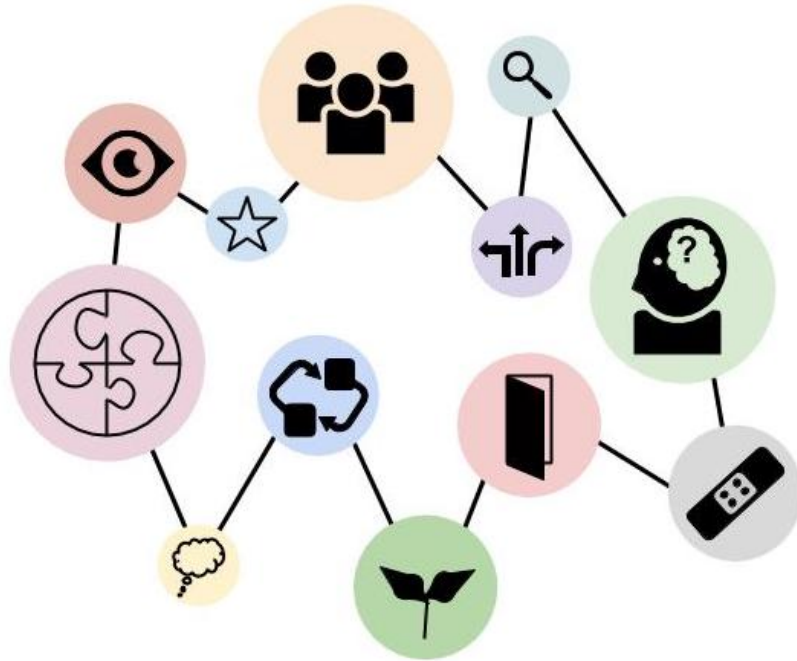A case study of the Areas of Advance at Chalmers

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Cover: Illustration of the twelve learning organisation characteristics
(by Frida Jedvert).

Abstract

Swedish universities play a key role making sure to encourage learning and knowledge transfer within their organisations. At Chalmers University of Technology so-called Areas of Advance have been developed which primarily aim to challenge major societal problems through multidisciplinary collaboration between different institutions and external actors.

Previous research on the subject of interdisciplinary projects means it is good for promoting knowledge transfer (Jeong & Chi, 2007). Knowledge transfer is today becoming more and more a product and service in modern organisations. In order to be competitive, it is therefore necessary to work on maintaining knowledge and spreading it to the greatest possible extent (Jonsson, 2012).

This study aims to identify the importance of the learning organisation characteristics and to what extent they are fulfilled by the Areas of Advance. Furthermore to describe a learning organisation with respect to the interdisciplinary environment and the Areas of Advance. The study is based on a quantitative survey and conducted qualitative interviews, literature review and document review.

Results show that the top five learning organisation characteristics perceived as most important by the Areas of Advance were; *External exchange, Holistic perspective, Leadership engagement, Openness, Transparency.*

The top five characteristics considered to be most fulfilled by the Areas of Advance were; *Leadership engagement, Holistic perspective, External exchange, Openness, Flexibility.*

The description of a learning organisation with respect to interdisciplinarity and the Areas of Advance resulted in a list consisting of following characteristics; *Flexibility, Transparency, Leadership engagement, Learning from mistakes, Reflection, Monitoring, Personal development.*

Acknowledgements

First we would like to thank Liane Thuvander for her supervision and patience without ever lasting flow of new ideas. Torbjörn Lund and Samuel Bengmark for taking time from their busy schedules to guide as well as inspire us on our way.

We would also like to thank the interviewees and respondents for their contribution which made this study possible. Our classmates and friends that have been supporting us and helped us through out the whole process of the study.

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Frida Jedvert & Viktor Persson, Gothenburg, May 2019

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Glossary

AoA - Areas of Advance
GL - Guidelines
VC - Virtual City
SDG - Sustainable Development Goals
RQ - Research Question
WF - Weight Factor
Chalmers - Chalmers University of Technology
KTH - KTH Royal Institute of Technology (Swedish: Kungliga tekniska högskolan)
LTH - Faculty of Engineering, Lund University (Swedish: Lunds tekniska högskola)

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1
Introduction

In this chapter, the background of the study, its purpose and goals are introduced. Furthermore, the limitations for the study are described.

Life-long learning is becoming increasingly important if Sweden are to be a prominent nation of knowledge (Hellmark Knutsson, 2016). This is also backed up by the fourth sustainable development goal (SDG) which aims to ensure inclusive and qualitative education and promote lifelong learning for all (UNDP, 2015).

Hereby Swedish universities play a key role by making sure to encourage learning and knowledge transfer within their organisations. This is something that Chalmers University of Technology (Chalmers) does by promoting interdisciplinary collaboration between different institutions and external actors. It was implemented by developing so-called Areas of Advance that primarily aim to challenge major societal problems. This development can also be seen as a commitment from Chalmers to strive to become more of a learning organisation.

A learning organisation is defined according to Granberg et al. (2004, p. 34) as the organisation that creates good conditions for employees' learning and takes advantage of this learning and makes use of it in the organisation's endeavour to influence and adapt to the outside world. For Chalmers to strive towards this type of organisation would be both reasonable as it is a university valuing learning, but also to stimulate learning so that the SDG are achieved.

In a fast changing market companies need to find new ways to stay relevant. One way is to use the competence and knowledge amongst the employees to develop new products or services (Jonsson, 2012). The subject of learning will then become of economic interest for the companies, how to get the most out of the employees and promote innovation. A shift from teaching the employees towards learning from them and making sure they all keep learning has occurred.

The authors of this study consider it exciting to investigate how one could describe the Areas of Advance of Chalmers from the perspective of a learning organisation. Another aspect that is interesting with the

Areas of Advance is that they provided an interdisciplinary context. This could be seen as something that causes the organisation to stimulate learning in its nature, which means that the researchers participating in these projects need to familiarise themselves with other disciplines. The combination of interdisciplinarity and learning organisations has not been investigated before which makes it even more interesting to look into it. The societal problems and challenges that lie ahead might really benefit from the combination of interdisciplinarity and learning.

Over the years various persons have tried to describe how a learning organisation arise and thus developed models of different characteristics that learning organisations should possess. These characteristics are developed for traditional organisations and do not emerge from an interdisciplinary context. It is therefore also of the authors' interest to see how these characteristics fit in with an interdisciplinary context, what needs more focus and what is fulfilled by the environment in itself.

1.1 Research aim and questions

This study aims to identify the importance of the learning organisation characteristics and to what extent they are fulfilled by the Areas of Advance. Also, the study aims to describe a learning organisation in the interdisciplinary environment of the Areas of Advance.

To support the aim, following three questions have been formulated to be investigated.

RQ1: Which five of the learning organisation characteristics are considered most important to the Areas of Advance?

RQ2: Which five of the learning organisation characteristics are considered to be most fulfilled by the Areas of Advance?

RQ3: How can the characteristics of a learning organisation be described with respect to the Areas of Advance and interdisciplinarity?

1.2 Limitations

The study does not aim to evaluate the Areas of Advance at Chalmers but to use it as a case. The case is rather used to give input on the relevance of the learning organisation characteristics from a operating organisations point of view. The Areas of Advance is seen as an organisation by it is own although it is a part of the larger organisation

Chalmers, where it is integrated across the departments (see chapter 3).

The literature on both interdisciplinarity and learning organisations refers to companies mostly while the case of the study is an organisation operating in the academia. The result are based on literature and theory regarding the environment as well as the practical input coming from the case, the Areas of Advance. The characteristics of a learning organisation in an interdisciplinary environment as the Areas of Advance presented in this study are therefore going to be general. Changes or modifications might be needed to adapt the characteristics to fit a certain organisation, company or context since they are all different.

Regarding research question one and two it was decided to define a number of characteristics that were considered most important/fulfilled. There is no natural limit for when a characteristic is considered important or fulfilled. Before a defined number of characteristics were decided to be used all that could be said was how the characteristics, when compared, related to each other. With that background, the decision was made to appoint the five most important and the five most fulfilled characteristics. By choosing five a broader picture of the top rated characteristics is given while still keeping the amount manageable.

1.3 Thesis layout

In the introduction chapter the background to the issue of investigation is presented and why it is relevant to investigate further. The purpose and goals are introduced as well as the research questions followed by the limitations of the study and finally the layout of the thesis.

The methodology chapter begins with the outline of the research followed by the methods for the data collection. The data collection is divided into subsections; literature review, project documents, guidelines, interviews and survey. In each subsection the specific data collection method is described. Last, the analysis method and discussion of the method's reliability are presented.

A description of the Areas of Advance is made to give understanding of the investigated environment and context. This includes the background to the initiative and how it is organised.

The next chapter provides the theoretical framework for the study used to answer the research questions. It treats the literature regarding interdisciplinarity and different characteristics of learning organisa-

tions.

The empirical data is then presented with respect to its origin. First the data collected from the guidelines and then the data from interviews and survey. The data presented in this chapter were used as a base and input to answer the research questions.

In the results chapter the data that has been collected are analysed and put together to answer the research questions. This is followed by a chapter containing a discussion of the execution and outcome of the research.

Finally there is a conclusion chapter where a summary of the answers to the research questions are presented followed by how the results could be used for further research.

2

Methodology

This chapter describes the method of the thesis, in what way the data were collected and why the collection was carried out this way.

2.1 Research outline

The research at large as well as the outline was created through a design process where different paths were explored and considered. As illustrated in figure 2.1 it started with an initiation where a first set of questions on the theme learning and digitalisation was used going into the first loop of investigation. With the digitalisation and learning in mind there was a large focus on the project Virtual City, a project initiated within an Area of Advance, during this point in time of the investigation. The project Virtual City started in 2018 with the aim to create a digital platform for urban planning. The goal is to recreate the city of Gothenburg in a virtual environment (digital twin). With this platform Virtual City wants to contribute to the ability to understand, analyse and plan cities towards sustainability. The project brings together competencies from the various disciplines and excellence that exist at Chalmers to create a platform that is both dynamic and interactive (Virtual City, 2018).

Interviews and a literature review were conducted with the first question set in mind and project documents on the subject were revised. From the collected data it was clear that this was a dead end and that is was not possible to go on as intended with the Virtual City project. New possible themes and questions were explored with the data collected so far as a base.

A new set of questions were created and so the research went into the second loop (see figure 2.1). The themes in focus were interdisciplinarity and learning as well as the case, the Areas of Advance at Chalmers. More data were collected through interviews, literature, a survey and documents regarding the Areas of Advance. Much of the data collected during the first loop was still relevant and so it was also used in the final analysis. After the second loop of the research all input and data were compiled and analysed from which conclusions were made, as

illustrated in figure 2.1. The method for each way of collecting data is described in following sections.
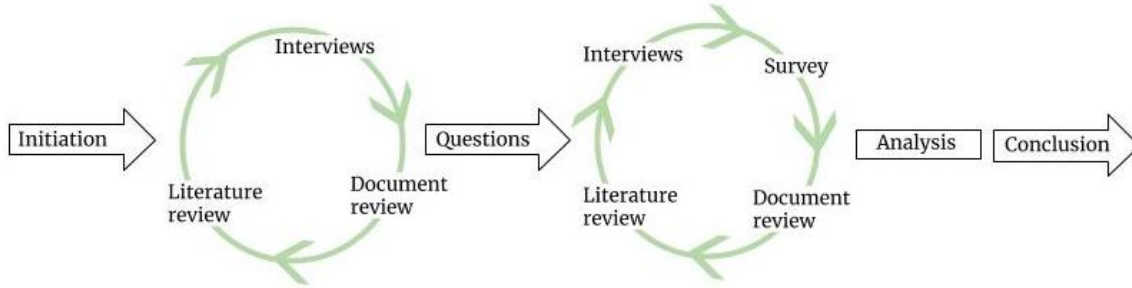
Figure 2.1: The research process from initiation to conclusion.

The nature of the study was mainly qualitative; literature studies, document studies, and interviews. Complementary data of quantitative nature was collected in a survey.

2.2 Literature review

The literature review was carried out in different stages (see figure 2.1) and thus with different themes and purposes in mind. Information on previous research regarding the themes of interest as well as information on the actual theme and context was the first focus. As the process proceeded the focus of the literature review shifted towards the research questions and what was needed to be able to answer and discuss them. The collected information from the literature review has thus been used not only to create the research questions and the design of the study but also to make up the foundation to answer RQ1, RQ2 and RQ3.

Relevant literature for the study was found searching for following keywords; Learning organisations, knowledge management, interdisciplinary and interdisciplinarity. Furthermore the literature search was restricted to publications dated no later than 2000. Exceptions were done for literature found through a recent publication where the original source was considered relevant and therefore used. In some cases are both sources referred to as they might have given slightly different perspectives.

2.3 Document review

The document review consisted of structured reading of the Areas of Advance guidelines (Chalmers University of Technology, 2016) that form the basis for how the operations within the Areas of Advance

should be run, developed and monitored. The purpose of this was to broaden the understanding of the organisation, but also to see how and to what extent the guidelines stimulates the organisation to create a learning climate and hopefully contribute to the creation of a learning organisation. This data collection is primarily intended to form the basis for answering RQ1 since this is a document describing how it would have liked the organisation to work.

2.4 Interviews

All together five interviews were conducted to get answers to the inaccessible information regarding the Areas of Advance and how they work at a project level. At first, in the first loop of investigation described in section 2.1, the interviews gave information on what was possible and interesting to investigate and then later used in further investigations as input for the second loop of investigation.

A good relationship with the interviewee was considered important to get honest answers, it was thus decided that the interviews were to be semi-structured and in a conversational style (Esaiasson et al., 2017). However, the interview guides (see appendix A and B) were created to give the interviewer an overlook of what the interview were to treat. The result from a brainstorm session were put together into themes that constituted a basis for the questions. Two interview guides were made, one for the project level and one for the Areas of Advance level.

Four interviews with interviewee A, B, C, D (see table 2.1) were conducted using the project level guide (see appendix A) which answers first and foremost RQ2. They gave information regarding the Areas of Advance on a project level as well as information on a individual level from the researchers on their learning experiences. From the interview with interviewee E (see table 2.1) using the Areas of Advance guide (see appendix B) information on the context Areas of Advance was collected. This was used primarily to answer RQ3 were information on both how the Areas of Advance fits into the interdisciplinary environment traits and the learning organisation characteristics. Although, as the research questions are linked together by the interdisciplinarity of the Areas of Advance and the learning aspects the interviews were not solely used to answer one of the research questions.

The interviews had a duration of one hour and were audio-recorded to be able to re-listen if needed so that as little information as possible was lost. Notes were taken during the interviews. The notes and audio-recordings were considered sufficient enough that the interviews

were not transcribed. A consent form (see appendix C) was produced and signed by both parts before the interview to establish both the interviewers and interviewees motives and rights (Esaiasson et al., 2017; Ekholm & Fransson, 1992).

2.5 Interviewees

The interviewees (see table 2.1) were selected in a strategic manor (Esaiasson et al., 2017) during the first loop (see figure 2.1) to be able to build knowledge around the Areas of Advance and an associated project, Virtual City.

Alias	Role of relevance	Date
A	Project coordinator VC	2019-02-11
B	Acting Area of Advance Director Building Futures, Project initiator VC	2019-02-13
C	Project member VC, expert in Urban planning and Architecture	2019-02-13
D	Conducted the pre-study for VC, Industry expertise	2019-02-15
E	Overall responsible for Chalmers' Areas of Advance, Organisation expert	2019-03-01

Table 2.1: Interviewees presented with role of relevance for the study and date of the interview.

2.6 Survey

In this study, a questionnaire was used to effectively reach the people who are in possession of relevant information for the study. These people are those who have leading positions within the organisation of Area of Advance such as the Area of Advance Directors, co-Directors and Profile leaders. The advantage of this method is that you can reach many respondents with efficient administration and analysis. The disadvantages of using a survey to collect data is that it is not possible to check and develop the respondent's answer during the collection (Esaiasson et al., 2017). Anonymity also makes it difficult to follow up respondents' answers if needed. Since this study has its limitations, the decision was made that the benefits overruled the disadvantages.

The survey is a respondent survey, which means that it is the respondents themselves and their opinions that are the study objects. Here the researcher wants to know what each respondent thinks and

therefore the same questions are posed to all participants. This is to find patterns in the answers and then describe and explain differences with regard to how they respond. (Esaiasson et al., 2017)

The purpose of the survey is primarily to get answers to RQ2 but the survey also aims to get input on RQ1. The input for RQ1 are given through insights into how important the respondents consider the various learning organisation characteristics to be.

The questions in the survey are based on different themes that have been developed by combining three models of factors that describe a learning organisation. The different models consist of lists presenting factors that should be considered in the strive to become a learning organisation. The survey was developed by merging these lists into a new list consisting of 12 themes (see section 2.7.1 for a detailed description of how this was done). The respondents of the survey was asked to rate the themes importance as well as rate of fulfilment on a scale from 1 to 5, 1 meaning not important/fulfilled and 5 very important/fulfilled.

The survey begins with presenting the purpose of the study and the layout of the survey. This is followed by a request to the respondent to approve that the information they provide in the survey may be used in the study. The study was sent out via email to 36 respondents and is answered digitally.

The survey was answered by 18 persons including the overall responsible for the Areas of Advance, 9 Area of Advance directors and 8 profile leaders. This leaves the survey with a response rate at 50 %. The survey can be seen in Appendix D.

2.7   Analysis

In the following sections one can find the analysis method for how the characteristics of a learning organisation and traits of the interdisciplinary environment was created. Also, how the guidelines, interviews and survey were analysed.

2.7.1   Learning organisation

The theory collected on the subject of learning organisations (Granberg et al., 2004; Jones, 2001; Pedler et al., 1989) were kept as short bullets that together created a long list of factors regarding a learning organisation (see section 4.1). The factors were then put into groups according to the theme of what they treated. This was done as an iterative process, a first paring and grouping was done and then

reviewed to see if all of the factors in a group treated the same thing or if a additional group was needed. Twelve groups emerged and were then given names that reflected what the main point of that specific group were, resulting in twelve characteristics. Using the factors and combining them a short description was created for each characteristic.

The twelve characteristics were used as the starting point and base for the list used to answer the research questions (RQ1, RQ2, RQ3). Furthermore the twelve characteristics were used when creating the survey. How the survey was created, used and analysed are presented in section 2.7.5.

2.7.2   Interdisciplinarity

Four sets of definitions of the interdisciplinary environment were found (see section 4.2) in the collected theory (Szostak et al., 2016; Strober, 2011; Bammer, 2013; Frodeman et al., 2010). These were originally presented in different ways, some were written as bullets and some as definitions incorporated in texts that were divided into sentences. Much like the process described in section 2.7.1 the definitions were organised according to what they describe. The groups were reviewed multiple times before arriving at the final six groups of traits. The traits were then named according to the theme of the definitions included in the group.

The traits of the interdisciplinary environments were developed to validate the Areas of Advance as an interdisciplinary environment. It was also used to map supporting and contradicting aspects between the interdisciplinarity and learning organisation. This was done as a step towards answering RQ3.

2.7.3   Guidelines

The analysis were done by carefully reading through the guidelines chapter by chapter and in a structured manor classifying different paragraphs and sentences that indicated linkage to characteristics of a learning organisation. Based on this, a matrix with the 12 characteristics in the columns and the different chapters in the rows was designed. This made it easy and clear to analyse which parts were reflected more in the guidelines and which ones lacked representation.

2.7.4   Interviews

The answers and notes from the interviews were categorised according to the themes in the interview guides (see appendix A and B). When this was done a search for patterns in the answers were made to see

how they differed. A second categorisation were made with respect to the characteristics of a learning organisation. The answers were placed into groups according to which characteristic it treated. From the two categorisations main points supporting and contradicting the characteristics were detected and used to validate them.

2.7.5 Survey

Data collected from the survey was analysed in a few different manors. Mean and standard deviation of the responses were calculated with respect to the different respondent groups; the Directors/co-Directors, Profile leaders and all respondents. It was 9 Directors/co-Directors that answered the survey and 8 Profile leaders making the groups close to equal when using them in the analysis. The overall responsible for the Areas of Advance answered the survey as well and were thus included in the summation of all responses. Although the overall responsible were not presented as a group by it self in general as it is a single source rather then a group.

Furthermore Z-scores for the responses were calculated to give a better overview of the variation of the ratings for the learning organisation characteristics with respect to the mean. The mean of all responses is given the Z-score 0 so that all positive Z-score indicates how much higher the rate is than the mean. In the same way a negative Z-score indicate how much lower the rate is than the mean.

A correlation analysis were conducted to see if there was a correlation between the answer to the questions in the survey treating the importance of the characteristics and the answers to the questions treating the fulfilment.

2.7.6 Compilation of data

To use the data from the guidelines and survey both at once required a way of combining them and so a decision matrix were created. In the matrix the the two types of data where weighted to give the data one more dimension. The guidelines were given the weight factor (WF) 0,3 due to subjectivity and the survey were given the WF 0,7.

The interviews were not used as input for the matrix as they were conducted at an early stage of the research where the research questions and focus was different. The different focus made it impossible for the interviewees to answer questions directly related to the characteristics and hard to quantify the answers for the matrix in a fair way.

2.8 Reliability

To evaluate the reliability of the study the following aspects have been considered according to Esaiasson et al. (2017) and Alvesson & Sköldberg (2017): authenticity, independence, concurrence, tendency.

Authenticity refers to the physical papers, document and books and whether or not they are authentic or could have been tempered with (Esaiasson et al., 2017). Therefore, the sources of books and papers have been gathered from Chalmers library, the University of Gothenburg library and both of there online search platforms and databases. The documents that were reviewed came from, what the authors consider to be, reliable sources with access to correct information.

Independence means to establish if the information in question is true or if it might have a hidden agenda (Esaiasson et al., 2017). This have been ensured by examining the origin of the information and see if there are any other sources that support the information. The interviews were more complicated to examine in this way, the authors had to trust their judgement regarding the interviewees and what they said. The same goes for the documents received and reviewed, the authors considered the possible motives of the source and judged whether or not the documents were usable.

Concurrence refers to the risk of time on the information. As time goes by the memory of an event will differ from the original one (Esaiasson et al., 2017). For the literature used in the study the concurrence was taken under consideration as the year of publication was set to be no later than 2000. For the interviews it was accounted for as the interviews were audio-recorded, notes were taken during the interviews of conversations as well as situations and other non-verbal information, directly after the interview the notes were reviewed by the interviewers. The interviewees and respondents of the survey are not seen as a risk in this case as they are to answer questions regarding their current state and not asked to retrieve a memory.

Tendency is when an interviewee or writer have a secret motive. When analysing a source one should also analyse possible motives to why the information is presented the way it is (Esaiasson et al., 2017). To counteract this during the interviews a consent form (see appendix C) was used to mediate that the study and interview are not set out to benefit the individual directly and that it is voluntary. In a similar manor, the survey was sent out with a motivation and then the survey it self begins with a presentation of the aim and intent of the survey (see appendix D). Other sources such as literature have been analysed by at least two parts and discussed before used as input for the study.

3

The Areas of Advance

In this chapter a background to the Areas of Advance is presented followed by descriptions of its organisation and areas.

The Areas of Advance is a cross-institutional organisation that is described by Chalmers as following:

> *The Areas of Advance are organised as strong, challenge driven thematic platforms for strategy and long-term collaboration that hunt down specific challenges, often directly relevant for industry and society. They also offer common access to cutting-edge research infrastructures as well as to several targeted centres.* (Chalmers University of Technology, 2018a)

The Areas of Advance started in 2009 as a initiative for interdisciplinarity and a strive for cross-institutional integration of the research, education and utilisation of Chalmers (interviewee E, 2019).

The main idea of Chalmers is to use and develop scientific excellence and relevance for the society through stimulating disciplinary work and multidisciplinary collaborations to develop the ability to take on broader issues (Chalmers University of Technology, 2016). With the Areas of Advance as strategic tools, Chalmers coordinates, collects and visualises activities that relate to society's challenges and development. It also further develops and integrates its leading research, education and utilisation to achieve the desired effects in society (Chalmers University of Technology, 2016).

An Area of Advance has a few specific characteristics (Chalmers University of Technology, 2016), for example it is;

- A challenging and border-crossing area with strength in excellent research.

- An open gathering point for cross-and multidisciplinary constellations of researchers/teachers.

- Chalmers' most important display window for challenge-driven and cross-border investments and an entrance for external stakeholders.

The mission of the Areas of Advance according to Chalmers University of Technology (2016) is to engage researchers och teachers to collaborate across disciplines within Chalmers, the private sector, public sector and the international research society. Through the collaboration then contribute to solving important societal challenges and be the driving force in sustainability, innovation and entrepreneurship (Chalmers University of Technology, 2016).

The Areas of Advance offers an overview, opportunities and added values internal for researchers, leaders and students at Chalmers. This also applies on external stakeholders from the academy, enterprises and society (Chalmers University of Technology, 2016).

The exact concept of Areas of Advance is something that not necessary is found elsewhere but there are other examples of how this kind of collaborations can be realised. The Royal institute of technology has something alike called competence centres that aims to increase the amount of interdisciplinarity within the institute (KTH, 2018).

At Lund University there is five beneficial areas (In Swedish: Nyttoområden) that is arranged in a similar way but especially restricted to three departments; Mathematics, Chemistry and Physics (LTH, 2019).

3.1 Organisation of the Areas of Advance

The Areas of Advance are one of the segments of a matrix organisation of Chalmers as shown in figure 3.1. The areas represent interdisciplinarity and the departments represent the disciplinary depth (Chalmers University of Technology, 2016).
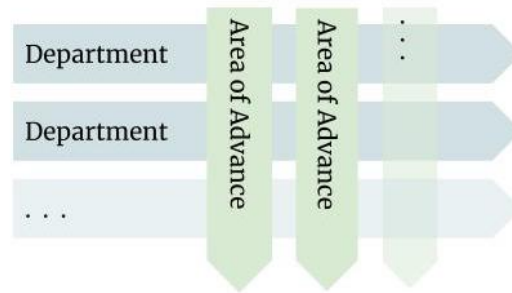
Figure 3.1: The matrix organisation of Chalmers with the Areas of Advance.

Each Area of Advance is defined by 3-5 challenge driven profiles or themes, here called Area of Advance profiles. These profiles are directly linked to a challenge within the Area of Advance which in turn are tackled by for example projects. The projects can vary in size and does often consist of researchers from different disciplines or have close collaboration with other profiles and Areas of Advance (interviewee E, 2019). Figure 3.2 illustrates the principle structure of Areas of Advance.
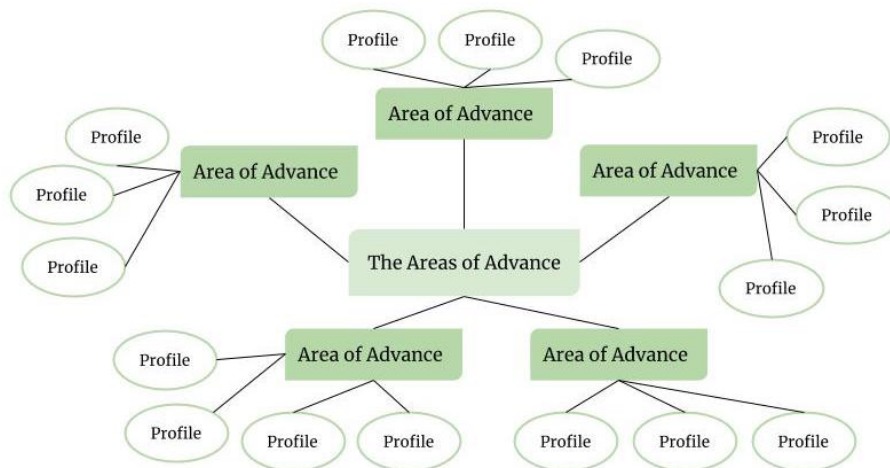
Figure 3.2: The Areas of Advance with connected areas and profiles.

The organisation is led by one person who has overall responsibility over all the Areas of Advance and is leading the Areas of Advance' management team, which consists of the directors for each Area of Advance. The directors are supported by a co-director and profile leaders for the

profiles within each Area of Advance (interviewee E, 2019). There are at the moment five different Areas of Advance of various size both regarding economic resources and collaborations (Chalmers University of Technology, 2018a).

3.2   The current Areas of Advance

Below the five current Areas of Advance are presented (Chalmers University of Technology, 2018a).

- The *Energy* Area of Advance covers the broader energy context with the vision to develop future sustainable energy systems with focus on industry and society.

- The *Information and Communication Technology* Area of Advance (ICT) is focusing on research that develops functionality of different systems, including intelligence and autonomy, fast and reliable communication, advanced data analysis and solutions to key questions regarding safety, security, integrity and sustainability.

- The *Materials Science* Area of Advance addresses the global challenges for health, energy and sustainability from a material perspective.

- The *Production* Area of Advance focuses on connected and sustainable production. This is done by investing in new resource and energy efficient processes for production systems and production of new products. This research makes Chalmers a leader in industrial digitisation.

- The *Transport* Area of Advance focuses on transport-related challenges in accordance with the UN's sustainable development goals. The research includes sustainable vehicle technology, road safety, transport efficiency and customised logistics. This through development towards autonomous transport, electromobility and the transition to future transport systems.

In addition to these five areas, there are also two areas that are under construction. These two areas are called Liveable Cities and Health Engineering and will hopefully be up and running next year. The people who are in these projects right now are only directors who are working on developing the respective area (Chalmers University of Technology, 2018b,c). Therefore these areas have no profiles and therefore no profile leaders. These two projects will be represented in the survey only by the directors as these still are considered relevant to the survey.

4

Theoretical framework

This chapter presents the theoretical framework used in the research. First the theory regarding learning organisations and what characterises such organisations are presented. This is followed by a section treating interdisciplinarity and what is considered to be defining for this environment.

4.1   Learning organisation

In a fast changing market companies need to find new ways to stay relevant. One way is to use the competence and knowledge amongst the employees to develop new products or services. The subject of learning then becomes of economic interest for the companies. How do they get the most out of the employees and promote innovation? A shift towards a mutual exchange of knowledge and learning opportunities between all members, management as well as employees, has occurred.

Over time the theories involving learning have been many and so the ones connecting it to the interaction between people. Vygotskij is one of the giants on the subject of learning. He claims that learning and development is created in the interaction with others (Phillips & Soltis, 2014). Further, acknowledged researchers Lewin, Dewey, Piaget and Kolb highlights the effect experience has on our learning and development (Phillips & Soltis, 2014; Granberg et al., 2004). These acknowledge researchers mean that what we learn is dependent on our preconceptions and experience. When we encounter some new situation or information it will challenge our preconception and then either create new knowledge or enhance the one we have already.

An organisation has a lot to win by satisfying the learning and development of both organisation and employees In short this could be defined as a learning organisation. A learning organisation creates good learning conditions for the employees and then makes use of the learning by letting it influence the organisation to adapt to the outside world (Granberg et al., 2004).

This definition of a learning organisation differs between researchers and is often confused with organisational learning. Organisational learning is a way of understanding the learning organisation (Jonsson, 2012). Here after it is the learning organisation that is referred to and that are to be described.

4.1.1 Factors of a learning organisation

There are a variety of factors and models for what it means to be a learning organisation. Some of them overlap and some are inspired by each other.

4.1.1.1 The learning company

Granberg et al. (2004) presents a list of eleven factors to benchmark a learning organisation with its origin in a list from Pedler et al. (1989) consisting of ten factors. Presented below is eleven factors as defined by Granberg et al. (2004, p. 63).

1. Working with the organisations strategies is an important learning experience.
2. All members of the organisation participate in policy development.
3. Informational technology and systems are used to make information at large accessible for everyone in the organisation.
4. Accounting, budgeting and reporting are done continuously as a help for the members of the organisation to understand how resources are used.
5. All units are seen as costumers and producers in a production chain with emphasis on learning from one another to create value in and for the organisation.
6. There is a flexibility in the reward system regarding both money and other alternative reward types.
7. The structures should be permissive, schedules and role descriptions are to be temporary and easily adapted to changes.
8. Those who have contact with costumers, clients and suppliers should learn from them and bring that information back into the organisation.
9. Benchmark, to compare the organisation to the best in the business and learn from it.
10. The climate in the organisation are to support learning.
11. Opportunities for one's own development are to be given for all members of the organisation.

4.1.1.2 Jones' six aspects

Jones (2001) has from literature by Argyris & Schön, Kolb and Revans, to mentions some, created six aspects that describes the characteristics

of a learning organisation (Granberg et al., 2004, p. 34).

- The organisational structures are to support questions from all levels in an active manor.
- The organisation develops through competence in critical reflection.
- Occasions to collectively ask questions and reflect are given on a regular basis.
- A continues search for learning opportunities are made in the organisations day-to-day operations.
- Actions are made based on such learning opportunities.
- The result of the actions are then critically reflected up on.

4.1.1.3 Ten facilitating factors

Studies made by Nevis, DiBellas and Goulds (Granberg et al., 2004) establish ten facilitating factors for learning organisations. The ten factors refer to the structures and processes that determines the possibility to establish a learning organisation. Presented below are the ten factors (Granberg et al., 2004, p. 78).

1. Be conscious of how one collects information regarding the organisations surroundings.
2. A collective view of what effectiveness that is desirable and then use setbacks as learning opportunities.
3. Effort is made to establish key factors when an investment is made, it is then used to evaluate and discuss around as a learning activity.
4. Have an interest in understanding how things work and provide support to explore new things without fear of failing. Changes in the work processes, strategies and structures are made continuously to enable learning.
5. Information is accessible and communication open in the organisation so that problems and failure are collectively handled. Debate and conflict are seen as possibilities to solve problems.
6. Members at all levels in the organisation participate in education to support personal growth.
7. There are a diversity in methods, processes and systems were a wide competence is appreciated.
8. New ideas and methods are developed by employees at all levels in the organisation.
9. Leaders work in an engaged manor to pass on there visions through out the organisation and actively keep contact with employees and there education.
10. The organisations units work independently all tough problems and solutions are seen as system related processes were there are connections between the units goals and needs.

4.1.2   Twelve learning organisation characteristics

The three previously presented sets of factors for a learning organisation have been put together to create twelve characteristic themes relevant for this study which are presented below together with a short description. How the factors were put together and characteristics created are described in section 2.7.1.

Leadership engagement
Leaders clarify visions and engage in the work of bringing them into the organisation. All members of the organisation participate in policy development.

Openness
Information is accessible for everyone in the organisation, the communication is open and debate and conflict are seen as possibilities to solve problems.

Transparency
Accounting, budgeting and reporting are done continuously as a tool for the members of the organisation to help them understand how resources are used.

Curiosity
An organisation is structured to support questions, new ideas and methods from all levels in an active manor. Have an interest in understanding how things work and provide support to explore new things without fear of failing. Changes in the work processes, strategies and structures are made continuously to enable learning.

Learning from mistakes
The organisation uses setbacks as learning opportunities and provide support to explore new things without fear of failing. Problems and setbacks are collectively handled and the result of the actions are critically reflected up on.

Personal development
Opportunities for one's own development are given all members of the community. There are a diversity in methods, processes and systems were a variety in competence is appreciated.

Reflection
A continuous search for learning opportunities are made in the organisations day-to-day operations. The organisation develops through competence in critical reflection, occasions to collectively ask questions and reflections are given on a regular basis.

External exchange
Be conscious of how information is collected regarding the organisations surroundings. Those who have contact with external actors should learn from them and bring that information into the organisation.

Monitoring
Effort is made to establish key factors when an investment is made, it is then used to evaluate and discuss as a learning activity. Actions are then made based on such learning opportunities.

Flexibility
The structures should be permissive, to enable schedules and role descriptions to be temporary and easily adapted to changes.

Reward system
There is a flexibility in the reward system regarding both money and other alternative reward types.

Holistic perspective
Problems and solutions are seen as system related processes were there are connections between the units' goals and needs.

4.2   Interdisciplinarity

In this section a general description of interdisciplinarity is made as well as its strengths and weaknesses. This is followed by two subsections. The first one presenting four different sets of interdisciplinarity definitions and the second a merge of the sets into six interdisciplinarity traits along with descriptions.

Oxford University Press (2019) defined interdisciplinarity as the quality or fact of involving or drawing on two or more branches of knowledge.

Gerlee & Lundh (2012) point out the increasing interdisciplinary research and the importance of this type of research. Szell et al. (2018), Szostak et al. (2016) and Frodeman et al. (2010) also state the importance of the interdisciplinarity which they present as the way to go if we are to solve the large challenges our society face today. These challenges can´t be tackled by one discipline but when collaborating and working together with other disciplines new perspectives might open up for different solutions or understandings of the problem that could help both disciplines on there way towards a sustainable long-term solution (Strober, 2011).

As Strober (2011) states, interdisciplinary research might need a larger initial investment which is a risk in comparison with a disciplinary research that needs much less investment. However, if the interdisciplinary research pays off the profit could be enormous. The profit could be a contribution to society, to the university as a part of its research portfolio and to the researchers in the form of expanded knowledge in the application of their own discipline and new knowledge in other disciplines.

Furthermore, both Szostak et al. (2016) and Gerlee & Lundh (2012) emphasise the importance of communication and understanding between the disciplines for successful interdisciplinarity. Szostak et al. (2016) mentions learning as an aspect of interdisciplinarity and relates it to knowledge organisations. The challenge is how to get an organisation to understand, not only the value of learning, but also how and where the learning takes place (Argyris, 1991).

4.2.1 Different perspectives

The descriptions of what defines interdisciplinarity are many and often mixed together with closely related environments such as multi-, trans- and crossdisciplinary environments. Below four different sets of interdisciplinarity definitions are presented.

4.2.1.1 Szostaks definition

Szostak et al. (2016) define interdisciplinarity by three parts. The first, interdisciplinarity tackles questions that are addressed in multiple disciplines. The second, interdisciplinarity seeks to integrate insights from the disciplines to generate a better understanding in a particular question. The third part is presented as a result of the two prior, Szostak et al. (2016) find that interdisciplinarity is thus open to theories, methods, philosophical perspectives, and types of data utilised in different disciplines. Szostak et al. (2016) also mentions the attitude toward disciplines and how, to what degree and at what level they are integrated as important aspects to consider interdisciplinarity.

4.2.1.2 Strobers definition

Strober (2011) highlights three defining parts of the interdisciplinary environment. First collaboration as a crucial part in order to work in this environment. The second part is the holistic view of problems that is created through the collaboration between disciplines. The third and last is the understanding of disciplines, what are the disciplines strengths and how can they contribute and how can that be complimented.

4.2.1.3 Bammers definition

What defines interdisciplinarity according to Bammer (2013) are the competence mix, the benefits of discipline-based research is maintained but one can still overcome limitations thanks to the mix. The different disciplines contribute to create a detailed understanding of the problem to be able to move beyond the restricted scope of just one discipline. It means that the search is for more options rather than a single best methodology. The problems tackled in the interdisciplinary environment are complex social and environmental problems where knowledge from both academic and practical expertise about the problem are pulled together. The research are to support the makers of policy and practice change by giving them a better understanding of the problem before making decisions and taking action. Bammer (2013) also state that it is important to appreciate that everything about a complex problem cannot be known and that the remaining unknowns must be taken into account in decision making and action as well.

4.2.1.4 Frodemans definition

Frodeman et al. (2010) present following defining keywords for the interdisciplinary environment; Integration, Collaboration, Complexity, Critique, Problem solving, Interacting, Linking, Focusing and Blending. Furthermore the importance of the disciplines concepts and insights which they can contribute with to understand problem. In this environment methods and theoretical concepts of a discipline might be modified as a result of the cooperation. Coordination, assessment, communication and culture are to be taken under consideration in order to make full use of the environments potential.

4.2.2 Six interdisciplinarity traits

Based on the theory presented above in section 4.2.1 the interdisciplinary environment can be described by the following six traits. How these traits were created is described in section 2.7.2.

Context

The problems in this environment are dealing with or tackling complex social and environmental problems. The connected questions are addressing multiple disciplines making it a complex problem. Problem solving plays a central role when the disciplines are blended to tackle a focused problem. The search is often for more options rather than one a single best methodology.

Openness

There are to be an openness between the disciplines in the shape of communications and attitude. To understand the other disciplines and be able to learn from them it is important to share ones own experiences and expertise. The openness thus include both giving and receiving critique or feedback.

Curiosity

When working in an interdisciplinary environment one are to be curios of what methods, theories and perspective the other disciplines bring to the table. By having a curios mindset it is possible to move beyond the restricted scope and search for more options rather than a single best methodology.

Collaboration

Collaboration is important to enable pulling together the knowledge from the different disciplines and individuals. The interaction between members plays a part in the collaboration to be able to make the most out of all expertise.

Integration

The level of integration can vary but some integration of disciplines and knowledge is needed. There should not be a full integration. The level of integration is supposed to be large enough to overcome disciplinary limitations and still maintain the benefits from the different disciplines.

Holistic perspective

A holistic view of problems is needed. This view is created by allowing all disciplines contribute with concepts and insights on the problem. By linking the disciplines together and letting them all contribute they will all have a better and more detailed understanding of the problem as a piece in a larger system.

5

Empirical data

In this chapter the empirical data is presented with respect to its origin. First the data collected from guidelines followed by the data from interviews and survey. The data presented in this chapter were later used to answer the research questions.

5.1 Guidelines

This document provides an insight into how the organisation from management level encourages learning within the organisation. Below we have gathered extractions from the guidelines for the Areas of Advance that are considered relevant for the result. All extractions are direct translations from the control document (Chalmers University of Technology, 2016) received from the Overall responsible of the Areas of Advance.

5.1.1 Defining the Area of Advance

An Area of Advance is characterised by the fact that it is:

- A challenge-driven and cross-border area with strength in the form of excellent research.
- An area with clearly formulated vision and goals and a clear strategic process for the long-term development of Chalmers research, education and utilisation.
- An open meeting point for cross and multidisciplinary constellations of researchers/teachers.
- An offer of added value and activities that are not done in the line and which attracts strong long-term interest and commitment from society and industry as well as internally within Chalmers.

With the Areas of Advance as strategic tools:

- Chalmers develops and integrates its leading research, education and utilisation to achieve the desired effects in society.
- New meetings are created across borders within Chalmers and with the outside world.

5.1.2 The mission

The areas' assignments are to engage researchers and teachers in collaborating, partly on subject boundaries internally and partly with the private and public sector and the international research community externally, to contribute to solving important societal challenges. The driving forces are sustainable development, innovation and entrepreneurship.

5.1.3 Overall goals

The overall long-term goals focus beyond 2020 and towards 2030:

- The Areas of Advance have contributed to integrating research, education and utilisation into the knowledge triangle.
- The Areas of Advance have become a meeting place for collaboration between academia, industry and society.

The overall long-term goals are common to all areas and are broken down into detailed goals and action plans and followed up in each area.

5.1.4 The functions

With the functions as tools, the areas help to strengthen challenge-driven, excellent and cross-border research, education and utilisation, promote synergies and create the conditions for broad and long-term financing.

The functions are intended to:

- Recruit and develop young researchers.
- Investments in cross-disciplinary projects, risk projects and conversion projects.
- Establish and develop strong networks with academia, business and society.
- Community building at Chalmers.
- Coordinate external analysis and foresight work.
- Measure, analyse and monitor the added value of the areas for quality and relevance.

5.1.5 Management - Overall responsible

The Overall responsible for the Areas of Advance has overall responsibility for the development of Chalmers Areas of Advance, and collaborations between the areas.

The Overall responsible for the Areas of Advance shall:

- Lead Areas of Advance-comprehensive strategy and development work.
- Support the Areas of Advance and continuously develop the concept.
- Responsible for ensuring that the Areas of Advance are communicated effectively within and outside Chalmers.
- Make visible and link centre formations and Chalmers infrastructures to suitable Areas of Advance.

5.1.6   Management - Directors

The directors of an Area of Advance leads the area and its strategy work, and represents the area internally and externally.

The assignment includes:

- Responsible for developing and clarifying the area's target image and profile(s).
- Work to integrate education, research and utilisation within the area.
- Initiate, follow up, analyze and develop the operations within the area.
- Responsible for analysing Chalmers strengths and opportunities in the area in relation to the outside world.
- Responsible for communication of the area as a whole internally and externally as a shop window for Chalmers activities in the area.

5.1.7   Strategic work, planning and follow-up

The areas, their profiles and action plans are followed up and adjusted annually to enable dynamic adaptation to society's needs and opportunities in research and education. Within the annual development work, forward-looking strategic discussions are conducted with research leaders, researchers/ teachers and external partners. The area's overall strategy, including the strategic direction of the profiles, is reviewed every three years in consultation with suitable advisory boards such as international scientific council and business and social councils.

The Areas of Advance are followed up every year with regards to both business and finances. The data is collected partly through their IT systems, and partly through a survey that is sent to all researchers/ teachers in the faculty, research assistants and key persons. The directors of the Areas of Advance analyse follow-up data in relation to

established goals and feedback the results to stakeholders as part of the annual strategy work.

5.2 Interviews

Below summaries of the answers are presented from the interviews with interviewee A, B, C, D and E (see table 2.1). Not all answers nor themes are presented, only those of relevance for the final research questions has been selected and presented. The answers that were heavily focused on the project Virtual City (VC) were dismissed and chosen not to be presented. The answers presented below are not quotations if not specified as one, they are summaries based on notes and recordings from the interviews. Section 5.2.1 is based on answers from interviews with interviewee A, B, C and D. All that is presented in section 5.2.2 is based on the answers from interviewee E.

5.2.1 Project level interviews

Theme 1: The project
Interviewee A, B and C (2019) presented different visions of what the project aimed to create and do. When faced with what other members had answered the reactions were different as well, some were aware of the difference in visions and others clueless to the various visions. Difference in visions was mentioned by interviewee E (2019) as a strength instead of a problem since it indicates multiple ways of using the outcome of the project.

When asked about what challenges the project VC were to face next the answers was unanimously about funding of the projects (A, B, C and D, 2019). Multiple applications have been sent out and depending on how they fall out the project will scale down or up. Not knowing if, when or how much funding the project will receive inhibit the project and its members. To keep the project running and relevant they need staff working on a daily basis which is hard when the funding is uncertain. The marketing of the project and its members that is needed to ease the search for funding are done through publications and citations. It is therefore a fine balance between time spent on the project and time spent on creating publications regarding the project. In addition the researchers also have to manage the teaching hours they are obligated to do, this amount of hours then depends on funding of the projects. In general the researcher, in some sense, goes where the money are.

Quote from interviewee B - *It is not that you don't want to teach but if you have no research at all you will get one hundred percent teaching and then it will be a huge number of exams to go trough and mark.*

(translated from Swedish)

Quote from interviewee C - *As a professional you get very vulnerable because you go to an area you don't know much about.*

The project group of VC are aware that there are similar products (digital twins, programs for digital replication of cities and simulation programs) to what the project aim to create (B and D, 2019). However the VC project have not been able to use much from these, the products on the market are already competing and would not benefit directly from sharing code or likewise (B, 2019). The existing products were therefore used as no more than inspiration. There are some projects where companies and the university have collaborated and applied for funding together, in these cases there are much more to gain for both parts.

Quote from interviewee C - *I think the project it self, not because I work in it but, it's kind of, it's a very good example of collaboration cross disciplinary and multi-disciplinary collaboration I guess.*

Theme 3: Learning
The Area of Advance project VC has been a learning experience for the project members (A, B, C and D, 2019). They have different backgrounds and special areas of expertise that have made them dependent on each other and was forced to learn from one another. All of the members mentions this as a positive thing, they truly appreciate the interdisciplinary collaboration of the project and that they complement each other (A, B, C and D, 2019). In urban planning they feel there is a lack of this collaboration and interdisciplinary work (C, 2019).

Quote from interviewee A - *I learn every day.*

Quote from interviewee C - *I definitely expected to learn. I learnt a lot and I think the others learnt a lot from my side as well.*

5.2.2 Areas of Advance oriented interview

Theme 1: Background
The Areas of Advance is a sort of multi science or interdisciplinary science, depending on how you define the terms. What it boils down to is coming together for a problem from different areas of expertise to learn and try to solve it in the best way possible. This then involve challenge driven personnel across the matrix organisation that is Chalmers.
Quote from interviewee E - *A majority of the researchers at Chalmers are involved in the Areas of Advance in one way or another.* (translated

from Swedish)

Those that can see the whole system and how to link it together are important and of great value. For example the SDG, one could try to solve each one as an isolated problem but it is when we try to solve them as a whole it gets really interesting and challenging. Another example is the autonomous cars, when developed isolated it is nothing but a car that does not need a driver. When developed together with or as a part of the research regarding fossil free cars and as a part of how tomorrows car ownership might look it gets a whole new meaning for all involved research areas.

Those that can see who else is needed for a project or could contribute to a problem are a good resource as well. Some people are standing still digging deeper into their own area of excellence and can not see what else it could be used for could then be headhunted to projects. Some need that kind of help more than others, and some just want to keep digging and stay in their research area.

It is close to impossible to plan for these collaborations, it comes foremost from meetings, interactions and discussions between different researchers. There is therefore seminaries held regularly to promote these meetings and discussions. The Areas of Advance are from time to time overseen to make sure that they are still creating value in their present form. If not they could be reshaped into something else to further develop the area or renamed to fit the actual value it creates, such as a area of excellence.

The Areas of Advance have a disciplinary width that are connected to urban challenges and sustainable development. Originally there was supposed to be three legs supporting the Areas of Advance: research, cooperation, education. The first two, research and cooperation, are well integrated whilst education have been foreseen so far. Although there have been indication from researchers that they use the knowledge gained from the Areas of Advance in there teaching.

The areas are supposed to be very interactive and dynamic, always ready to change its course and adapt to the ever changing surrounding that is the society. The areas themselves does not change often but the profiles within the areas changes more frequently. In these projects there are no problems with many different visions, all of them could come in handy which prove the great potential with the projects.

Theme 2: Evaluation and follow-up
From 2010 until 2014 yearly evaluations of the Areas of Advance were conducted on behalf of the government which at the time financed

the areas. This is no longer done, it is too expensive. There are Areas of Advance that do evaluations but in a different way. The Area of Advance Energy does a gap analysis continuously where they have a far fetched goal that they describe in what way they are getting closer to and how they are to go forward to get even closer.

5.3 Survey

In this section unprocessed data from the survey will be presented.

5.3.1 Distribution of roles

Below table 5.1 is presenting the distribution of roles that is represented in the survey.

Roles	Percentage	Respondents
Overall responsible for AoA	5,6 %	1
Director/co-Director	50 %	9
Profile Leader	44,4 %	8

Table 5.1: Distribution of the roles that answered the survey.

5.3.2 Distribution of areas

Below table 5.2 is presenting the distribution of areas that is represented in the survey.

Areas/Projects	Percentage	Respondents
ICT	22,2 %	4
Energy	27,8 %	5
Materials	16,7 %	3
Transport	33,3 %	6
Production	16,7 %	3
Project Liveable Cities	11,1 %	2
Project Health Engineering	11,1 %	2

Table 5.2: Distribution of areas/ projects that answered the survey.

5.3.3 Importance of the characteristics

Below table 5.3 is presenting unprocessed data from the survey.

Characteristics	1	2	3	4	5
Leadership engagement	0	0	1	5	12
Openness	0	0	0	10	8
Transparency	0	0	1	10	7
Curiosity	0	0	5	4	9
Learning from mistakes	0	0	5	6	7
Personal development	0	2	6	5	5
Reflection	0	0	4	8	6
External exchange	0	0	1	5	12
Monitoring	0	3	5	6	4
Flexibility	0	0	3	10	5
Reward system	2	1	12	3	0
Holistic perspective	0	0	1	8	9
Total	**2**	**6**	**44**	**80**	**84**

Table 5.3: Unprocessed data from survey regarding the degree of importance presented where the characteristics are lined up together with the 1-5 grading, 1 meaning not important and 5 very important.

5.3.4 Degree of fulfilment of the characteristics

Below table 5.4 is presenting unprocessed data from the survey.

Characteristics	1	2	3	4	5
Leadership engagement	0	0	6	4	8
Openness	0	0	4	12	2
Transparency	0	1	9	6	2
Curiosity	0	0	9	6	3
Learning from mistakes	0	1	7	5	5
Personal development	0	4	6	6	2
Reflection	0	1	6	9	2
External exchange	0	0	7	5	6
Monitoring	0	2	9	6	1
Flexibility	0	0	5	10	3
Reward system	1	2	11	4	0
Holistic perspective	0	0	3	11	4
Total	**1**	**11**	**82**	**84**	**38**

Table 5.4: Unprocessed data from survey regarding the degree of fulfilment presented where the characteristics are lined up together with the 1-5 grading, 1 meaning not fulfilled and 5 very fulfilled.

6

Results

In the following chapter the results and findings from the study are presented. The results are divided into three sections where the findings related to each research question are presented.

6.1 RQ1: Importance of characteristics

In this section the data used to identify the five most important learning organisation characteristics are presented. The data are presented according to how it was collected, first data from the guidelines for the Areas of Advance followed by data from the survey.

6.1.1 Guidelines

Figure 6.1 gives an overview of the appearance of learning organisation characteristics in the guidelines. In general, the guidelines focus in greater occurrence on *External exchange* and *Holistic perspective* as seen in figure 6.1.
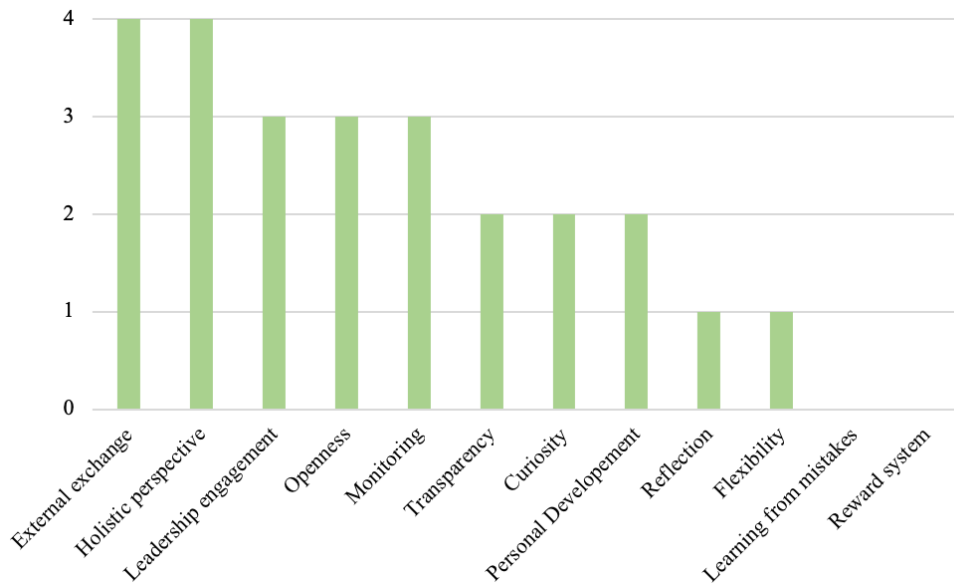

Figure 6.1: Number of connections drawn between the guidelines and the characteristics.

Below are summaries of what the guidelines said about each of the connected and mentioned learning organisation characteristics.

External exchange

Regarding *External exchange* the guidelines is aiming to offer added values and activities that attracts strong long-term co-operations outside Chalmers (section 5.1.1). Furthermore the guidelines mentions a long-term goal where the Areas of Advance is to become a meeting place for external collaborations (section 5.1.3). Another aim is that the Areas of Advance will establish and develop strong networks with academia, industry and society (section 5.1.4). Mentioned is also that the Directors of every area is responsible for analysing Chalmers strengths and opportunities in relation to the outside world (section 5.1.6).

Holistic perspective

To generate a *Holistic perspective* the guidelines states that the Areas of Advance will have a clear strategic process for the long-term development of Chalmers' research, education and utilisation (section 5.1.1). The Areas of Advance shall also contribute to integrating research, education and utilisation into the knowledge triangle (section 5.1.3). The guidelines also states that the Overall responsible for the Areas of Advance has responsibility for the development of the organisation and collaborations between the areas (section 5.1.5). At last it also means that the Directors shall work to integrate education, research and utilisation within the Areas of Advance (section 5.1.6).

Leadership engagement

What the guidelines address regarding *Leadership engagement* is that each area is defined by a clear vision and goal (section 5.1.1). The guidelines also clarify the responsibilities of the various leadership roles within the organisation (section 5.1.5 and 5.1.6).

Openness

Regarding *Openness* the guidelines means that an Area of Advance shall be an open meeting point for researchers (section 5.1.1), engage researchers in collaborating (section 5.1.2) and community building at Chalmers (section 5.1.4).

Monitoring

Monitoring is addressed in a few different sections in the guidelines and aims in its entirety to measure, analyse and monitor the area in terms of quality and relevance (section 5.1.4). Responsible for the monitoring to be done is the Directors of each Area of Advance (section 5.1.6) and in section 5.1.7 it is stated that forward-looking strategic discussions are conducted on an annual basis with research

leaders, researchers and external partners. Furthermore it is stated that data is collected partly through an IT system and partly from an annual survey sent to all key persons.

Transparency
Transparency is addressed in the guidelines through the focus on the importance of effective communication both internally and externally (section 5.1.5 and 5.1.6).

Curiosity
This characteristic is addressed through mentioning that the Areas of Advance is challenge-driven where excellent research occur across boarders (section 5.1.1). Investments in cross-disciplinary projects, risk projects and conversion projects is also brought up (section 5.1.4).

Personal development
Regarding *Personal development* recruiting and developing young researchers is addressed as a way of developing the competence within the Area of Advance (section 5.1.4). Formations of new research-centres and Chalmers infrastructures is made visible within the Areas of Advance (section 5.1.5).

Reflection
This characteristic is relevant in a more indirect way since the guidelines is not directly mentioning reflection as an important activity. But what is mentioned is the importance of analysing follow-up data and send feedback to stakeholders (section 5.1.7). In order for this to be done, reflection is a prerequisite.

Flexibility
Regarding *Flexibility* the Areas of Advance, their profiles and action plans are adjusted annually to enable dynamic adaption to society's needs and opportunities in research and education (section 5.1.7).

6.1.2   Survey

First and foremost the degree of importance is presented. The answers regarding this are found in figure 6.2. The Directors/co-Directors gave in general a higher score than the Profile leaders as seen when looking at the two groups in figure 6.2 and in table 6.6. A compilation of the mean, standard deviation and Z-score for each characteristic and total average at the bottom is presented in table 6.2.
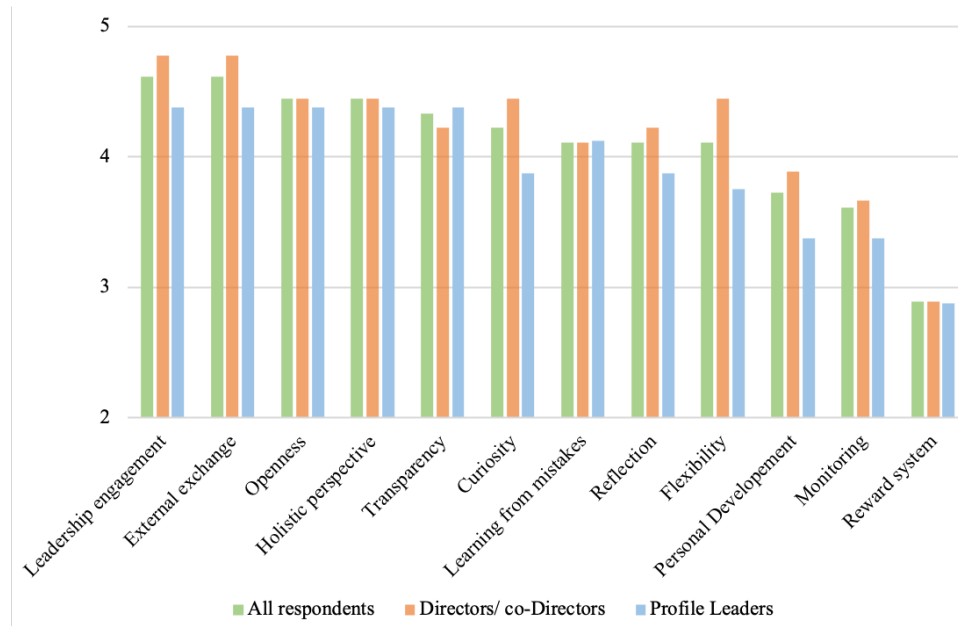
Figure 6.2: Mean for the degree of importance from all respondents (green), Directors/co-Directors (orange) and Profile leaders (blue).

	Characteristics	All	Directors/ co-Directors	Profile leaders
1	Leadership engagement	4,61	4,78	4,38
2	External exchange	4,61	4,78	4,38
3	Openness	4,44	4,44	4,38
4	Holistic perspective	4,44	4,44	4,38
5	Transparency	4,33	4,22	4,38
6	Curiosity	4,22	4,44	3,88
7	Learning from mistakes	4,11	4,44	3,75
8	Reflection	4,11	4,11	4,13
9	Flexibility	4,11	4,22	3,88
10	Personal development	3,72	3,89	3,38
11	Monitoring	3,61	3,67	3,38
12	Reward system	2,89	2,89	2,88
	Average	**4,10**	**4,19**	**3,93**

Table 6.1: Mean of all respondent levels responses regarding importance.
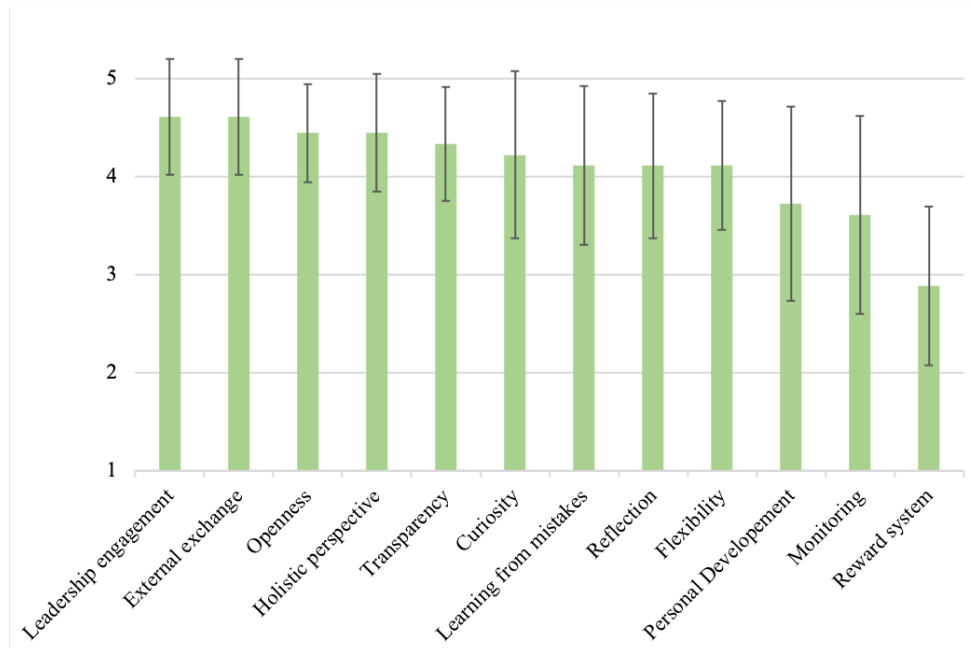
Figure 6.3: Mean and standard deviation for the degree of importance from all respondents.

	Characteristics	Mean	Standard deviation	Z-score (Mean)
1	Leadership engagement	4,61	0,59	0,70
2	External exchange	4,61	0,59	0,70
3	Openness	4,44	0,50	0,47
4	Holistic perspective	4,44	0,60	0,47
5	Transparency	4,33	0,58	0,32
6	Curiosity	4,22	0,85	0,17
7	Learning from mistakes	4,11	0,81	0,01
8	Reflection	4,11	0,74	0,01
9	Flexibility	4,11	0,66	0,01
10	Personal development	3,72	0,99	-0,52
11	Monitoring	3,61	1,01	-0,68
12	Reward system	2,89	0,81	-1,67
	Average	**4,10**	**0,73**	

Table 6.2: Learning organisation characteristics ranked according to the mean from most to least important with the standard deviation and Z-score presented on the right side, based on data from all respondents.

6.1.3 Decision matrix

To combine the data from the guidelines and survey a decision matrix was used where the data types were given different weight factors (WF) depending on how important they were considered to be for the result. In table 6.3 the matrix is presented containing the mean for the importance (see table 6.2) of the characteristics with WF 0,7 and the rate of appearance in the guidelines (see figure 6.1) with WF 0,3 and a total rating in the column to the right.

	Characteristics	Mean	WF1	GL	WF2	Total
1	External exchange	4,61	0,7	4	0,3	4,43
2	Holistic perspective	4,44	0,7	4	0,3	4,31
3	Leadership engagement	4,61	0,7	3	0,3	4,13
4	Openness	4,44	0,7	3	0,3	4,01
5	Transparency	4,33	0,7	2	0,3	3,63
6	Curiosity	4,22	0,7	2	0,3	3,56
7	Monitoring	3,61	0,7	3	0,3	3,43
8	Reflection	3,72	0,7	2	0,3	3,21
9	Personal development	4,11	0,7	1	0,3	3,18
10	Flexibility	4,11	0,7	1	0,3	3,18
11	Learning from mistakes	4,11	0,7	0	0,3	2,88
12	Reward system	2,89	0,7	0	0,3	2,02
	Average	**4,10**		**2,08**		**3,50**

Table 6.3: Learning organisation characteristics ranked with respect to mean of importance according to the respondents and rate of appearance in the guidelines. The total is given by multiplying the mean with WF1 and the GL to WF2 and then add the results.

6.1.4 RQ1: Result summary

Input from the guidelines and the survey, which were used to answer RQ1, was combined in the decision matrix (see section 6.1.3). From the matrix the top five learning organisation characteristics were found. The following five characteristics were considered most important by the Areas of Advance.

6.2   RQ2: Fulfilment of characteristics

The data used to identify the five most fulfilled learning organisation characteristics are presented in this section. It is presented with respect to how the data was collected, first the data from the interviews are presented and then the data used from the survey.

6.2.1   Interviews

The analysis of the interviews indicate that the organisation have a high rate of fulfilment regarding the *Holistic perspective*. The system perspective is mentioned as highly respected and valued by the organisation (section 5.2.2). The holistic perspective has put a stamp on the projects in the organisation, problems are seen and solved as a whole system where all related research areas are involved (section 5.2.2).

The *Openness* were found to be sufficiently fulfilled by the organisation as well. There are a clear awareness of the knowledge excising among the other members of the projects as well as members of the organisation at large. When entering a project the members know that they will depend on others knowledge and that they will learn from each other (section 5.2.1). The organisation work to create events and opportunities for knowledge transfer between areas, projects and members (section 5.2.2).

It is clear that *External exchange* plays a big role in the organisation. The project members look for external inspiration and cooperation (section 5.2.1). The *External exchange* is also highlighted by the management level (section 5.2.2) as something the organisation continuously work on.

Flexibility was only mentioned by the management level during the interviews. When mentioned it was in away that indicated that this characteristic is fulfilled (section 5.2.2).

The answers regarding *Leadership engagement* differ, some indicate that it is fulfilled and some contradict it. Without a clear indication of the rate of fulfilment it is not possible to say anything with certainty about this characteristic.

There were two characteristics that the result from the interviews indicated to be low prioritised and not fulfilled bu the organisation. First *Monitoring*, in some cases evaluations were made but not in general and not in a collective manor as it was considered to be to expensive (section 5.2.2). Second *Reward system*, the project members expressed

stress related to funding and time disposal (section 5.2.1). This indicated a low rate of fulfilment of the *Reward system.*

6.2.2 Survey

From the survey the questions treating to what extent the respondents felt the Areas of Advance fulfilled the characteristics was the ones used to answer RQ2. The mean of the answers from all respondents, Directors/co-Directors and Profile leaders are presented in figure 6.4. In figure 6.5 the mean as well as the standard deviation of the answers from all respondents are found. In table 6.5 a compilation of the mean, standard deviation and Z-score for each characteristic are presented.

The Directors/co-Directors were not always in agreement with the Profile leaders. In general one can see that the Directors/co-Directors rated the degree of fulfilment higher than the Profile leaders.
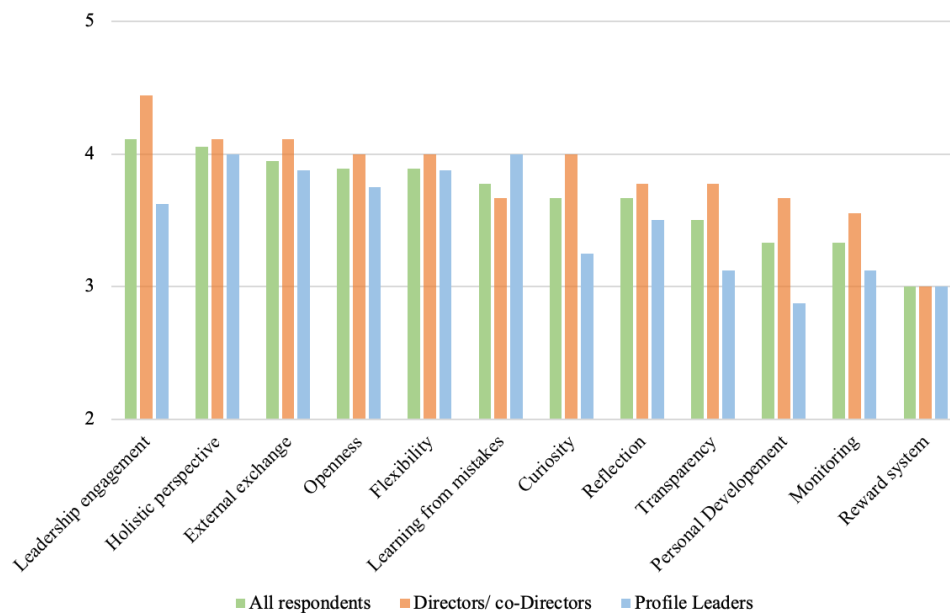
Figure 6.4: Mean for the degree of fulfilment from all respondents (green), Directors/co-Directors (orange) and Profile leaders (blue).

	Characteristics	All	Directors/ co-Directors	Profile leaders
1	Leadership engagement	4,11	4,44	3,63
2	Holistic perspective	4,05	4,11	4,00
3	External exchange	3,94	4,11	3,88
4	Openness	3,89	4,00	3,75
5	Flexibility	3,89	4,00	3,88
6	Learning from mistakes	3,78	3,67	4,00
7	Curiosity	3,67	4,00	3,25
8	Reflection	3,67	3,78	3,50
9	Transparency	3,50	3,78	3,13
10	Personal development	3,33	3,67	2,88
11	Monitoring	3,33	3,56	3,13
12	Reward system	3,00	3,00	3,00
	Average	**3,68**	**3,84**	**3,50**

Table 6.4: Mean of all respondents levels responses regarding fulfilment.

Figure 6.5: Mean and standard deviation for the degree of fulfilment from all respondents.

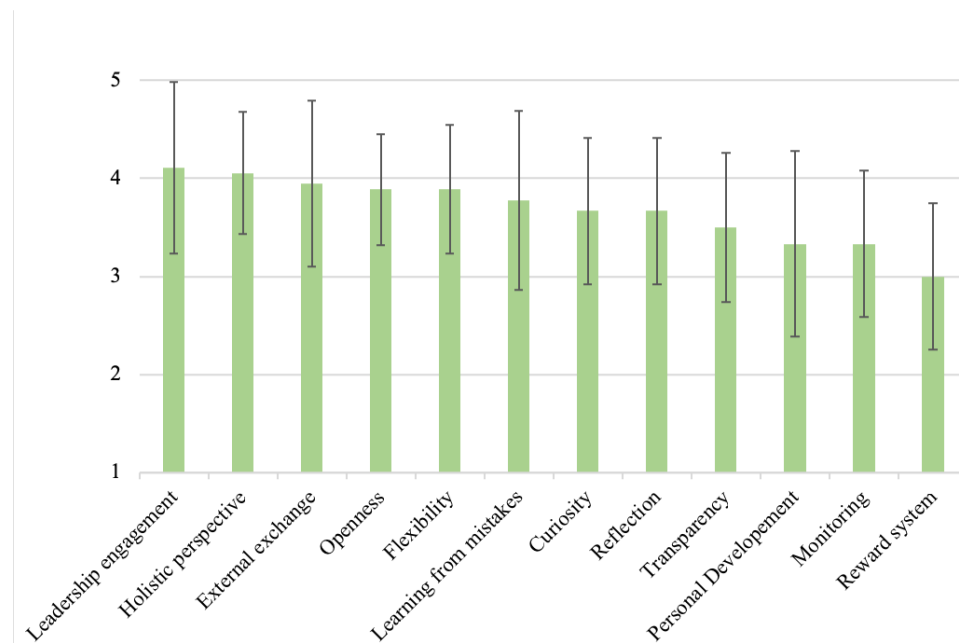|	Characteristics	Mean	Standard deviation	Z-score (Mean)
1	Leadership engagement	4,11	0,88	0,56
2	Holistic perspective	4,05	0,62	0,49
3	External exchange	3,94	0,85	0,35
4	Openness	3,89	0,57	0,27
5	Flexibility	3,89	0,66	0,27
6	Learning from mistakes	3,78	0,92	0,13
7	Curiosity	3,67	0,76	-0,02
8	Reflection	3,67	0,75	-0,02
9	Transparency	3,50	0,76	-0,24
10	Personal development	3,33	0,94	-0,45
11	Monitoring	3,33	0,75	-0,45
12	Reward system	3,00	0,75	-0,89
	Average	**3,68**	**0,77**	

Table 6.5: Characteristics ranked according to the mean from highest to lowest degree of fulfilment.

6.2.3 RQ2: Result summary

From the result of the interviews *Holistic perspective, Openness, External exchange* and *Flexibility* was seen as fulfilled which was supported by the result from the survey as well. In first place, with the highest rate of fulfilment, according to the survey was *Leadership engagement*, this was not clearly contradicted by the interviews and so this characteristic will be considered to be in the final top five.

The interviews presented two characteristics in the other end of the scale, with very low rate of fulfilment, these were also supported by the result from the survey. The result was following five characteristics which are considered most fulfilled by the Areas of Advance.
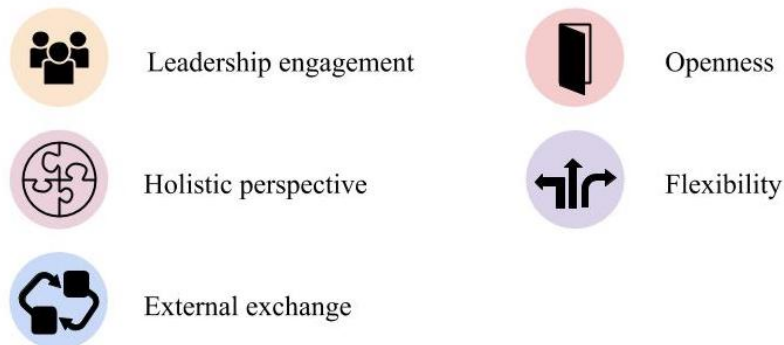
6.3 RQ3: Description with respect to the case and environment

To answer RQ3, data from literature on interdisciplinarity, guidelines and survey were used. To get a better grip of this question it can be divided in two parts. One part regarding which characteristics that can be dismissed with respect to the interdisciplinary environment and one regarding which characteristics that can be dismissed with respect to the case. When reading the results below one can think of it as a list of characteristics that the Areas of Advance should focus on to maximise their investments becoming more of a learning organisation.

Openness is mentioned as an interdisciplinarity trait as well as a learning organisation characteristic. The same goes for *Curiosity* and *Holistic perspective* which are also mentioned as interdisciplinarity traits and learning organisation characteristics. When describing the characteristics of a learning organisation with respect to the interdisciplinarity described in theory (section 4.2.2) these three (*Openness, Curiosity, Holistic perspective*) were dismissed as they were fulfilled by the environment and not dependent on the learning organisation (see figure 6.6).

When looking at the decision matrix there is one learning organisation characteristic (*Reward system*) at the bottom that is considered to be the least important with a good margin to the one above. Therefore this characteristic were also dismissed from the list (see figure 6.6).

From the description of the case, Area of Advance, in chapter 3 yet another learning organisation characteristic was dismissed, *External exchange* (see figure 6.6). It was considered self-fulfilled by the case which is also supported by the guidelines (see figure 6.1) where the *External exchange* is one of the most featured. The survey supports it as well where it is one of the top rated characteristics considered to be fulfilled (see figure 6.4 and 6.4).
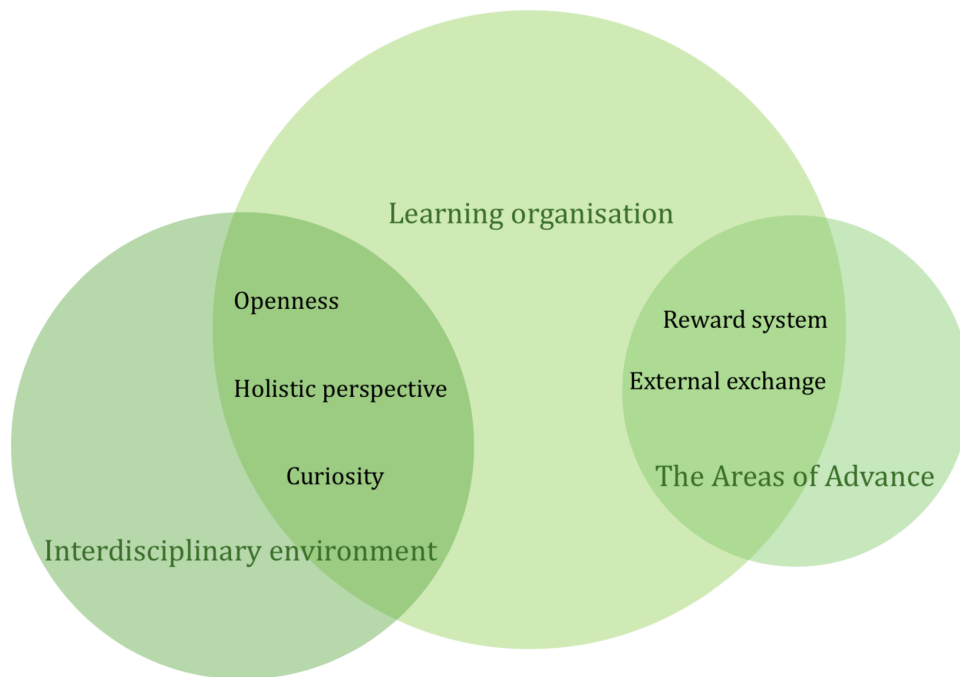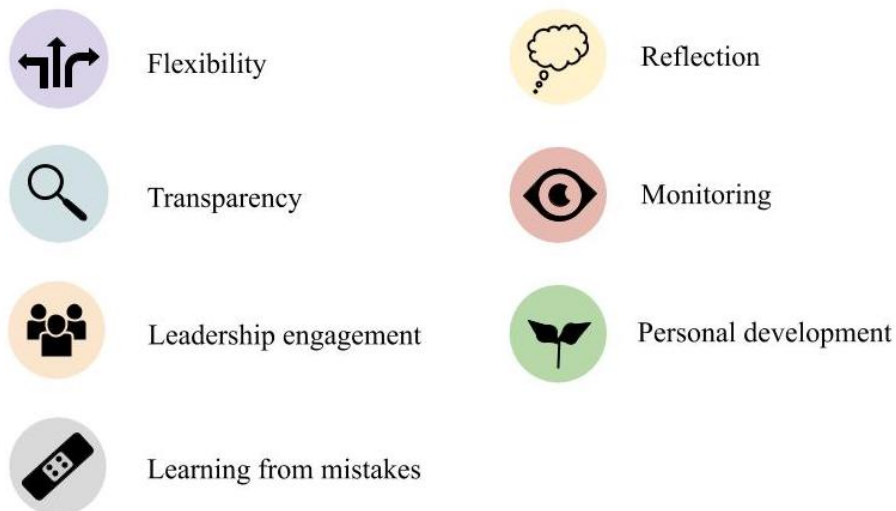
Figure 6.6: Venn-diagram of the interdisciplinarity, learning organisation and the Areas of Advance.

To answer how the characteristics of a learning organisation be described with respect to the Areas of Advance and interdisciplinarity a list consisting of seven characteristics is presented below.

6.4 Analysis of the survey responses

Further analysis of the responses and respondents are presented in this section to give a wider understanding of the result. The respondents gave in general higher ratings the higher up in the hierarchy they work which can be seen in table 6.6. Although the ratings for fulfilment are more in line throughout the hierarchy.

Roles	All ratings	Importance	Fulfilment
Overall responsible for AOA	4,17	4,67	3,67
Director/co-Director	4,02	4,19	3,84
Profile Leader	3,71	3,93	3,50
All respondents	3,89	4,10	3,68

Table 6.6: Mean of all ratings, ratings of importance and fulfilment from the different groups of respondents.

In figure 6.7 the mean and standard deviation are plotted for all responses. From the plot one can see that the respondents are in greater agreement regarding what they consider important, higher rating and lower deviation. The characteristics that the respondents find the least important have a higher standard deviation implicating that they are not in agreement in that matter.
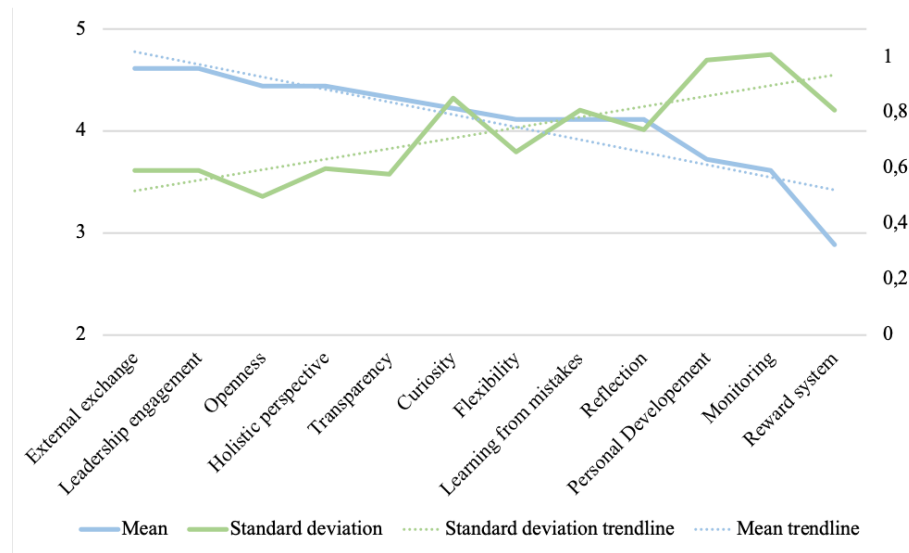
Figure 6.7: Mean and standard deviation plotted together for the importance of the characteristics from all responses.

When plotting the mean and standard deviation for the fulfilment of the characteristics the responses vary in a different manor than the importance. The deviation is almost constant for all characteristics in the matter of fulfilment.
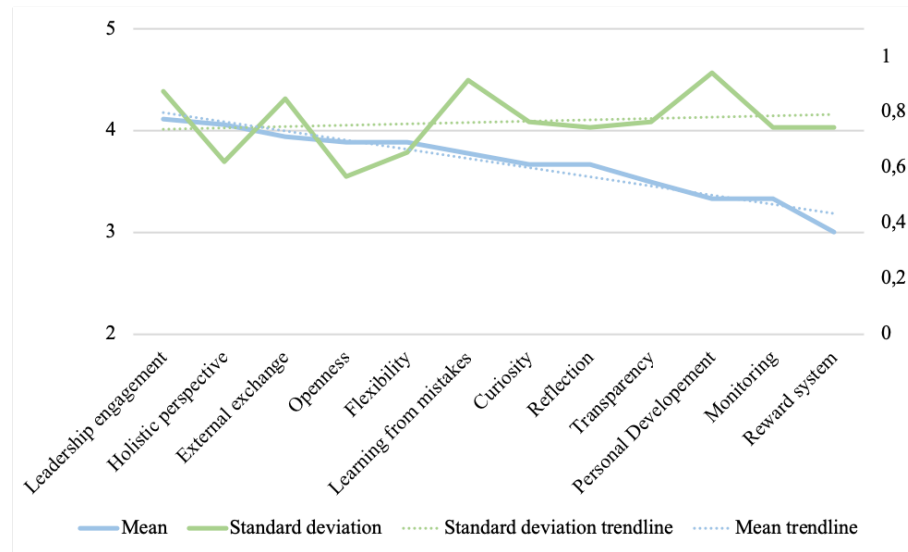
Figure 6.8: Mean and standard deviation plotted together for the fulfilment of the characteristics.

An analysis of the correlation between the responses on importance and fulfilment were carried out with respect to the respondents groups Directors/co-Directors, Profile leaders and all respondents. From the analysis, presented i table 6.7, one can see that there are a correlation, especially when looking at the responses from the Directors/co-Directors. The analysis indicates that the respondents rate what they find important as fulfilled and in the same way what they find unimportant as less fulfilled.

Roles	Correlation
Director/co-Director	0,75
Profile Leader	0,55
All respondents	0,66

Table 6.7: Correlation between answers on importance and fulfilment from the respondent groups Directors/co-Directors, Profile leaders and all respondents.

7

Discussion

In this chapter the results will be discussed with respect to each component of the result. The chapter begins with discussions of the research questions followed by discussions related to data from the guidelines, interviews and survey.

As presented in the introduction, this study aims to identify the importance (RQ1) of the learning organisation characteristics and to what extent they are fulfilled (RQ2) by the Areas of Advance. Furthermore to describe a learning organisation with respect to the interdisciplinary environment and the Areas of Advance (RQ3). The study is based on a quantitative survey and conducted qualitative interviews, literature review and document review. With the presented results as a basis, the discussion will hopefully provide a more nuanced picture and share different perspectives on the result.

7.1   Discussion of Research Question 1

The result of RQ1 gave answers to how important the different characteristics are according to the Areas of Advance organisation. Over all, the result shows that most characteristics are important.

The result from the guidelines testifies to the fact that there are many components in how to run this part of Chalmers which largely resembles the learning organisation concept. However, there are at the same time some characteristics that are not addressed in the guidelines.

As seen in figure 6.1 the guidelines do not address *Learning from mistakes* and *Reward system*. This could be because these characteristics are of a slightly more concrete nature than, for example, *Holistic perspective*. Due to this concreteness it makes sense that they are not part of a management document. It may also be because it is simply not considered to be as important as other characteristics.

The characteristics with greater representation are *External exchange* and *Holistic perspective*. According to the paragraph above, this may be because they are at a higher level of abstraction than the others,

which means that they to a larger extent belongs to a control document like the guidelines. It may also be that it is simply considered to be of higher weight than other values.

In the same way as the guidelines, the survey shows that the organisation generally considers the characteristics of a learning organisation to be important. In the bottom of table 6.2 the average mean for all characteristics is presented and with 4,10 of 5 it confirms what is stated in the previous sentence.

By analysing the groups Directors/co-Directors and Profile leaders among themselves, it is found that according to the mean value in table 6.1, the Directors/co-Directors consider these learning organisation characteristics more important than the Profile leaders. At the same time, the Profile leaders find that *Transparency* according to the average is more important, which is interesting as this group is the lowest in the hierarchy.

There are nine out of twelve characteristics with positive Z-score which shows that there are more extreme negative than positive rates. This makes the means more even in the top than in the bottom of the table 6.2.

As shown in the result (figure 6.2) there are clear winners who, according to the respondents of the survey, are considered the most important characteristics. The five most important are *Leadership engagement*, *External exchange*, *Openness*, *Holistic perspective* and *Transparency* with both highest mean and lowest standard deviation.

The results from the survey also show the lack of importance of the characteristics *Reward system*, *Monitoring* and *Personal development*. The same characteristics have slightly higher standard deviation than the rest, which means that the respondents did not really agree on the importance but not to the extent that the low mean value is rejected.

To combine these results, a decision matrix (table 6.3) was used where all the characteristics received a weighted score. The five most important characteristics were then *External exchange*, *Holistic perspective*, *Leadership engagement*, *Openness* and *Transparency*. The three least important characteristics turn out to be *Reward system*, *Learning from mistakes* and *Flexibility*. The list of which characteristics are considered most/least important is changed, but not very much when the guidelines and the survey are broadly agreed.

However, the characteristic *Monitoring* differed between the two results. The analysis of the guidelines resulted in a shared third place

while the results from the survey was second to last. An explanation for the high grade is that the guidelines (section 6.1.1) state that, on an annual basis, both strategic discussions and surveys should be carried out. At the same time, from the interview with the Overall responsible for the AoA (section 5.2.2) we found that structured evaluations do not take place any longer as it is too costly. This contradiction demonstrates the fact that the guidelines reflect a desirable organisational state while the survey and the interviewees reflect a more realistic state.

Overall, it is gratifying to see that these characteristics of a learning organisation are generally important for our case. It demonstrates positive conditions for tackling the social challenge to cope with the fourth sustainable development goal regarding life-long learning.

7.2 Discussion of Research Question 2

The result of RQ2 gave answers to what extent the Areas of Advance consider themselves fulfil the different characteristics. Generally, the the result shows that the Areas of Advance fulfil the characteristics they also consider important.

The results of the interviews show that there are some elements of fulfilment of the learning organisation characteristics, but since these do not cover all the characteristics, it is difficult to get a general picture of the degree of fulfilment from these. However, one of the main points taken from the interviews was the fulfilment of *Holistic perspective* (section 6.2.1) which is the same characteristic that according to the results from the survey is most fulfilled (table 6.5).

The characteristics *Monitoring* and *Reward system* is found least fulfilled from the results from both the interviews and the survey. This is positive as it strengthens the credibility of our results.

Leadership engagement is the characteristic that is most fulfilled according to the results of the survey but does not stand out in the interviews. This may be because the group that participated in the interviews is not represented in the survey.

It has been difficult to categorise the various specific answers from the interviews, which is an uncertainty of the study. An example of this is that interview responses such as, excitement to learn, may just as well fall under *Personal development* as *Curiosity.*

From the results of the survey *Personal development* together with *Monitoring* and *Reward system* forms a list of the three least fulfilled characteristics according to the mean (table 6.5). Of these three there

is only *Reward system* that is at the bottom of the rank of importance which contradicts the correlation analysis (section 7.6).

The results from the survey also shows that the respondents consider the organisation to get 3.68 out of 5 (table 5.4) in its grade for its fulfilment of the learning organisation characteristics. In the same table, *Leadership Engagement*, *Holistic Perspective*, *External Exchange*, *Openness* and *Flexibility* are top five, all with a mean around 4 and a standard deviation slightly above average.

This is almost the same five as the results from RQ1 (table 6.3). What is different is that *Transparency* was replaced by *Flexibility*, which also aligns with the results of the interviews as these do not deal with anything regarding transparency, but lift the organisation's ability to adapt as something prominent.

By analysing the groups Directors/co-Directors and Profile leaders among themselves, it is found that according to the mean value in table 6.4, the Directors/co-Directors consider these learning organisation characteristics fulfilled to a grater extent than the profile leaders.

The Z-score analysis that was done on the mean in table 6.5 shows that the distribution of grades is relatively even. The midpoint is right in the middle which means that there are an equal amount of characteristics on both sides of the mean.

Two sum up, it is not entirely given that the Areas of Advance can be considered a learning organisation. What can be said, however, is that it is on the right track since the results generally gives a picture of the characteristics being more fulfilled than unfulfilled.

7.3   Discussion of Research Question 3

The original list consists of twelve characteristics (section 4.1.2) that together describe what an organisation needs when striving to become a learning organisation. But in this given climate it turned out that all characteristics are not needed or considered important. The original list has been modified after input from RQ1 and theory about interdisciplinary environments and now consists only of seven characteristics.

The interdisciplinary environment according to the theory describes a purely interdisciplinary environment (section 4.2). The environment in this case, however, is not entirely pure as the organisation that constitutes our case is part of a larger organisation which is not purely interdisciplinary (figure 3.1). This, of course, affects the result, but not

to the extent that this is taken into account.

Three out of five learning organisation characteristics that were removed from the original model were motivated by the fact that the interdisciplinary context contributes to their fulfilment (section 6.3). A fourth characteristic, *Transparency*, could be rationalised as it touches the point of *Integration*. This has not been done since it was considered not to overlap sufficiently enough.

Another characteristic that was removed from the original list is *Reward system*. This was done due to low score from the result in RQ1 and should therefore not be the focus in the case of this study. Why *Learning from mistakes* was not removed is due to its high ranking when looking at the results from the survey exclusively (table 6.1).

Finally, one can see these seven characteristics as a list that should be in focus as an interdisciplinary organisation like the Areas of Advance are striving to become a learning organisation to a higher extent.

7.4   Data from guidelines

The input from the document analysis must be interpreted with some caution as the guidelines represents the organisation's management and its objectives. This makes it difficult to use the input to answer RQ2 but can advantageously be used to evaluate what the management considers important in an interdisciplinary environment. With this in mind the decision was made that this input will only form basis for RQ1.

The advantage of this is that we make sure that we do not draw any conclusions about how the organisation looks based on goals but on reality. The disadvantage of this is that we get a thinner basis for RQ2. However, this is weighted up by supplementary input from the interviews.

7.5   Data from interviews

There are more interviewees from the project level than management level which is a good representation of the organisations distribution of employees and levels. However a single source, as the management level interview was, is not as certain as if multiple independent sources gave the same picture or information. In this study the single source was treating more concrete information rather than information that would need validation or backing from others to mean something in a

general sense.

The interviewees from the project level are all from the same Area of Advance. This could be seen as a strength since it gives more nuanced information regarding the organisation from the same place and project from a variety of disciplines. It is possible that we would have gotten a different result if the interviewees were from another Area of Advance or from multiple Areas of Advance and compared and compiled the input.

Because the interviews were done at an early stage, where a different set of research questions were under investigation, the results from them were hard to fit into the final research questions. The result could be different if the interviewees had answered more specific questions fitting for the final research questions. It is interesting that most of the themes of characteristics were treated anyway of the interviews. Although one have to consider the human factor, some of the answers are strait forward connected whilst some are connected through our interpretation of them.

7.6   Data from survey

The distribution of the respondents regarding the roles is satisfactory as the distribution between the larger groups is even (table 5.1). This has made the analysis between the groups more reliable since they are represented by as much data. If the distribution had been uneven, it would not have been possible to investigate the results with the same certainty with regard to seeing differences between the groups.

The respondent distribution regarding areas is also representative of how large the respective areas are seen for research funding (table 5.2). This also makes the results more representative of our case, which further strengthens our investigation.

By making a comparison between the different respondent groups (table 6.6), we see that the average value of the answers to the different question categories varies. Generally, all characteristics are more important the further up in the organisation one come. This is not surprising as the management should both attach more importance to this type of questions and be more aware of potential problems that may arise if one does not work actively on such questions.

Regarding fulfilment in the same table, the result is a bit more evenly distributed and here are the Directors/co-Directors who, to the greatest extent, consider the organisation as a learning organisation. However, we see that there are still higher levels in the upper part of

the organisation.

In figure 6.7 there is presented a discovered relationship between the mean and standard deviation. What is shown is that the respondents agree more (ca 0,55) about which characteristics they consider important and agree less (ca 0,95) on the characteristics that they consider less important. This is an interesting connection as it gives a view that one with greater certainty can state that one characteristic is important than to state that one that is less important.

In figure 6.8 we find that the standard deviation is constant as the mean of the characteristics decreases from left to right. Here, instead, the standard deviation between the values (ca 0,75) from figure 6.7. This means that the respondents generally agree to the same extent on all characteristics regarding the fulfilment of a learning organisation.

Since there early was an idea that the respondents' answers were largely equal to the question of importance and the question of fulfilment, a correlation test was made. This is to see to what extent the responses to the two question categories co-varied. The correlation test showed strong correlations between importance and fulfilment, which is not really surprising as it feels reasonable to think that what you are good at is also important.

If it is also assumed that the organisation meets the characteristics that are considered important, it would imply that high correlation coefficients means that the employees and the organisation consider the same characteristics important. With the same reasoning low correlation coefficients implies that employees and the organisation consider different characteristics important.

These assumptions, for this case, with this correlation coefficients (table 6.7) thus imply that the employees and the organisation agree to a great extent. With the reasoning above, these coherent values lead to satisfied employees when the organisation seems to prioritise the right things.

The reason why it is addressed is because the connection or behaviour pattern may have affected the result. But if that is the case or not or to what extent it affects the result is not included in this study.

7. Discussion

8
Conclusion

This final chapter concludes upon the answers to the research questions and presents recommendations for future research.

The study contributes to the existing research on the subject by filling in the gap of knowledge that exists in the incision between learning organisations and interdisciplinarity.

The five learning organisation characteristics considered most important were determined. Furthermore the five considered to be most fulfilled by the case, the Areas of Advance, were established. The result of the study show that the characteristics seen as important in general correlated with higher rate of fulfilment by the case, the Areas och Advance.

The result indicate that the Areas of Advance in general both fulfil and consider the characteristics as important. It has been concluded that theories regarding the interdisciplinary environment and learning organisations overlap. This also applies to our findings from the case, which supports the result of our final model.

The result imply that the Areas of Advance has come a long way towards becoming a learning organisation and that there are good preconditions to take it further. To establish what steps that are needed to continue the strive of becoming a learning organisation is yet to be investigated, as well as how the steps are to be implemented in the organisation to reach the best result.

What had been interesting to investigate in the future could be to find out more about one of the twelve characteristics and try to map out its mechanisms. An example that had been extra interesting is the *Reward system*. What is it that makes it considered so unimportant and how does the reward systems work within the academy?

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A
Interview guide Virtual City

Theme 1: The project
1. Describe the process from when you got involved with virtual city until today.
2. What is your view of the vision of the project?
3. Major challenges of the project?
4. Has anyone outside the project group tested the platform from a user perspective?

Theme 2: The user
1. Who is going to use the platform?
   (a) What defines the different users?
2. How does the communication between you and the user(s) work today?
   (a) Is there information about the user you which you had and feel you miss today?
3. What parts and/or functions of the platform do you think the user will find valuable for collaborating?
   (a) What do you think makes them valuable?
   (b) What is the greatest challenge in ensuring that the value is created?

Theme 3: Learning
1. What have you learnt from the project?
2. How do you think of the platform as a tool for learning?
3. To what extent do you think the platform could be used for learning purposes?
   (a) How?
   (b) Who is in charge of this?
4. How do you think of the platform as a tool for feedback?
5. In what way could the platform be a tool for dialogue?
   (a) What is the greatest challenge with this?

Theme 4: Implementation
1. Where in the time-line from the pre-study would you say that the project are?
   (a) When is the focus shifting from technical challenges to implementation and user related challenges?
   (b) What risks do you see with the implementation?
2. How do you think the implementation would look like?
3. Where do you believe the biggest challenge lays with the implementation?
   (a) Why is that so?
   (b) What do you think could be done about this?

Theme 5: Additional questions
1. What do you think about the future of the project?

B

Interview guide Areas of Advance

Theme 1: Background
- Why do Chalmers have the Areas of Advance?
- How would you define the Areas of Advance?
- How do you define a interdisciplinary project?
- Where dose one draw the line? On one side a group of researchers working together and on the other side a coordinator that communicates between silos.
- What background would you like to see in a AoA-leader?
- What is the process for when an AoA-project is created?

Theme 2: Evaluation and follow-up
- What kind of evaluation or follow-up is there of the projects and of the implementation?
- What evaluation or follow-up is made regarding the result of the projects?

C
Interview Consent Form

Research investigator: Frida Jedvert, Viktor Persson
Research Participants name:

I voluntarily participate in this research study.

I have had the purpose of the interview and the study explained to me and have had an opportunity to ask questions about it.

I understand that the participation in this research will not benefit me directly.

Even if I agree to participate now I understand that I can withdraw at any time and also refuse answer any question at any time.

I agree that the interview will be audio-recorded.

I understand and agree that extracts from the interview may be quoted in the research report.

If the material from the interview will be used in any way that is not stated above the research investigators will contact you.

Signature of research participant

_____   _____
Signature of participant   Date

Signature of researcher
I believe the participant is giving informed consent to participate in this study

_____   _____
Signature of researcher   Date

D
Survey

Describing the AoA from a learning organisation perspective

We are two students from the masters program Learning and Leadership writing our master thesis about Learning Organisations. The aim of the survey is to get input to be able to describe a learning organisation in an interdisciplinary environment. The Areas of Advance (AoA) are therefore of interest as an organisation in an interdisciplinary environment. The survey have been sent to you since you are a part of AoA and it is with that in focus that we wish you to answer.

This survey will present twelve characteristics that originate from three models of characteristics for a learning organisation. The characteristics are presented in a general manor were your answer later will bring the AoA-perspective. The characteristics will be presented one at a time and you will then determine both how important one is to the organisation of AoA and to what extent you consider the characterises permeates the organisation of AoA.

It would be most helpful if you would answer this survey and we would truly appreciate your participation. It will only take about 10 minutes.

The outcome of the survey will later be available to you. However, if you wish to have access to the outcome before the thesis publication please contact us.

1. I agree that the information I submit can be used in this master thesis.

	Yes, I agree

2. What is your primary role within AoA?

	Profile Leader
	Director/co-Director of AoA
	Over all responsible of AoA

3. Which AoA are you active in as a leader?

	Energy
	Transport
	Materials
	Production
	ICT
	Project Liveable Cities
	Project Health Engineering

1. Leadership engagement

Leaders clarify visions and engage in the work of bringing them into the organisation. All members of the organisation participate in policy development.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

2. Openness

Information is accessible for everyone in the organisation, the communication is open and debate and conflict are seen as possibilities to solve problems.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

3. Transparency

Accounting, budgeting and reporting are done continuously as a tool for the members of the organisation to help them understand how resources are used.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

4. Curiosity

An organisation is structured to support questions, new ideas and methods from all levels in an active manor. Have an interest in understanding how things work and provide support to explore new things without fear of failing. Changes in the work processes, strategies and structures are made continuously to enable learning.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

5. Learning from mistakes

The organisation uses setbacks as learning opportunities and provide support to explore new things without fear of failing. Problems and setbacks are collectively handled and the result of the actions are critically reflected up on.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

6. Personal development
Opportunities for one's own development are given all members of the community. There are a diversity in methods, processes and systems were a variety in competence is appreciated.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

7. Reflection
A continuous search for learning opportunities are made in the organisations day-to-day operations.The organisation develops through competence in critical reflection, occasions to collectively ask questions and reflections are given on a regular basis.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

8. External exchange

Be conscious of how information is collected regarding the organisations surroundings. Those who have contact with external actors should learn from them and bring that information in to the organisation.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

9. Monitoring

Effort is made to establish key factors when an investment is made, it is then used to evaluate and discuss as a learning activity. Actions are then made based on such learning opportunities.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

10. Flexibility

The structures should be permissive, to enable schedules and role descriptions to be temporary and easily adapted to changes.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

11. Reward system
There is a flexibility in the reward system regarding both money and other alternative reward types.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much

12. Holistic perspective
Problems and solutions are seen as system related processes were there are connections between the units' goals and needs.

How important do you think it is to the organisation of AoA?

Not important	1	2	3	4	5	Very important

To what extent do you think it characterises the organisation of AoA?

Not at all	1	2	3	4	5	Very much