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MSc Wirtschaftsinformatik

Artificial Intelligence in Central Switzerland

Applied R&D Project - aF & E

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Accronym

AI artificial intelligence

DAI distributed artificial intelligence

ML machine learning

NLP natural language processing

Statutory declaration

We hereby declare that we have written or produced this work independently, without the assistance of third parties and using only the sources indicated.

In the early stages of the project, we were supported by Marcel Erismann, who went on to work on a separate project.

Location, Date: online, 22.06.2021

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Management Summary

Problem Switzerland is known for being an innovative country and it's not surprising that a lot of AI research is being done there. But when looking at the actual implementation of AI in companies, Switzerland is not a world leader. An AI hub could provide some place where research and economy could meet to push Switzerland's AI activity further and close the gap to more experienced countries. Commissioned by the HSLU, this report aims to evaluate whether Central Switzerland as a region would be suitable to host such a hub. Therefore, the research question asks for strengths and weaknesses of the region in terms of AI and evaluates the opportunities and threats of the same. Literature shows that in order for such hubs to work, a collaboration between research, business and government needs to be achieved. This report provides a basis for this by creating a better understanding about the perspective of executives towards AI.

Procedure In order to answer this research question, we firstly conducted a desk research that provided valuable insights into the topics of Artificial Intelligence and the region of Central Switzerland, respectively. After acquiring knowledge from the desk research, interviews were conducted with executives and research leaders located in the Central Swiss region. Through categorizing and coding the statements the interviews were analyzed. Lastly, the findings of the analysis were put into a bigger context and combined with the theory-based knowledge AI and Central Switzerland in order to answer the research question and draw recommendations.

Artificial Intelligence Artificial Intelligence enables machines to build and make use of knowledge through large volumes of data. Since its start in the midst of the 20th century, AI has become very versatile and finds application in many industries, e.g. fraud detection in finance, recognition of cancer cells in images in healthcare or speech-recognition in consumer goods. A well-known subset of AI is Machine Learning, which enables systems to learn through data and experience. It is further differentiated into supervised, unsupervised and reinforcement learning based on the input data. A further subset is deep learning which is used to deal with complex problems through large neural networks. Current research shows that the implementation and application of AI is getting better, faster and cheaper. This democratization and the differentiation of application possibilities make it highly unlikely that AI in general will find itself in a third AI winter. Nevertheless, more accessibility means more responsibility. Therefore, ethics and data privacy issues need to be addressed on an international level to prevent major implications in the growth of AI, i.e. through companies using AI that discriminates against certain social groups or companies using data to train an AI without telling the data owner what the AI will do.

Central Switzerland Research shows that despite their geographical proximity, the Central Swiss cantons differ strongly in their characteristics. As an example, both the poorest and richest canton in Switzerland find themselves part of the same region. Lucerne and Zug seem to hold a strong position when it comes to attracting the highest-grossing companies or biggest employers. There seem to be few big players present in the more rural cantons. What all cantons have in common is their low profit tax rates which may be an explanation for why 79 out of Switzerland's 500 highest-grossing companies are located in the region. As a region, there seems to be no single industry Central Switzerland is exceptionally strong in. Each canton's strengths get cancelled out by the other cantons' weaknesses when looking at the region as a whole.

Findings Among our interview partners, Machine Learning seems to be the most attractive application of Artificial Intelligence. Their reasons behind the adoption of AI can be categorized into two types: Concrete goal-based reasons like wanting to gain efficiency or needing AI to stay competitive. The other type of reason is vaguer and stems from companies wanting to put their gathered data to use or feeling the pressure to follow a trend without having a specific use case in mind. While following these goals and implementing their use cases, our partners identified several requirements. Cultural Change was mentioned by almost every executive as a topic that must be considered when implementing AI. Also, and especially in the case of machine learning, companies found that the ability to provide clean data is vital. However, especially SMEs seem to have problems with that. Naturally, external factors such as regulations, budgets and ethical concerns also prohibit the adoption of AI in certain industries. In terms of the process of adopting AI, our interview partners differed on whether they depended on external consultants or built their knowledge inhouse. Companies that were more experienced in the field of AI and/or considered it their core business

already have structured processes in place for adopting a new AI application. These types of companies also described clear visions regarding AI when looking into the future of their company and that they already had a plan to adapt their business model to be able to handle AI in the future. Less experienced companies know they would need to change, but they haven't yet integrated this fact in their strategy. In general, executives agree that AI will lead to benefits and make life easier in the future. Yet some raised concern about privacy and security issues that will need to be looked out for. Whether AI will grow exponentially or rather deflate is a question the executives did not agree on. In terms of location, most executives see AI as an international topic. Therefore, some of them don't see the location of their company having a specifically positive or negative impact on their business. But some of them do see it relevant when trying to find capable employees with suitable qualifications and experience in AI. They mostly look for people that combine the latest AI knowledge with domain expertise and soft skills such as open-mindedness. Our interview partners agreed that the competition for this talent is fierce and while some see a few talents rising in Central Switzerland, most still look for these talents near Zurich and thus prefer a location in proximity to that canton. Among our interview partners, universities are not only seen as educators for future employees but also as valuable network partners when starting an AI project. It also seemed as though the location of our partners' network depended on where they got their education. Most executives were very happy with their network and said they wouldn't know where to look if they needed to extend it in another region, like for example in Central Switzerland. Most executives didn't talk about politics, which implies that it does not seem to have a big impact on their business. However, it was evident that in certain cases some cantons seem to get more political support than others.

Discussion. The study finds that AI influences all industries in the region of Central Switzerland in a positive way and that Central Switzerland seems to be an attractive region economically due to low profit taxes and low unemployment. Know-how and use cases are available in the region and AI is becoming more and more popular and accessible. But companies looking to adopt AI need guidance and they said they don't know where to find that guidance within the region. The region is missing a way to connect supply and demand. A closer proximity to Zurich was seen by many executives as an advantage since Zurich is thought to have the most well-educated AI talents. However, a rise in talent within the region of Central Switzerland was identified by some interview partners, which may lead to more accessibility in AI talents for companies in more rural or less connected areas.

Recommendations. The strategic decision to build a well-connected AI community or cluster in the region would certainly help the region to take advantage of its strengths and to seize the opportunities AI provides and will continue to provide in the future. With regards to Central Switzerland's diverse economic and political landscape, a single city would be a better hub since it would be more accessible and understandable than an entire region. However, such initiatives already exist in different forms within the region. Therefore, further research is needed to evaluate the existing initiatives and evaluate the possibility of a merger or a niche. Also, the importance of Zurich as a tech hub should be researched further as that was not part of this study but Zurich has been mentioned frequently as an influence on AI players. For education institutions, such as the HSLU, it is important to recognize that talent is needed in the region but that domain experience and soft skills are just as important as having the latest knowledge of AI.

1 Introduction

The regional study is conducted as part of the Master of Science program in Business Informatics at Hochschule Luzern by four students. It is commissioned by Dr. Donnacha Daly, Head of AI and Machine Learning at Hochschule Luzern.

Over the last half-century AI has developed continuously and became the technology of the future. Especially over the last decade a remarkable progress and evolution can be observed. It can be said that AI can potentially alter the life of every human being and impact almost every area of life. Already nowadays, it is hard to imagine a life without AI. For example AI related technologies that guide everyone customized through the vastness and tangle of the internet or assistance devices in the car that can save our lives. Or automation through AI, that constantly changes the content of our jobs. In view of the fast-paced development of AI and its significant leverage, it is crucial to take a closer look at the technology and the regional activities regarding that technology.

Although a lot of research is being done in the field of AI, not much can be found about the perspective of executives, who are increasingly facing AI related challenges. Especially with regard to qualitative collected data through interviews. While studies have proven that gathering qualitative data provides a sound understanding of regional AI clusters [6]. Also little regional data can be discovered about AI in Central Switzerland and its ecosystem. However, the authors agree that it will be critical in the future for every executive and also entire institutions to enhance their knowledge about the AI ecosystem in which they find themselves in. This enables them to proactively help to shape the future of their own industry and the inevitable AI transformation.

The purpose of this regional AI study is to examine the effect of AI on organizations in Central Switzerland. It provides insights into whether AI is already being used and if yes, how are the results and how does the process of adopting it look like. Further, the aim is to support the understanding of the perspective of locally based executives and their perception towards Central Switzerland as a region and its state in terms of AI. Another objective is to explain how executives obtain AI expertise and how they characterize future AI experts. At a higher level, the study shows strengths and weaknesses as well as the opportunities and threats to the economy of Central Switzerland related to AI. It should also encourage executives, associations and unions to join forces and corporate within the ecosystem and across industries.

This regional study focuses on the geographical region of Central Switzerland. The rest of Switzerland is not taken into account. Further, interviews have been executed in the following industries: Tech, Energy, Insurance, Publishing, Research, Healthcare, Network Platform, Manufacturing, IT and Engineering.

This regional study includes the following deliverables:

- Overview of the subject AI
- PESTEL analysis of Central Switzerland
- Analysis of the conducted interviews
- Findings and conclusions for the regional fit in terms of AI

The above mentioned deliverables are developed within the following document structure: Firstly, an overview of related literature and the scientific research gap is addressed. Secondly, the research questions and design are defined. The introduction of the two subjects AI and Central Switzerland follows to build a theoretical base. Based on the two subjects the results of the interviews are presented. Lastly, the findings and conclusion of the regional AI study are introduced.

2 Literature Overview

In this chapter, the current state of regional AI studies and a debate within existing AI literature will be elaborated. First, the methodical search and selection procedure of the literature is explained. Subsequently, based on the current scientific basis, the Regional AI Reports and their Research Subjects are introduced. Finally, the commonalities and differences of the literature and the identified research gap of this paper will be addressed.

2.1 Search and Selection Procedure

At the beginning, the following keywords have been defined for the search procedure:

Regional AI Report, AI Hub Report, AI Ecosystem Report, Local AI Report, City AI Report, AI Tribes Reports, AI Cluster Study, Regional AI Study, AI Hub Study, AI Ecosystem Study, Local AI Study, City AI Study, AI Tribes Study and AI Cluster Study.

Using the defined keywords, a detailed search was conducted in the search engines Google Scholar, Microsoft Academic, Web of Science and Scopus. In a second step, the search was extended to the following specific publishers: AIS, ACM, IEEE, Elsevier, Springer and Wiley Blackwell. Further, the content of journals BISE, MISQ, ISR, JMIS, JAIS, ISJ, EJIS, JIT, JSIS, HMD, WUM, Industrie Management, and IM+io, as well as conferences such as WI, MKWI, ICIS, HICSS, ECIS, and AMCIS were reviewed. This resulted in the identification of 15 potentially relevant documents. The literature was evaluated for its citation eligibility, citation worthiness, and relevance. Based on the defined selection criteria, the documents were selected and evaluated.

2.2 Regional AI Reports and their Results

The evaluated reports have significant differences in terms of their research subjects. Eight reports focus on actual AI related ecosystems and provide insights into specific geographical regions. For instance, Arenal et al. evaluate the status of China's AI innovation. It shows a complex and evolving AI landscape. The authors have developed a theoretical framework and applied it from a descriptive and qualitative perspective to the AI ecosystem in China. The study shows that AI technologies have already a strong impact on daily activities and describes a picture of deep economic and social change. The situation how regulations and market forces are combined can not be compared to the EU or the US. It shows that China is able with its government power to mobilize resources of the entire technology sector and the final consumers like no democratic country can. Further, it allows the country to strictly pursue a long-term vision also in term of AI, which is not influenced by any political cycle [6]. Stix presents a survey of the EU's AI ecosystem and provides insight to a number of initiatives, that are related to the promotion of young ICT talents and the entire digital sector. Nevertheless, the author shows rising concerns within the EU over brain drain and the loss of influential and promising AI companies through acquisitions. In summary talent creation provides a strong baseline, however brain drains remains a serious issue of the EU [128].

Turnika reviewed Montreal's AI cluster and provides a conceptual framework and the role of the fastest growing firm Element AI. The authors mentioned the intra-firm networking as one of the key success factors of the company Element AI. The company has a faculty fellow network composed of over 20 world-renowned AI scientists. These scientist do not only research, they also provide valuable advice on client-oriented projects and enables the company to remain at the forefront of AI science. Further, AI Element benefits from positive spillovers from agglomerations and therefore from the density and quality of the local AI ecosystem in Montreal. So the local and national embeddedness is crucial for an AI driven company, however international networks are a critical success factor as well. It can be observed, that over time local communities are subject to isomorphism what makes international networks and important driver for new ideas and innovation [142]. While the International Institute of Communications in London has examined the regional cluster of Asia Pacific and its diverse countries. China, Singapore and South Korea putting much effort in building AI ecosystems in order to offer an excellent environment for companies and innovation models related to AI can grow. In Malaysia, Indonesia and Thailand plenty of new initiatives, which combine private and public are under development. The target of the initiatives is to facilitate experimental AI that goes beyond economical profit [58]. Konstadulakis and Celac have as well worked on several countries and offer a brief overview of the leading AI clusters around the globe. The authors identify the US, China, the UK, France, Germany, Canada, Israel, Singapore, Seoul and Tokyo as leading AI clusters. It is explained that there is a growing global war for

talent within the AI clusters. The demand for AI-related roles has more than doubled over the last three year. Another common challenge is the availability of quality data and the current computational power, which is often insufficient in complex applications like deep learning. Further, the authors see the following factors as the ultimate challenges for an AI-driven society: Ethics, regulations, acceptability and implementation [73]. Whereas Queiroz et al. expended their scope of research and explored inter-regional Digital Innovation Hubs (DIH) around the world and their current states. Based on the report, DIHs are a good instrument to make use of digital opportunities. Not only big and high-tech companies benefit from DIHs also small and middle size companies, which are still at the beginning of their technological development. It evolves, innovates and increases the global competitiveness of companies [107]. The European Commission Joint Research Centre conducted a survey among DIH managers and regional policy managers working with Smart Specialisation Strategies in the entire EU. It provides an insight of the different maturity level of the different DIHs. Additionally, a case study analysis of six DIHs was done. The survey has shown that the DIHs share an overall pattern in digital competitiveness and maturity across sectors. It also shown that focus topics of policy programs do not always correlate with the perception of local executives. The authors suggest that it may be useful to formulate policy based on challenges, which can be addressed with technologies rather than just look at technologies itself. The survey also shows that in the most DIHs the digital maturity of the public sector is significantly lagging behind [35]. One brief report on the Swiss AI Hub from Switzerland Global Enterprise cloud be identified. According to the report Switzerland has the highest number of AI patents per inhabitants in the world. This highlights the AI innovation potential within the region. It also points out that companies located in Switzerland benefit from efficient technology transfer, sustainable software systems and non-bureaucratic assistance from the cantons and government. [134].

Two reports describe the economic factors of AI and their implications on industries. Buchanan researches the finance sector and comes to the conclusion that AI is just at the beginning in the finance industry. However, AI will gain much more importance in the coming years what brings more challenges related to the topic as well. The author identifies for example ethical, economic and social obstacles. AI will transform the finance industry into a much more complex ecosystem and therefore the paper describes an increasing demand for more education on AI literacy and awareness [10]. Deloitte provides information about the global AI-Industries itself. Based on the report, AI is rising from a commercial point of view and alters every industry. The further development of AI will be highly depend on the specific integration of the key technologies in the industries. It can be discovered that AI leading institutions prefer to invest into more basic AI technologies and easy-to-deploy applications. The report points out the importance of cities as drivers when it comes to innovation, integration and application of AI technologies. Cities are seen as meeting point and center where people build up their experience with AI technologies [22].

Three reports give a global picture of the AI Situation. Jansen provides a socio-economic impact assessment (SEIA) in order to examine the current and future influence of AI and robotics. The research has been conducted with the help of desk research, interviews and commentaries on drafts of the report by field experts. The assessment has identified a wide range of social, environmental and economic impacts caused by AI and robotics. The influences are diverse and go from very negative to very positive. For example from autonomous weapon systems to medical diagnostic applications. Based on this, the report suggests the implementation of regulation and other mitigation measures to counteract the current and future negative impact. It draws a special attention to social costs such as job losses due to AI and robotic technologies. These negative impacts need particular effort to be reduced. Further, the report detected educating people about the negative and positive impacts of AI and robotics can have a positive influence on the acceptance on the same what reduces the social strife like isolation and disaffection [59]. The AI Index Report 2021 from the University of Stanford provides detailed and state of the art insights to the complex field of AI. It aims to give unbiased, rigorously vetted, and globally sourced data for policymakers, researchers, executives, journalists, and the general public. It shows that AI investments in drug design and discovery increased significantly and the rising importance of AI in the industry. Also Image classification, face recognition, video analysis and voice identification experienced a remarkable progress in 2020, what makes surveillance technologies fast, cheap and more and more ubiquitous. AI ethics remains an important issue and still lacks benchmarks and consensus. A couple of groups provide qualitative or normative content in the ethic domain, however there is still a lack of benchmarks that can measure or assess the connection between broader societal discussions about the AI development and the technology itself [151]. McKinsey explains the benefits of automation and AI and the four most important practices that are the basic of successful automation. First of all, it is crucial to continuous assess opportunities, and once you take the opportunity you need to move early. Secondly, the right balance of quick tactical wins and long-term visions need to be applied. Thirdly, processes need to be redefined from a end-to-end perspective and organizational changes need to be managed accordingly. Lastly,

technologies such as AI need to be integrated into the core business functions, what will set the basic for continuous improvement and competitive advantage [87].

The Government AI Readiness Index analyzes Governments and their readiness to use AI. The Index comes to the conclusion that the majority of the world's government are at the initial phase of using AI within the public services. The authors believe that understanding the readiness of using AI will be the key in order to implement AI. Therefore, the Index describes gaps and strengths to understand the corresponding readiness situation and improve it accordingly [121]. Dutton pictures in the report Building an AI World the strategic AI priorities for policymakers, businesses, and civil society actors. The authors have analyzed 18 national AI strategies. It can be said that every strategy is unique and pursues a different objective and the strategic priorities vary explicitly. However, industrialization is the top priority for 8 of the 18 national strategies. Another 7 describe scientific research as a top priority [26].

2.3 Commonalities of the Literature

12 out of the 15 reports collected secondary data and conducted desk research on the same. Concluding that the mentioned research method can be considered the favored one for AI reports. Only three reports are mainly based on primary data, which were collected through interviews. The theoretical foundations and importance of AI are acknowledged by all reports, however, the comparison of the concrete contents is limited due to the diverse research subjects and objectives.

2.4 Differences of the Literature

From a Swiss perspective, there are discrepancies if we take a look at the global role, that Switzerland takes on in the AI-World. The AI Index Report 2021 from Stanford University, that aims to be the world's most credible and authoritative source for data and insights about AI, accredits the importance of Switzerland in the various rankings. For example number four in peer-reviewed AI publications field-weighted citation impact, that implies that much AI relevant research is being done in Switzerland. Also in the rank of relative AI skill penetration in the field of education from 2015 to 2020, Switzerland occupies rank number five [151]. However, the Global AI industry whitepaper from Deloitte does not even mention Switzerland or a Swiss city hub in the context of AI Innovation. For example in the top 50 of global high-growth AI enterprises only companies from the US, India, China, Japan, and the UK are represented. As global hubs of AI innovation, integration and application the following cities are identified: San Francisco Bay Area, Toronto, New York, Boston, Los Angeles, Dallas, Montreal, Dublin, London, Paris, Amsterdam, Stockholm, Berlin, Tel Aviv, Singapore, Shenzhen, Beijing, Shanghai, Tokyo and Sidney [22]. Rankings mostly based on different data sources, what makes reports more challenging to compare. Nevertheless, the focus on the big two USA and China followed by a various selected and diverse pairing of further countries and hubs can be observed.

2.5 Debate and Research Gap

Although Switzerland occupies top positions in the research of AI, only a few specialized AI programs can be found on Master level in 2019 and 2020 and therefore far behind countries such as the US, the UK, Australia or Canada. These countries provide already on Bachelor level plenty of courses in the field of AI. If we take a closer look at the content, it is shown that Robotics and Automation are the main topics on Bachelor's as well as on Master's level. However, where are the second focus on Master's level Machine Learning is, is it more AI applications and ethics on Bachelor's level [151]. This leads to the conclusion that Switzerland is able to attract foreign researchers. As the current Swiss educational programs creates only a small number of talents. If we take a look at the Global AI industry whitepaper from Deloitte it draws a picture, that other countries developing powerful AI hubs, which are possibly will attract talents all over the world [22]. Therefore, these hubs will be in direct competition with Switzerland's research institutions and companies to hire talents. Also Konstadulakis and Celac have discovered a growing global war for talent within the AI clusters [73]. Moreover, the AI Index Report 2021 shows that AI talents in Switzerland are currently mainly in the field of research, but if we follow the general trend of AI, we know that the demand for talents in industries will increase drastically [151]. To this comes an increasing threat also for Switzerland of brain drain as from Stix already pointed out. The author mentioned it as a remaining serious issue of the EU [128].

This poses a tremendous challenge for Switzerland that has obviously not yet been recognized at all levels.

If this complex situation is underestimated or hardly taken into account as a whole, it can be assumed that Switzerland will lose ground in terms of prosperity and security. The authors of this report believe therefore that there is an urgent need for coordination between research, business and government and that Switzerland as a whole must proactively react to the changing environment. This will not be done just with a strategy paper. Rather, all stakeholders down to each SME must actively be involved in this process. For this reason, this report intends to address the perspective of executives and examines the affect of AI on organizations. It aims support the understanding of challenges, successes and concerns of Swiss based executives and the implications for their institutions and companies. This should also enhance the mutual understanding and encourage executives and associations to cooperate within the ecosystem. What also the The latter has proven to be key to successfully master AI and transform it from a threat to a incredible opportunity for the entire society as the review on Montreal's AI hub states [58].

Arenal et al. highlight the advantage of a qualitative approach in order to address the complexity of innovation ecosystems, particularly when the availability and reliability of statistical data is difficult [6]. However, in regards to the selected reports a lack of qualitative data, especially from industry executives can be identified. If we take a look at the current Swiss AI situation, there could be one brief report observed with quantitative data about the Swiss AI Hub [134]. For that reason we identify a research gap on the one hand for qualitative interview data directly form the industry and on the other hand for a regionally delimited study within Switzerland. Therefore, the regional study is limited to the geographical region of Central Switzerland with its six cantons and the data will be collected through qualitative interviews with executives within the targeted region.

3 Research Questions and Research Design

This regional industry study puts its focus on Central Switzerland and attempts to draw a bigger picture of the region in terms of AI usage, research and education. Therefore, this study examines the possible overlap between the two separate research objects "AI" and "Central Switzerland". This is done by answering one superior research question (Q1) which can be further divided in a question focusing on AI (Q1a) and the other focusing on the region of Central Switzerland (Q1b).

Q1: What are the strengths and weaknesses as well as the opportunities and threats to the economy of Central Switzerland related to AI?

> Q1a: How does AI influence different industry players and R&D institutions in Central Switzerland?
>
> Q1b: What is the perception of regional industry players and R&D institutions towards Central Switzerland in terms of AI?

These research questions being the first of their kind answered for the region of Central Switzerland open up opportunities for future research and might imply actions for institutions and economic players in the region. On a strategic level, this study also includes recommendations from the authors' point of view in chapter 7 regarding a regional AI strategy and necessary future actions to thrive the AI ecosystem in Central Switzerland.

3.1 Scope and Limitations

This study does not allow to answer the research questions in any statistically significant way. Conclusions rely only on the conducted interviews and the qualitative data sample and do not represent the opinion of a whole industry or region.

3.2 Research Design

The following research design describes the procedure chosen to adequately address the research question. The categorization of the study design is followed by a description of the execution of the research work. Subsequently, the chosen research methods are explained.

3.2.1 Description of Research Design

There needs to be data in order to answer the research questions. As the research questions show a strong practical orientation and focus on a very specified geographical area, there is little data available. This prevents the authors from doing a secondary analysis of existing data. Therefore, this study collects new data and does a primary analysis of the latter. The research questions are formulated openly and put practitioners with real life experience in several industry sectors in the center of interest. As the literature overview shows, the study hereby addresses an existing research gap. Because of the openly formulated research questions and the novelty of the gathered data regarding Switzerland, this research follows a exploratory-qualitative approach. This study is intended to serve as a basis for theory building and further quantitative research in the future.

3.2.2 Categorization

The following table 1 shows the selected variants of each research design characteristic along with a reasoning of its choice.

Characteristic of the Research Design	**Selected Variant**	**Reason**
Scientific theoretical approach	Qualitative study	Open research questions, targeted data gathering, interpretative data analysis, theory formation
Object of study	Empirical study	Independent data collection and analysis
Data basis	Primary analysis	Analysis of newly collected data
Interest in knowledge	Explorative study	Independent data collection for theory formation and hypothesising of following quantitative studies
Screening site	Field study	Data collection happens in the real world with real world economic players
Amount of research objects	Group study	16 single interviews

Table 1: Categorization of the research design including the selected variant and the associated reason.

3.2.3 Graphical illustration of the process

Figure 1 shows the most important steps of the conducted research. The process can be divided in three main parts: The theoretical part, the practical part regarding data gathering and an analysis part, where all the information is combined and conclusions are drawn. Not each step has to be fully finished before starting the next one, as feedback is incorporated several times between the authors themselves and third parties. The writing of the present study is ongoing during the research process and done step by step as soon as new information is found or received.

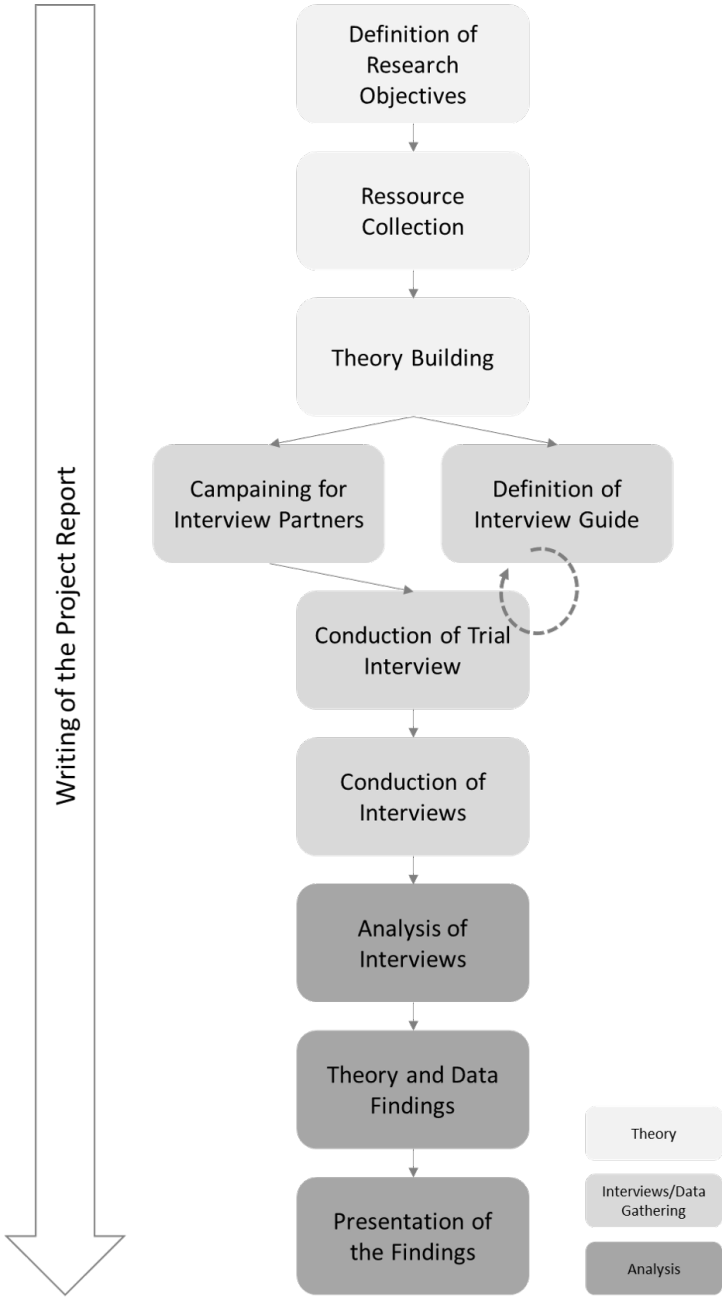

Figure 1: Graphical illustration of the complete research process.

3.2.4 Methodology

The outlined research gap shows a need for qualitative data, which is gathered by conducting expert interviews. The data should cover several aspects of the usage of AI and the perception of Central Switzerland in terms of AI usage. Therefore, the interview partners are rather homogeneous in their role and function in industries, but heterogeneous regarding their specialty. Expert interviews allow for deep insights and open up possibilities to ask detailed questions, consider the reactions of the interview partner during the interview and give the interviewed person the chance to highlight their personal experience and point of views regarding the topic [25].

3.2.5 Sampling

In order to understand what the economy of Central Switzerland is doing regarding AI, economic players in the region are interviewed. As this research aims to focus on a strictly defined, narrow region, only economic players which are based in the region of Central Switzerland are taken into account. This study has no focus on one special industry, but rather on various aspects of the region in terms of AI. Therefore, participants of the interview are involved in several industries namely tech, energy, insurance, publishing, research, healthcare, network platform, public administration, IT engineering or manufacturing. The interview partners are mainly decision makers on a C-Level, as it is crucial to the study to gain insights about strength and weaknesses, potentials and threats in terms of AI usage for the economic players. In exceptional cases, the interview partners are not in a C-Level role, but have high technical expertise and experience in their industry regarding AI or were directly involved in a successful implementation of an AI solution on a large scale. Interview partners are found in the network of the participants of this study or independently acquired via LinkedIn[1] for certain industries, when there was no applicable interview partner in the existing network. The detailed list of interview partners is shown in table 6. Invites to participate in the interview are sent between 19th and 30th of April including one reminder. The interviews were held between end of April and in the first two weeks of May 2021.

Semi-standardized interviews The interviews are semi-standardized to improve flexibility and broadness of the data. The interviews take about 45 minutes but with the possibility to take longer, if the interview partner is willing to give more information. There are no more questions answered in longer interviews, but longer answers are accepted for each question.

Interview Set Up The participants are invited to the interview by email. The emails include a short list of the interview questions (appendix A) as well as a one pager explaining the project goals and presenting the project team (appendix B). The interview partners can choose, whether they want to do the interview online or in person. Due to efficiency reasons and because of the influence of the ongoing Covid-19 pandemic, the majority of the interviews is held online via MS Teams or Zoom. Whenever possible, two of the project team members participate in an interview, whereas one is in the lead asking the questions and the other focuses on note taking and general conditions, such as time keeping.

Transcription In accordance with the project supervisors, the transcription of the interviews is done mainly based on the notes taken during the interview. To exclude errors and biases, the notes are compared and if applicable complemented with the content of the recording of the interview. As C-level experts are targeted for interview partners the confidentiality level is substantially high. As a result, this study focuses on presenting the findings and does not include a word by word transcript of the interviews. These have been provided separately to the Thesis Supervisor for review purposes, but will not be made available more generally.

Data analysis Because of the exploratory-qualitative approach of this study, the data is analysed using a qualitative method of category building. Overall the goal is to interpret the data in relation to the economical and social context by interpreting both, the obvious and the hidden content of the obtained data [25, pp. 357-359]. The analysis includes the following steps which are the central elements of all qualitative data analysis [25, pp. 603f.]:

- Case related evaluation
- Segmentation and Analysis
- Coding
- Categorization

As all authors conducted at least one interview, close exchange of the contents of the data was essential to ensure a holistic view of the data. Therefore, group discussion between the authors took place after each step. In the **case related evaluation** one interview represents one case. The interviews are viewed sequentially,

[1] https://www.linkedin.com

one after the other by the responsible interview lead. In this process, an initial rough understanding of the obtained data is developed. The following **segmentation and analysis** divides the interviews in logical text units. For this step, the interview short list serves as a basis to find similar logical text units to analyse in each interview. When the interview partner talked about use cases, each mentioned use case represents one logical text unit. Each unit of analysis is examined in terms of its content and formal characteristics. This allows to find superior key words or examples the unit of analysis represents. All steps of this process happen with a strong focus on the research questions. Afterwards, the **coding** takes place. Each unit of analysis is assigned a code. Corresponding to the example above, one text unit describing one use case gets a code like "Supervised Learning". The last step, the **categorization**, groups the outlined codes into into thematic content areas.

The outcome of these steps is shown in appendix C, which includes all categories, codes and the corresponding text units.

Because of the iterative process and the inductive derivation of codes and categories, the procedure represents a qualitative content analysis according to Mayring [89, pp. 498f.]. The iterative examination of the interviews ensures that meaningful categories are build, which allow for a targeted answering of the research questions. In addition, interrelationships become visible and codes and superior categories can be linked with each other.

4 Artificial Intelligence

This chapter provides an in-depth overview of AI, which includes a definition of the term AI, a brief look at the history of AI, as well as an exemplary description of AI use cases. Additionally, technological background knowledge of AI is outlined. The chapter concludes with a look at the future of AI and a summary of the most important aspects after considering ethical aspects of AI.

4.1 Definition and Overview of AI

Concepts of AI are part of people's daily life, sometimes without the awareness of the user. Speech recognition, facial recognition to unlock a phone or spell checkers and wording suggestions while texting are some AI features which are present in day to day life. The topic of AI is very broad. Understanding the term AI is essential for the further work on the influences AI has on industries in Central Switzerland.

4.1.1 Definition of Intelligence

In a recent paper from April 2021, Melanie Mitchell wrote that the ability of AI to imitate or reflect human intelligence is often overestimated, resulting in a loss of trust towards its potential (see AI Winters in chapter 4.2)[91]. The reason for this overestimation lies in the fact that the complexity of human intelligence is often underestimated. It is therefore essential to first understand the definition of human intelligence before understanding the definition of Artificial Intelligence.

Intelligence has been defined in many ways. It can be considered as higher level skills, such as abstract thinking, mental representation, problem solving and decision making. Certainly the ability to learn, assimilate knowledge, plan ahead with an idea of the future, emotional knowledge, the ability to think creatively and adapt when necessary, to effectively meet the demands of the environment in the long run are all skills that require intelligence [118].
Another well-known definition comes from Robert Sternberg (1997). He defines intelligence as follows: "Intelligence is the ability to learn from experience and to adapt to, shape, and select environments." Thus, for many, the ability to learn from the environment and to reign in the environment with what one has learned is an important aspect of intelligence. Sternberg continues further:
"The mental abilities necessary for adaptation to, as well as shaping and selection of, any environmental context." [127] Legg & Hutter defined intelligence as "the ability of acquiring and applying knowledge and skills for resolving a specific problem." [82].

4.1.2 Definition of Artificial intelligence

The pervasive nature of AI and its constantly evolving commercial potential in diverse applications has steadily increased its popularity across numerous industries. The term "artificial intelligence" was coined in 1955 by John McCarthy, a Stanford professor [108]. John McCarthy, a founding father of AI, admitted that there is no solid definition of intelligence that denies the human factor since it is not possible to characterise intelligence in general as to what computational procedures can be distinguished as intelligent. However, he referred to AI as "the science and engineering of making intelligent machines" [92].
In order to fulfil the definition of AI, it is important for a system to possess certain capabilities, such as natural language processing NLP, knowledge representation, machine learning and automated reasoning [129].
NLP refers to a system's ability to communicate in a "natural language" by employing computational techniques, while knowledge representation requires it to possess and store knowledge in a memory [51], [129]. Additionally, machine learning refers to the ability of a system to learn from its natural environment, while automated reasoning refers to fulfilling reasoning capabilities on the basis of stored knowledge [60].
AI systems are capable of performing complex tasks in the absence of human supervision or minimal human intervention, for example, driving cars, performing surgeries and so forth [137].
Artificial intelligence further is a branch of computer science that deals with the automation of intelligent behavior and machine learning. The term is difficult to define, as there is already a lack of a precise definition of "intelligence". Nevertheless, it is used in research and development. Most often, artificial intelligence refers to an attempt to emulate certain decision-making structures of humans, for example, by building and programming a computer so that it can handle problems relatively independently. However, it is often also used

to refer to imitate intelligence, whereby "intelligent behavior" is to be simulated by mostly simple algorithms, for example in computer opponents in computer games [96]. The Term AI refers to any human-like intelligence exhibited by a computer, robot, or other kind of machine. The term originates in computer science and refers to the intelligence of a living being. In principle, AI refers to the ability of a computer or machine to mimic the capabilities of the human mind. Thus, the computer program should gather data and learn from examples and earn more and more experience, to develop even further and to solve more complex problems. The overall goal is for the machine to think and solve problems. It should make independent decisions from what it has learned. These capabilities require to learn from existing experiences and apply them in new situations to make a decision that otherwise only humans could make [57].
Another explanation of artificial intelligence refers to the simulation of intelligence in machines and robots that are programmed to understand and think like humans would and therefore to mimic their actions [40].

The authors aim to define AI in the context of this research as a common basis for the following interviews and the easier understanding for the reader:

Definition

Based on the definitions of Sternberg, Ruhl and Frankenfiel, as part of this work, we define AI in the context of this paper as follows:

A non-living system, which is independently able to learn and to process knowledge to make decisions towards achieving a goal. The decisions are data-based and mimic human thinking.

Although this definition sums up the general definitions of AI, it is also important to understand what AI is not. Mitchell (2021) lists four fallacies in how AI is talked about today that should always be taken into account when talking or reading about AI. The first fallacy includes seeing small successes in specific tasks as a step towards a general AI, when it's only a mere addition to a fixed set of separate skills that do not interconnect. Another fallacy is the assumption that it's hard to have an AI replicate a task that is hard for humans to execute and easy to have it replicate a task that is easy for humans to do. However it's easier to program an AI to solve a complex mathematical problem than to make a robot walk down the streets without bumping into other objects or people. The third fallacy refers to the way AI is being talked about. Oftentimes, the verbs used reflect cognitive action like read, listen, learn or understand. In reality however, AI does not execute these actions like us humans would interpret them, i.e. if an AI has "learned" something, it can oftentimes not apply this "learning" in any given context, but a human could. The fourth and final fallacy refers to the belief that all intelligence happens in the brain, so if an AI can replicate a brain, it can replicate human intelligence. Psychology research however shows that human intelligence cannot completely be separated from the rest of the body as they need to work together to have cognition [91].

Not being aware of these fallacies and their counter arguments can lead to irrational expectations of AI and unfulfilled promises, as the following chapter explaining the history of AI will show.

4.2 The History of AI

AI contributes to many of the latest discoveries and achievements in numerous research fields. The research field of AI exists just since the middle of the twentieths century. Some significant milestones are covered in Table 2 and the development of the different technologies are illustrated in Figure 2.

Table 2: Milestones in the development of AI

1931	The Austrian Kurt Gödel shows that in first-order predicate logic all true statements are derivable. In higher-order logics, on the other hand, there are true statements that are unprovable, which is described in Gödel's Incompleteness Theore.
1937	Alan Turing points out the limits of intelligent machines with the halting problem, which is the problem of determining, if a computer program with a certan input will finish running, or continue to run forever.
1943	McCulloch and Pitts model neural networks and make the connection to propositional logic since a neuron is kind of a logic gate.
1949	Donal Hebb describes the synaptic plasticity of learning neurons in his book The Organization of Behavior also known as Hebb's postulate [50].
1950	Alan Turing defines machine intelligence with the Turing test and writes about learning machines and genetic algorithms.
1951	Marvin Minsky develops a neural network machine. With 3000 vacuum tubes he simulates 40 neurons.
1955	Arthur Samuel (IBM) builds a learning checkers program that plays better than its developer.
1956	John McCarthy organizes a conference in Dartmouth College. Here the name Artificial Intelligence was first introduced.
1956	Newell and Simon of Carnegie Mellon University (CMU) present the Logic Theorist, the first symbol-processing computer program.
1958	McCarthy invents at MIT (Massachusetts Institute of Technology) the high-level language LISP. He writes programs that are capable of modifying themselves.
1958	Frank Rosenblatt publishes his paper about perceptron, which revolutionizes the supervised learning with its algorithm [117].
1959	Gelernter (IBM) builds the Geometry Theorem Prover.
1961	The General Problem Solver (GPS) by Newell and Simon imitates human thought.
1963	McCarthy founds the AI Lab at Stanford University.
1965	Robinson invents the resolution calculus for predicate logic.
1966	Weizenbaum's program Eliza carries out dialog with people in natural language.
1969	Minsky and Papert show in their book Perceptrons that the perceptron, a very simple neural network, can only represent linear functions.
1972	French scientist Alain Colmerauer invents the logic programming language PROLOG.
1972	British physician de Dombal develops an expert system for diagnosis of acute abdominal pain. It goes unnoticed in the mainstream AI community of the time.

Table 2: (continued)

1976	Shortliffe and Buchanan develop MYCIN, an expert system for diagnosis of infectious diseases, which is capable of dealing with uncertainty.
1981	Japan begins, at great expense, the "Fifth Generation Project" with the goal of building a powerful PROLOG machine.
1982	R1, the expert system for configuring computers, saves Digital Equipment Corporation 40 million dollars per year.
1986	Renaissance of neural networks through, among others, Rumelhart, Hinton and Sejnowski. The system Nettalk learns to read texts aloud.
1990	Pearl, Cheeseman, Whittaker, Spiegelhalter bring probability theory into AI with Bayesian networks. Multi-agent systems become popular.
1992	Tesauros TD-gammon program demonstrates the advantages of reinforcement learning.
1993	Worldwide RoboCup initiative to build soccer-playing autonomous robots.
1995	From statistical learning theory, Vapnik develops support vector machines, which are very important today.
1997	IBM's chess computer Deep Blue defeats the chess world champion Gary Kasparov.
1997	First international RoboCup competition in Japan.
2003	The robots in RoboCup demonstrate impressively what AI and robotics are capable of achieving.
2006	Service robotics becomes a major AI research area.
2009	First Google self-driving car drives on the California freeway.
2010	Autonomous robots begin to improve their behavior through learning.
2011	IBM's "Watson" beats two human champions on the television game show "Jeopardy!". Watson understands natural language and can answer difficult questions very quickly.
2015	Daimler premiers the first autonomous truck on the Autobahn.
2015	Google self-driving cars have driven over one million miles and operate within cities.
2015	Deep learning enables very good image classification.
2015	Paintings in the style of the Old Masters can be automatically generated with deep learning. AI becomes creative!
2016	The Go program AlphaGo by Google DeepMind beats the European champion 5:0 in January and Korean Lee Sedol, one of the world's best Go players, 4:1 in March. Deep learning techniques applied to pattern recognition, as well as reinforcement learning and Monte Carlo tree search lead to this success.
2017	The company DeepMind develops a self teaching AI based on reinforcement learning, which can teach it self the game Go from scratch and gets better than the best human Go player in 40 days [48].
2018	Google presents Duplex, supplementary to Google Assistant that is able to call on behalf of a user and execute tasks such as booking hair salon appointments [148].
2019	AutoML simplifies the use and setup of an AI system [43].
2020	AI solves protein folding and revolutionises one of the biggest challenges in biology [79].

Table 2 is inspired by [34].

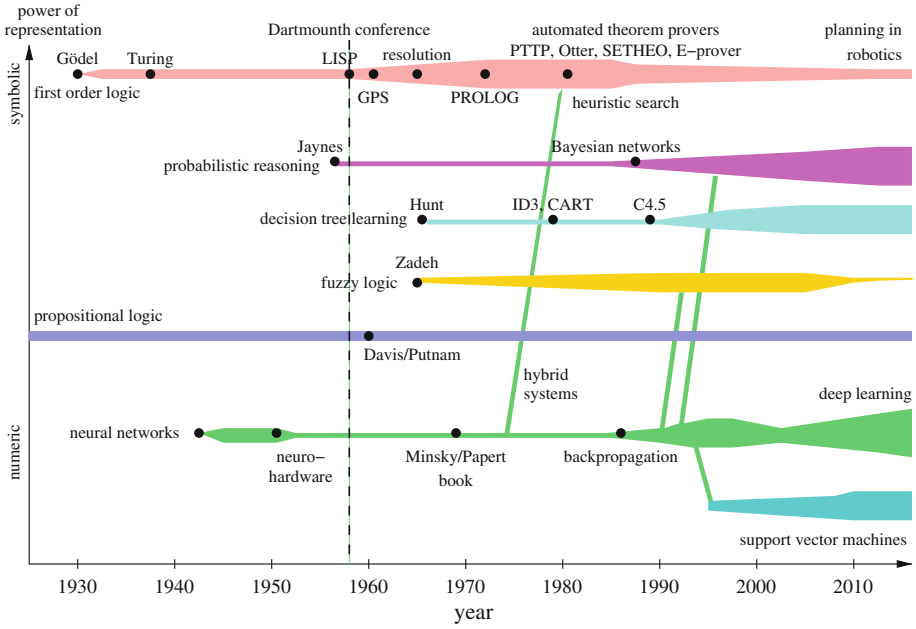

Figure 2: AI technology development since the beginning in the 1930's until today [34]

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The Birth of AI In the 1930's three researchers, Alan Turing, Kurt Gödel and Alonso Church, began with the logic and theoretical computer science. The completeness theorem and the incompleteness theorem from Gödel showed the limitations of the logic based concept. With the incompleteness theorem Gödel demonstrated that higher-order logics have an unprovable true statements. In the same time period Alan Turing accomplished the proof of the halting problem, which describes that no program can decide if it will run in an infinite loop or not [34].

Logic Based Problem Solving With the invention of programmable computers the practical use of AI was made possible. This happened in the 1950's, when Newell and Simon developed the first automatic theorem prover, the Logic Theorist, and enabled processing of symbols. Simultaneously, McCarthy invented the programming language LISP for the processing of symbolic formulated structures. At the historical Dartmouth Conference in 1956 these two major inventions were published [34]. For the first time the name Artificial Intelligence was used by John McCarthy, one of the pioneers of AI, at a conference in 1955. He roughly defined AI as:

> "Every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves"

Almost 20 years later the programming language PROLOG was introduced, which is also symbolic based like the LISP language from McCarthy. PROLOG had additional features, which allowed simpler and faster programming of more complex logic structures. Although PROLOG brought a performance improvement, the economic success of AI did not match the expectations. Use cases for this symbolic based AI were very limited trough the combinatorial growth of the search space. The consequence of this under performing logic based AI was a significant reduction in investments in the corresponding research field [34].

Connectionism With the introduction of more powerful computers, mathematical models of neural networks could learn from training examples and perform well in the area of pattern recognition. Soon after, the limitations of this successful and powerful subdiscipline of AI became obvious. Mostly it was not possible to convert the neural networks into formulas and logic rules. Also combinations of neural networks, logical rules or human expertise tend to fail [34].

Hybrid Systems There were many attempts to combine the strengths of logic, the ability to explicitly work with knowledge, and neural networks, which are great in handling uncertainty. One attempt was the usage of fuzzy logic, which is based on a logic system that can take any value between zero and one. Today fuzzy logic is used in the area of control engineering, even though the theoretical foundation still needs to be proven. The most successful attempt of combining logic and neural network was the hybrid system approach. There, the neural network reduces the vast search field heuristically for the searched proof [34].

Data Mining Since 1990, data mining has gained popularity, because more and more processes were digitized, which produced a lot of data. The aim of data mining is to extract hidden knowledge out of huge data sets. Data mining is applicable in every industry where data is generated in some sort [81].

Computing Power The need to solving problem complexity for AI is increasing. Therefore, distributed artificial intelligence, DAI, developed since 1985. One method is to parallelize the work load. It turned out, that the parallelization of highly dependent work load is less effective than an optimized "traditional" system. According to Moor's law the transistor density double every two years.

Another approach was the use of agents and robots, which performed just little tasks on their own, but clomerized they were able to solve complex work loads. Ants can serve as an analogy: An ant on its own can not achieve very much, but an entire colony is able to create a complex building structure [81].

The AI Revolution After researching neural networks for over 25 years, in 2010 the work of the scientists started to pay off. Very powerful neural networks do exist, which are often open source and trivial to set up for usage. One example is the image classification, which has a lot of use cases [81].

AI Winters Like the Gartner report says, every technology goes through different cycles, one of which is the depression cycle [42]. AI went through two depression cycles, where the economy lost the faith into this emerging technology. The first AI winter was the 1980's because of over ambitious promises, that after 8 years there would be machines with a human-like intelligence [97]. AI was clearly overestimated and could not hold up with the expectations.

After a successful time period with expert systems, which required proprietary hardware, the second AI winter arose. These expert systems were brittle, the software was difficult to update and expensive to maintain. Alternatively, desktop computer got better and finally outperformed the proprietary expert system hardware, which led to the downfall of the expert system in just one year [2].

Now the questions arises "is a third AI winter coming?". The authors of this document share the opinion that, as long as the reality can keep up with the expectations of society and economy, the there will be no third AI winter, which is comparable to the two AI winters before. This utopian scenario probably will not occur, especially not when taking the Gartner hype in consideration. Nevertheless, their will be no third comparable AI winter, because today, AI consists of numerous disciplines, which will all have their individual winter phase at a different time, see Figure 3 [36].

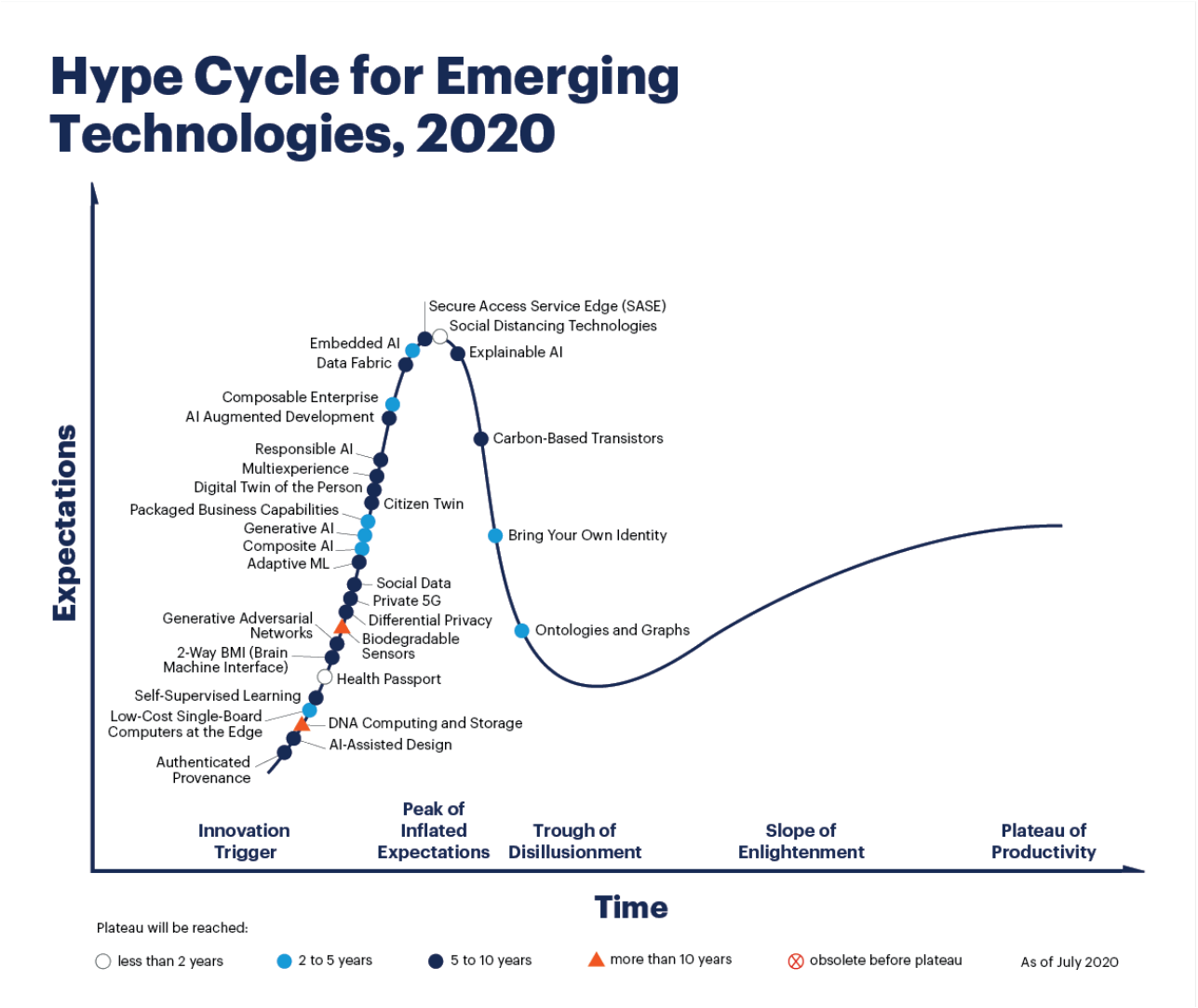


Figure 3: The Gartner Hype Cycle of emerging technologies shows in which time frame the listed technology will reach their plateau after an initial hype [42].

4.3 AI Use Cases

Some everyday examples have already been mentioned in which the use of AI takes place. Apart from private life, AI use cases and implementations are of high interest with regard to this study as it focuses on industry players and R&D institutions in Central Switzerland. An AI study conducted in 2020 in the European Union shows that robotic process automation, image recognition, text understanding and conversation agents are the most important use cases for AI in several industries [28]. The following compilation gives an overview of AI use cases that are already implemented today in certain industries. These examples are not final, but focus on the industries which seem to be important for the region of central Switzerland.

Manufacturing and Industrial In the manufacturing industry, the most common use case is predictive maintenance. The advanced analytic AI applies helps to determine the condition of, for example, a machine. Thus, the remaining useful life of an asset can be estimated and production downtime is eliminated.

Information Technology AI helps to detect and repel cyber threats. The network infrastructure is observed by an AI algortihm in real time analysing network traffic and endpoint detection and response [5].

Healthcare The healthcare sector provides a variety of AI use cases. In diagnostics, AI can analyse pictures to detect cancer cells. AI is even used to prevent major diseases such as obesity or at least facilitate its early detection to take countermeasures [105].

Consumer Goods and Services Every time consumers and companies interact with each other, there is a possible AI use case. A chat bot facilitates communication 24/7 and robo-advisors handle financial investments [93].

4.4 Different kinds of AI

In general Artificial intelligence and their applications falls under two broad categories. These are Weak AI and Strong AI. [37]

Weak AI This type of artificial intelligence is also called "Narrow AI" and works in a limited and well-defined task domain. It is a simulation of human intelligence on a specific use case. The focus is on a excellent execution of a defined task. The application shows little flexibility. Narrow AI is already widespread and integrated into our everyday life. At the present time it is a very successful realization of artificial intelligence. With a focus on performing specific tasks, Narrow AI has made numerous breakthroughs over the past decade and will be continually redistributed in a wide variety of applications [11].

Strong AI It is characterized by a general intelligence and can, similar to a human, apply this intelligence to solve a variety of different problems. It is constantly evolving and learning from the past. With the ability to adapt. With strong AI, machines can actually think and carry out tasks on their own. They can process and make independent decisions. Therefore strong AI has a complex algorithm that helps it act in different situations [27].

In the following, a few technical differences between the various categories of artificial intelligence will be discussed in more detail. Furthermore, different learning mechanisms will be discussed and the strengths and weaknesses of some learning methods and applications will be highlighted. The following figure 4 shows artificial intelligence with data-based machine learning at its core. Deep learning is understood as a sub-category of ML. The following chapter gives a differentiated view of the learning methods.

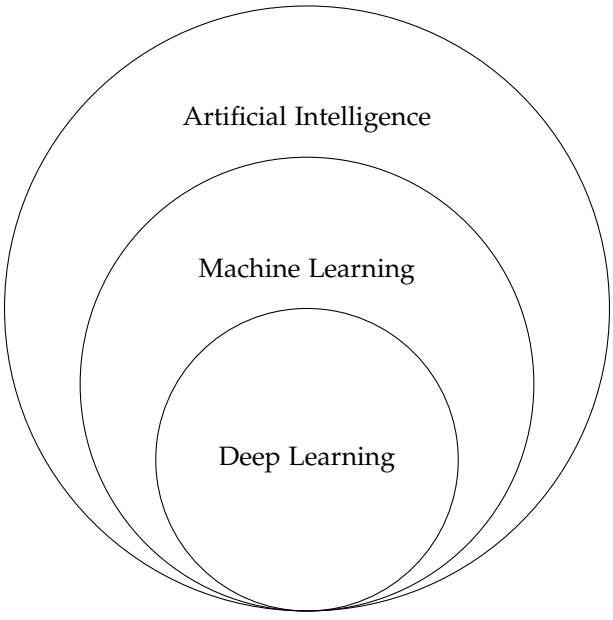


Figure 4: An overview of AI with the two subcategories Machine Learning and Deep Learning [116].

4.5 Machine Learning

The aim of this chapter is to present Machine Learning (ML) and its subcategories. There are three subcategories to distinguish: Supervised learning, unsupervised learning and reinforced learning, see Figure 5.

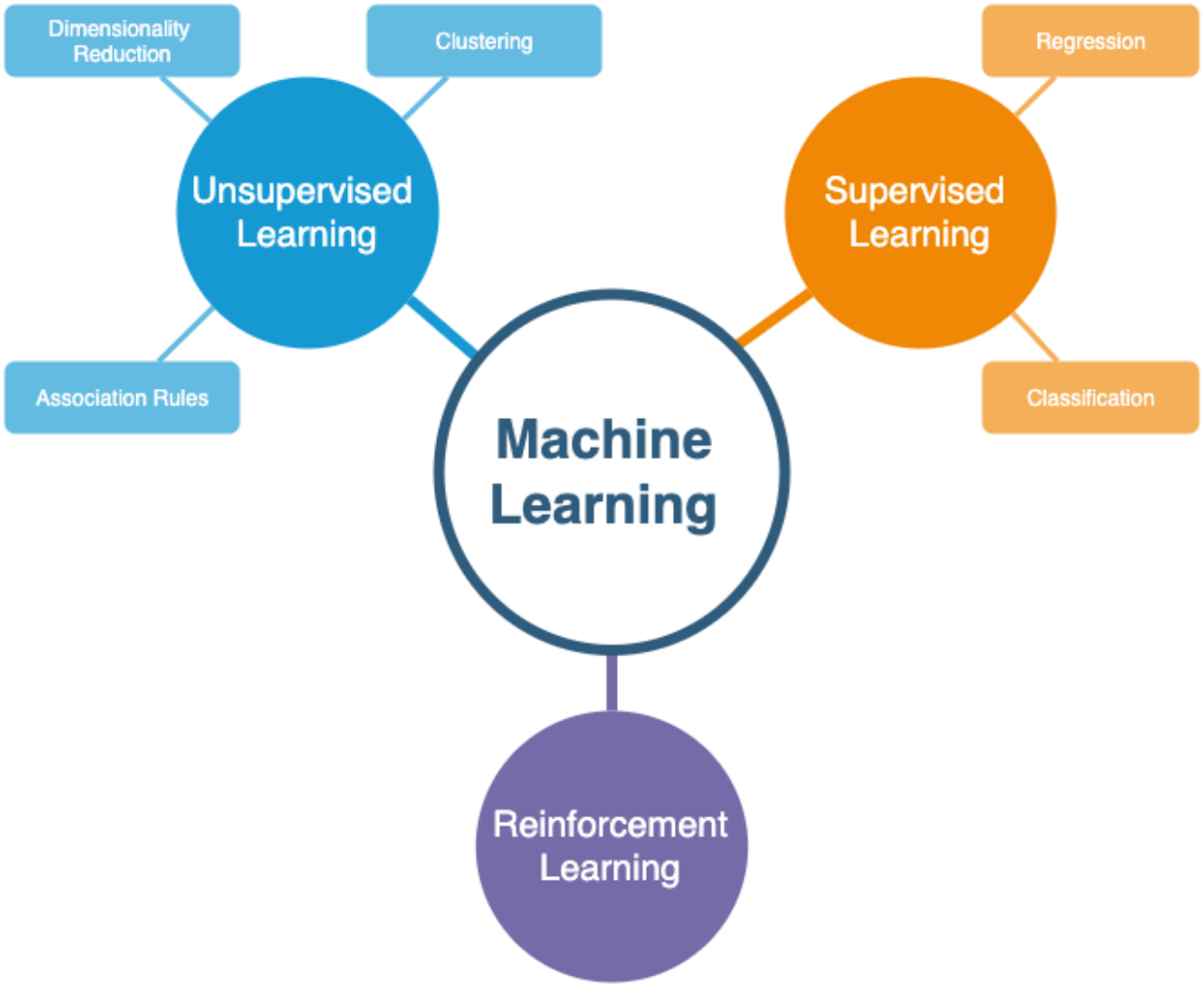


Figure 5: Overview of Machine Learning and its subcategories [18].

Machine learning is a generic term for the "artificial" generation of knowledge from experience. An artificial system learns from examples and can generalize these after the learning phase is complete. To do this, machine learning algorithms build a statistical model based on training data. This means that it does not simply learn the examples by heart, but recognizes patterns and regularities in the learning data. Thus, the system can also evaluate unknown data (learning transfer) or fail to learn unknown data (over fitting). From the wide spectrum of possible applications, the following may be mentioned: Automated diagnostic procedures, credit card fraud detection, stock market analysis, classification of nucleotide sequences, speech and text recognition (like Siri and Alexa), and autonomous systems [115].

The topic is closely related to "Knowledge Discovery in Databases" and "Data Mining", which, however, are mainly about finding new patterns and regularities. Many algorithms can be used for both purposes. Methods of "Knowledge Discovery in Databases" can be used to produce or preprocess learning data for "machine learning". In turn, machine learning algorithms find application in data mining. The term should also be distinguished from the term "deep learning", which is only one possible learning variant using artificial neural networks [101], see chapter 4.6.

4.5.1 Unsupervised Learning

Unsupervised learning refers to a method of ML in which the algorithm learns to recognize patterns and relationships in data in an exploratory manner independently and without supervision. Here, the input data is unlabeled and has no predefined target variable, i.e., the desired output data is not predefined. The two strongest areas of unsupervised learning are reducing data dimensionality and data clustering [3].

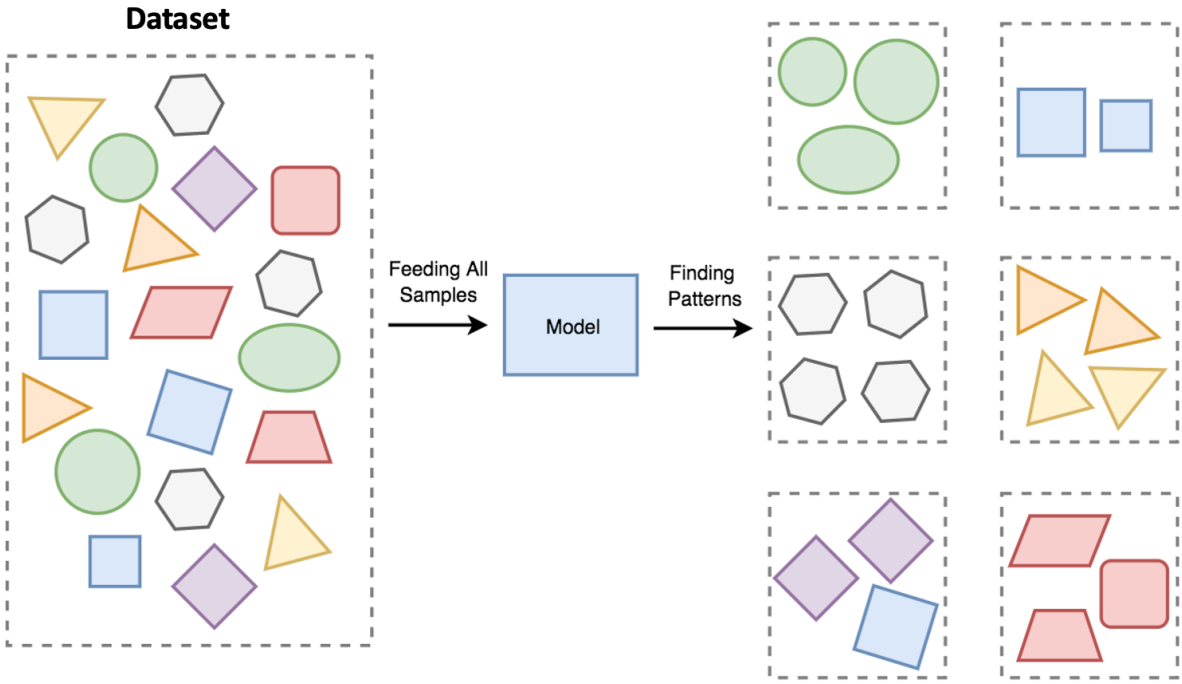


Figure 6: Example of the concept of unsupervised learning. All data is fed into the model and it independently generates an output based on the similarity between the samples and the algorithm used to create the model [75].

Pattern Recognition and Data Clustering As shown in the Figure 6, unstructured shapes with different shapes and colours are fed into the model. The model finds patterns and clusters the data accordingly into six groups [23].

Reducing Data Dimensionality Dimensionality reduction is about limiting the selection of variables present in the data to the essential and target variables. This method prevents the algorithm from learning only the specific patterns of the training data set (overfitted) and subsequently being unable to make any accurate statements about other data sets. Through this simplification of the model the computational time decreases by reducing the numbers of calculations for a classification, because there are fewer dimensions to choose from [76].

Association Rules Association analysis is concerned with finding strong rules in the data set that describe correlations between data points. E-Commerce basket analyses are mostly based on association analyses [147].

4.5.2 Supervised Learning

From a technical perspective, supervised algorithms primarily perform analytical tasks by using the training data and building contingent mapping functions of new attribute instances, see Figure 7. For example, in the medical field by the analysis of radiology images [72]. Since algorithms require prespecifications of desired

performance levels and outcomes, the training data set forms over two-thirds of the rationale at optimum computational time. The learning objective here is to minimise empirical risks with regularisation in cases where corresponding labels are already given for input and output attributes [17]. In other words, it allows the machine to generalise the responses so as to act accurately in contexts that are not present in the training data set. Supervised learning algorithms are further categorised into regression and classification algorithms.

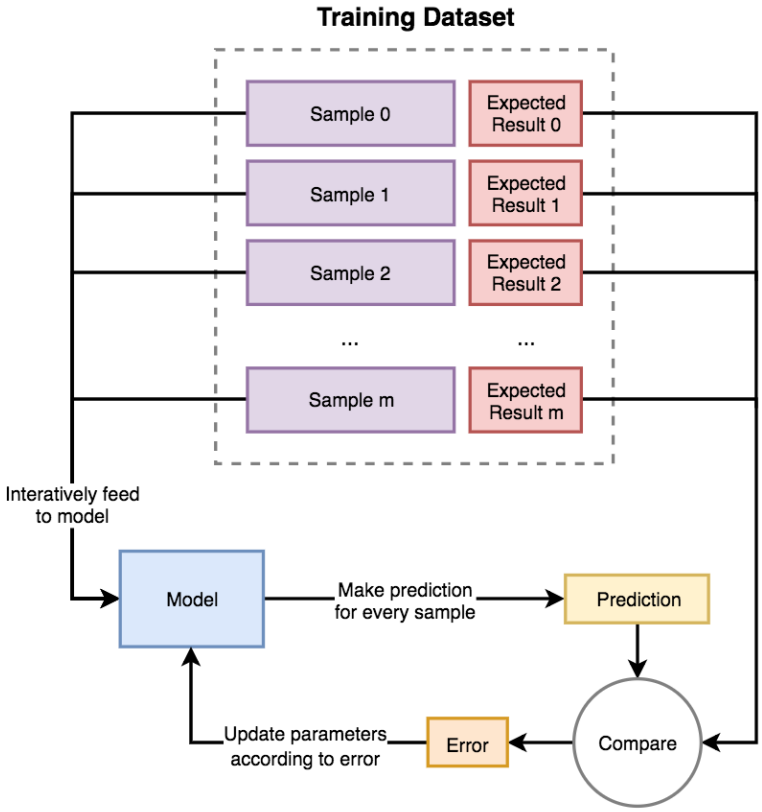


Figure 7: A schematic illustration of how Supervised Learning works [75].

Regression Regression analysis is a statistical method, which provides a connection between an independent and a dependent variable. There are several regression models with various amount of variables and different mathematical models, but all have the same purpose to analyze the effect of the independent variable on dependent variables[38]. An example of a linear regression can be seen in the Figure 8.

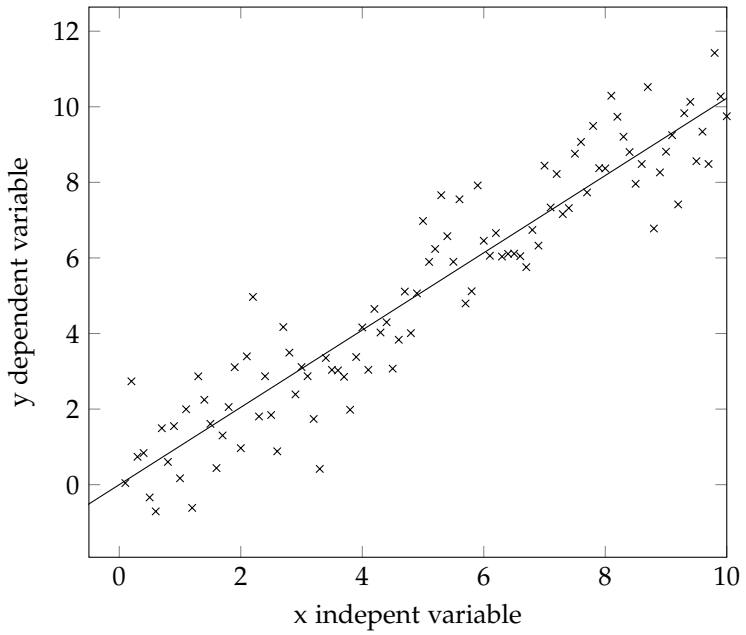


Figure 8: Here a linear regression is applied on to these data points.

Classification In classification inputs are assigned to a selection of predefined properties. For example, if we want to recognize objects in pictures, a selection of classes is determined beforehand to which the respective objects can be assigned. This could be for example "dog", "cat" and "mouse". But you could also let the program (based on other parameters) distinguish between "spam email" and "no spam email". Any input will be assigned to one of the classes. Important here: It will always come to a result, even if there is neither dog, cat nor mouse on a picture. Also, a classifier can only return a single result. In practice, it is therefore important to interpret the results correctly to find out how sure the system is with an answer [24].

Semi-supervised learning Semi-supervised machine learning uses both sample data with concrete target variables and unknown data and is thus a mixture of supervised and unsupervised learning. The application areas of semi-supervised learning are basically the same as for supervised learning [153].

The difference is that only a small amount of data with a known target variable is used for the learning process and a large amount where this target variable is not yet present. Especially in image or object recognition, semi-supervised learning finds application. Here, a small dataset of known (labeled) images is created, this is usually done by humans. Subsequently, for example, an artificial neural network is trained for classification and then applied to the rest of the data. This way, the sample data for the unknown data can be created much faster [147].

4.5.3 Reinforced Learning

Reinforcement learning deals with closed-loop problems in which the system's actions influence its inputs without informing the learner as to what actions should be taken, see Figure 9. Instead, the learner is left on its own to trial and error which particular actions result in the best rewards. The three significant distinguishing features of reinforcement learning are closed-loop, lack of direct instructions and lack of information about which actions are efficient in an extended period of time [136]. Additionally, reinforcement learning is also known as the third machine learning paradigm. Since machines are required to perform actions that were already tried out in the past, they are required to explore better selections, while simultaneously exploiting existing knowledge to generate rewards. Moreover, in this type of learning, a goal-seeking agent is allowed to interact with an uncertain environment by choosing actions that influence this environment. In cases where planning is essential, reinforcement learning requires a balance between real time action and planning selection to improve the environment model. One of the most important features of this type of learning is that it affects the future state of an environment. Reinforcement learning finds its applications in

neuroscience, psychology and engineering among others [130].

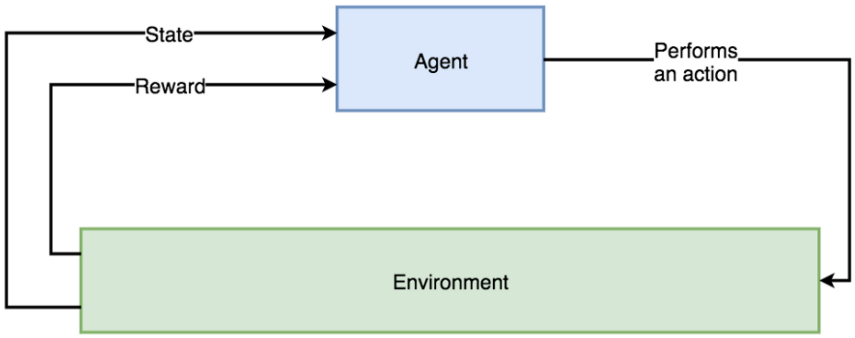


Figure 9: A schematic illustration of how Reinforcement Learning works [75].

4.5.4 Strength and Weakness of Machine Learning

While machine learning (ML) is considered as a powerful tool that is capable of revolutionising technology, it has its own strengths and weaknesses, which will be discussed below.

Strengths ML is capable of identifying various trends and patterns across large amounts of data that are otherwise difficult to analyse by humans [41]. One of the best examples is that of e-commerce platforms, such as Amazon, which use ML to analyse customers' browsing behaviour and purchase patterns, and in turn suggest suitable deals and products to customers [102]. Additionally, since ML does not require human intervention, machines use their own algorithms to predict and improve algorithms. For instance, certain antivirus softwares use ML to filter new viruses and system threats, and the same mechanism is applied for the classification of spam messages [88]. Another significant strength of ML is its capability to undergo continuous improvements through experience and make better decisions. For instance, weather forecast models use ML to make accurate and faster predictions based on large volumes of data [49]. Additionally, ML also has the potential to handle multi-variety and multidimensional data in dynamic environments. Most importantly, its strength is visible among a wide range of applications, such as delivering efficient personal experiences to targeted consumers.

Weaknesses On the other hand, one of the main weaknesses of ML is its dependency on high quality data. Because training requires large amounts of data, it is important to ensure that the data available is unbiased and of high quality without compromising confidentiality. The preparation and administration of the training data still takes a lot of time for the data scientists. [144]. Moreover, there could be longer waiting times for data to gain new learning experiences in order to generate outcomes with more relevance and accuracy. The kind of resources required for machine learning, such as computer power, and the cost required for collecting, storing and analysing data is also higher [135]. With regard to interpreting results, the accuracy of interpretation solely depends on the type of algorithm chosen by the user. Furthermore, ML is highly susceptible to errors as training machines on limited data may not generate inclusive outcomes resulting in bias.

4.6 Deep Learning as a Subset of ML

Deep learning can be specified as a sub-class of ML algorithms. The term deep describes in this context the property of being particularly complex. Hence, ML techniques that are not deep can be named as shallow learning. The term deep learning has become a buzz word lately and definitions for the same vary within literature. Zhang et al. have examined those definitions and summarized the content with the following commonality: Knowledge acquired through deep learning is of a hierarchy of multiple layers of abstractions and representations [152]. Thus, deep underlines the high-level complexity that multiple hidden layers perform. The architecture allows to run data through a large amount of layers. By doing so, the information learned in previous layers is used for the next ones in order to dive in more abstract concepts. This allows to construct a representation of the data and is called feature extraction. This procedure of automated feature learning is done by deep neural nets and not by humans as you would do for example for

shallow learning. This is the fundamental idea behind deep learning. On the one hand feature engineering, which is performed by humans requires expertise. On the other hand feature learning, which is performed by deep neural nets, requires lots of data [106]. Therefore Deep Learning, which is also known as feature learning or representational learning, extracts complex data abstractions into representations and demonstrates them as a hierarchical learning program [80]. The algorithms can be trained on unstructured data, which allows to process tremendous amounts of data and learn from the same. This provides the fundamental advantage towards shallow learning.

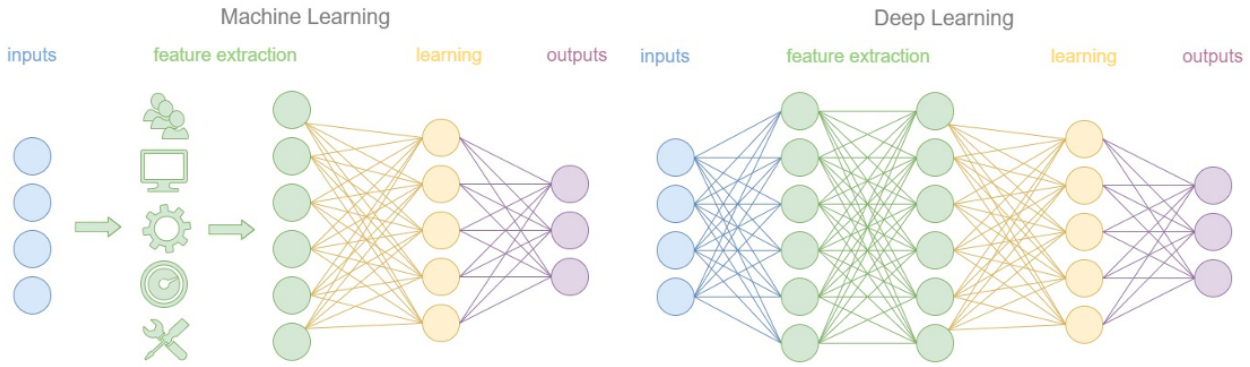


Figure 10: Machine Leaning vs. Deep Learning. The key difference is that Deep Learning does not require manual feature extraction [106].

Deep Learning Algorithms Algorithms in Deep Learning work by passing information through multiple layers, in which each layer extracts features on a progressive basis and transfers to the subsequent layer [19]. Also known as non-linear processing, deep learning processes data in multiple layers by passing on the output of the current layer as the input of the next layer. In the initial layers, only low-level features are extracted. However, as the algorithm goes through the succeeding layers, the features are combined to generate a complete representation [19]. Furthermore, hierarchy is maintained between each layer to realise whether or not the significance of the data is useful. These algorithms work successfully in scenarios demanding supervised learning, unsupervised learning, hybrid learning and reinforcement learning [86]. The performance of such a network architecture is high, although it is very time consuming for training. However, techniques such as GPU computing and transfer learning can be used to minimise the time consumed by deep learning algorithms [20]. Other powerful techniques that are efficient in reducing the time required for training include back propagation, learning rate decay, maxpooling and transfer learning among others [86]. Back propagation is a gradient-based method which calculates a function gradient for each iteration [80]. Similarly, learning rate decay is used for manipulating the learning rate so as to enhance performance, while simultaneously minimising the training time through stochastic algorithms. Alternatively, maxpooling uses filters to obtain the maximum input values to generate the output. This technique is efficient in minimising computational costs and dimensionality [86]. Another important technique is transfer learning, which uses a particular task to exploit other associated tasks. The information obtained from resolving a problem is used for resolving similar problems, which not only ensures rapid progress, but also enhances performance of the machine while solving the second problem [86].

Deep Learning examples Examples of Deep Learning are used in a variety of applications, such as natural language processing, fraud detection, facial recognition, image and voice recognition, automatic language translation, image-to-text and text-to-image translation, image-to-image synthesis, forecasting the prices of the stock market and real estate, aggregation of news and weather reports, accurate prediction of earthquakes and other natural calamities and so forth [86].

The learning models used in deep learning are capable of yielding outcomes more quickly and accurately when compared to standard learning mechanisms. Hence, giant organisations in the technology industry, such as Apple, Facebook and Google, which collect large volumes of data for analysis on a regular basis use deep learning mechanisms for information processing, signal processing, pattern classification and so forth [145].

4.7 Ethics of AI

In the past, two other research fields, physics and biology, were at a similar point like AI is today. The great advancement in physics in the 1930's brought countless technological inventions, but also enabled the creation of the nuclear bomb. Ethics failed in physics to prevent the construction and use of nuclear bombs, which are still in use today to threaten opponents. On the other hand, the ethics in biology succeeded with the ban of biological weapons from warfare [141].

For manager and developers ethics are often seen as a surplus and not as a necessary point in strategic planning and the development pipeline [46]. Moreover, the first mover, who implements a strict AI ethics policy on every level in the organization, will have a competitive disadvantage [94]. This can be seen in big tech companies, where the ethics owner needs to cope with the external pressure and simultaneously experiences pressure from internal processes [95]. Mostly, the company's interests get prioritised over the ethical and public pressure to not get an competitive disadvantage. Another indicator for the lack of relevance of ethics in big tech companies is for example, that Google reduces its ethic department [122].

The ethics questions need to be embedded on every level of the company, which reaches from the product development pipeline to the top management [94]. The responsibility for ethical AI gets distributed even further directly to the customer, who has to decide, if the product is ethically acceptable or not [39].

An example, where AI has to answer an ethical questions is, when a self driving car has to decide, if it runs into a wall, killing the driver, or into an elderly person. There is no right or wrong to this question, but it still needs to be answered by an AI. One might argue, that it is the driver's responsibility, analogous to a dog owner, where the owner is responsible for the dog's actions. Another example are racist recruiting AIs, which are generating ethnic based recommendations. Who is now responsible? Is it the AI developer or the person who collected the data or the recruiter who is using the results? Each of them can argue that, his/her action is not racist and that they act ethical correct, but the combination of all these actions gets ethical questionable. Which leads back to the point, that the ethical responsibility gets distributed on every level, from the developer to the business decision maker to the user. At the moment, the awareness of this distribution is not sufficient and therefore ethical guidance is required.

Very recently, on the 21st of April 2021, the European Commission announced a new set of rules for AI, which increases the regulations for many parts of AI. It categorises the risks of AI into four different categories with associated measurements, "Unacceptable", "High Risk", "Limited Risk" and "Minimal Risk". The commission just proposed these rules, which will be adopt by the European Parliament and the member states. This is clearly a movement into a more regulated AI and companies need to prepare for this new regulated AI environment [1].

Nevertheless, the risks of unethical AI are growing, but if the concerns and the resulting measures against unethical AI, like the introduced rules from the European Commission, can keep up is unknown. At the moment the risks are growing and the intentions of big tech companies to take counter measurements are not sufficient, with the tendency to get worse. If the updated rules of the European Commission bring the intended changes remains to be seen. The situation looks similar regarding the awareness of the public and the developers, they mostly focus on the successes of AI and do not take the ethics into account, but the public awareness of the threat is slowly growing.

4.8 AI of the future

This section is showing the ongoing and emerging trends in AI based on the latest significant development. Out of these developments four different AI trends were identified. As a conclusion, the authors see today's research as tomorrow's industry. The trends were examined based on the official report of Stanford University "Artificial Intelligence Index Report 2021" and other reports, which represent the world wide situation of AI.

General growth of Research The number of publications and peer reviewed journal articles increased dramatically over the last 20 years. The number of AI journal publications grew by 34.5% from 2019 to 2020, which indicates a growing research and the general growing interest in AI [151].

Generative everything Nowadays, AI is so refined in the areas of text composition and picture creation, that it is difficult for humans to distinguish between artificial content and human made content. This ability

will find its use cases in a large amount of applications and services, but it can also be used with criminal intentions. A development caused by this ability to fake content is DeepFake, which is a detection software for artificially created content [151].

Natural Language Processing (NLP) outruns its evaluation metrics NLP has been a big part of AI since its beginning, with the Turing Test for example. Today the rapid improvement of NLP outpaces the benchmark test, which indicates the progress in NLP even more. Two of the biggest tech companies (Google and Microsoft) deployed the new language model BERT into their already very powerful search engines for further optimizations [151].

Machine learning is changing the game in healthcare and biology The power of deep learning was shown with the introduction of DeepMind's AlpahFold. AlpahFold is tackling the highly complicated challenge of folding proteins, which is crucial for the drug discovery and the general understanding of processes in biology [151].

AI at the Edge The internet of things (IoT) is growing at an ever faster rate and so its challenges, namingly fog and edge computing [9], [44]. With the distributed computing resources new use cases for AI services appear, but also the requirements for AI applications in these remote and distributed computing locations change significantly [45]. The trend is to have AI services directly at the data source and not in an centralized data center.

4.9 Summing Up Artificial Intelligence

Artificial intelligence is one of the ground breaking technologies that is capable of revolutionising the world through its variety of applications. Through its capabilities, such as NLP, knowledge representation, ML and automated reasoning, AI enables machines to learn and implement knowledge through large volumes of data sets. AI can be applied to several commercial applications, such as speech recognition, self-driving vehicles, military equipment, cameras and so on. Most importantly, it is a useful tool in the fields of cyber security, healthcare, medicine, retail and banking industries among others. ML, an important branch of AI enables systems to learn through data and experience similar to how the human brain functions. It works on the basis of algorithms that take input from computer science, statistics, psychology, neuroscience and control theories. While ML is capable of identifying trends and patterns, the process of collecting large volumes of data is a humongous task. ML techniques include supervised, unsupervised, semi-supervised and reinforcement learning and the distinction between each technique depends on the presence of labels in the data set. Deep learning is an integral element of ML, which works on the basis of algorithms to resolve complex computer problems. It follows hierarchical learning by passing on the output of the previous layer as the input of the next layer. It finds its applications in signal and data processing, classifying patterns and so forth. Deep learning uses framework architecture to facilitate multi-task learning and primarily efficient for fraud detection, image synthesis and accurate forecasting of weather among others.

The development of AI and all the different AI applications had their ups and downs in the past, but is now here to stay and probably will never go away. AI found its place in different forms in several locations in everyday life and a future without these great performing services is unthinkable. Therefore we will hardly see a third AI winter again. If the development and ever more complex AI applications lead to fourfold applications, the market penetration of AI technologies will affect all industries and sectors as an initially slow but then more and more accelerating AI revolution. So we support AI in human work and decisions and AI is probably described with the words: better, faster, cheaper.

And on the other hand, there are points that must be critically observed. So the concerns about the complex ethics of AI are growing and the future does not look very promising. Some big tech companies are reducing their ethics department and the developers do mostly not care about ethics in the first place. The world is seldom black and white, but this development needs to be questioned critically, as it is by the European Commission, who tries to regulate AI. The role of society in dealing with AI and the use of private data. The companies and organizations worldwide have a great responsibility in the use of AI and the use of data.

5 Central Switzerland

A deep understanding about Central Switzerland is crucial to describe and analyse the role of AI in said region. This section starts with key facts about Switzerland as a country. The main part focuses on Central Switzerland. Each canton is analysed using a PESTEL method. Mapping the differences and similiarities of the cantons results in a final view on Central Switzerland, which is described in the last subsection.

5.1 Facts about Switzerland

With its around 8.5 million people, Switzerland is located in the middle of Europe despite not being part of the European Union. Switzerland shares a border with five countries, all of which influence the economy and society in those regions highly. 60% of Switzerland is occupied by the alps, yet only 11% of its population live there [30].
Switzerland operates as a Federal Republic and is made up of 26 cantons which are further divided in more than 2,300 municipalities. The competencies regarding politics are divided between the Swiss Confederation, the cantons and the communes [29].
Switzerland is worldwide a leading nation regarding innovation, research and development. The expenditures of 22.5 billion CHF spent on research and development amount to 3.4% of the Swiss GDP. The OECD average is only at 2.4%. Other numbers support the focus of Switzerland on R&D and its leading position: Switzerland ranked on the first place in the global innovation index in 2019 and as well in the European Innovation Scoreboard [31].

5.2 Economical Aspects of Switzerland

With almost 82,000 USD, the GDP per capita of Switzerland is one of the highest in the world. For comparison, Germany's GDP per capita amounts to only 46,400 USD, Austria's GDP per capita reaches 50,000 USD and Italy's GDP per capita is about 33,200 USD [146].
Switzerland's successful economy is highly driven by the service sector which generates almost three quarters of the county's GDP. The agricultural sector amounts to only 1% of total GDP leaving the manufacturing industry responsible for a quarter of the GDP. Despite not being part of the European Union, the EU is the main trading partner of Switzerland where almost half of Switzerland's exports go. In return, three quarters of the country's imports come from the EU. The company landscape is shaped strongly by SMEs[2], as 99% of all companies in Switzerland are characterized as the latter [33]. In general, Switzerland's economy is considered to be highly competitive on an international level. The economic policy follows an overall liberal approach with more than 28 free trade agreements with 38 partners, additionally to the most important free trade agreement with the EU considering the import and export volumes between the EU and Switzerland. Switzerland is a strong supporter of the work of the WTO and considers the organization as an important partner regarding access to international markets and free trade. All the economic factors lead to a low ratio of unemployment, making Switzerland overall a wealthy and livable country [32]. Despite showing mostly positive indicators of the Swiss economy, there are several points to consider. Switzerland has been generating a trade surplus for years [126], making the country dependable on its exports. Several associations, like the Swiss Federation of Trade Unions criticise the Swiss economic policy as the purchasing power especially of lower income households declines [78].

5.3 Overview of Central Switzerland

The region called Central Switzerland consists of six cantons: Lucerne, Zug, Nidwalden, Obwalden, Schwyz and Uri [119]. These six cantons account for 12% of Switzerland's landmass and around 10% of its population. Compared to the other six grand regions, these numbers place Central Switzerland in the middle field in terms of landmass and second to last place in terms of population. Only the Ticino region has a smaller population [13]. Four of the cantons - Uri, Schwyz, Nidwalden and Obwalden - are the "original cantons" (ger. "Urkantone") who founded Switzerland in 1291 and make up the "Urschweiz" [52].

[2]Per definition of the Swiss Federal Department of Economic Affairs, Education and Research, all companies with less than 250 employees are considered a SME.

Education In terms of tertiary education, Central Switzerland's universities are located in the canton of Lucerne with the exception of the HSLU Informatics in Rotkreuz, Zug [133]. In the autumn semester of 2020, more than 10,000 students were enrolled at the Universities in Lucerne[3] [53], [143]. There are three colleges of education in Lucerne, Schwyz and Zug [133]. Cumulatively they counted 2,960 enrolled students in the autumn semester 2020 [98]–[100].

Employers There are 71,800 employers and around 503,500 employees in Central Switzerland. 79 of those employers are part of Switzerland's 500 highest grossing enterprises with three being part of the Top 10 [8]. Table 3 provides an overview over the ten highest grossing companies in Central Switzerland as well as their rank in the Top500 and industry.

National Rank	Company	Industry	Canton	Revenue in Billion CHF
1	Glencore International	Materials & Construction	ZG	217.5
3	Trafigura	Materials & Construction	LU	136.4
10	BHP Billiton Group	Materials & Construction	ZG	37.7
17	Kühne + Nagel International	Industrial Goods & Services	SZ	22.2
26	Schindler Holding	Industrial Goods & Services	NW	10.2
29	Also Holding	Technology & Telecoms	LU	8.9
30	MET Group	Materials & Construction	ZG	8.4
36	Ceva Logistics	Industrial Goods & Services	ZG	6.9
41	Sika	Materials & Construction	ZG	6.2
59	Kolmar Group	Energy & Utilities	ZG	4.0

Table 3: Top10 Companies in Central Switzerland by Revenue [8]

However when sorted by number of employees the list of biggest employers looks different. The Lucerne Cantonal Hospital tops this list with around 7,000 employees. Other Top 10 employers in the health industry include Roche Diagnostics, Spitex Central Switzerland and the Swiss Parapletiker Group. Migros Lucerne is the company with the most employees in the private sector. The Manufacturing industry is represented three times by Siemens Switzerland, Pilatus Aircraft Factories and Schindler (see table 4).

Nr.	Company	Industry	Employees
1	Lucerne Cantonal Hospital	Health Care	7,008
2	Migros Lucerne	Consumer Goods & Services	6,651
3	Roche Diagnostics	Health Care	2,724
4	Spitex Central Switzerland	Health Care	2,707
5	Siemens Switzerland	Technology & Telecoms	2,157
6	Pilatus Aircraft	Industrial Goods & Services	2,150
7	Schindler	Industrial Goods & Services	2,142
8	Galliker Transport	Indusrial Goods & Services	2,086
9	Stiftung Brändi	Public Sector	1,933
10	Swiss Parapletiker Group	Health Care	1,778
11	Hochschule Luzern	Public Sector	1,758
12	CKW-Group	Energy & Utilities	1,741
13	CSS Insurance	Financials & Real Estate	1,637
14	Hirslanden Private Hospital Group	Health Care	1,637
15	Fenaco	Primary Sector	1,570

Table 4: Top15 Employers in Central Switzerland by Number of Employees [84]

In 2017, Central Switzerland produced a GDP of around 59.7 billion CHF, which breaks down to 69,218 CHF per person.

[3] 3,155 at the University of Lucerne and 7,581 at the University of Applied Sciences HSLU

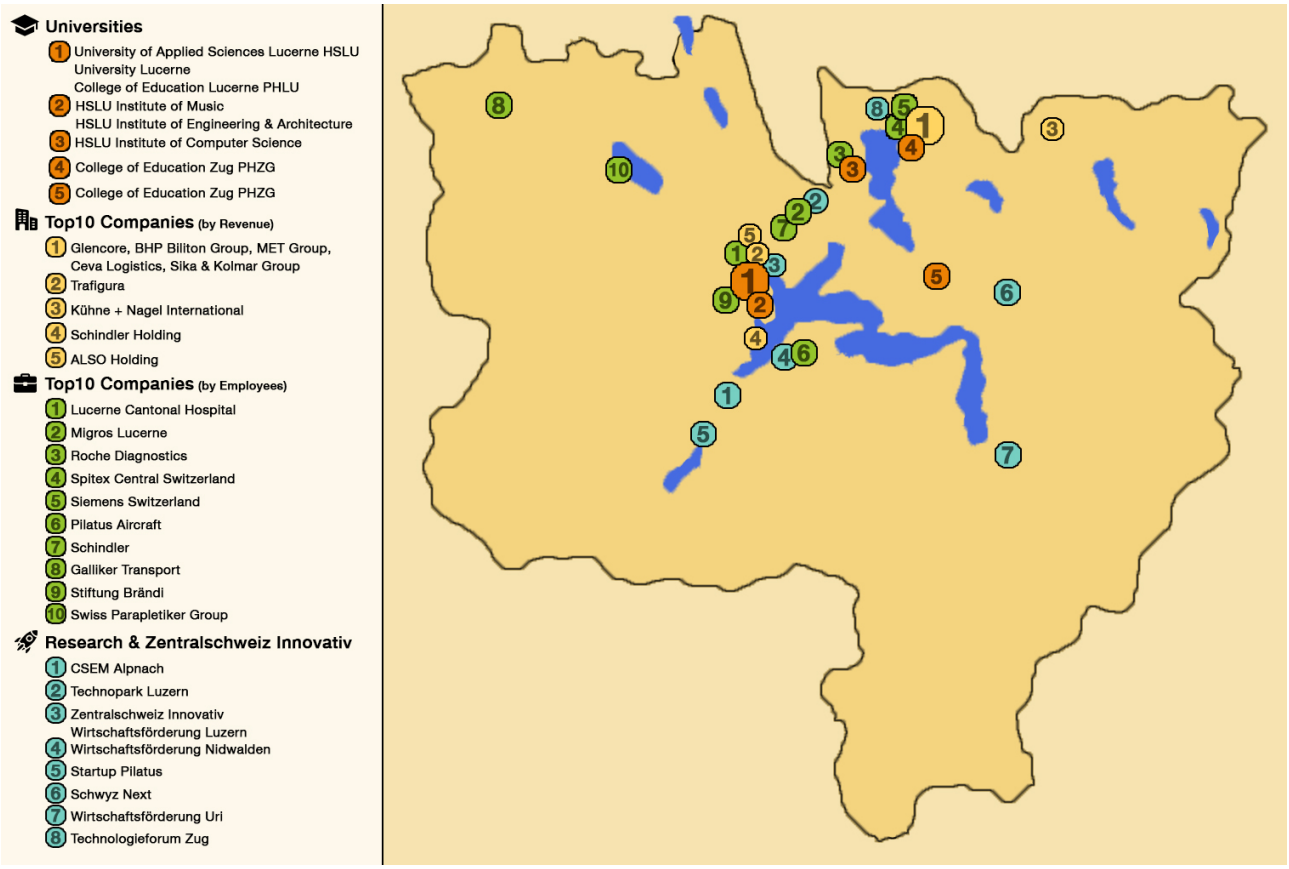


Figure 11: Key players and institutions in Central Switzerland ranked by revenue and by employees (own graphic).

The map in figure 11 shows key players and institutions in Central Switzerland mentioned in the previous chapters. This allows for a better visual classification of where these key players are located. An interactive version of this map can be found under the following link:

`https://www.google.com/maps/d/edit?mid=1Y4IFIEnGYtwyUhySg3SdaLFmu6H_A27j`

5.4 PESTEL-Analysis of the Six Cantons

A PESTEL analysis helps to analyze different dimensions which might affect an organization. As the goal of the study is to gain an in depth understanding about the usage of AI in Central Switzerland, it is essential to understand the factors which characterize this region. Therefore, a PESTEL anaylsis is conducted for each of the six cantons. This PESTEL analysis relies mainly on the cantonal portraits released by the BFS [13] and the previously mentioned sources from Bisnode (see table 3) and Luzerner Zeitung (see table 4). The environmental and legal dimension is only considered in the analysis if there were particularly interesting findings, as the authors see a much higher importance for this study in the economic, political and social dimensions. For the technological dimension only notable initiatives or success stories are mentioned for each single canton. From a technological point of view, all cantons, like all of Switzerland, relies on a good technological infrastructure. The availability of LTE mobile data is high throughout Switzerland and the availability of the new standard of mobile data exchange, 5G is growing [120]. The overview helps in identifying clusters, similarities and differences in the region which can be used as a basis for decisions regarding the strategic orientation of politicians and companies in the region and ultimately add information for answering the research questions.

	Lucerne	Nidwalden	Obwalden	Schwyz	Uri	Zug
Political						
Political tendency	right with leftwing tendency; more liberal than conservative	rather right, more conservative than progressive	rather right, more progressive than conservative	right with liberal tendencies	right and rather conservative	rather right and still liberal
Economical						
Biggest employers by employees:[4]	1. Hospital Lucerne (7,008) 2. Migros Lucerne (6,651) 3. Schindler (2,142) 4. Galliker Transport (2,086) 5. Stiftung Brändi (1,933)	1. Pilatus Aircraft Manufacturing (2,150) 2. Bürgenstock Hotels (815) 3. Hospital Nidwalden (561) 4. Zentralbahn (282)	1. Maxon (1,281) 2. Leister (590) 3. Hospital Obwalden (456) 4. Mountain Railroads Engelberg-Trübsee-Titlis (381) 5. Gasser Felstechnik (285)	1. BSZ Stiftung (1,036) 2. Victorinox (1,025) 3. Hospital Lachen (684) 4. Hospital Schwyz (619) 5. PayrollPlus (576)	1. Andermatt Swiss Alps (964) 2. Dätwyler (885) 3. Hospital Uri (619) 4. Uri Foundation for the Disabled (369)	1. Roche Diagnostics International (2,724) 2. Siemens Switzerland - Smart Infrastructures (2,157) 3. Metall Zug (1,493) 4. Hospital Zug (991) 5. Johnson & Johnson (920)
Biggest employers by revenue:[5]	1. Trafigura (136bn CHF) 2. ALSO Holding (8.9bn CHF) 3. Emmi AG (3.4bn CHF) 4. Schmolz+ Bickenbach (3.1bn CHF) 5. Aldi Suisse (2.1bn CHF)	1. Schindler Holding (10.2bn CHF) 2. Artemis Holding (2.9bn CHF) 3. Pilatus Aircraft Manufacturing (986m CHF) 4. SoftwareONE (790m CHF)	1. Maxon (420m)	1. Kühne & Nagel Internationel (22.2bn CHF) 2. OC Oerlikon Corporation (2.8bn CHF) 3. Vorwerk International Stecker & Co (2.1bn CHF) 4. Octapharma (1.9bn CHF) 5. Stäubli (1.2bn CHF)	1. Dätwyler Holding (1.3bn CHF) 2. Orascom Development Holding (244m CHF)	1. Glencore International (218bn CHF) 2. BHP Biliton Group (37.7bn CHF) 3. MET Group (8.4bn CHF) 4. Ceva Logistics (6.9bn CHF) 5. Sika (6.2bn CHF)
GDP per citizen	66,655	71,329	66,970	60,313	52,468	151,747
Employers primary sector[6]	4752 (14.7%)	457 (11.2%)	651 (17.8%)	1,642 (10.7%)	594 (21.2%)	592 (3.3%)
Employers secondary sector[7]	4,620 (14.3%)	570 (13.9%)	534 (14.6%)	2,420 (15.8%)	416 (14.9%)	1,688 (9.4%)
Employers tertiary sector	22,923 (71.0%)	3,071 (75.0%)	2,469(67.6%)	11,289 (73.5%)	1,790 (64.0%)	15,675 (87.3%)
Total Employers						
Employees primary sector	13,624 (5.4%)	1,239 (5.2%)	1,743 (7.9%)	4,427 (5.3%)	1,499 (8.1%)	1,687 (1.5%)
Employees secondary sector	57,132 (22.8%)	6,795 (28.7%)	7,226 (32.6%)	21,086 (25.4%)	5,316 (28.8%)	22,236 (19.7%)
Employees tertiary sector	177,181 (70.6%)	15,632 (66.1%)	13,220 (59.6%)	57,481 (69.3%)	11,635 (63.1%)	88,783 (78.8%)
Profit Tax Rate [125]	12.32%	11.97%	12.74%	14.06%	12.63%	11.85%
Social						
Population	409,557	43,223	7,841	159,165	36,433	126,837
of which are 0-19 yr	20.4%	18.2%	20.2%	19.5%	20.1%	20.3%
of which are 20-64 yr	62.0%	61.4%	61.0%	62.8%	59.4%	62.8%
of which are over 65 yr	17.6%	20.3%	18.8%	17.7%	20.4%	17.0%
of which don't have an higher education	18.2%	17.1%	22.2%	18.1%	25.1%	13.0%
of which have a secondary education level	49.1%	49.7%	49.1%	49.2%	49.7%	41.2%
of which have an education on tertiary level	32.7%	33.2%	28.8%	32.7%	25.3%	45.8%
Unemplyoment rate	1.6%	0.8%	0.7%	1.1%	1.1%	1.9%

Table 5: PESTEL Analysis of the Six Central Swiss Cantons

5.4.1 Canton of Lucerne

Political The governing council of Lucerne is made up of five people, two of which represent the conservative party ("Die Mitte", formerly CVP). The longest sitting member is an Independent and the remaining two members represent the FDP and SVP, respectively [61]. Although the governing council is rather conservative, the more liberal parties SP and "Die Grüne / Junge Grüne" are represented by 19 and 15 seats respectively in the cantonal council (120 seats total) [62]. Notable goals for the legislature period from 2019 to 2023 include educating law enforcement on cyber-criminality, connecting education institutions with companies and becoming a "pioneer" in the digital transformation of public administration. Topics like Climate Change, Sustainability and equal inclusion of rural and urban areas are also addressed in the document [109], [110].

Economic Lucerne is home to the biggest two employers in the central Swiss region: The Lucerne Cantonal Hospital and Migros Genossenschaft Lucerne (see table 5). A calculation of the workplaces generated by the Top 100 Employers in Central Switzerland shows that the biggest industries in Lucerne by number of employees are by far the Consumer Goods & Services industry (19,000 - of which 1,500 are in the Tourism industry) and the Health Care industry (15,000) [84].

Lucerne Business mentiones the following industries as particularly interesting in the Canton [83]:

- Industrial Goods & Services, particularly Machinery
- Consumer Goods & Sciences, particularly Food
- Financials & Real Estate
- Health Care, particularly Pharma and Chemistry (Life Sciences)
- Materials & Construction
- Technology & Telecoms, particularly ICT

Out of the Top 100 Employers in Central Switzerland, 72 are located in Lucerne. However, with a GDP of 66,655 CHF per capita, Lucerne stands out neither negatively nor positively among the other Central Swiss cantons (see table 5).

Social Its population of more than 400,000 makes the canton of Lucerne the biggest canton in Central Switzerland. However, it also has the second highest unemployment rate (1.6%) in the region. As in most other central Swiss cantons, Lucerne's population is well educated with around half having completed the secondary education and around a third having a degree from tertiary education (see table 5).

Technological Since 2003, there is a special hub for Start-Ups in Root, a suburb of the city Lucerne. The Technopark AG is part of the D4 Business Village Lucerne and provides office space that can be flexibly booked as the Start-Up grows. More than 40 Start-Ups are already working from Technopark, which provides valuable network possibilities. These networking possibilities are extended through the many partners of Technopark, including CSEM, HSLU, ITZ (see map in figure 11) and many more [138]–[140]. Having such a hub for Start-Ups in the canton surely helps to draw innovative companies and leaders and encourages new ideas through networking. In addition, a map of the biggest Data Centres in Europe lists four companies who operate a total of seven Data Centres within the canton of Lucerne [77]. This availability of local data storage might be relevant to companies that want to use AI but need to store their data locally.

5.4.2 Nidwalden

Political The governing council of Nidwalden is composed of three CVP-Members as well as two SVP and FDP-Members each. This reflects the canton's general choices in the national vote, which can be classified as rather right [65]. The Goals for the legislature period from 2021 to 2024 consider topics like Climate Change (renewable energy, raise awareness) and Sustainability (sustainable Mobility) as well as Digitalization. Like Lucerne, Nidwalden has recognized Cyber Criminality as an emerging threat that law enforcement needs to

be prepared for. The canton also states that it would like to digitalize the interface of administration and the public, for example through E-Tax, E-Service and digitalized information. Another important goal in the document is to remain an attractive region nationally and internationally by keeping an attractive tax strategy for companies and residents. Some industries that are specifically mentioned in the legislature document are agriculture, tourism, Law Enforcement and Health Care [111].

Economic At 71,329 CHF, Nidwalden produces the second largest GDP per capita in the region. However, this is less than half of the GDP-per-capita in Zug, which tops the list. The biggest employer located in the canton is Pilatus Aircraft Manufacturing, which offers 2,150 workplaces. It's followed by Bürgenstock Hotels (815) and the Cantonal Hospital Nidwalden (561) (see table 5). All of these companies are located in Stans or Stansstad respectively. Out of the Top 100 Employers in the region, only four are located in Nidwalden. The final one being the Zentralbahn in Stansstad, which offers 282 workplaces [84].

In terms of revenue, Nidwalden is home to four Top500-companies in Switzerland. The biggest one is Schindler Holding which generates more than 10 billion CHF per year. It is followed by Artemis Holding with a little less than 3 billion CHF per year. These two holdings are both based in Hergiswil. The two Stanser companies Pilatus Aircraft Manufacturing and SoftwareONE produce 986 and 790 million CHF respectively [8].

As the legislature goals specifically address the Tourism and Agriculture industries, it can be assumed that these industries are important for the canton.

According to the "Pendlermatrix", almost half of Nidwaldens workforce commutes to other cantons to work [12].

Social Nidwalden is home to 43,223 people, which makes it part of the smaller cantons in the region. However, it is still a little larger than Obwalden and Uri. The education profile of this population resembles the one of general Central Switzerland with around half of the population having completed the secondary education and a third having a tertiary education. Despite being similar in terms of education and having less workplaces than most other cantons, Nidwalden has one of the lowest unemployment rates in the region with only 0.8% of the population being unemployed (see table 5).

Technological In 2011, Nidwalden was the first and only Canton in Switzerland that implemented a patent box in its tax policy. This patent box allowed revenue, which was directly related to the patent, to be taxed at a much lower rate (up to 80% lower than the usual tax rate). This made the canton attractive to Research & Development institutions and R&D activities in private companies [63, p.34][47], [64]. However, as of 2020 a new tax reform took effect in Switzerland, which requires all Cantons to implement a patent box in their cantonal tax policy. Although some cantons do not grant such low rates as mentioned before, this tax reform rids Nidwalden of its unique position and it remains to be seen how this impacts the appeal of the canton to companies with lots of R&D-activities [47].

5.4.3 Obwalden

Political The governing council of Obwalden consists of five members. There are no two members of the same party however CSP (mid-left) and CVP (mid-right) might be considered to have very similar ideologies. The FDP and SVP are also represented by one member each and one member is an Independent. This constellation means Obwalden's governing council is rather liberal and leaning towards a right-wing agenda. There are also some conservative tendencies from the SVP. The constellation of the governing council differs from the results of the national council vote in 2019 where more than a third of Obwalden's population voted for SVP and CVP each with FDP receiving only 11% and the SP only 3% of the vote [13], [66].

For the legislature period from 2018 to 2022 the council wants to focus on Digital Transformation in public administration and education in particular. Also the common topic of sustainability, namely in terms of mobility and renewable energy. The canton also mentions the tourism industry in its goals and wants to remain an attractive region financially and tax-politically for residents and companies. There's also an initiative to build an intercantonal police operations center in cooperation with Lucerne and Nidwalden [112].

Economic With 66,970 CHF, the canton of Obwalden reaches a very similar GDP per capita as the canton of Lucerne. As in the other cantons, the tertiary sector employs the most people in Obwalden as well. However in relation to the total workforce, the tertiary sector only employs around 60%, while a third of the workforce works in the secondary sector and around 8% work in the primary sector. This distribution is notably different from the other cantons where the secondary sectors share of the workforce is only around 20-28% and the primary sector only employs about 5% of the workforce. A big influence into these statistics may be Obwalden's biggest employer: Maxon Group, a company in the Industrial Goods industry which employs 1,281 people. It is followed by Leister, which also produces Industrial Goods and employs 590 people. The third-biggest employer is the cantonal Hospital of Obwalden with 456 employees (see table 5).

Social Obwalden's population is only 1,400 people more than Uri which makes it the second smallest canton. Although more people don't have a higher education than in other cantons (except Uri), Obwalden has the lowest unemployment rate in the region (see table 5). Whereas in other cantons most people live in cities, in Obwalden only 27.4% live there [13]. The rest lives in more rural areas. This might be caused by the fact that Obwalden doesn't have a big city centre but few and small cities like Sarnen and Sachseln and more small, rural or mountain communities like Lungern, Engelberg and Giswil [123].

Technological The CSEM (Centre Suisse d'Electronique et de Microtechnique SA) operates an office in Alpnach Dorf . The research and Technology Organization opened this office in 2000 to conduct research and development in industrial innovation [103]. It is also a research partner of the location promotion program "Zentralschweiz Innovativ" (see 5.5.4) [150]. In September 2020, Obwaldens tax administration won the third place in an international eGovernment contest. They implemented a software that uses AI to check if a tax return needs to be checked manually. If that is not the case, the tax return is validated automatically. Such a success story marks Obwalden as a pioneer in terms of AI usage in a public administration context [85].

5.4.4 Schwyz

Political In the canton Schwyz, eight people build the governing council with a majority of three members being part of the SVP. FDP and CVP are represented by two members each. The final member of the governing council does not belong to a political party [67]. This represents as well the tendency of the citizens choices during the last votes on a national level (see table 5). The political program from 2020 to 2024 focuses mainly on overcoming the Covid-19 pandemic, digitization and sustainability. Regarding taxes, the canton specifically wants to offer competitive tax rates for all categories of taxable companies. For the economy, the strategy emphasizes being attractive for SMEs, as a positive impact on the society and the economy is expected from them. For example, SMEs are supposed to have a positive impact on the amount of people who have to commute to their workplace. Finally, the canton specifically aims to support economic actors regarding innovation, usage of new technologies and digitization [113].

Economic The GDP per capita is a little higher than 60.000 CHF. Most employees, almost 70% work in the tertiary sector. Only 5% of employees work in the primary sector. The biggest employers in the canton measured by the amount of workplaces are the BSZ Stiftung and Victorinox with a little more than 1,000 employees, followed by the hospital in Lachen. Measured at yearly revenue, Kühne & Nagel International is by far the biggest company in the canton with a total yearly revenue of 22,220 billion CHF (see table 5). In a strategy paper published by the cantonal office for economics it is explicitly stated, that the canton promotes itself as being attractive for SMEs which generate high valued workplaces, act locally and rely on high qualified, white-collar workers and additionally for headquarters of global companies, like Kühne & Nagel International is one [4]. Notably efforts are made by the canton Schwyz in enabling local companies to be innovative and to profit from and actively build clusters, like a rising finance industry cluster. An example is the provision of education offers for practitioners by the Swiss Finance Institute, which offers master classes tailored for the finance sector of the canton Schwyz. Despite offering master classes in whole Switzerland, the approach to offer tailored programs for a single canton is unique [132].

Social There are almost 160,000 people living in the canton of Schwyz, of which 60% are between 20 and 64 years old which is average in Central Switzerland. The population has tendencies to be rather young, as there are more people being younger than 20 as there are being people being older than 64. The unemployment

rate is low. Most people received an education on a secondary level. The population of Schwyz is growing over the last years [13, pp. 49-51].

Technological Notable efforts are made in the canton of Schwyz regarding Blockchain technology. With tailored training programs and a possibility to network, the canton of Schwyz started the initiative "SchwyzTech - Blockchain Innovation" running from 2020 to 2023 with support of Switzerland's government and the Swiss Blockchain Academy [131].

5.4.5 Uri

Political Eight members build the governing council of the canton Uri of which three are members of the CVP [69]. During the last vote on a national level, most of the citizens voted rather conservative for the CVP and the SVP (see table 5).

Economic With only a little more than 50,000 CHF GDP per capita, Uri is the poorest canton not only in Central Switzerland but of the whole country. More than 8% of all employees are working in the primary sector which is the highest percentage of employees in the latter sector in Central Switzerland. The largest company in terms of the amount of employees is active in the tourism sector. Andermatt Swiss Alps has almost 1,000 employees (see table 5). Tourism plays a crucial role for the canton. Around one million tourists visit Uri for day trips per year and almost 10% of the total employees work in the tourism industry. In tourism, Uri works closely together with the other cantons of Central Switzerland to promote the region for summer and winter activities around the Lake of Lucerne[124] Despite the large impact the tourism industry has on Uri and the close connection to the cantons of Central Switzerland, Uri has special role. Because the northern side of the tunnel connecting north and south, the Gotthard-Tunnel starts in Uri, the canton maintains a close relationship with the southern cantons Ticino and Valais and positions itself as an interesting opportunity for investors in the industry and service sector with low taxes and a comparably cheap place to live [124].

Social With its slightly more than 36,000 citizens, Uri is the smallest canton in Central Switzerland. Whereas around 60% of the people are between 20 and 64 years as in the other cantons, the population has in total a tendency to be comparably old. More than 20% are older than 64 years. The unemployment rate is low. However, the amount of people with an education on a tertiary level is the lowest in Central Switzerland. The amount of immigrants living in Uri is with a little more than 10% comparably low. The population has been growing over the last years, but slower than in other cantons in Central Switzerland [13, pp. 64-66].

Technological There are two companies located in Uri that operate data centres in the canton [77]. Although the canton does otherwise not have a clear focus on the technology industry, the availability to store large amounts of data might sound attractive to companies that need to store their data close-by due to regulations.

5.4.6 Canton of Zug

Political The governing council of the canton Zug consists of seven members, of which three are a member of the CVP, two of the SVP and two of the FDP [71]. The voting behavior of the citizens of the canton Zug proves this political direction: During the last national council election 65% of votes were given to these three parties followed by 20% of votes for the leftwing party GPS (see table 5). The political strategy 2019-2026 of the governing council of the canton Zug indicates the expected development direction of the canton. The strategy defines 40 central strategic goals which aim to strengthen the position of the canton as an attractive place to live and to do business. Several goals are of special interest regarding the economical attractiveness and the educational respectively R&D orientation of the canton. One of the central goals of the strategy is to continue to offer internationally competitive corporate tax rates. The corporate tax rates can be seen as one key success factor of the canton's richness. Regarding education an R&D the canton relies on the widespread use of digital solutions, new teaching formats and the establishment of a higher technical school for computer science and electronics [70]. The canton has a leading role in Switzerland regarding the offering of e-government services. Namely the city of Zug offers a blockchain based ID solution allowing citizens to obtain governmental services securely and fully digital [104].

Economic The economic situation of the canton Zug is extremely well in terms of GDP per citizen. With a GDP per capita of more than 160,000 CHF, Zug is the second richest canton in Switzerland and with high margin to the other cantons the richest in Central Switzerland. The largest employers are located in Rotkreuz (Roche Diagnostics) and the city of Zug (Siemens Schweiz - Siemens Smart Infrastructure and Metall Zug). The three companies offer together 6,500 jobs in the canton. In terms of yearly revenue generated, Glencore International Holding and BHP Billiton Group, both located in Baar, are the largest players in the canton (see table 5).

Social Zug is the second largest canton regarding its population. More than 125.000 people live there. Despite having the highest rate of people with an education on a tertiary level, the unemployment rate is the highest in Central Switzerland. The canton's population is growing fast, which can be partly explained by the amount of immigrants living in Zug: Almost every third citizen of Zug is not from Switzerland originally [13, pp. 76-78].

Technological. Zug is part of the so called crypto valley. The term crypto valley developed in reference to the silicon valley and describes the location around Zug, which is well known for its blockchain cluster. More than 430 registered companies are active in the blockchain ecosystem in the city of Zug. Zug and Zurich together employ around 3,000 people and in total almost 600 companies are registered in that blockchain ecosystem [74]. In addition to blockchain knowhow, Zug also offers six major data centres to store the data [77].

As mentioned above, HSLU's campus of informatics is located in Rotkreuz, Zug. Being the first Swiss university of applied sciences with its own dedicated school of informatics and information technology, a high relevance can be identified to the latter topic. HSLU Informatics offers several future-oriented bachelor and master study programs of which for example the bachelor level program in AI and Machine Learning is unique in their way of being deeply rooted in computer science but still allow for a broad mixture of applied technologies, business knowledge, social awareness and project work [55]. Relevant for the topic of AI in this paper is as well the Algorithmic Business Research Team (ABIZ) which is part of HSLU and located in Rotkreuz. The team aims to connect innovative algorithms and technologies with business models and thereby supports industry players. ABIZ offers as well consulting services, auditing, on-site training and coaching related to AI, machine learning and data analytics [54].

5.5 Deep Dive of Central Switzerland

Three key aspects will be investigated further and connected with the results of the PESTEL analysis for each canton. First, the most important industries are derived from the biggest employers in Central Switzerland mainly in terms of the amount of jobs rather than in terms of yearly revenue of a holding company. Afterwards, clusters are described based on research and information of the PESTEL and the corporate tax rates from Central Swiss cantons are put in a national and international context. As a last step, the location promotion program "Zentralschweiz Innovativ" is presented.

5.5.1 Industries

A more detailed look at the distribution of industries allows for a better understanding of the economic landscape of said region. Unfortunately, there are no exact numbers of workplaces or employees per industry on a cantonal basis. The PESTEL-Analysis in chapter 5.4 attempted to describe the economy of a canton on a high level by looking at the biggest employers. This chapter now refers to a study conducted by the BFS which states the number of employees grouped by industry in the region of Central Switzerland [14]. This study was chosen as a reference point because of its more scientific character compared to the study conducted by the Luzerner Zeitung and because it seems to incorporate every company, not just the biggest 100 employers. The following graph 12 shows the industries and their respective number of employees in Central Switzerland.

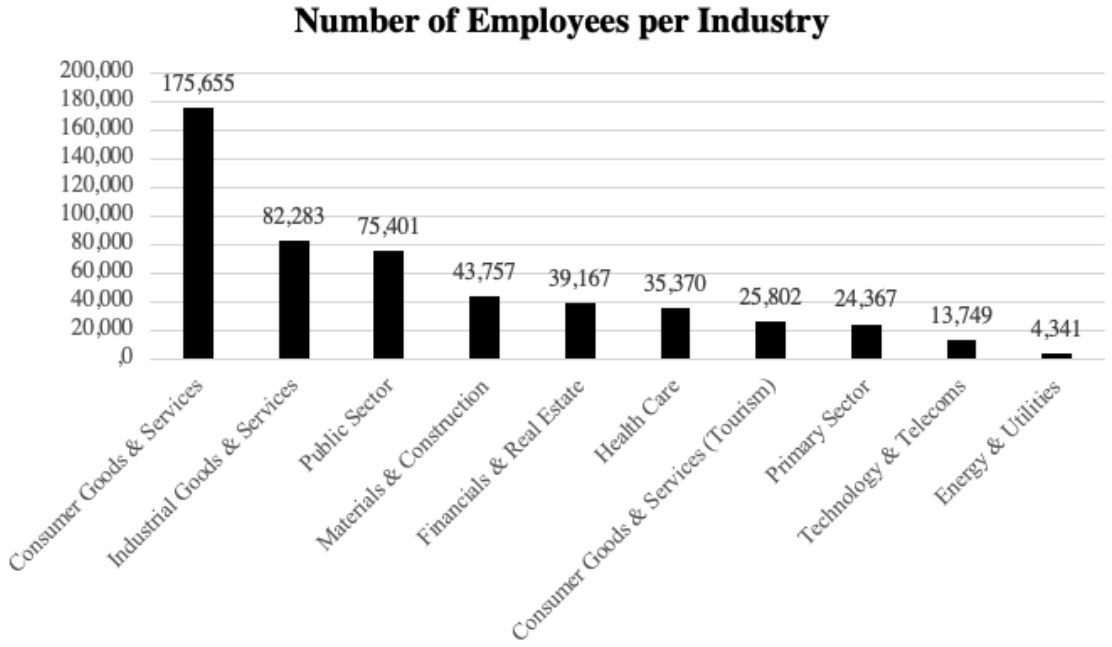


Figure 12: Number of employees per industry in Central Switzerland.

The Consumer Goods & Services industry (excl. Tourism) is the biggest industry in Central Switzerland, followed by Industrial Goods & Services. This implies that manufacturing goods and providing services is the biggest activity central Swiss companies participate in. The public sector, including educational institutions is the third largest industry.

It must be noted that Central Switzerland is a very diverse region and each canton has other industries they are stronger in than the other cantons (see PESTEL in chapter 5.4). Thus, a general look at the industries of the total region results in a distribution that does not show the different cantons peaks and lows in comparison to each other. For example, Zug has many companies in the Financials & Real Estate industry but this is cancelled out in the graph by the industries low presence in other cantons like Uri or Obwalden. This can be interpreted as Central Switzerland not having a single industry it is stronger in as a region than the rest of Switzerland. The ranking also matches the one of Switzerland in general, except the ranks of the Health Care industry and the Materials & Construction industry are switched and the public sector plays a larger role in Switzerland overall (Rank 2).

5.5.2 Clusters

A cluster describes a network of producers, suppliers, research organisations, service offerings and related institutions such as chambers of commerce, which are geographically close to each other and operate in the same value stream. The players in a cluster have a relation to each other and mostly share a common interest [21]. Regarding Switzerland as a whole, the finance industry around Zurich is a cluster. By foreigners, Switzerland is known for its watch industry. In Central Switzerland, no big cluster can be obviously identified. However, taking a deeper look, there are initiatives and agglomerations which resemble a cluster. One example is the Microtechnology Initiative of Central Switzerland. It operated on its own from 1999 to 2019 and now has concentrated its activities as a part of the CSEM in Alpnach. The main goal is to have a regional RD which focuses on the regional big economic players in the industrial sector. Partners of the initiative are for example Schindler Aufzüge, Pilatus Flugzeugwerke, Sika Manufacturing or the Aurovis AG. All of these companies are located in Central Switzerland and rely on technological innovation to foster production processes [90].

Blockchain technology is strongly connected to Switzerland. With Zug as an initiator of the Crypto Valley and since a short time the canton of Schwyz leveraging the ideas behind decentralized finance (DeFi), two cantons of Central Switzerland are highly active in this area. With several initiatives, a strong connection to the HSLU and the financial backing for certain initiatives of the government of Switzerland, a Blockchain

cluster can be identified. However, it is in a young stage and is focused on education and solution providing as a potential enabler for other industries.

Located in Schwyz, the Health Tech Cluster Switzerland focuses on establishing a network of the Swiss Healthtech Community. Its network is even international, but with the head quarter in Schwyz and around 100 of in total 245 Swiss members located in Central Switzerland, its regional impact is given [56]. The Healthtech clusters originates from a regional promotion program and was funded with CHF 350,000 by the Swiss government. In the initial phase, Roche Diganostics, Maxon Motors, the HSLU and members of the governing bodies of the cantons of Central Switzerland were involved [114].

In the canton of Schwyz, a cluster in finance and financial services can be identified. Yet it cannot be considered alone as it is strongly connected to the worldwide known finance cluster in Zurich. Unique about the cluster is the educational offer as outlined in the PESTEL analysis of the canton Schwyz. In Pfäffikon, more than 150 companies offering financial services are located which amounts to about 2,500 jobs [68]. The support of the canton combined with the research and educational efforts being made indicates growth for this cluster.

5.5.3 Corporate Taxes

The PESTEL Analysis in chapter 5.4 showed the profit tax rates of each canton in Central Switzerland. It is evident that with the exception of Schwyz, all Central Swiss cantons have very low profit tax rates around 12%. When putting these tax rates into a national context as shown in figure 13, it becomes clear that Central Switzerland is a very attractive region in this regard.

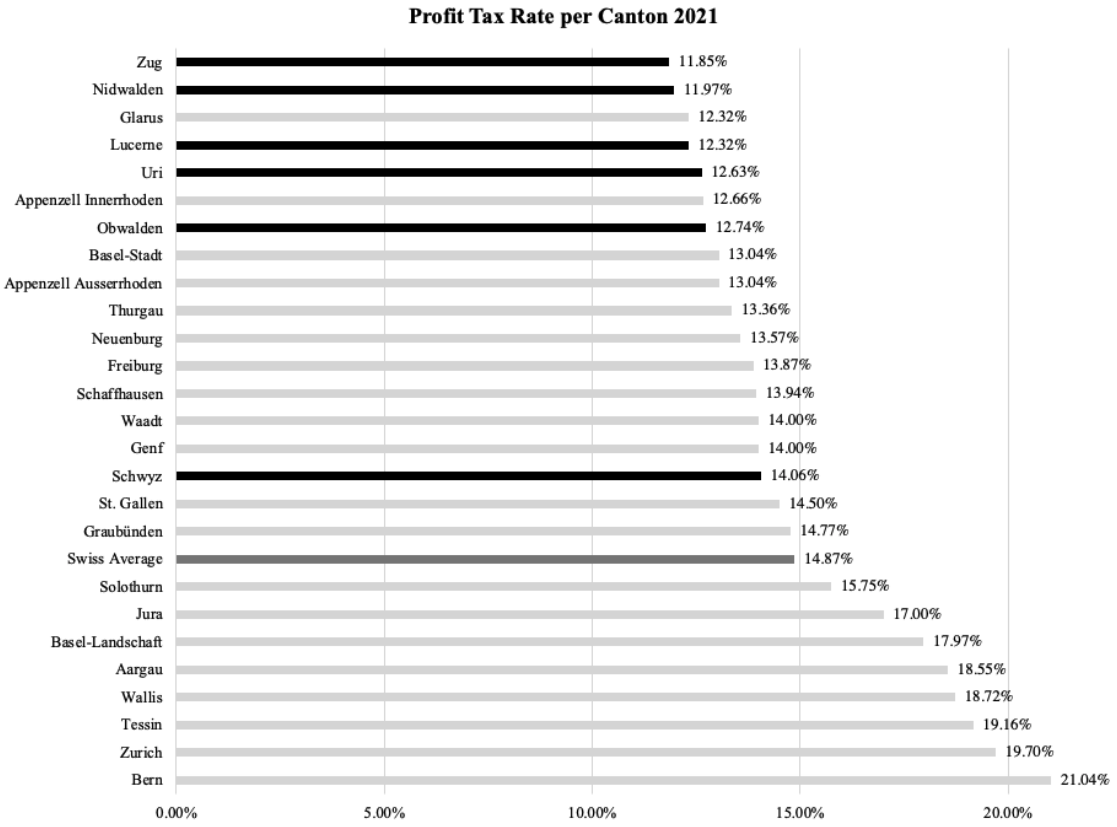


Figure 13: Profit tax rate per canton in 2021. The black bars are the cantons of Central Switzerland, which all are below the Swiss average (dark grey bar) (in style of Statista, 2021).

The Swiss average profit tax rate is around 14.87%. All Central Swiss cantons are below this number with Zug, Nidwalden, Lucerne, Uri and Obwalden being on the very low end of the scale [125].

This attractive tax-situation becomes even more clear when looking at it from an international standpoint. Commissioned by the ESTV (Eidgenössische Steuerverwaltung der Schweiz), the BAK Economics AG pub-

lished the BAK Taxation Index 2019 (see figure 14). This report includes the profit tax as well as the capital tax and property tax, if applicable.

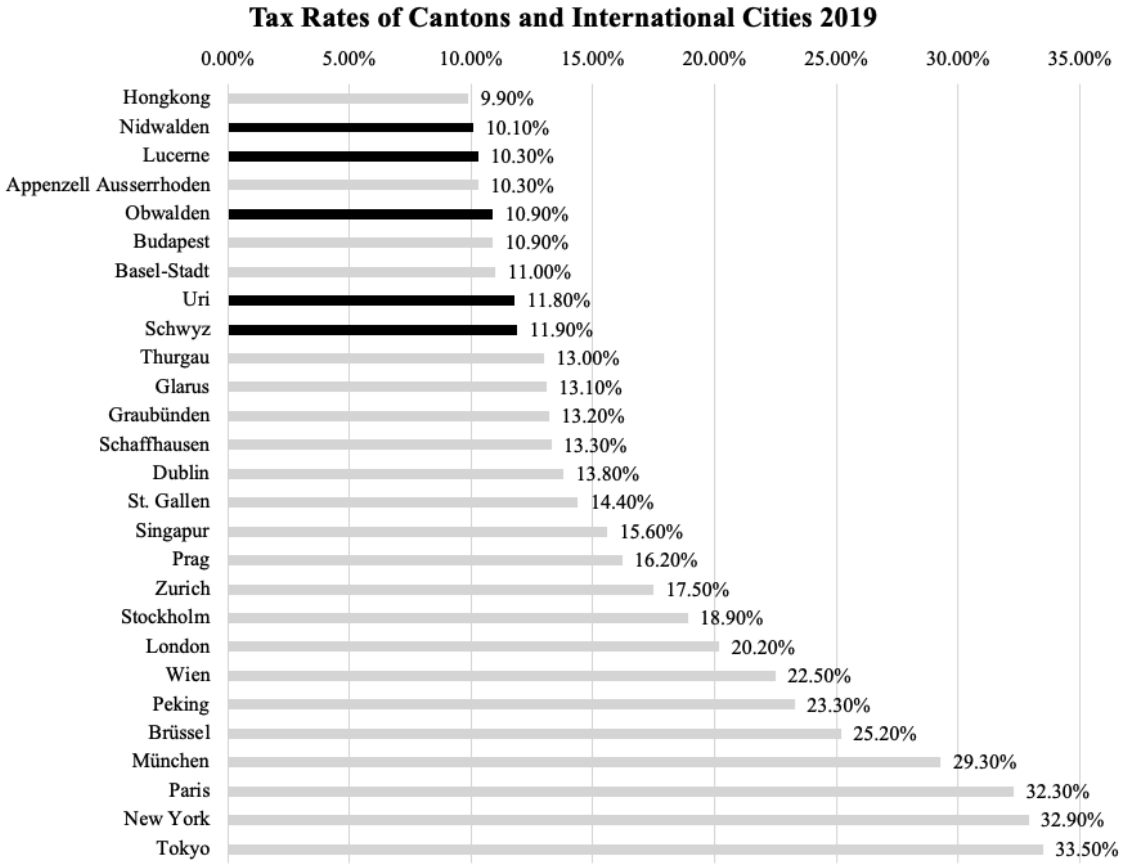


Figure 14: Tax Rates per Canton and selected International Cities (in style of BAK Economics AG, 2019).

Their ranking puts Nidwalden as the second most attractive location worldwide in terms of tax burden. Lucerne takes third place with Obwalden, Uri and Schwyz standing on rank 5, 8 and 9 respectively [7]. The exact ranking is to be digested with regard to the fact that this study was published before the Swiss tax reform took effect in 2020. However, since this is the latest publication as of the writing of this paper, it provides the most accurate ranking.

These rankings imply that Central Switzerland in general is a financially attractive region for Swiss and international companies. For international companies just looking for a cheap location to build a Swiss headquarters, Central Switzerland might be the ideal option. However, many companies might not want to rely on tax rates alone when choosing their location. For those who are looking for proximity to partners, specific infrastructure or special networks, the benefits might be worth the higher tax rates in other regions such as Zurich or foreign cities like London, Tokyo or New York. It must also be noted that while international holding companies and headquarters might bring in a lot of tax revenue for the region they do not necessarily create jobs for the population of Central Switzerland.

5.5.4 Exkursus - "Zentralschweiz Innovativ" - Location Promotion Program

The program "Zentralschweiz Innovativ" is governed by the not-for-profit organisation "Innovationstransfer Zentralschweiz ITZ". This program aims to support the Central Switzerland's economy through tailored measures, financially, through coaching and regarding network building in the region. The organisation builds on the assumption, that the Swiss economy and especially the economy of Central Switzerland is knowledge-based. As a result, innovation is the most important driver for this knowledge-based economy to succeed. Each canton has its own point of entry to the organisation to keep the barrier of entry as low as possible and the have targeted regional contact directly where it is needed. [149]. In addition to regional

trade associations and chambers of commerce, several start-up communities and educational institutes like the HSLU, the university of Lucerne and the Swiss Center for Electronics and Microtechnology are part of the network [150].

5.6 Summing up Central Switzerland

Putting together all of the information above, some conclusions regarding Central Switzerland can be made.

Firstly, despite the geographical closeness, the cantons of Central Switzerland vary in their characteristics. One of the poorest and one of the richest cantons of Switzerland are both part of Central Switzerland. The educational level of the population is as well different in the cantons. Especially the amount of people with a tertiary education differs. Connected to the educational levels, differences in the importance of the three economic sectors are identified. By taking a look at the generated map of Central Switzerland where the biggest employers, educational institutions and R&D initiatives are marked it gets clear, that these organizations are located close to the bigger cities with a strong focus on Lucerne. The cantons in the southern part of Central Switzerland is not a home to the big players.

Secondly and in contrast to the undeniable differences of the cantons, the merge of the six cantons to a region can be seen in, for example, location promotion initiatives such as "Zentralschweiz innovativ". Politically and economically local programs to foster innovation and growth are highly relevant to react to local circumstances. The cantons also seem to share a similar approach to corporate taxes as most of them have rather low corporate tax rates. This approach could be interpreted as an attempt to be an attractive location for international corporations.

A third aspect of Central Switzerland is the building of clusters. Clusters can, but don't necessarily have to, rely on political implied boarders. This means there is no such thing as a cluster of any kind in Central Switzerland alone, but rather a bigger picture has to be taken into account like for example the fintech cluster partly located in the canton of Schwyz but with a high relation to the canton of Zurich on a broader scale.

For most of the cantons, SMEs play a crucial role and are a driver for economic prosperity. However, as some of Central Switzerland's cantons are very small, the influence of just one global player in the corresponding canton is considerably high in that region. It is important to take both aspects into account: The potential international players bring to a canton in terms of revenue and image gains and yet the importance of large employers giving direct benefits to the population and are mainly the driver for prosperity and wealth. For Central Switzerland as a whole and for each canton, both points of view are equally important.

One final interesting factor is the perception of the importance of the tourism industry in Central Switzerland: While almost all cantons mention tourism as important in their strategies, the numbers of employees as well as the revenue generating companies do not operate in tourism on a large scale. Reasons for this different perception between the strategies and the hard numerical facts could be, that tourism is probably locally very important because many SMEs operate in that sector. Another factor could be the external perception of a region and the cantons: when a place is attractive for tourists, it accelerates other industries and sectors as well as the general positive picture of a region in terms of life quality.

Overall, it seems as all the cantons of Central Switzerland identified the importance of innovation, R&D and digital transformation for their economy and their own administrative processes. The region of Central Switzerland and each single canton follow a growth strategy regarding economical and social factors. Derived from existing initiatives, educational and research institutions and financial and political support measures, the region is subject to mid- and long-term wealth. Despite the regions heterogeneous characteristics, the six cantons form a unity, as Central Switzerland is one of seven officially defined regions in Switzerland and because of their collaboration in, for example, clusters and location promotion programs.

6 Analysis of Interviews

After the theoretical basis has been established regarding AI and Central Switzerland, the newly gained data through Interviews is now analysed.

6.1 Overview of the Data

The following table gives and overview of all the conducted interviews. Not all cantons are represented in these interviews. However, in terms of size of the population, the canton of Lucerne and the canton of Zug with the cities Lucerne and Zug are the biggest cantons of Central Switzerland. Therefore it is natural, that many companies are located in this region and more interview partners were available there.

Canton	**Industry**	**Role**
Canton of Lucerne	Tech (Media and Marketing)	CEO
Canton of Lucerne	Tech (Digital Marketing)	Founder & CEO
Canton of Lucerne	Energy	CEO
Canton of Lucerne	Energy	Lead Technology Manager
Canton of Lucerne	Insurance	Lead Analysis and Consulting
Canton of Lucerne	Publishing	COO and Co-Founder
Canton of Lucerne	Research	Head of AI Research
Canton of Lucerne	Healthcare	Lead BI and AI
Canton of Zug	Healthcare	CEO & Co-Founder
Canton of Zug	Network & Platform	CEO
Canton of Zug	Manufacturing	Vice President
Obwalden	Public Administration	Department Lead
Obwalden	Research	Head Industry 4.0
Uri	Manufacturing	Head of Innovation
Uri	IT & Engineering	CEO
Uri	Engineering	CEO

Table 6: Overview of the conducted Interviews (No executives could be sourced within the time frame of this project in the cantons of Nidwalden and Schwyz)

It is important to take into account that many of the interview partners were contacted because of personal contacts of the project supervisor or the team members. As the authors work on behalf of HSLU and stated to do so during all interviews, the interview partners might have been unconsciously biased in some interview questions, for example when asked about AI experts. As there was a broad set of questions asked, the authors assume no negative impact on the data for answering the research questions.

In accordance with the research design outlined in chapter 3.2, text units of the interviews are assigned a code which summarizes the content of the text units. The codes are then classified into categories. The iterative analysis process leads to ten categories and 61 codes. In this study, a category consists of at least four codes. The biggest category has eleven codes assigned. Table 7 lists all categories and corresponding Codes. The codes are ordered regarding the amounts of statements they consist of and thereby indicate their importance. The code which is listed first in a category, has the most amount of statements. The last code of each category

has the least amount of corresponding statements in that category. Appendix C shows in detail the categories, codes and statements as well as the amount of statements per code. Appendix D illustrates the amounts and categorizations of all the logical text units.

ID Category	Category	Codes
1	AI technologies & use cases	Predictive Analytics, Classification, Natural Language Processing, Computer Vision, Core business
2	Planned implementations and visions	Concrete Ideas, more insights, decision making will be easier, more companies will (need to) adapt to use AI
3	Future of AI in general	AI will become more democratized, privacy and security issues will need to be solved, abilities of aI will grow exponentially, hype/expectations will deflate
4	Reasons for adopting AI	Staying competitive, improving efficiency, having a lot of data, for the sake of AI
5	Requirements for AI adoption	Ability to live through cultural change, ability to provide clean data, interest in the topic, right people in the team, cross-functional discourse, explainability of AI, external factors prohibit adoption, financial factors prohibit adoption, recognition of ethical aspects, strategic alignment, no challenges
6	Processes for AI adoption	Clearly defined process for AI adoption, ideas come from customer's demands, external know-how, building internal know-how, companies are not using AI as they could
7	Know-how & network	Universities are good partners, Network not in Central Switzerland, Network in Central Switzerland, Network in Zurich, International Network, Region of Network not relevant, No Knowledge of AI-Network Platforms, no Innovation in Central Switzerland
8	Political support	There is support for startups, there is no support for startups, politics don't care about AI, Federalism is a problem, the taxes are attractive
9	Importance of location	location (in Switzerland) doesn't matter, Central Switzerland holds advantages compared to other Swiss regions, location of employee/employer is relevant, location of employee/employer is not relevant
10	Workforce	Need more good people, the good people are in Zurich, the good people are in the region, combination of domain & IT will be relevant, future employees will need AI/technical knowledge, soft factors are relevant, management must change abilities, good work life balance, salary, network influences recruiting

Table 7: Categories and codes of the interview analysis.

6.2 Findings

Each category is analysed separately in order to structure the analysis in a reader friendly and understandable way. Additionally, this procedure minimizes the risk of missing important statements and ensures, that all aspects of the data is considered for answering the research questions and for drawing the right conclusions.

AI technologies and use cases Out of 16 interviewed executives, 12 described concrete use cases for AI. Many of those use cases can be found in the field of Predictive Analytics, for example predicting the probability and/or date of a patient re-entering the hospital after a finished treatment or using predictive maintenance techniques to fix equipment before it fails. Other use cases described can be attributed to Natural Language Processing and Computer Vision. They mostly deal with Text-to-Speech or analyzing images or videos. Also, the categorization of Help Desk Tickets via NLP is a use case of a Central Swiss company. Further use cases lie in the classification of tax forms and insurance cases. Another use case is found in marketing analytics where an AI-based tool determines the ROI of certain marketing measures such as billboards or TV spots. A special use case lies in an AI writing its own beer recipe after analyzing other recipes. The executive called this an "Artificial Creativity".

In general, most of these applications are based on the technology of machine learning. This could imply that machine learning is an accessible technology to Central Swiss companies. The exact reason for this could not be identified by conducting the interviews, however it could relate to machine learning having a very good performance record.

It must also be noted, that three companies specifically define AI as the core of their business, so they will certainly keep developing new use cases that will be available for other companies to adopt.

Planned implementations and visions Most of the executives surveyed have specific ideas about their future AI plans and a clear picture of their vision. However, the differences of ideas and visions vary within the executives. For instances, a clear separation of human and AI tasks will take place. Others see the potential in marketing and sales and that it will be further exploited with the technology. They expect high investments, but also specific technical challenges in their field. Furthermore, a lot data will be extracted, evaluated and platforms for networks will be built where AI matches demand and supply.

Many expect that decision making processes will be greatly simplified, what provides plenty of small benefits in everyday lives and solve problems, that could not be solved in the past. It was mentioned that many repeating tasks will be executed by AI in ten years. Other mentioned fundamental changes in their industry, where everyone will be connected, and lives will be saved through more proactive systems instead of simply reacting to events like today.

A couple of companies are very much aware that they need to adapt to the technology but follow no specific strategy. In their opinion in five years AI will be used on a regular basis and enables new businesses. Furthermore, they will make use of it and fully exploit all advantages. One is also aware that they perhaps need to overthink their current business model to take advantage of future opportunities. Another AI experienced executive acknowledged a fundamental difficulty, which is the causal relationship that needs to be solved to go beyond the current development of AI.

In summary, most executives are optimistic and have concrete plans, expectations and visions of AI in their industry. Nevertheless, differences can be identified, especially among those who are already familiar with the technology and its challenges. They have usually a defined strategy, where the other have none (yet).

Future of AI in general In general, most executives believe that AI will become more democratized in the future. It should be used by the entire society in everyday products and not just from big tech companies for advertising and click-through rate optimization. Furthermore, neuronal networks become a commodity of everyday life. AI will have an exponential development until it becomes state of the art. The processing power will decrease, and the use of AI increases at the same time, what makes the development of AI so powerful. Thus, the technology and its exponential growth will have an impact on all industries, with almost no exception.

Nevertheless, interviewees raised also concerns regarding privacy and security issues, which need to be solved in the future. For example, the technology could be used from institutions to increase and improve

the monitoring of people and consciously influence them in everyday life. Data transparency will be an important topic. Other recognize that the freedom of private rights is already threaten. Therefore, a crucial task of future society will be to implement a data protection law.

It has been said that the hype will deflate, however no third AI Winter is expected. It will be important to have a realistic attitude towards the use of AI and communicate the same clearly to customers. Creating disappointment or false expectations on the part of customer must be avoided.

To sum up, the majority believe that the general AI development will have a positive impact on society. However, it has also been recognized that data security issues still need to be solved. A few voices called AI a hype and recommend some restraint, especially when it comes to communication.

Reasons for adopting AI Derived from our data set, the main reasons for adopting AI technology within a company are the expected efficiency gains and to stay competitive within the industry. The expected efficiency gains result in considerable savings for example in labour costs. A positive ROI is expected when implementing an AI solution. Another reasons for adopting AI technology lies in the demand of customers. There are cases, where AI is needed in order to satisfy customer demand and to create valued added for the customer.

Other reasons for adopting AI are not as tangible as the previous considerations. Participants of this study are aware, that they have a lot of data and now feel the need to use the latter to establish possible competitive advantages. At the same time, the data of this study shows that some companies do not know what exactly they want to do with all the data they have and how exactly AI can help them. As a result, companies feel pressure to adopt AI technology because of a fear of missing a trend. In few cases companies implement AI solutions because they need to show their innovative spirit and chose AI in order to do so.

Apart from some very tangible and some rather intangible reasons for adopting AI, one specific reason for AI adoption is improved security for example when it comes to fraud detection or the detection of anomalies in certain processes.

In total the reasons for adopting AI are homogeneous. There is no contradiction in the gathered data. All statements in this category complement each other, which implies consensus regarding the reasons for AI adoption within a company. This implies as well, that there are no considerable differences in companies' reasons for AI adoption between industries or between the location of a company.

Requirements for AI adoption The data shows that being able to implement AI technology heavily relies on one's ability to live through cultural change. Cultural change needs to happen on all levels within a company. Employees need to think innovative and must have a positive mindset towards digitization in order to ensure a successful adoption of AI. In this category, many statements regarding the availability and quality of data are included, which is another requirement for AI adoption. Both requirements bring challenges into a company. Cultural change is hard to achieve, as several statements include the fear of technology in general, personal skepticism or bad experiences towards new technologies and a lack of technical comprehension. Regarding clean data SME's face the challenge, that they are sometimes not able to provide clean data, as it is not their core business and as they do not have time for providing clean data. They are "too busy to innovate", which implies that AI adoption needs time and effort.

Companies need the right employees in order to adopt AI. The study finds the right employees need to have technical knowledge as well as business knowledge. It is crucial to ensure communication between all involved parties. This can also be linked to the subject of cultural change, as every employee within a company needs to know about initiatives and mutually interacting requirements for new solutions.

Some factors which prohibit AI adoption lie in external, financial and ethical factors. External factors include missing laws and regulatory security and the absence of incentives to be innovative. This is for example the case for companies which do not have competitors due to their state affiliation. Financial factors refer to the costs of innovation initiatives and the availability of budgets to initiate and carry out projects regarding the adoption of a new technology. Ethical factors are not necessarily a prohibition of AI adoption, but must always be recognized. Conversely, this means that requirements for AI adoption are the availability of budgets, the willingness to deal with ethical aspects of AI technology and a regulatory security from the legislators.

The data in this category is rather divers. Different industries have different requirements for AI adoption. As well the size of a company play a role for AI adoption processes. It is striking that the participants of

the study do not outline requirements exclusively for AI adoption but for implementing new technologies in general. The location of a company does not have an influence on the needs of companies for adopting AI withing their processes.

Processes for AI adoption Most interview partners favour a clearly defined process for implementing new technologies in general. AI solutions are seen as such a new technology. Whereas most of the interview partners rely on a clearly defined process, the process itself varies. Bigger companies have a more structured approach for implementing new technologies. Smaller companies tend to have a more iterative approach with fast decisions. Especially for AI solutions the data shows a need for iterative approaches where cycles of training, testing and adopting the new solution take turns. The ideas for implementing an AI solution come on the one hand from customers and on the other hand from personal interest and exchange with ones network. Depending on where the idea comes from, the process for AI adoption starts differently with sometimes more and sometimes less stakeholder engagement. Another difference in the processes can be found in the importance of external knowledge. Some companies specifically rely on external consulting partners to get new ideas and to implement an AI solution. Others focus on building internal AI knowledge for the long term. Exchange about solutions and adoption processes are seen as positive by all interview partners. Yet the data shows a surplus on the possibilities AI offers to companies and a deficit on the speed of companies adopting AI. AI experts claim that the market, represented by companies which are not specialised in technology, does not know yet what it wants in terms of AI usage. This influences the AI adoption process as there is an imbalance of knowledge and therefore speed within companies. Overall, tech and consultancy companies have a more strategic process for adopting AI. They know of the importance of iterations and of the importance of clean data. As well, they tend to have a broad knowledge base within the company. Larger companies usually rely on initiatives which need a dedicated amount of time for stakeholder management and convincing management and colleagues. This makes them slower. The process for AI adoption does not differ from a geographical perspective.

Know-how and network When talking about network and partners, most interview partners mentioned that they work together with universities. Out of 9 statements, the HSLU was mentioned 7 times. However, it must be noted that most interview partners were referred by the supervisor of this study who teaches at HSLU. Other mentioned universities included the ETH in Zurich (2), the ZHAW in Zurich (1), the university of Lucerne (1) and the EPFL in Lausanne (1). One interview partner even interpreted that companies will probably reach out to their nearest university as a research partner. This implies that in Central Switzerland, the HSLU holds a strong position as the first point of contact for companies looking to adopt AI.

In terms of location of the network, the answers were very heterogenous and even contradicting. About half of the interview partners mentioned they had a great network in Central Switzerland and they could find all necessary know-how in companies located the region. One even stated explicitly that there is no need to reach out to Zurich since deep expert know-how can be found in the region. The other half of interview partners however stated their network was not located in Central Switzerland specifically but rather spread across the nation or international.

The reason for why they don't have a network in the regions were mostly identified as not knowing where to look for partners or already having a big network that can answer their questions. One partner even stated that there is no innovation happening in Central Switzerland regarding AI. Another reason why networks are not always built regionally is that many interview partners see AI not as a regional topic but an international one. So they are looking for partners that are most competent no matter where they are located. As the COVID-19-pandemic has shown, we can now connect with people across the world within seconds. As one interview partner mentioned: "It doesn't matter who you have a Zoom call with as long as that person is competent."

The challenge for networks in Central Switzerland or Central Swiss companies in the AI industry therefore seems to be the communication of their existence and their knowledge. A known network that promotes these companies would certainly help Central Switzerland gain a bit more recognition for the know-how that is already available locally.

Political support Out of the interviews a pronounced political support for AI could not be observed. A potential reason for the lacking support is that AI is a self sustaining industry which is booming. Another reason for the lack of support is that AI is still is seen as a threat therefore it is not popular to support AI.

So the companies who were interviewed are on there own and do not get any support because of there AI business.

Although there is little political support for AI, there is support for start-ups, regardless if there business has to do with AI or not. The support varies significantly between from a very good support until a no support. The same variance applies for the covid pandemic support too. In the canton of Zug for example the support for start-ups and smaller businesses was excellent. The government reached out proactively to potential companies which were needing support due to the covid pandamic. In other cantons the situation was almost the opposite, because there was little to no support and it was challenging to get it.

No interview partner from a big and well established company received support for their AI business. AI is in these established companies mostly not a core business and therefore the demand and the necessity for specific AI support is not strategic enough.

The political support for AI in central Switzerland is rather limited and heterogeneous. However, the interviewed start-ups get helpful support. In contrast the interview partners from bigger companies do not get any AI related support.

Importance of location The location determines mostly the employees of the company, because most people prefer a short commute. Locations close to a major train station or to a highway is desirable in order to minimize the commute. Further, locations influence also salaries, what increases the attractiveness of a region as well.

The region Zurich is seen as competitor to Central Switzerland through there high salaries and the big tech companies, which convince with high salaries and interesting work for the AI employees. Because of Zurich and the general scarcity of AI employees it is challenging for the companies in Central Switzerland, who were interviewed, to find suitable employees. For interview partners who get external AI experts on a project bases do not suffer from this problem. For them it does not matter from where the AI experts are coming from, especially today when every body is just a video call away.

The city of Zug has the unique advantages in Cenral Switzerland being close to Zurich with all the AI knowledge and the developing crypto community in the city of Zug also known as Crypto Valley. Another positive aspect for the canton of Zug are the low taxes. Also Schwyz and Nidwalden have low taxes which are attracting companies.

Another common opinion is that the location in Switzerland itself does not matter, but being in Switzerland is an advantage. Switzerland itself is attractive because of its excellent educational system and the general international importance.

The importance of the region depends on the company itself. For the interviewed companies with AI as their core business it is a challenge to find suitable employees. However for companies which are relaying on external AI experts the region does not matter.

Workforce The interview partners unanimously agreed that capable employees in the AI sector were scarce. However, they disagreed on where those employees could be found best. Half of them argued that the competent people could be found in Zurich and are more easily accessible in a location close to Zurich, such as the city of Zug. Some stated that even though the train connections to Zurich are good, people from Zurich rarely commute to Lucerne or Kriens. Companies from other locations like Uri or Obwalden did not talk about bringing in employees from Zurich. A few interview partners argued that there is talent available in the region but certainly not as much as in Zurich. For some that is an advantage because the fight for employees in the region is not as big as in Zurich. The interview partners specifically mentioned that it is easier to find Data Scientists in the region and Crypto experts in Zug.

It can certainly be said that the demand for competent people is rising amongst our sample and while many companies are still convinced the big part of the talent is located in Zurich, there are also companies that see more talent being formed within the region. Having such talent available in the region might be an opportunity for local companies, especially in cantons more distanced from Zurich, to catch up to competitors that have had talent more readily available to them in the past.

The interview did not just consist of finding indicators where talent might be located but also which skills employees will need in the future to cope with AI. The interview partners agreed on most terms that a combination of domain and IT knowledge will be relevant in the future. However, interview partners differed

in their expectations on how extensive this knowledge must be. Some want their employees to have master degrees and concurrent work experience, others are fine with basic programming skills. The tendency over all interview partners seems to lean more towards graduates with rather little experience but, in turn, the latest insights into AI research. More homogeneous answers were given in relation to the domain experience. There, the soft factors seem to play a much bigger role. A key term in the statements is "open-mindedness". The companies in our sample are looking for employees that can adapt to the situations they're in, are curious and willing to learn and think analytically and abstract. In conclusion, they are not just looking for trained AI-experts that know the latest about the topic but that are also able and willing to learn and understand the specifics of each industry they work for.

The following table 8 summarizes the key findings of each category. These findings are high level and intend to give a broad overview of the latter. For detailed analysis and interpretation the corresponding paragraphs above as well as chapter 7 have to be read.

ID	**Category**	**Key Finding**
1	AI technologies & use cases	Many use cases of Central Swiss companies apply the technology of machine learning. Use cases are found in the field of predictive analysis, natural language processing and computer vision among others.
2	Planned implementations and visions	Most executives are optimistic and have concrete plans, expectations and visions of AI in their industry.
3	Future of AI in general	The majority believe that the general AI development will have a positive impact on society. However, it has also been recognized that data security issues still need to be solved.
4	Reasons for adopting AI	The main reason for adopting AI in the sample data are the expected efficiency gains and savings.
5	Requirements for AI adoption	The ability to live through cultural change is the main requirement for AI adoption.
6	Processes for AI adoption	Companies rely on structured processes for adopting new technologies such as AI, yet the process itself differs related to company sizes and industry focuses.
7	Know-how & network	Many partners don't know where to start looking for local partners, except for approaching the local university. But they prefer an international network, anyway.
8	Political support	Out of the interviews a pronounced political support for AI could not be observed.
9	Importance of location	A common opinion is that the location in Switzerland itself does not matter, but being in Switzerland is an advantage.
10	Workforce	Demand for AI-talent is rising as supply remains stagnant with most Swiss talents residing in Zurich. However, there is a slow growth in Central Switzerland.

Table 8: Key Findings of each category

7 Answering Research Questions and Strategic Impacts

After the description and analysis of the data in the previous chapter, the research questions are answered. This step takes not only the newly gained data into account, but also the general research on AI outlined in chapter 4 and on Central Switzerland as outlined in chapter 5.

7.1 Answering of Research Question 1a

How does AI influence different industry players and R&D institutions in Central Switzerland?
In order to answer research question 1a it is important to verify *if* AI influences the parties in question in Central Switzerland. Relying on the data set of 16 conducted interviews, AI does influence all kinds of industries in the region. In the sample data, the general tonality towards AI is positive. Many expect positive effects in terms of efficiency gains or even new business models. This is of particular interest, as chapter 4.2 explains past AI winters in relation to the Gartner Hype Cycle. Just like the authors state in the latter chapter, the interview participants of this study do not expect another AI winter. At the same time, there are challenges which have to be met. As the theoretical bases in chapter 4.5.4 shows, one main challenge when thinking about implementing AI solutions is the dependency on high quality data. The analysis of the interviews proves this challenge to be true by many industry representatives. The data shows a gap between what AI offers and what is able to solve already today and what industry players have implemented up to today. Additionally, companies that tend to be classified as larger companies, claim to need help in identifying the right use cases for their purposes. While in our data all companies are aware of possible positive effects of AI solutions in general, some tend to be troubled in evaluating and assessing which specific problem could be solved with AI. (Tech) Consultancies and R&D institutions claim that the market in various industries does not know yet what it wants. At the same time, a barrier to start dealing with AI solutions can be identified in the data, as companies without existing AI knowledge show aversion to AI because of missing laws, regulations, precedence cases and ethical reasons.
Clearly, AI does influence different industry players and R&D institutions in Central Switzerland in a strong and mostly positive way. However, AI poses new challenges which can only be addressed with the right resources. Therefore, while AI itself positively influences the different parties in terms of innovation, process automation and even new business models, it binds at the same time highly valued resources within a company and leads to expenses. The authors see the tied up resources and the initial costs of knowledge and experience building as something that occurs regularly when adopting to new technologies. It is the trade-off between being innovative and continuing to work in existing ways. The data shows as well a tendency from AI professionals that AI becomes cheaper and more broadly democratized, which could balance the short term challenges and expenses. In conclusion, AI positively influences the different industry players and R&D institutions in Central Switzerland.

7.2 Answering of Research Question 1b

What is the perception of regional industry players and R&D institutions towards Central Switzerland in terms of AI?
The perception of the region Central Switzerland in terms of AI differs in the dataset. In general, Central Switzerland is seen as a location which is attractive for employees and employers likewise. Looking at the low corporate tax rates and at the low rate of unemployment in all cantons of Central Switzerland in chapter 5, this is ought to be true. The successful establishment of the city of Zug as the Crypto Valley shows that it is possible to establish a technology cluster in Central Switzerland. At the same time, Zug is geographically very close to Zurich. This geographical closeness to Zurich is seen as an important factor for companies in central Switzerland when it comes to recruitment and social networks as the data shows. This results in a field of tension when trying to make statements about Central Switzerland as a region: The six cantons are so diverse that it is not possible to generalize a success story from one canton, as more factors have to be taken into account than just the political construct of six cantons forming a region. At the same time the data indicates, however, that the importance of the location of a company as well as of the places of residence of employees declines. Location is not totally unimportant, but the data suggests that employees who work in technology or IT are willing to live further away from their employers as there is no obligation to be physically present in an office for five days a week. In this context, the data shows as well a generally distinct focus on the region of Zurich when it comes the presence of other companies and technological affinity. Whereas the

HSLU plays an important role for Central Switzerland, both, in terms of education of future employees and in terms of consultancy offers and expert knowledge for the industry, the data indicates an importance for the presence of a top university such as the ETH in Zurich or the EPFL in Lausanne.

7.3 Answering of Research Question 1

What are the strengths and weaknesses as well as the opportunities and threats to the economy of Central Switzerland related to AI?

In order to answer research question 1, the arguments in the answers to research questions 1a and 1b as well as some additional findings from chapter 6.2 are consolidated and arranged in a SWOT-matrix (see figure 15).

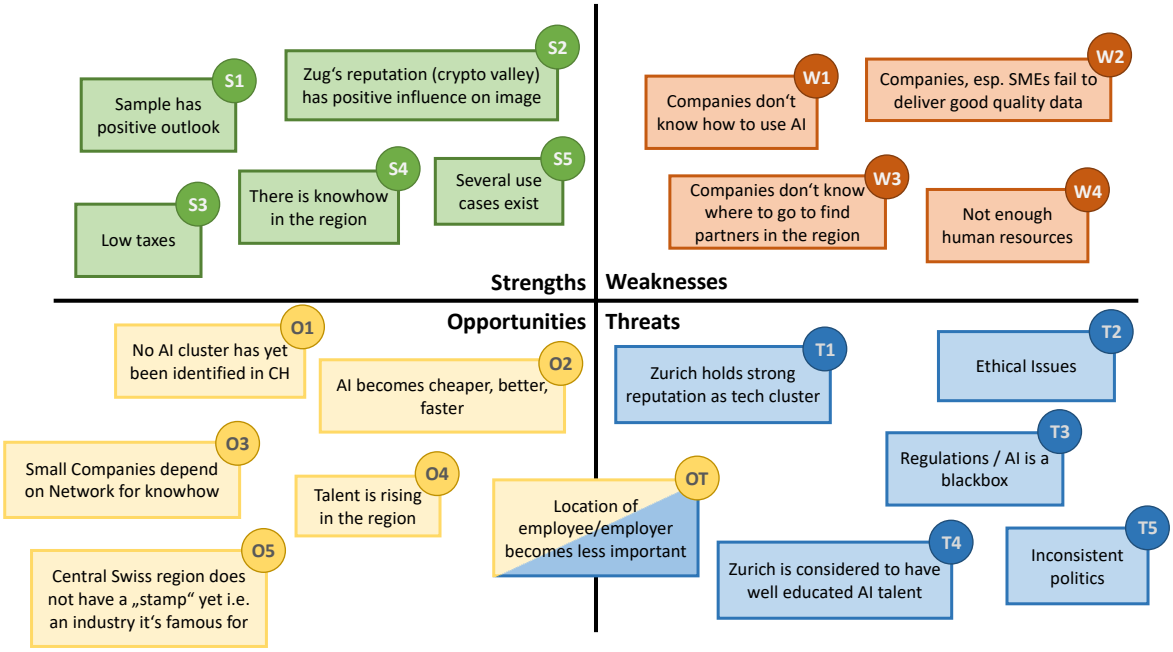


Figure 15: SWOT-matrix resulting from analysis and theory.

Research question 1a explained that companies in Central Switzerland are being positively influenced by AI. Some companies in certain industries however are prohibited of using AI because of regulations or ethical issues that first need to be solved on an international level (T2, T3). Nevertheless, the outlook towards the future of AI provided by our sample is very positive: More and more companies are planning to adopt AI but they need guidance on how to do it (S1, O3, W1, W2). Although there is knowhow and use cases to be learnt from available in the region, many companies don't know where to start looking for partners (S4, S5, W3). So, the question is: "How can companies that offer knowhow be found by companies looking for it?" This question will further be evaluated in chapter 7.4.

The SWOT-matrix also shows that in addition to not knowing where to start with an AI project, companies also struggle to attract AI talent (W4). This, in part, can be traced back to the fact that most talented AI people reside in Zurich. However, some professionals see a rise of talent in the region of Central Switzerland. If their education is of comparable quality to Zurich's talents, it might be an indicator that Central Swiss companies will get better access to employees for their AI projects (T4, O4). Another possibility to attract talent to the region in general would be the formation of an AI cluster. Literature Research shows that there is no one single AI cluster identified in Switzerland itself. Since Central Switzerland is not yet known for any region-wide clusters this could prove to be the perfect opportunity (O1, O5). Especially, since the region might be able to profit from the reputation of the tech-clusters in Zug and Schwyz, which would allow the region to keep up with Zurich's big reputation as tech cluster at least a little (S2, T1).

The fact that the relevance of location is declining can be seen as an opportunity or a threat (OT). The authors interpret that it is a matter of timing which one it will be for Central Switzerland. If Central Switzerland is able to build a community and even a cluster of AI experts and companies, this aspect will prove to be an opportunity since this community or cluster will be recognized nation-wide and possibly even internationally. However, if another region is quicker in building a well-connected community or cluster that is nationally and internationally recognized, Central Switzerland will probably lose its experts and companies to that region.

7.4 Strategic Impacts

From a strategic point of view for the region it is favourable to promote a platform or a network where the local economic players get access to technology and consultancy service providers dedicated to AI. The authors assume AI to be democratized in the future and accessible to many. With the rise of digital natives as employees, the basic technological knowledge and education of each employee will be on a much higher level than it is today. For this reason, new technologies will thrive more easily when they prove to be as efficient and effective as anticipated. AI already proved to facilitate many aspects in many processes, not only for companies but as well in everybody's private life. Therefore, despite declining importance of location, a local center can only help the local economies. Now it is important to take into account, that such initiatives already exist. Future research needs to evaluate the exact need of the local economic players and match this need with existing networks. Additionally, future research should focus on evaluating the importance of Zurich as a technology hub, as Zurich was mentioned very often in the data. This will allow for a conclusion, if an AI hub in Central Switzerland stands a chance against the influence of Zurich. The rather disparate data on Central Switzerland and the theoretical comparison of the cantons indicate, that a single city with its surroundings and catchment areas has a larger potential to be associated with a hub. This holds true for the many mentions of Zurich and of the city of Zug. Therefore a city should be promoted as a center of interest for a certain technology like AI when building a network and not a whole region. A city is far more accessible and understandable for potential network partners compared to talking about a region. For Central Switzerland this means, a well known city with a thriving ecosystem should be chosen as a starting point for promoting AI in the region. The authors see Lucerne or Zug as such a city. As Lucerne is more centrally located for the region, it should be chosen as a starting point for establishing an AI centre. Zug already gets associated with the crypto valley which makes it harder to establish a new technology with that city. Additionally, Lucerne is closer to the southern cantons of Central Switzerland which makes it easier to include them. As well, this step should happen fast. As no AI cluster could be identified so far, but Zurich was mentioned several times in the interviews as an important location for technology, the first to establish a successful network will have a promising position in enhancing the AI ecosystem and in establishing an association between a location like Lucerne in Central Switzerland and an AI center.

Furthermore, the economy not only in Central Switzerland but in Switzerland as a nation needs regulatory security. This is especially important for larger companies which tend to be more risk-averse.

For the economy, there are lots of use cases yet to be exploited. AI can solve many problems, but other concern might arise. It is open, if the positive aspects can outweigh the negative ones. The authors expect mainly positive effects. Only in the case of an external shock, e.g. a massive publicly known ethical missuse of AI, the technology will in short and midterm lose attractiveness.

For the HSLU and other educational players, AI proves to be a key topic for the future, where education is needed. This insights can be scaled not only to AI, but to technological knowledge in general.

8 Conclusion

In this chapter the complete paper gets recapitulated and in the end the authors recommendations for further research can be found.

The literature research in chapter 2 has shown that there is no study which is focusing on AI in Central Switzerland after searching for defined keywords in the search engines Google Scholar, Microsoft Academic, Web of Science and Scopus. Although there are 15 potentially relevant documents with a similar content which all of them undergone an evaluation for its citation eligibility, citation worthiness and relevance. All these papers are focusing on other parts of the world and are researching the regional situation of AI. The unique setup of Switzerland makes it difficult to transfer the findings of the other papers to Central Switzerland. Furthermore, 12 of these papers are based on secondary data and pure desk research with divers research subjects and objects, which enhances the difficulties for a comparison. So was the research gap identified and confirmed.

For this identified research gap a suitable research design was created for elaborating primary data through qualitative interviews with executives. The data should cover several aspects of the usage of AI and the perception of Central Switzerland in terms of AI usage. Therefore, the interview partner should cover a broad spectrum of expertise. The interviews are semi-standardized allowing flexibility for a good knowledge extraction and still show a clear pattern for a better comparison for the analysis. The interviews are conducted with two authors in order to gather every information from the interview partner and are discussed directly afterwards. Because of the exploitative-qualitative data acquisition the data is analyzed with qualitative method of category building with the steps, *case related evaluation, segmentation and Analysis, Coding* and *Categorization*. All the statements and answers of the interview partners are segmented into logical text units. In a second step all the same text units are added up to indicate the frequency of a text unit. In the last step the text units are categorized into thematic content areas.

Chapter 4, *Artificial Intelligence*, starts with a brief overview about the history of AI and the most influential milestones from the "birth of AI" until to the present. Beside the achieved milestones, the cause of the two AI-Winters were described. Regarding a third AI-Winter, the authors argued that their will not be a third AI-Winter, because AI is deeply embedded into the day-to-day life and their are numerous AI technologies in the development pipeline, which provide a continuous release of new AI technologies. Perhaps some technologies can not keep up with the expectations and will fail, but the complete field of AI will be unharmed. Beside the past and future of AI, the current situation was analysed. The main subcategories of AI were identified and described. In order to enhance a better understanding of the theory, common use cases of AI are presented to sensitise the approximation of AI. Another major part of the chapter *Artificial Intelligence* are the ethics of AI, which describes the unawareness and the difficulty of the distributed responsibility of AI systems. Also the reasons for the competitive challenges of ethical AI and the general declining interest of big tech companies in ethical AI are described. The resulting counter measurements taken by institution like the European Commission, because of the worsening situation.

In the chapter 5.3 , *Central Switzerland*, the economies, laws and other aspects of the cantons within Central Switzerland are in the focus. The research shows that the cantons are in general heterogeneous. One of the poorest and one of the richest cantons of Switzerland are both part of Central Switzerland. The educational level of the population is as well different in the cantons. The difference in the educational level is mainly in the tertiary sector. The corporate taxes of all cantons in Central Switzerland are below the average in Switzerland and Nidwalden and Lucerne have the world wide second and third lowest cooperate taxes. Therefore the region has an financial advantage over other cantons in Switzerland and also in an international comparison. Another interesting fact is that the tourism industry is mentioned in almost every strategy map as important, but the numbers of employees as well as the revenue generating companies do not operate in tourism on a large scale. The authors assume that the importance of tourism is crucial for SME's and by promoting the tourism industry the region gains in attractiveness. Overall, it seems as all the cantons of Central Switzerland identified the importance of innovation, R&D and digital transformation for their economy and their own administrative processes.

In the second part of this paper the focus lies on the 16 conducted interviews and their analysis. Most of the interview partners are working in the upper management of companies with variant amount of employees in different industry sectors of Central Switzerland. Based on gained knowledge out of the conducted

interviews, the research questions were answered. Out of the data it is clearly visible that all interviewed companies have AI at least in some form on their roadmap. The majority is already using AI in their processes to support their core business. In other companies AI is deeply woven into their core business or is their core business. The data shows that some companies have clear goals which they want to achieve with the aid of AI and others have accumulated data and are figuring out an AI based use case for this data. It is also visible that the opinion about the location differs. Many companies are operating exclusively with experts and knowhow from Central Switzerland and others have an international network. It can be said with certainty that AI knowhow is available for all use cases from the interview partners within the region through AI experts in consulting companies and at the HSLU.

Additional to the information needed to answer the research questions supplementary findings were made. For one the need for a well established network or platform was identified to exchange about AI related technologies and also to find suitable AI experts. The expertise is already in the region and some individuals have built a strong but personal network. So the goal would be to make the existing knowhow and network accessible to the public in an appealing way. Further research needs to be done to identify all of the already existing public networks and knowhow hubs to make us out of potential synergies in order to create one well established and powerful network in Central Switzerland. This network should be the place to go with all AI related questions in Central Switzerland. The location needs to be chosen wisely regarding accessibility, political support and other factors to ensure the success of this knowledge hub. The interview data shows that a concentration of companies is located in the city of Zug and the city of Lucerne and in between those cities, see also chapter 5.3. So it would make sens to locate the hub in this region to make use out off already existing knowhow and networks. The southern cantons of Central Switzerland are geographically and culturally closer to the city of Lucerne than to the city of Zug, because of that the authors recommend placing the hub close to the city of Lucerne or directly in it. As mentioned above, the demand for such a hub excised already and should be satisfied, otherwise companies will get the support from alternative source. Because of that the authors believe that now is the time to promote such a hub in order to not get overtaken by other regions. Zurich for example was mentioned several times as a technology hub in general with a high potential for an AI hub.

Appendix

A Appendix: Interview Guide

Lucerne University of Applied Sciences and Arts
HOCHSCHULE LUZERN
Informatik

AI in Central Switzerland

Interview Guide

In this document you can find the main interview questions, which touch on the subjects we would like to discuss in the interview. It will be a semi structured interview, which provides room for flexibility regarding the interview questions.

Interview Questions

AI

1. How does AI affect your organization and your industry sector?
2. Is your organization already using AI?
   If yes, for how long? Was the implementation exceptionally difficult? How is the result and performance of you implemented AI?
   If no, have you ever thought about using AI? Why did you decide against it?
3. How does your process look like for implementing new technologies, like AI?

Central Switzerland

4. Do you think central Switzerland as a region is a good place for your company in general and in terms of AI? Why (not)?
5. Who would you ask locally, if you need expert knowledge or resources in an AI project?
6. How would you characterize future employees, which you need in the AI environment?

General Question

7. If you had to make a prediction into the future regarding AI usage in your industry and/or in general, what would it be (e.g. trends, threats, challenges, personal expectations)?

B Appendix: One Pager

Project Overview

AI in Central Switzerland

regional Study

Project Members


Iris Amrein
CRM Consultant, SugarMountain GmbH


Tina Messner
Business Consultant, Inacta AG


Sascha Sutter
Business Analyst, Kantonsspital Winterthur


Michael Ulrich
Technical Sales, IBM

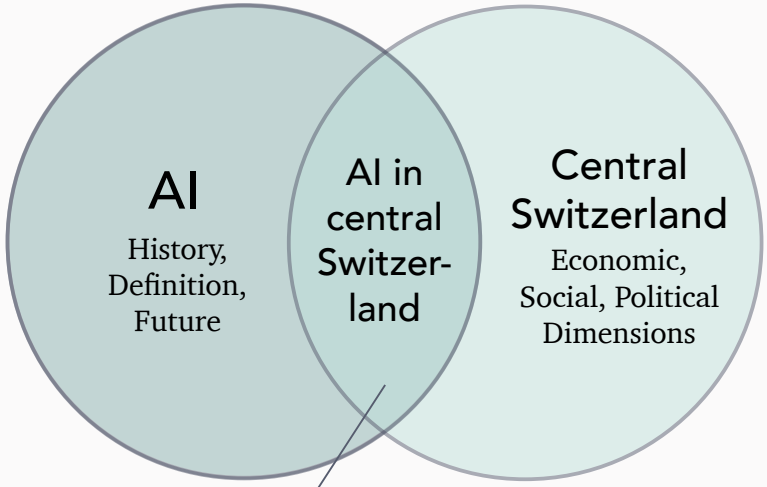
Project Owner


Dr. Donnacha Daly, PhD
Head of AI & Machine Learning, HSLU

This Project is conducted as part of the HSLU's Master of Sciences Program in Business Informatics. The findings of this study will be integrated into further studies by the NGO *LAC²*.

Topics / Structure

The regional Study first looks at the topics of Artificial Intelligence and the region of central Switzerland separately to gain an understanding before connecting the two topics through interviewing companies in the region that are interested in or already using Artificial Intelligence.



Goals

- Gain a deeper understanding of how AI is being used in the region (Key Factors, Success Stories)
- Get an insight into how fit the region of central Switzerland is in terms of AI? (Strength and weaknesses, education and research programs)

C Appendix: Interview Analysis

Overview

Question	Category	Code	Sum
Influence of AI on Regional Players	AI technologies and use cases	Predictive Analytics	4
		Classification	2
		Natural Language Processing	2
		Computer Vision	1
		Core Business	3
		Others	4
	AI planned / vision	concrete Ideas	7
		More insights	2
		decision making will be easier	3
		more companies will (need to) adapt to use AI	5
	Future of AI in general	AI will become more democratized	5
		privacy and security issues will need to be solved	5
		abilities of AI will grow exponentially	2
		hype will deflate / expectations	2
	Reasons for adopting AI	Staying competitive	6
		Improving efficiency	6
		Having a lot of data	3
		For the sake of adopting AI	3
		others	1
	Requirements for AI Adoption	Able to live through Cultural Change	7
		Able to provide clean data	6
		Being interested in the topic	3
		Having the right people on the team	3
		Cross-functional discourse	3
		AI must be explainable to adopt it	3
		External factors prohibit adoption	2
		Financial topics prohibit adoption	2
		Ethical aspects must be recognized	1
		Strategic alignment must be met	1
		there were no particular challenges	1
		others	1
	Processes for AI adoption	Clearly defined Process for AI adoption	6
		Ideas come from Customer Ideas/Demands	3
		Find Knowhow externally	4
		Keep/Build Knowhow internally	3
		Companies are not using AI like it could be	2

Perception of the Region in terms of AI	Knowhow / Network	Universities are good partners	9
		Network not in Central Switzerland	8
		Network in Central Switzerland	6
		Network in Zurich	3
		International Network	3
		Region of Network doesnt matter	2
		Knowledge of network plattforms	2
		no Innovation in Central Switzerland	2
		others	2
	Political Support	There is support for startups	3
		There is no support for startups	1
		Politics don't care about AI	2
		Föderalismus is a problem	1
		The Taxes are attractive	1
	Importance of Location	Location (in Switzerland) doesn't matter	4
		Central Switzerland holds advantages compared to other swiss regions	4
		Location of employee/employer is relevant	1
		Location of employee/employer is not relevant	2
	Human Ressources / Workforce	Need more good people	5
		The good people are in Zurich	4
		The good people are in the region	4
		Combination of domain and IT will be relevant	7
		Future Employees need AI / technical knowledge	6
		Soft factors are relevant	5
		Management must change abilities	1
		Good work life balance	2
		Salary	2
		Network influences recruiting	2
		others	3

Codes and their respective statements

INFLUENCE FO AI ON REGIONAL PLAYERS

AI technologies and use cases

Predictive Analytics

- Automated Order Prediction
- Calculation of possible Re-Entry
- Predictive maintenance
- Marketing Analysis and Prediction

Classification

- Classification of tax forms
- Classification of insurance cases

Natural Language Processing

- Abstract Dubbing
- Help Desk Tickets NLP

NLP and Computer Vision

- Image & Video Analysis

Core Business

- There were three companies that mentioned AI was their core business

Others

- Fall detection
- Cost Estimator for complex machine jobs
- Beer Brewing
- Recommender Tools for Engineering Questions

AI planned

Concrete Ideas

- clear separation of AI and Human Tasks
- Potential in Marketing & Sales
- Expect high investments in MarkTech
- Public Admin would be able to extract a lot from their data
- Platform for network building where AI matches needs & offers of network Participants
- Connected Healthcare / save lives in health-care
- electromobility will certainly be a challenge

To generate more Insights

- detailed customer data evaluations
- the mapping of causal relationships will be a fundamental challenge of AI in the future

Decision making will be easier

- For the future, it is expected that everyday decisions will be taken away. Many small benefits in everyday life due to AI
- Expectations and the hope for an increase in value due to many small support systems and decision-making aids in everyday life
- AI will certainly help to solve problems that could not be solved in the past

More companies will (need to) adapt to use AI

- No concrete plan, but he vision to use AI in 5 years on a regular basis
- in 10 years, the majority of repeating tasks are done by AI
- AI enables new Businesses
- fully exploit all advantages of aI.
- Business Dev. Is dictated by AI
- Perhaps we need to adapt our own business model to take advantage of the opportunity

Future of AI

AI will become more democratized

- AI is becoming democratized
- AI should be used by society in everyday products and not just from big tech companies for advertising optimization/click-through rate optimization
- The neuronal network becomes a consumable good
- AI will have an impact on all industries

- AI will have an exponential development until AI becomes state of the art. The processing power will decrease and the use of AI will increase. This is a strength of the current AI development

Privacy and Security Issues will need to be solved

- it could also be used to control people/Employees
- Data transparency will certainly be a sensitive issue in the future
- Threat lies in the freedom of private rights
- negative is the data security issue, the legal issues and the privacy of the data will be major issues for us as a society
- The adaption of data protection laws will be important

Abilities of AI will grow exponentially

- AI will have an exponential development until aI becomes state of the art. The processing power will decrease and the use of AI will increase. This is a strength of the current AI development
- The sector will be very shaken up, the development will meet exponentially

Hype will deflate

- hype will deflate, but there won't be a third winter
- It's a hype, look at the possibilities realistically and communicate clearly to customers. A realistic attitude to the use of AI must be made clear to customers

Reasons for Adopting AI

Staying competitive

- To stay competitive in the market, otherwise a huge market will get lost improve processes and current products
- To stay innovative with leading edge technology
- customer demand
- added value for Customer
- clear trends in the sector visible

Improving efficiency

- reduce labor costs
- Be more efficient and use the data that is there anyways
- Optimizing complex ordering process which is a core business
- improve processes and current products
- Improvements in AI projects bring millions
- Positive ROI of the initiative

Having a lot of data

- Companies collected a lot of data but don't know what to do with it
- We had a lot of structured data and thought "there must be something we can do with it"
- Be more efficient and use the data that is there anyways

For the sake of adopting AI

- Innovation managers need to fill their quota
- Most companies don't have a specific problem for aI to solve, they just want to adopt it
- AI is becoming a mass product and it's becoming cheaper

Others

- For more security (fraud detection, anomaly detection)

Requirements for adopting AI

Able to live through Cultural Change

- people/employees need to think technologically and innovatively
- Companies must want to work with data and be innovative else projects will fail
- positive mindset towards digitization to be successful (that's often hard for people who work with other people that lost their job due to it, i.e. social work)
- people need to be able to handle change
- employees need to accept the technology, esp. In public admin people are insecure about tech
- Cultural Change required within the company
- The technical solution is challenging. The cultural and organizational change is the biggest challenge.

Able to provide clean data

- SMEs are sometimes not able to extract data from their system for AI to work with
- The old software generates not AI applicable data --> labor intensive data labelling is required
- Big challenge is data security. Many are afraid of providing their data. Lack of trust
- The real challenge lies in correctly labeled data
- The difficult part is the correct labeling of the data. The data must be in a high quality structured form. Transfer learning is very strong, and is being used more and more
- In video analysis, the big challenges are the traction data. The manual data label is very time consuming. The need for resources is great

Being interested in the topic

- SMEs are too busy for innovation
- Personal interest of people on middle Mgt. Level
- Show initiative and do trial & error

Having the right people on the team

- Building, Testing Models/Algorithms needs a lot of creativity and effort
- you need a diverse Set of employees with different expertise (statistics, AI, Creativity)
- Having the right people on the team is a big challenge

Cross-functional discourse

- The most important thing is for Data Scientists and Domain Experts to talk to each other
- you need a diverse Set of employees with different expertise (statistics, AI, Creativity)
- for project you always need technical experts and domain experts

AI must be explainable to adopt it

- Phyisicians are very critical towards AI. Therefore, it needs explainable AI, not a blackbox
- The lack of reproducibility and explainability pose major problems
- The maturity of a technology must be very advanced before adopted

External factors prohibit adoption

- Regulations often slow down innovations
- No incentives of the swiss health care system to optimize the service (AN: no incentive to invest resources)

Financial topics prohibit adoption

- budget must be available
- No incentives of the swiss health care system to optimize the service (AN: no incentive to invest resources)

Ethical aspects must be recognized

- Ethical aspects must be recognized

Strategic alignment must be met

- Often there are other solutions than AI. The introduction of a technology must be adapted to the strategy.

there were no particular challenges

- The implementation was not particularly difficult. Pilot Projects are always a challenge for a company

others

- Important is the version management/control and the lifelong learning of the AI application

Processes for adopting AI

Clearly defined Process for AI adoption

- Clearly defined 6 step process for an AI project
- structured process of analyzing what other companies are doing and cooperation with AI specialized companies
- very agile in decision making. Within 2 weeks from a paper publication (new tech), a first prototype/MVP can be created. Each employee has weekly meeting for new publications and topics. Engineering gets the MVP from the research team and makes it ready for production
- Business Case with clear scope, limited in time → agile project approach → Measure results → Decide productization/rollout
- From customer idea, the first data are evaluated. Are there existing solutions for the same problem? Starting from this, it is an iterative process
- In the first instance, the data is analyzed. After that, an example project is used. So that can be tested how far probably an adaption must be made. Important is a modular structure which simplified adaption. It is an iterative approach. Train and compare, train and compare. Based on a base model.

Ideas come from Customer Ideas/Demands

- Talking to customers leads to ideas
- The idea of a customer is often at the beginning
- The demand of the partner is central

Find Knowhow externally

- Organizations lack knowhow -> they need consultants
- Companies listen more to external consultants than internal employees
- first MVP with external personnel, second further development of the MVP: if process = core business → internalize, else it stays outsourced
- structured process of analyzing what other companies are doing and cooperation with AI specialized companies

Keep/Build Knowhow internally

- first MVP with external personnel, second further development of the MVP: if process = core business --> internalize, else it stays outsourced
- all AI services are developed inhouse
- Build specialized knowledge targeted to the exact use case

Companies are not using AI like it could be

- Organizations are the "bottleneck" - Technology is here but not being adopted
- The market doesn't know what it wants in terms of AI

PERCEPTION OF THE REGION IN TERMS OF AI

Knowhow / Network

Universities are good partners

- HSLU is a good partner for discussions
- Companies will probably reach out to their nearest University/HS as a research partner
- HSLU is a great place to go for knowhow
- best contacts with HSLU and University of Lucerne. Communication is very good. So far, all concerns have ben solved in Central Switzerland
- Close cooperation with HSLU. However, must be intensified much more like in Cambridge where University and Hospitals work hand in hand for many years in the AI-field
- The partners come from all over German-speaking Switzerland. Certainly, schools like the ETH but also the HSLU are partners
- ETH EPFL HSLU, Private institutions and Partner.
- External Partners. Certainly also at the universities ZHAW HSLU and ETH
- For MedTech: Most research happens at university hospitals, Central Switzerland does not have any of them

Network not in Central Switzerland

- I wouldn't know who to ask in Central Switzerland. My Network isn't there
- I don't have any network in Central Switzerland
- I wouldn't know where to look for a Central Swiss partner
- The partners come from all over German-speaking Switzerland. Certainly, schools like the ETH but also the HSLU are partners
- ETH EPFL HSLU, Private institutions and Partner. It has enough Partners. There are very good system integrators and the technology is moving towards a Plug and Play direction. Innovation Parks and others are ready to help
- Private Groups, Hacker Groups or references, even to other companies. The network is crucial, the community helps each other
- Network doesn't need geographical closeness anymore. "My network is all over Switzerland and even international"
- Experts and Money are available in Switzerland

Network in Central Switzerland

- One of our partners in in Zug
- HSLU is a good partner for discussions
- Deep expert knowhow is available in the region and there is no need for reaching out to Zurich
- Innovationspark Zentralschweiz aims to bring an innovation network to life
- best contacts with HSLU and University of Lucerne. Communication is very good. So far, all concerns have ben solved in Central Switzerland
- Cooperation with Zug and a possible AI cluster in Central Switzerland would be great

Network in Zurich

- The rest of our network is more in Zurich or internationally based
- My network is in Zurich, a bit Bern, one partner in Baar
- Until now, just worked together with experts from Zurich and Germany

International Network

- The rest of our network is more in Zurich or internationally based

- Until now, just worked together with experts from Zurich and Germany
- Softwarepartner in Germany, Israel and London. Not US because auf the time shift. At the moment, no AI Innovation is perceived in the region. Neither Central Switzerland nor Switzerland

Region of Network doesnt matter

- AI is not a regional topic, more international → it doesn't matter who you have a Zoom Call with as long as the person is competent
- Network doesn't need geographical closeness anymore. "My network is all over Switzerland and even international"

Knowledge of network plattforms

- There is the GRID Network but it's too IT-centered
- It is not favorable to build more and more networks from zero, because all face the same problem (how to bring action on platforms, how to gain members) → for central Switzerland it would be better to have one large, functioning network instead of several small initiatives

no Innovation in Central Switzerland

- At the moment, no AI Innovation is perceived in the region. Neither Central Switzerland nor Switzerland
- The need for AI is NOT there at the moment. The traditional methods are sufficient

others

- Technopark is a nice location to network with other startups but topics are startup-business not AI-business
- The knowhow and personal is found in the C-level community

Political Support

There is support for startups

- Zug would be a better location for bigger startups
- Lots of foundations who support startups in founding phase, also financially
- Great support from Zug also during the COVID-19 pandemic. Great service and location promotion. Direct requests from the canton for coordination of many support. However, nationally startups are not well supported

There is no support for startups

- bigger Startups in Lucerne are not well supported

Politics don't care about AI

- It's not possible that politics would deliver an input for an AI project in OW
- Politics will lag behind technology

Föderalismus is a problem

- More cooperation on a national level and a clear strategy on regulations (data security, AI, etc.). Every canton pursues ist own way

The Taxes are attractive

- Very good tax deal, much better than anywhere else

Importance of the location

Location (in Switzerland) doesn't matter

- No particular positive reason for central Switzerland more for Switzerland in general
- Compared to US: personal contact is valuable in Lucerne. In case of problems, you can call directly to the right person from the canton side and solve problems. Not only Central Switzerland but generally in Switzerland
- For a software company, the location is not very relevant

- Where you base your business typically depends on where the founder is rooted

Central Switzerland holds advantages compared to other swiss regions

- Great support from Zug also during the COVID-19 pandemic. Great service and location promotion. Direct requests from the canton for coordination of many support. However, nationally startups are not well supported
- Good location, customers are also in the region
- Central Switzerland is a good location for the companies orientation
- Central Switzerland is more attractive than other regions in Switzerland (for employees)

Location of employee/employer is relevant

- Complete outsourcing does not work, cultural aspects and mindset are very important

Location of employee/employer is not relevant

- Location of employer and employees will not be relevant post-pandemic → remote work employees will look for a job that gives them the benefits they need
- It doesn't matter where the workforce is coming from → no need for local Knowhow

Human Resources / Workforce

Need more good people

- We need education programs in the AI topic here in the region but the quality of the program must be at least equally as good as i.e. ETH
- Market is dried out -> Region needs to educate more people to keep up
- It's hard to find tech people who still understand the business needs
- We need developer with Business Knowhow and have also to work with Swiss or German Developers (half of our developers are swiss)
- it is certainly difficult to hire employees in the region

The good people are in Zurich

- It's easier to get people when you're near Zurich
- There are more competent people in the region than expected but still less than in ZH
- We work with a company in Zurich that works with developers in Vietnam
- Zug is strategically a good catchment area since still people from Zurich can be attracted. However, it's hard to bring a developer from Zurich to Zug. Lucerne or Kriens would be impossible

The good people are in the region

- There are more competent people in the region than expected but still less than in ZH
- Data scientists are easier to find because they work in several fields.
- Zug as crypto Valley provides good work force
- In Central Switzerland, the fight among companies for talent is not as big as in Zurich. We are still an interesting player in Central Switzerland

Combination of domain and IT will be relevant

- In the future, we'll need employees that use their domain expertise to train/Control models and not just do their job
- We'll need 2 types of employees: the hardcore mathematicians and the domain experts
- future employees need domain and IT knowhow

- A key point is the connection between domain knowhow and AI/Data knowhow

- There is not one profile, experts with a deep knowhow in the combination with a domain expert is excellent
- It's hard to find tech people who still understand the business needs
- We need developer with Business Knowhow and have also to work with Swiss or German Developers (half of our developers are swiss)

Future Employees need AI / technical knowledge

- SMEs don't need ultimate experts but people with solid education in AI (Engineering)
- Management needs leadership ability and technological affinity to lead the employees towards new tech
- Developer need at least a bachelor degree in computer science and willing to do a master in the same field (both parttime with work experience)
- you can either take young people with little experience but the latest knowhow or experienced project managers who lack the latest knowhow. We have chosen the first option and have had very good experience with it
- Good programming skills should be a base
- Have a basic knowledge of programming

Soft factors are relevant

- Curious employee with an open mind, analytical structured work is an advantage
- Smart brains - people like in other IT projects: Analytics abstract thinking
- Open minded and learning on the job. There is a worldwide specialization in the data science area
- There are no AI specific requirements. For the work one should be very structured, open midned and broad based field of thought
- Person willing to learn, train fellow tenants themselves. Must be open-minded, curious and have a basic knowledge of programming

Management must change abilities

- We need a change in abilities of management, not employees they need leadership ability and technological affinity to lead the employees towards new tech

Good work life balance

- Work life balance in Central Switzerland is considered good
- Work-Live Balance is a positive Aspect of the region

Salary

- Capable people are expensive
- Switzerland is too expensive. Developers are three times cheaper abroad than the Swiss equivalent, therefore we work with a company in Zurich that works with developers in Vietnam

Network influences recruiting

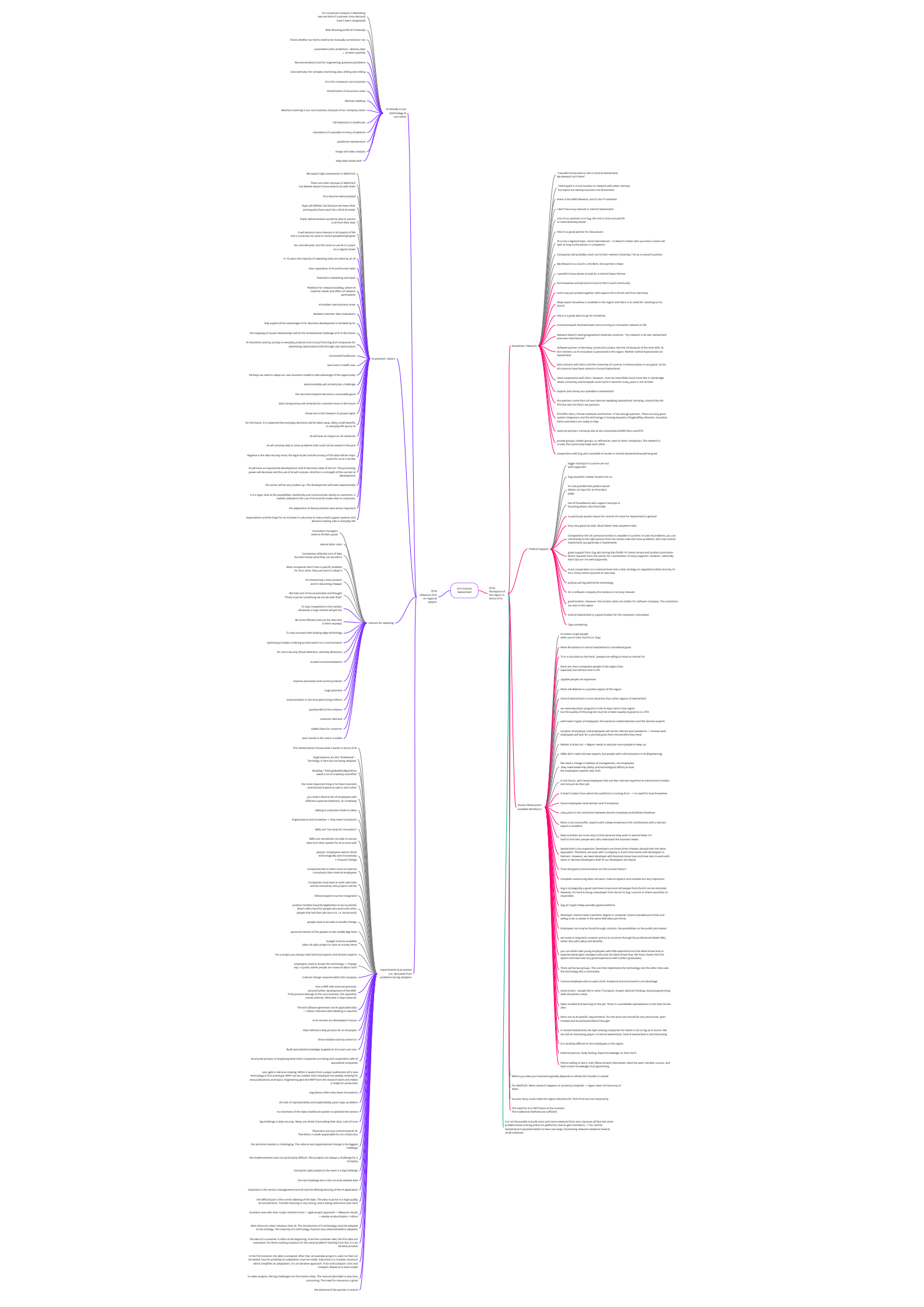
- Employees can only be found through contacts. No possibilities on the public job market
- We invest in long-term contacts and try to convince through the professional depth (ML) rather less with salary and benefits

Others

- Trust and good communication are success factors
- There will be two groups. The one that implements the technology and the other that uses the technology like a commodity

- External partner, body leasing → expert knowledge available on short term

D Appendix: Interview Mind Map


AI in Central Switzerland
Q7A1 influence of AI on regional players
reasons for adopting
Innovation managers need to fill their quota
reduce labor costs
Companies collected a lot of data but don't know what they can do with it
Most companies don't have a specific problem for AI to solve, they just want to adopt it
AI is becoming a mass product and it's becoming cheaper
We had a lot of structured data and thought "There must be something we can do with that!"
To stay competitive in the market, otherwise a huge market will get lost
Be more efficient and use the data that is there anyway
To stay innovativ with leading edge technology
optimising complex ordering process which is a core business
for more security (fraud detection, anomaly detection)
Sucked recommendations
improve processes and current products
huge potential
improvements in the AI projects bring millions
positive ROI of the initiative
customer demand
added vlaue for customer
clear trends in the sector a visible
requirements & processes (i.e. derivated from problems during adoption
The market doesn't know what it wants in terms of AI
Organisations are the "bottleneck" - Technology is here but not being adopted
Building / Testing Models/Algorithms needs a lot of creativity and effort
the most important thing is for Data Scientists and Domain Experts to talk to each other
you need a diverse set of employees with different expertise (Statistics, AI, Creativity)
talking to customers leads to ideas
Organizations lack Knowhow -> they need consultants
SMEs are "too busy for innovation"
SMEs are sometimes not able to extract data from their system for AI to work with
people / employees need to think technologically and innovatively -> Cultural Change
Companies like to listen more to external consultants than internall employees
Companies must want to work with Data and be innovative, else projects will fail
Ethical aspects must be recognized
positive mindset towards Digitization to be successful (that's often hard for people who work with other people that lost their job due to it, i.e. Social work)
people need to be able to handle Change
personal interest of the people on the middle Mgt level
budget must be available (idea: do pilot project to save on money here)
For a project you always need technical experts and domain experts
employees need to accept the technology -> Change mgt. in public admin people are insecure about Tech
Cultural change required within the company
first a MVP with external personal. second further development of the MVP. If the process belongs to the core business, the operation comes internal, otherwise it stays external.
The old software generates not AI applicable data -> labour intensive data labeling is required
AI AI services are developed in house
Clear defined 6 step process for an AI project
Show initiative and try and error
Build specialised knowledge targeted to the exact use case
structured process of analyzing what other companies are doing and cooperation with AI specialized companies
very agile in decision making. Within 2 weeks from a paper publication (of a new technology) a first prototype /MVP can be created. Each employee has weekly meeting for new publications and topics. Engineering gets the MVP from the research team and makes it ready for production
regulations often slow down innovations
the lack of reproducibility and explainability pose major problems
no incentives of the Swiss healthcare system to optimize the service
big challenge is data security. Many are afraid of providing their data. Lack of trust
Physicians are very critical towards AI. Therefore, it needs explainable AI, not a black box
the technical solution is challenging. The cultural and organizational change is the biggest challenge
the implementation was not particularly difficult. Pilot projects are always a challenge for a company
having the right people on the team is a big challenge
the real challenge lies in the correctly labeled data
important is the version management/controll and the lifelong learning of the AI application
the difficult part is the correct labeling of the data. The data must be in a high quality structured form. Transfer learning is very strong, and is being used more and more
business case with clear scope, limited in time -> agile project approach -> Measure results -> decide productization / rollout
often there are other solutions than AI. The introduction of a technology must be adapted to the strategy. The maturity of a technology must be very advanced before adopted.
the idea of a customer is often at the beginning. From the customer idea, the first data are evaluated. Are there existing solutions for the same problem? Starting from this, it is an iterative process
In the first instance, the data is analyzed. After that, an example project is used. So that can be tested, how far probably an adaptation must be made. Important is a modular structure which simplifies an adaptation. It is an iterative approach. Train and compare, train and compare. Based on a base model
In video analysis, the big challenges are the traction data. The manual data label is very time consuming. The need for resources is great
the demand of the partner is central
AI planned / visions
We expect high investments in MarkTech
There are other startups in MarkTech but Market doesn't know what to do with them
AI is become democratized
Hype will deflate, but because we have other prerequisits there won't be a third AI-winter
Public Administration would be able to extract a lot from their data
It will become more relevant in all aspects of life but it could also be used to control people/employees
No concrete plan, but the vision to use AI in 5 years on a regular bases
in 15 years the majority of repeating tasks are done by an AI
clear separation of AI and human tasks
Potential in Marketing and Sales
Plattform for network building, where AI matches needs and offers of network participants
AI enables new business areas
detailed customer data evaluations
fully exploit all the advantages of AI. Business development is dictated by AI.
the mapping of causal relationships will be the fundamental challenge of AI in the future
AI should be used by society in everyday products and not just from big tech companies for advertising optimisation/click-through rate optimisation
Connected healthcare
save lives in health care
Perhaps we need to adapt our own business model to take advantage of the opportunity
electromobility will certainly be a challenge
the neuronal network becomes a countable good
data transparency will certainly be a sensitive issue in the future
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for the future, it is expected that everyday decisions will be taken away. Many small benefits in everyday life due to AI
AI will have an impact on all industries
AI will certainly help to solve problems that could not be solved in the past
negative it the data security issue, the legal issues and the privacy of the data will be major issues for us as a society
AI will have an exponential development until AI becomes state of the art. The processing power will decrease and the use of AI will increase. And this is a strength of the current AI development
the sector will be very shaken up. The development will meet exponentially
it is a hype, look at the possibilities realistically and communicate clearly to customers. A realistic attitude to the use of AI must be made clear to customers.
the adaptation of data protection laws will be important
expectations and the hope for an increase in value due to many small support systems and decision-making aids in everyday life
AI already in use (technology & use cases)
for conversion analysis in Marketing (we are kind of a pioniere since demand hasn't been recognized)
Beer Brewing (artificial Creativity)
Check whether tax forms need to be manually corrected or not
automated order prediction: delivery date + product quantity
Recommendation tool for engineering questions/problems
Cost estimator for complex machining jobs; drilling and milling
AI is the company's core business
Classification of insurance cases
Abstract dubbing
Machine Learning is our core business and part of our company vision
Fall-detection in healthcare
calculation of a possible re-entry of patients
predictive maintenance
image and video analysis
Help desk tickets NLP
Q7A2 Perception of the region in terms of AI
KnowHow / Network
"I wouldn't know who to ask in Central Switzerland. My Network isn't there"
Technopark is a nice location to network with other startups but topics are startup-business not AI-business
there is the GRID Network, but it's too IT-centered
I don't have any network in Central Switzerland
one of our partners is in Zug, the rest is more around ZH or internationally based
HSLU is a good partner for discussions
AI is not a regional topic, more international -> it doesn't matter who you have a Zoom call with as long as the person is competent
Companies will probably reach out to their nearest University / HS as a research partner
My Network is in Zurich, a bit Bern, One partner in Biel
I wouldn't know where to look for a Central Swiss Partner
the KnowHow and personal is fund in the C-Level community
Until now just worked together with experts form Zürich and from Germany
Deep expert knowhow it available in the region and there it no need for reaching out to Zürich
HSLU is a great place to go for knowhow
Innovationspark Zentralschweiz aims to bring an innovation network to life
Network doesn't need geographical closeness anymore. "my network is all over Switzerland and even international"
Software partner in Germany, Israel and London. Not the US because of the time shift. At the moment, no AI innovation is perceived in the region. Neither Central Switzerland nor Switzerland.
best contacts with HSLU and the University of Lucerne. Communication is very good. So far, all concerns have been solved in Central Switzerland.
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Experts and money are available in Switzerland
the partners come from all over German-speaking Switzerland. Certainly, schools like the ETH but also the HSLU are partners
ETH EPFL HSLU, Private Institutes and Partner. It has enough partners. There are very good system integrators and the technology is moving towards a Plug&Play direction. Inovation Parks and others are ready to help
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private groups, hacker groups, or references, even to other companies. The network is created, the community helps each other
cooperation with Zug and a possible AI cluster in central Switzerland would be great
Political Support
bigger Startups in Lucerne are not well supported
Zug would be a better location for us
It's not possible that politics would deliver an input for an AI-project (DM)
lots of foundations who support startups in founding phase, also financially
no particular points reason for central CH more for Switzerland in general
Very very good tax deal. Much better than anywhere else.
Compared to the US: personal contact is valuable in Lucerne. In case of problems, you can call directly to the right person from the canton side and solve problems. Not only Central Switzerland, but generally in Switzerland.
great support from Zug also during the COVID-19. Great service and location promotion. Direct requests from the canton for coordination of many supports. However, nationally Start Ups are not well supported.
more cooperation on a national level and a clear strategy on regulations (data security, AI etc.). Every canton pursues its own way
policies will lag behind the technology
for a software company the location is not very relevant
good location. However, the location does not matter for software company. The customers are also in the region
Central Switzerland is a good location for the company's orientation
Type something
Human Ressources/ available Workforce
It's easier to get people when you're near Zurich (i.e. Zug)
Work life balance in central Switzerland is considered good
"It is a nice place to live here", people are willing to move to central CH
there are more competent people in the region than expected, but still less than in ZH
capable people are expensive
Work-Life-Balance is a positive aspect of the region
Central Switzerland is more attractive than other regions of Switzerland
we need education programs in the AI topic here in the region but the quality of the program must be at least equally as good as i.e. ETH
we'll need 2 types of employees: the hardcore mathematicians and the domain experts
Location of employer and employees will not be relevant post-pandemic -> remote work employees will look for a job that gives them the benefits they need
Market is dried out -> Region needs to educate more people to keep up
SMEs don't need ultimate experts, but people with solid education in AI (Engineering)
We need a change in abilities of management, not employees: they need leadership ability and technological affinity to lead the employees towards new Tech
In the future, we'll need employees that use their domain expertise to train/control models and not just do their job
It doesn't matter from where the workforce is coming from -> no need for local KnowHow
future employees need domain and IT knowhow
A key point is the connection between domain knowhow and AI/Data knowhow
there is not one profile, experts with a deep knowhow in the combination with a domain expert is excellent.
data scientists are more easy to find, because they work in several fields. It's hard to find tech people who still understand the business needs
Switzerland is too expensive. Developers are three times cheaper abroad than the Swiss equivalent. Therefore, we work with a company in Zurich that works with developers in Vietnam. However, we need developer with Business know how and have also to work with Swiss or German Developers (half of our Developers are Swiss).
Trust and good communication are the success factors
Complete outsourcing does not work. Cultural aspects and mindset are very important.
Zug is strategically a good catchment area since still people from Zurich can be attracted. However, it's hard to bring a developer from Zurich to Zug. Lucerne or Kriens would be no impossible.
Zug as Crypto Valley provides good workforce
Developer need at least a bachelor degree in computer science (studied part-time) and willing to do a master in the same field (also part-time).
Employees can only be found through contacts. No possibilities on the public job market.
we invest in long-term contacts and try to convince through the professional depth (ML), rather less with salary and benefits.
you can either take young employees with little experience but the latest know-how or experienced project manager who lack the latest know-how. We have chosen the first option and have had very good experience with it (HSLU graduates).
There will be two groups. The one that implements the technology and the other that uses the technology like a commodity
Curious employee with an open mind. Analytical structured work is an advantage
smart brains - people like in other IT projects. Analytic abstract thinking. Good programming skills should be a base.
open-minded and learning on the job. There is a worldwide specialization in the Data Science area
there are no AI specific requirements. For the work one should be very structured, open minded and broad based field of thought
In central Switzerland, the fight among companies for talent is not as big as in Zurich. We are still an interesting player in Central Switzerland. Central Switzerland is still interesting
It is certainly difficult to hire employees in the region
External partner, body leasing. Expert knowledge on short term
Person willing to learn, train fellow tenants themselves. Must be open-minded, curious, and have a basic knowledge of programming
Where you base your business typically depends on where the founder is rooted
For MedTech: Most research happens at university hospitals -> region does not have any of them
Success Story could make the region attractive for Tech firms but not necessarily
The need for AI is NOT there at the moment The traditional methods are sufficient
It is not favourable to build more and more networks from zero, because all face the same problem (How to bring action on platforms, how to gain members) -> For central Switzerland it would be better to have one large, functioning network instead of several small initiatives

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