LAB University of Applied Sciences

Utilizing AI in Innovation Management

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Abstract

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Abstract

Integrating AI into the innovation field is currently a new research topic. So far a limited amount of empirical studies have been published in the subject matter. This paper aims to find guidelines of current practises and challenges for scaling up AI and proposes a holistic multi-dimensional approach to integrating it for those organisations that are experimenting or in foundational steps of using AI.

The researcher utilized subject matter experts from two different domains, AI and innovation, in order to cultivate a solution that provides practical implications. Qualitative data contains interviews with eight different leaders. Design thinking method was adopted to pin-point challenges from these two different fields and to come up with a versatile solution. The approach is thus descriptive and not normative in its aim to capture characteristics and identify patterns of thought.

The results show that in order to integrate AI into innovation work it is important to have clear, categorized and robust data. The Innovation Department could benefit from AI by having pattern recognitions and forecasting customers, partners, risks and profitability. It is often that the innovative culture needs to be cultivated in the organisation. This paper provides recommendations for how experimental organisations can start their use of integrating Artificial Intelligence into their innovation work.

Keywords

Artificial Intelligence (AI), Design Thinking, Innovation

CONTENTS

1 INTRODUCTION

Artificial Intelligence reshapes many processes in organizations. This paper focuses on how Innovation might be organized now and in the future through rapid development in technology and AI. Management might need to rethink the whole innovation process. The aim of this study is to review and explore some possible implications where AI could help to enhance the innovation work done in an organization. Finding applicable ways to integrate AI and machine learning in innovation processes should be a mentionable interest for many organizations.

1.1 Background

Rapid advances in AI are making major transformations in business. AI systems are not only automating and making efficient many processes but also enabling people and machines to work collaboratively. This changes the nature of many tasks. A common myth is that AI will replace all the human work needed. AI will rather augment and help humans to collect data and preliminary analysis leaving more room for humans to solve complex cases. (Daugherty & Wilson 2018.)

The availability of information has increased as well as, simultaneously, the risks and the costs of innovation work. Among these factors, Innovation managers are facing challenges of the highly volatile and changing environments as well as competitive global marketplace. Also, pivots in technology and political landscapes are reshaping innovation work. (Jones et al. 2016.)

The academics and practitioners have claimed that AI may impact companies' innovation processes in the future and many companies are investing heavily in AI but the adoption level is considered low. There are four areas where AI is seen to make value: smarter research and development and forecasting, optimized production and maintenance, targeted sales and marketing and enhanced user experience. (Bughin et al. 2017.)

This means that by examining AI and machine learning in the innovation field, it can make an impact by reducing the costs of the innovation work as well as assist developing new innovations due to faster information processing done by AI.

1.2 Thesis objectives, research questions and limitations

The aim of the study is to give practical recommendations for how AI could be adopted in innovation. The study explores how AI could be enabled in different stages and processes of Innovation management. Based on this objective the main research questions are:

How could AI be adopted in Innovation and what could future innovation management look like with the enhanced innovation model using AI?

The sub-questions include:

1. **What are current and future challenges of an Innovation leader?**
2. **What tools or methods are utilized in Innovation?**
3. **In which part of the innovation AI is seen as a potential tool?**

Although this study examines AI and innovation together, it does not include AI as a business model. Thus, the study aims at answering the question How can AI help the innovation work rather than AI based innovations. The implications and recommendations are tailored for innovation leaders and organizations.

1.3 Theoretical Framework

Design thinking methods are used in this study in order to find innovative solutions in co-operations. The design thinking concept consists of five parts: emphasize, define, ideate, prototype and test. This framework is meant to work as a ground principle to test and design new innovative solutions enabling AI and Innovation to build together with experts from different disciplines.

1.4 Research methodology and data collection

The theoretical framework mentioned above is best implemented with pragmatic philosophy utilizing a case study design that deploys both primary and secondary methods. The primary data observes experts in innovation and artificial intelligence field with semi-structured interviews. In addition to interviews, prototyping and co-designing tools and methods are sought to find practical implications and to obtain rich data from experts in the subject matter. The secondary method involves obtaining data of the newest tools and methods in innovation from different sources.

1.5 The structure of the thesis

The thesis is structured and organized into six different parts, as displayed in the figure below.

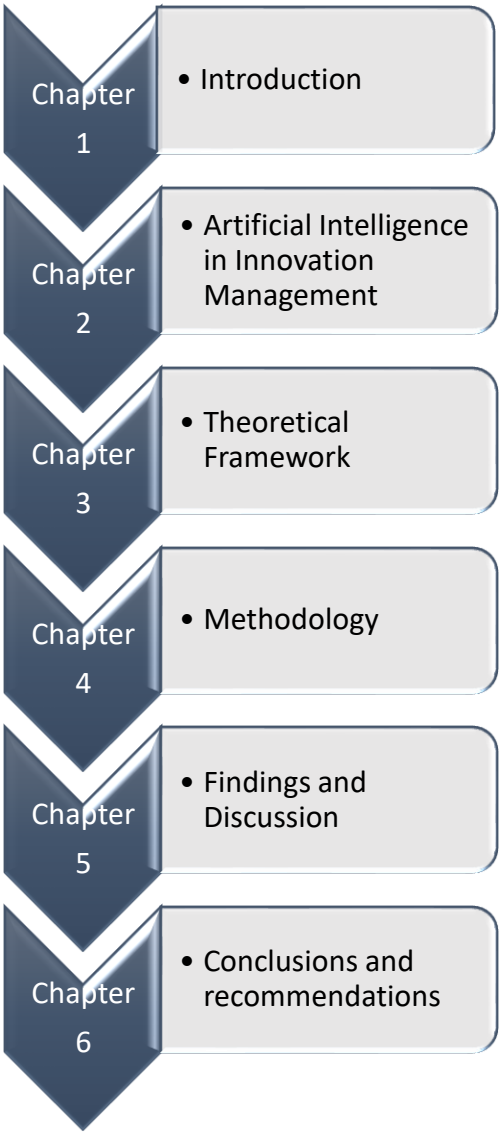

Figure 1 Thesis Structure

The current situation is discussed in Introduction. It also introduces the problem space as well as presents the objective of the thesis. Chapter two dives deeper into the subject and shows different challenges from two different domains: artificial intelligence and innovation management. Chapter three presents the framework to answer the research questions and how the co-creation process is done. The following chapter presents the data collection and discussions of the research philosophy and data reliability. Findings and discussions of the data will be discussed in Chapter 5 in a systematic approach and the final chapter shows the recommended framework for current and future needs for the problem space.

2 ARTIFICIAL INTELLIGENCE IN INNOVATION MANAGEMENT

The following discussions are mainly for developing the fundamental perspectives to promote a framework of innovation through artificial intelligence and the challenges associated in the subject matter. In this chapter the latest tools and methods in innovation are examined as well as how AI technology could be integrated.

2.1 Innovation Process

The innovation process is commonly known as having a series of stages. The main themes are ideation, discovery, validation and confirmation as shown in the figure below.

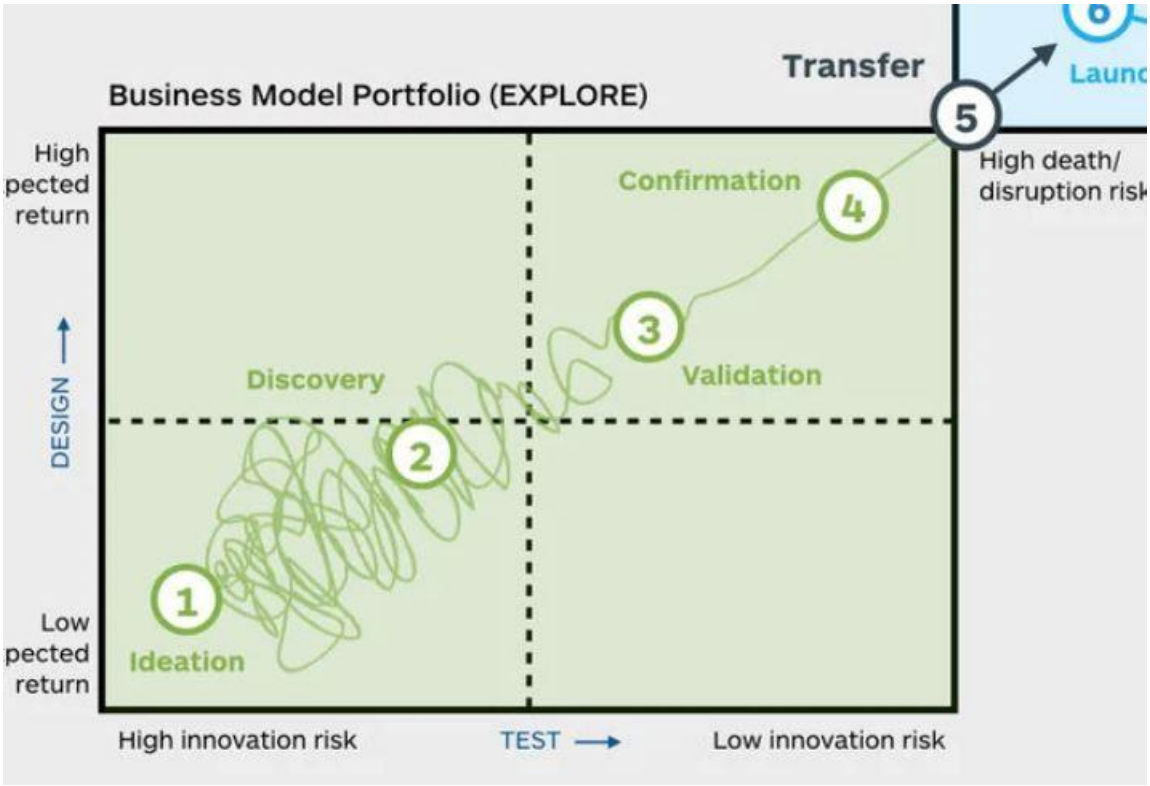

Figure 2 Business Porfolio Map (Osterwalder et al. 2020)

Business Model Portfolio map shows the evolution, risk and return of the business models. There are two parts, explore and exploit. In the exploration part, there are four different stages: Ideation, Discovery, Validation and Confirmation. There is a shift to the exploitation part when innovation goes from innovation to implementation. The Exploit Portfolio has six different stages: Launch, Sustaining innovation, Efficiency and Matured business, Declining business and Renovation. (Osterwalder et al. 2020.)

The above figure helps leaders to assess the progress of the innovation projects. It can assess the disruption risk and validate new potential projects. This tool helps leaders to strategize their innovation management by defining objectives, allocating resources and making new actions. The tool can help to measure the performance of the innovation work done in the organization. Leaders can have a clear roadmap of which projects are at risk or which projects to eliminate. Also, the objective is to get a project from the bottom left corner towards the top right. (Osterwalder et al. 2020.)

According to Blank (2018) large companies are not 100% focused on innovation as many start-ups are. Team-based innovation is a process that helps teams to solve problems and gather evidence that tests if their idea is feasible, viable and desirable. The process emphasizes rapid learning, urgency, accepting failure and innovation metrics. The step that leaders and teams need to take is to think the innovation process from end-to-end and visualize the entire flow of how and from where an idea is generated.

A canonical lean innovation comprises six stages as shown in the figure below: Innovation Sourcing as generating list of ideas and problems that might be worth investing in, the next stage is Problem Curation that combines utilizing surveys and building minimum viable product. The third stage focuses on Prioritization by refining the ideas and showing which projects are worth of investment. The fourth stage focuses on exploring and testing the Solution and the fifth Incubating so that the winning project gets the resources needed and the last stage is Integrating the innovation into the existing organization. (Blank 2017.)

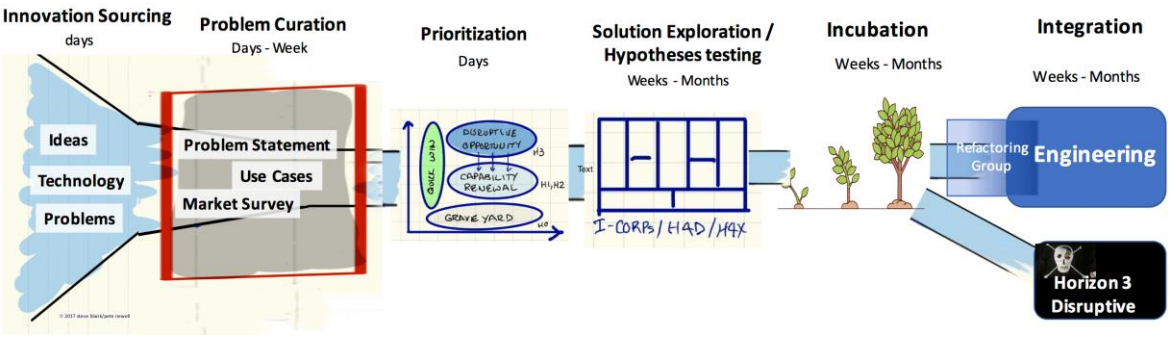

Figure 3 Canonical lean innovation process (Blank 2017)

2.1.1 Innovation methods

Design thinking

There are different types of design thinking models but they all have in common the double diamond method (Design Council 2017). Figure 4 below describes the double diamond process.

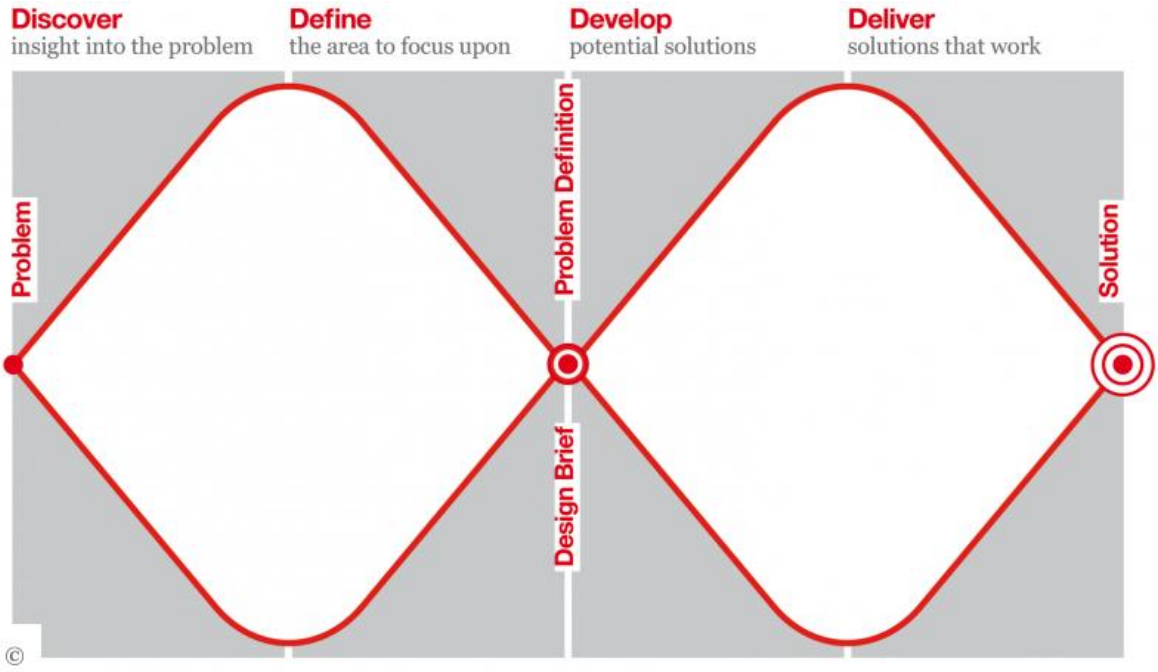

Figure 4 Design Council (2017) Double Diamond

The first diamond helps to understand the problem space rather than making assumptions. It involves spending time and learning insights with the people who are affected by the problem. After discover stage, the area is defined where to focus on and the challenge is more clearly defined. The second phase of the diamond is to seek answers from different people to the defined problem and develop potential solutions. The last part is to deliver and test the solutions at a small-scale and improving it. The method is not linear, rather it can go back to the discover phase as new insights come up. The main values of design thinking are the multi-level communication, collaborating and iterating. (Design Council 2017.)

Design Thinking is a commonly used method in large corporates. Especially, human-centric methods in business are needed in the digitalization era. The main idea is to build empathy and developing emotionally resonant projects that not only brings value to external users but changes the organizational culture to be more tolerating towards failures and seeing it as an iterative process. (Kolko 2015.)

Design thinking method brings together and considers user desirability, viability and feasibility in order to define and develop a solution. Used methods in design thinking are utilized in the format of interviews and observations from the users in a non-linear iteration way. Important is to collect the feedback and learn from it in each different stage. Design thinking promotes divergent thinking and availability. A common way for design thinking is to pivot back to any prior stages or narrowing it down to a most optimal solution (Mateo 2017).

Lean startup

Lean startup was founded by Eric Ries in 2008 as a management principle. The principle comes from Ries' own experiences working in a high-tech start-up companies. The main purpose is to minimize waste and work on new products and services with high uncertainty. There are three main processes; iterative process following the feedback loop and measuring how customers respond then learn whether to pivot or move forward. The second one is testing hypothesis with experimentations and the last one is measuring the impact and progress. (Mateo 2017.)

There are three stages in the Lean Startup method. The first step is to build the idea and turn it into minimum viable product (MVP). The main purpose of the MVP is to make a simple version of the product or service made with the smallest effort so that the idea can be tested fast. The second stage is to measure the impact and collect feedback, qualitative and quantitative. After data collection the last stage is to learn whether to pivot or persevere with the original idea.

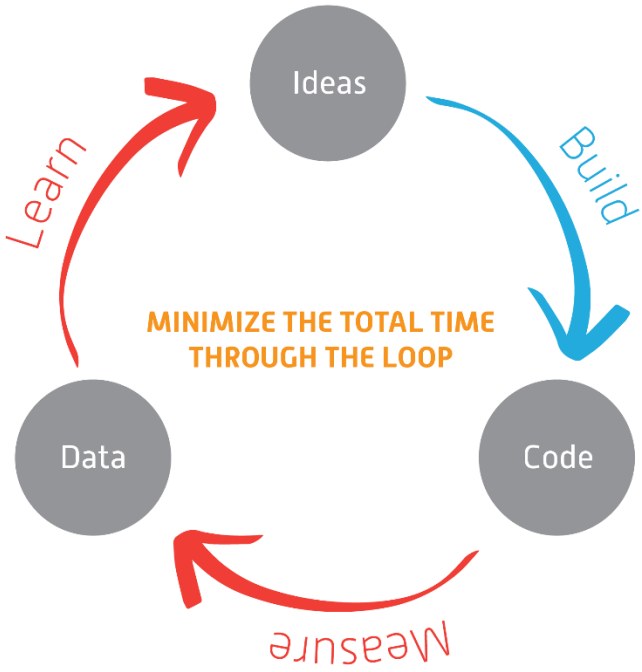

Figure 5 Lean Startup method (Ries 2011)

Agile

The Agile method was founded in 2001 by software development practitioners through discussing their best practices. The main approach has four values; interactions and people over processes and tools, working towards the project rather than documenting, collaborating with customers rather than selling and responding to changes over following a strategy (Mateo, 2017).

The stages of Agile is the main framework called SCRUM which has five steps: Creating a Product Backlog. Backlog contains a list of features which needs to be built in the development process of the product. These are presented in a priority order. Every team works on their own backlog and use it as a guide manual to build. The second phase is a Sprint where the product owner manages the product backlog items with the highest priority and moves the teams to work towards the items in a fast iterative way. The third phase contains working towards the sprint and tracking the progress daily with meetings where every team member shares his progress. This is followed by a Sprint Review where the product is demonstrated and reviewed. Lastly, the sprint is discussed with the team members, learnings and outcomes are determined. (Braintrust Consulting Group 2021.)

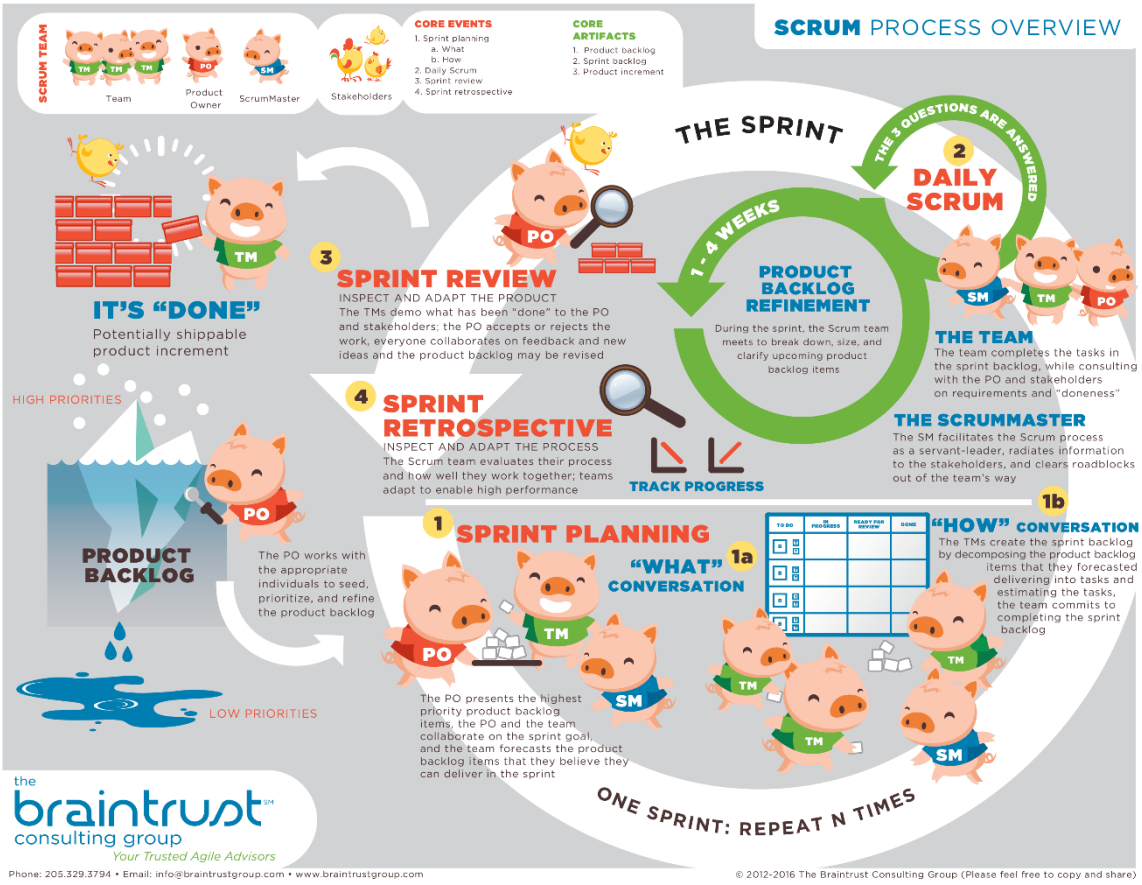

Figure 6 Braintrust Consulting Group (2021).

2.1.2 Comparison of the innovation methods

	Design Thinking	Lean Startup	Agile
PURPOSE	Give answer to any complex problem within any aspect of life	Develop new businesses and products under conditions of extreme uncertainty and minimize waste	Create and respond to change for succeeding in an uncertain and unstable environment
EMPHASIS ON	User and collaboration	Testing and learning	Building in small chunks
APPROACH	Analytical and creative	Experimental	Progressive
STARTING POINT	User needs No assumptions	Hypotheses Initial assumptions	Solution Initial assumptions
WORKS BEST FOR	Exploring the problem and potential solutions	Building the right solution	Building the solution right

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Figure 7 Comparison Chart (Mateo 2017)

There is a comparison of the innovation methods presented in the figure above. The main difference is that **design thinking** focuses on exploring and solving a problem. **Lean** is a framework for testing and pivoting to the right outcomes and **agile method** adapts to changing conditions in software development. The best outcome comes from utilizing different methods and adapting different methods in different situations. (Mateo 2017.)

Open innovation

Open innovation is a method where an organization ideates from external activities and on the other hand gives innovation possibilities to external use to other organizations or partners. The benefit for using open innovation is that it reduces the costs. As an organization can leverage the resources from others. Also, an organization can benefit by partnering up with another from the middle of the innovation process rather than initiating from the starting point. Furthermore, this means that open innovation can be time saving. (Chesbrough 2003.)

As for an organization initiating the innovation, the benefits are that it is possible to expand the value chain and network. As an example, distribution can become much easier by open innovation. Also, sharing a technology can bring revenue for the organization from the start. This makes the research and development economically more sustainable because rather than restricting the business it can open up and scale. (Ibid.)

Especially companies that are working in traditional industries can benefit from open innovation and make their business more sustainable by sharing value and getting back value: as an example, partnering up and getting distribution network as a value add for their new product. This could cost more if everything was handled by themselves from the production to sales. Open innovation can also be challenging for many organizations to open up and sharing their resources. This needs a change in the organization’s innovation culture. Open innovation is not outsourcing. It is leveraging the external ecosystem and enhancing the internal talent and capabilities and sharing the innovation risks with others. (Chesbrough 2003.)

2.1.3 Innovation tools

This chapter examines the latest publication of innovation tools presented by Osterwalder et al. (2020). The objective is to experiment with subject matter experts if the innovation tools could be improved with Artificial Intelligence.

The key is to build and upgrade innovation tools for innovation leaders and organizations in order to make their innovation performance one step further. The idea of the tools and theories is to support and map out the business idea. This is done by utilizing the tools to further develop the operations of the business idea. The objective is to innovate together with the subject matter experts how the innovation tools could be improved with the use of artificial intelligence.

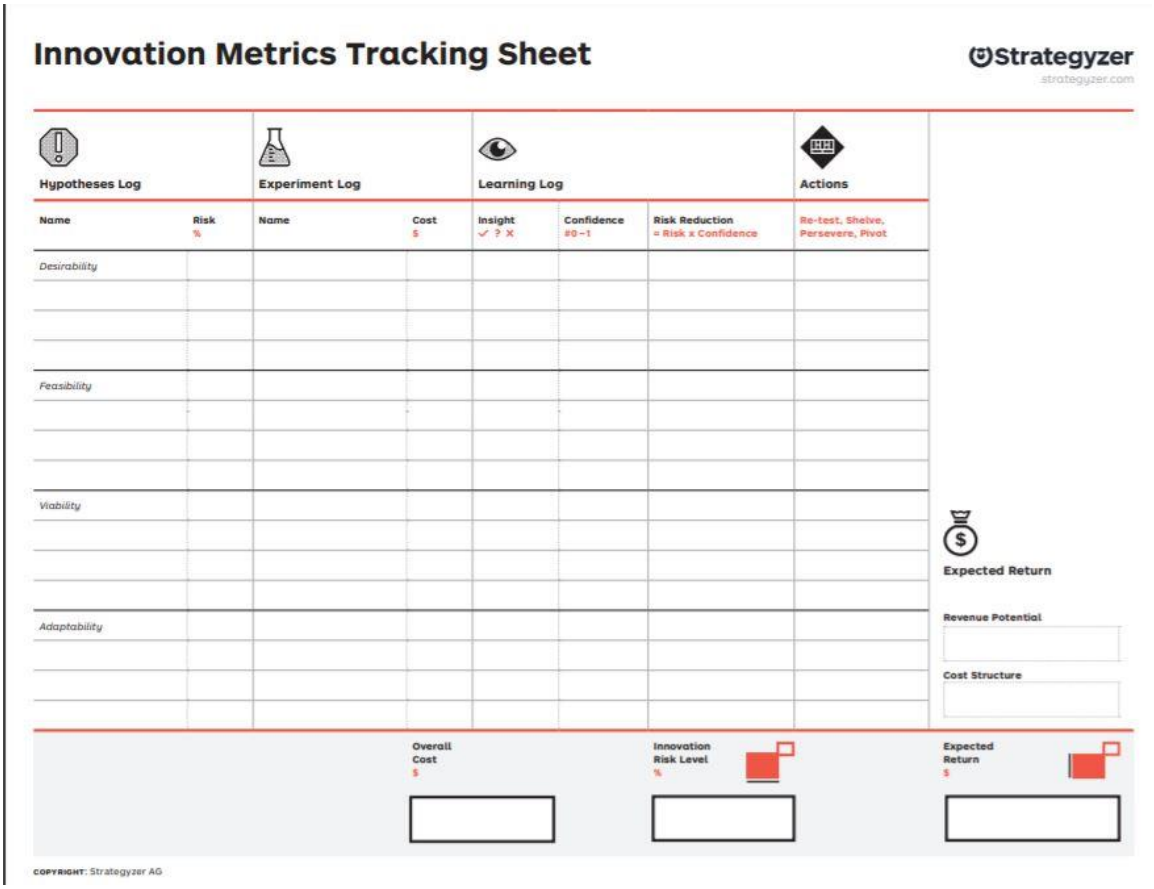


Figure 8. Innovation Metrics Tracking Sheet (Osterwalder et al. 2020)

In this figure above, Innovation teams can track their innovation progress. An Innovation tracking sheet helps innovation teams to break down the idea into smaller parts by making multiple experiments, which in turn helps to de-risk the idea and track all the costs done for the innovation project. Also, the tool helps innovation leaders to make data-influenced decisions systematically.

There are four parts in this tool for the innovation team to track: **hypothesize**, **experiment log**, **learning log** and **actions**. The key is to test the hypothesis underlying the idea. After selection of the hypothesis, it is time for experiments and to collect and capture the evidence. Evidence is turned into insights and the last part is to determine how confident you are with the evidences in order to make the idea successful. (Osterwalder et al. 2020.)

Figure 9 Innovation Scorecard (Osterwalder et al. 2020)

Another tool that is presented is the Innovation Scorecard which helps assessing if the idea can be profitable and feasible. This scorecard helps innovation teams to make sure that the experiments are making progress to their main objective, finding a business model that works.

According to Osterwalder et al. (2020) the tool can be utilized as an example for Innovation leaders and teams to evaluate the pitch investment, to guide the teams and ask better questions, see the current status and updates of the innovation project, evaluate their own progress or to decide the next steps.

There are three parts in this scorecard: the first section is the strategic fit which helps to assess how well the project will get sponsors and resources from the organization. The next part focuses on risk reduction so that it helps to evaluate if there is market demand and opportunity for the project. The last part helps to determine if there is financial value for the project. (Ibid.)

The testing loop concept helps to map out and break down business ideas into smaller chunks so that they can be tested. The key is to reduce uncertainty by making assumptions in the form of hypotheses. It is important to find and prioritize the most essential ones for the business. The testing loop has three parts: hypothesize, experiment and learn. After covering these steps, the business idea will be mapped out based on the following tool. (Osterwalder et al. 2020, 77.)

Hypothesize

According to Osterwalder et al. (2020, 80-81) the first step is to understand the underlying risks and uncertainties that a business idea could potentially have. The main theme is to understand how to make the business idea work from different angles so that the business idea is broken down into testable pieces. The main task is to identify and prioritize the most critical hypotheses for the business so that it exploits to test them. There are four main themes: desirability, feasibility, viability and adaptability. The main question to ask when formulating is “What things need to be true to make the business idea work”.

Desirability	Does the market want this idea?
Feasibility	Can we deliver at scale?
Viability	Is the idea profitable enough?

Adaptability	Can the idea survive and adapt in a changing environmental

Figure 10 *The 4 types of Hypotheses (Osterwalder et al. 2020, 81)*

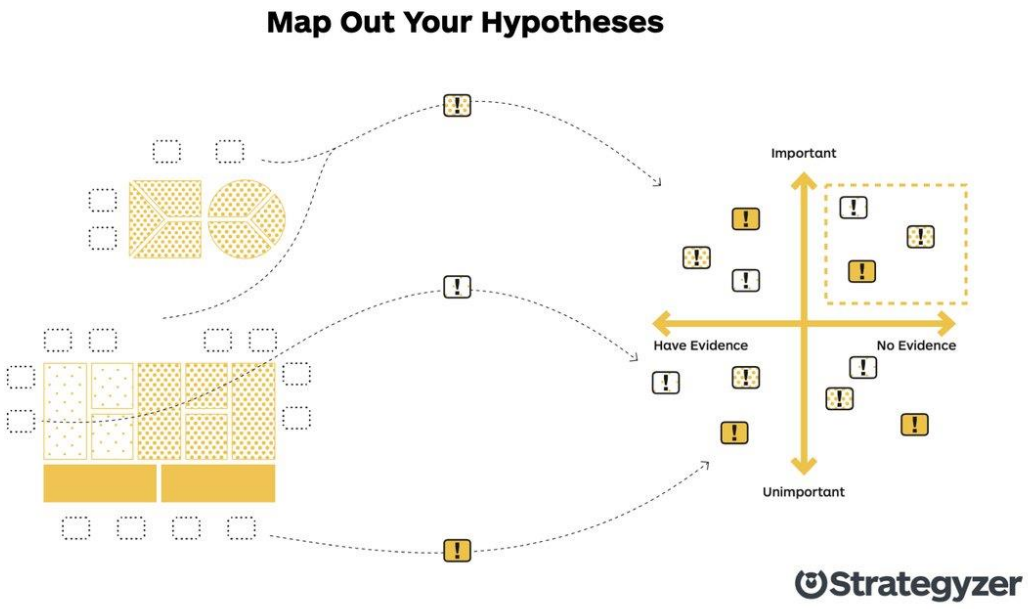


Figure 11 Assumption Map (Osterwalder et al. 2020, 81.)

The figure above helps to identify the most important hypotheses, namely those that are categorized as important with no evidence. Also, it is important to ask how critical the hypothesis is for the business idea. If the hypothesis is proven wrong the business idea will fail and all the other hypotheses are no longer relevant. Another important task to keep in mind is the existence of evidence. It is important to keep on track how much evidence one has to support a specific hypothesis. (Osterwalder et al. 2020, 81.)

Experiment

According to Osterwalder et al. (2020, 82-83) the next step is to test your most important hypothesis and then continue further if there is enough confidence that the idea will work. The idea of the business experiments is to test ideas to reduce the risk and uncertainty of the business idea. The experiments will produce weak or strong evidence which either supports or refuses to back up the evidence. There are four good rules to follow when picking up the right experiment for the business idea:

1 Cheap and fast

2 Increase the strength of the evidence with multiple experiments to the same hypothesis

3 Pick the one that produces strongest evidence

4 Reduce uncertainty as much as possible before moving any further

5 Learn

The last step of the Testing loop is to learn if the evidence supports the hypothesis. The idea of the last step is to detect patterns and insights and with more experiments the more evidence can be gained. The more there is evidence, the more confidence it brings on the insights. The evidence data can be in different formats and categorized as weak or strong for the hypotheses. Different data can be gathered such as quotes, behaviors, conversion rates, orders, purchases. There are four areas to check for the strength of the evidence:

Weak	Strong
Opinions (beliefs)	Facts (events)
What people say	What people do
Lab settings	Real-world settings
Small investments	Large Investments

Figure 12 *Four Areas of Evidence (Osterwalder et al. 2020, 84.)*

Insights are the important part of learning, and the main task is to find patterns that support or deny the hypotheses that are being tested. These insights are the foundation to make informed business decisions and actions. Another part is a confidence parameter to indicate how much there is belief that the evidence is strong enough to support or deny the specific hypotheses. The indicator is 0-1. (Osterwalder et al. 2020, 84-85.)

2.2 Potential AI adaption areas in the innovation process

The objective of this section is to find solutions and implementations from AI that could benefit the innovation role in organizations. Artificial Intelligence is rapidly emerging in organizations. There are three parts in AI: **Task input** (data, text, images, sound, numbers), **Task process** (algorithms) and **Task outputs** (decisions and solutions). (Grogh 2018.)

Currently, research lacks a systematic approach to how AI can support different aspects of Innovation management. Even though, there are discussions on how AI is used for enhancing a product or feature, AI enables new innovations e.g. developing new products (Cockburn et al. 2019.) AI methods are utilized successfully for example in process optimisation and automation. AI can strengthen innovation capabilities by sensing changes in the environment and predicting the future (see e.g. Raisch & Krakowski 2020.)

The future of AI will affect all the business decision making. There are many tasks that will be automated instead of manual work. As an example, the majority of marketing is already automatized. Online advertising and tasks that require repetition will be automated by using AI systems that can process a much larger amount of information. (Unemyr 2018.)

Rapid AI adoption in organizations is the cause of the improvements and advancements in AI methods (neural network and convolutional networks). Many companies have made this as an open-source license (e.g. Google's tensorflow, Amazon, Alexa). Secondly, IT has become more efficient in collecting and storing data in organizations. This data feeds the algorithms of AI that are the pre-requisite for task automation (Grogh 2018).

Large organizations see a huge potential in AI technologies but only 8% of companies consider AI widely spread across the organization. As AI is in its early stage of commercialisation, there are various pivots that need to be done to enable AI in organizations. Firstly, working towards a more collaborative way and decision making needs to shift from experience-based to data-driven. Secondly, organization culture needs to be adaptable, experimental and agile. (Fountaine et al. 2019.)

Machine learning

Machine learning is one type of Artificial Intelligence where the system learns patterns from the data and improves the future experience (Accenture 2020).

There are three different types of machine learning:

1 Supervised learning

2 Unsupervised learning

3 Reinforcement learning

Supervised learning uses binary classification where the task is to predict the correct output or label. Unsupervised learning does not predict the outputs but rather the structure of the data called clusters. Reinforcement learning utilizes the feedback if the choice is good or bad. (Elements of AI 2020.)

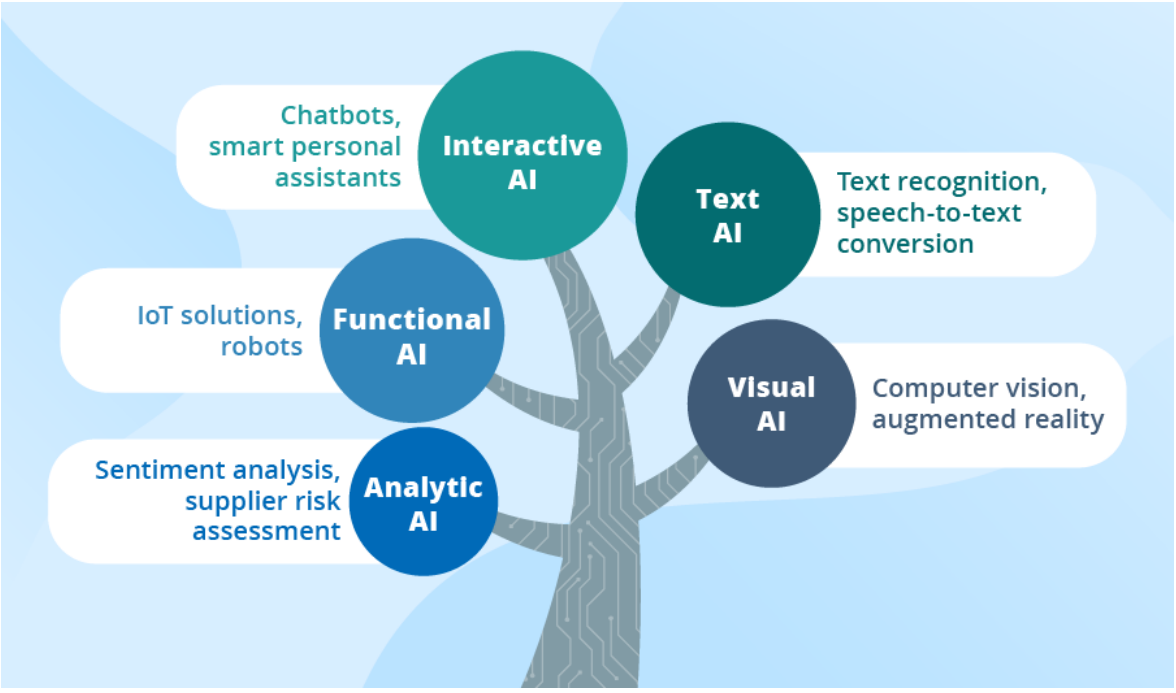


Figure 13 Types of Artificial Intelligence (Bekker 2019)

According to Bekker (2019) there are five types of Artificial Intelligence for business use:

1 Analytic AI – AI scans for large sets of data that produce recommendations or insights.

2 Functional AI – similar to analytic AI instead of recommendations takes actions.

3 Interactive AI – automates communication e.g. chatbots

4 Text AI – Text recognitions and speech utilizing natural language processing.

5 Visual AI – identifies, recognizes and classifies images and videos and converts to insights.

2.2.1 AI Applications in Innovation

Haefner et al. (2021) have developed a framework for how AI can reshape innovation in an organization. The framework starts by examining how an information flow is processed in innovation and the objective is, in the first phases of the innovation process, Discovery and Development. Accordingly, the main theme was that there are increased implementations of electronic services and automation which, eventually, will change the way of innovation management in organizations. The framework separates the AI's role in innovation management into four areas:

1 Developing ideas by overcoming information processing limitation

2. Generating ideas by overcoming information processing limitation

3. Developing ideas by overcoming search routines

4. Generating new ideas

		INNOVATION PROCESS	
		Develop ideas	**Generate ideas**
BARRIERS TO INNOVATION	**Information processing constraints**	**(1)** AI system is able to identify and evaluate *more* information that can then be used to develop ideas.	**(2)** AI system is able to recognize *more* problems, opportunities, and threats that may be used to generate new ideas.
	Ineffective or local search routines	**(3)** AI system is able to identify and evaluate more *creative/exploratory* ideas.	**(4)** AI system is able to recognize and create more *creative/exploratory* problems, opportunities, and threats to generate new ideas.

Figure 14 Application areas of AI in innovation process (Haefner et al. 2021)

The figure above, and referring to quadrant 1, there are many AI applications that support humans in developing ideas by processing a much larger quantity of data than a human can make manually. The system relies on deep neural networks which help to process a large amount of data (Ng 2017).

Furthermore, AI can be used to optimize energy consumption of different buildings. It can optimize the air-conditioning, heating and ventilation system by utilizing automation. In addition, with the help of natural language processing, it can help children to learn emphatic human skills by having a conversation with a robot that can respond naturally in conversation with facial expressions (Oriel 2020). AI applications can also identify treatments for diseases. As an example, the adaption of neural networks can help to stop the transmission of malaria (Johansen & Quon 2018).

The second quadrant of the figure 13 shows that AI application can generate new ideas and opportunities that can be hard to detect by humans. As an example, an AI system can utilize raw metrics data and turn it into actionable insights which leads to innovative opportunities: Outlier AI's customer was a large restaurant chain that was selling twice as much of a high-margin product after a change in the restaurant layout. This pattern change was detected by AI. Information provided by AI can help organizations to find new innovations and ideas by showing the leaders the most promising new ventures with backed data. (Petersen 2018.)

The third quadrant of the figure 13 is showing some evidence that AI applications can identify ideas and opportunities that are used by local search routines, in other words distant search: as an example, an AI model that can generate art. It is trained to utilize 82 000

paintings from over 1000 of artists from 15th to 20th century. The model called CAN generates new art by learning from these styles. (Elgammal 2017.)

The fourth quadrant of the framework means that AI systems are able to recognize ideas and new innovation opportunities in an unknown knowledge area. According to the study of Haefner et al. (2021), the best application area for this specific task is by utilizing reinforcement learning. Advancements in this AI application area where the algorithms learn to recognize and achieve the objective without any supervision will open up interesting opportunities in innovation and creativity.

In this paper, the tools that are presented above, Figure 2 Business Portfolio Map and figures from innovation tools Chapter 2.1.3. are also presented in the interviews as a part of this research. These tools were chosen in order to boost ideas, prototype together and get more insights. In Chapter five the results of the findings will be further discussed.

3 A CLOSER LOOK AT THE THEORETICAL FRAMEWORK

This research focuses on designing new innovation styles in a cooperative format with experts from two different fields (AI and Innovation). Design Thinking methodology provides a framework for interviewing different stakeholders and combining the best solutions and ideas together in an iterative way. As the problem space and solutions are uncertain, design thinking provides a framework to observe and interview in a non-linear way. Also, the design thinking method gives the possibility to go back and try again in a human centric way. Design thinking can be justified to be an excellent tool to use especially when digitalization plays a role. In this implementation, innovation leaders are the users of the end-result, so it emphasizes the importance of having a human-centered design in place.

3.1 Design Thinking

Design thinking utilizes a human-centered approach to creativity and problem solving. The main anchor is to understand customer needs, test fast and generate ideas in a cooperative manner. In design thinking decision making is based on what the customers want to achieve instead of historical data or instincts. Design thinking provides three different lenses for ensuring a successful solution: **Desirability** which focuses on making a sensible solution for the people, **feasibility** to ensure that it is possible to build technically now and in the future and **viability** for making sure that it is possible to build as a sustainable business model. (Ideo 2021.)

3.1.1 Emphatize

As the purpose is to find a solution to how AI could be implemented in innovation work, the idea of the emphatize phase is to observe and ask the experts what their thoughts, objectives and difficulties in the space are. Empathize phase captures the subtle nuances as for the customers' feelings, experiences and hardships in their line of work.

3.1.2 Define

Define is putting all the information from the previous stage into a package and defining the problem statement precisely. Clustering the ideas and finding repetitive patterns from observation is the key for defining the solution. Moreover, it's important to find the most impactful patterns in order to make a more innovative solution.

3.1.3 Ideate

Ideate phase gives space for creativity, as the protype of the solution is not yet locked in. The main purpose is to explore solutions as the problem space is now defined. It is important to brainstorm different ideas and evaluate the most promising ones for the prototype.

3.1.4 Protype

Prototyping is experimenting the ideas and getting valuable feedback from the end-users. Typically, a minimum viable product is presented in order to learn quickly with minimum effort. Prototyping should be a realistic presentation of the solution in order to get understanding what works and what doesn't. This is the iterative phase where pivots and updates are done based on the feedback

3.1.5 Test

The final stage is testing the final solution. The test phase is still done in interaction so that the end-user's opinions and thoughts are heard. Testing needs revisiting the problem statement and making sure that the solution resolves end-users' problems.

3.1.6 Limitations of Design Thinking

Design thinking has its own limitations, as have all the methods and does not provide a one-size 'fits all' procedure. As Design Thinking relies on qualitative data it can be hard to validate and observe the right end-users. Also, many organizations are not willing to risk a project for a method that digests flexibility, experimentation, risks, failure and agility. Design Thinking method can lack a clear assignment which an organization is looking for. Moreover, design thinking relies on designing a solution rather than executing a solution. Organizations can easily make the creative method into a linear process with not enough qualitative data and feedback as well as forgetting the iterative part that design thinking is made for.

4 METHODOLOGY OF RESEARCH

This chapter demonstrates the data collection method and discusses the research philosophy. The concept of pragmatic and a case study design is discussed which aligns to the primary data collection. The use of the primary data is discussed further with the help and integration of the Design Thinking framework.

4.1 Research Philosophy

The definition of the research philosophy concerns assumptions about knowledge. There are five major philosophies: positivism, interpretivism, realism, postmodernism and realism. The positivism is a natural scientist alignment where observing leads to new knowledge. Interpretivism on the other hand believes that variations of the background and experiences of the human needs are to be taken into account. (Saunders et al. 2015.)

This study utilizes interpretivism as subjective experiences are in question and for this reason also practical implications are sought. The pragmatic approach supports accurate knowledge acquisition while taking respondents' experiences from the interviews into account. Moreover, pragmatic philosophy aligns with the theoretical framework as the design thinking method drives for identifying the problem and defining a solution. Pragmatic philosophy gives space for reflections and feedback utilizing multiple techniques for the desired practical solution.

4.2 Case study design

The research strategy chosen is that of a case study design. The case study approach is useful for obtaining in-depth information of an issue, event or phenomenon. The case study method is a learning technique that allows the researcher to face a particular problem by using a variety of data and exploration of a real problem. A case study consists of a real situation and information as a methodological tool. (Herrera 2016.)

The aim of this study is to find a practical solution for deploying AI in innovation practises. It leverages multiple data sources with a flexible approach in order to come up with the best possible solution. Flexibility allows one to utilize different tools and techniques in order to design a solution that fits in both categories; AI and Innovation field.

4.3 Data collection

In this study primary data was collected through interviews with subject matter experts utilizing the design thinking method. The data was collected in co-creation with an emphasis on ideating and defining with the subject matter experts. The main objective was to find how AI could be enhanced in an innovation process. A figure representing the data collection process is presented below.

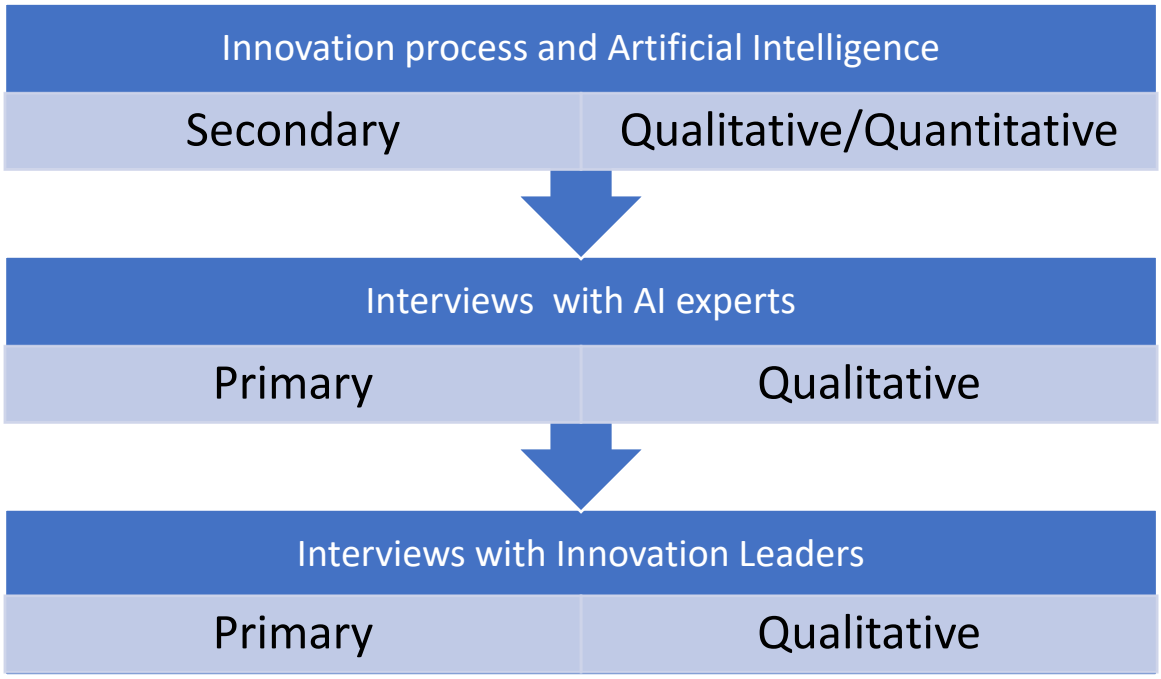


Figure 15 Data collection process

4.3.1 Collecting Primary Data

The data collection process was done in an iterative way by having interviews from two different domains, Innovation leaders and Artificial Intelligence experts. The interviews were held in Teams which lasted a period of time from 15 to 30 minutes. The main objective was to understand if Artificial Intelligence could enhance the innovation tools and methods. The data collection was done by utilizing a design thinking method.

The reason for one-to-one meetings rather than using a focus group was to get leaders to have a conversation in a convenient manner. Also, there are benefits of having more private discussions on what the challenges and pain points are. Also, the participants came from different time zones and nationalities.

The interviews were held with three accomplished AI experts who had previous experience in not only in the technical matter but also implementing AI solutions in different organizations. The years of experience in the subject matter scaled from 5-15 professional years. The main objective was to gather information of how Artificial Intelligence could improve innovation work.

The interviews were held one to one and in an unstructured manner in order to keep conversation flowing and to guarantee the possibility for the experts to freely express their perspectives and know-how. The results are divided into two themes that arise in all interviews: clear data points for AI and change management in innovation culture.

As for the innovation experts the meetings were held in a semi-structured manner with five innovation leaders. All the respondents had 10-20 years of experience driving innovation in different industries. The main purpose of the discussions was to validate if the innovation tools are needed and could they be enhanced with AI. Also, the main theme was to clarify what it takes to lead innovation work successfully; what are the best methods and tools for innovation as well as what are the most challenging parts in innovation work? The results are divided into main themes that arise with the respondents' views. Also, the innovation tools were presented and these meetings were done in a design thinking method in order to validate the user needs and iterate the innovation tools further.

4.3.2 Collecting secondary data

The secondary source for the paper came up from preliminary reading of existing literature and research papers that included previous studies of Innovation and AI. The purpose was to obtain an understanding of the best practices in innovation work as well as realizing the limitations and possibilities of Artificial Intelligence. The secondary source helped to create an outline for this study. Information was collected from previous studies in Innovation and AI as well as of how Innovation and AI have been integrated before, thus giving more in depth understanding of the problem space.

The emphasis in this respect was on the newest research done for the Innovation and AI. Furthermore, this study heavily leans on Osterwalder's tools that were presented in a published book format in 2020. Also, the study utilized the newest research which focused on integrating AI into the Innovation process. The data for the present study was collected in between March – August 2021.

4.3.3 Data Analysis

Since the researcher was merely asking questions in a co-creative manner, only the important points were noted and marked. Also, as the interviews were held several times and with different respondents, the similarities were analysed further and accurately noted. In addition, the observation data was highly qualitative, small and revealed it did not require any further (content) analysis. The co-creation of the innovation tool was done with carefully selected respondents based on their expertise and background. The main objective in the data analysis was to find clear points that were mentioned repeatedly and in an iterative manner. Data was separated into two parts depending on the two domains, Artificial Intelligence or Innovation.

The co-creation was done in a design thinking manner shown in the table below:

Design thinking	Stage used	Purpose
Empathize	Artificial Intelligence expert interview, Innovation leader interview	Possibilities and implications of AI
Define	Artificial Intelligence expert interview and Innovation leader interview	Possibilities and implications of AI and innovation challenges
Ideate	Innovation Leader interview & Artificial Intelligence expert interview	Innovation leader challenges and Idea generation
Prototype	Innovation Leader expert interview	Learn and get new ideas

Test	Innovation Leader expert interview	Insights, new ideas and redefine problem

4.3.4 Reliability and Validity

The terms validity and reliability are commonly used in qualitative research. *Validity* is defined as how accurately a study measures the objective, in other words, if you can draw conclusions from the test scores related to the concept being studied. *Reliability* is defined as how accurately the research gives the same results in the same situation, i.e. the consistency of the measurement. As an example, participants completing a survey having the same responses when the survey is completed. (Heale 2015.)

The relevance of the research comes from the selection of the respondents with broad knowledge and experience of Innovation and AI field. Respondents had positions such as innovation manager, innovation leader, innovation consultant, innovation and technology director, artificial intelligence architect, artificial intelligence expert and PhD in AI and data science. The respondents had 5-20 years of experience in the field. Truthfulness was ensured by having consultative one-to-one meetings and presenting innovation tools in order to make tangible solutions in co-operation.

4.4 Ethical considerations

The study was obtained by voluntary participation and maintaining anonymity. It was conducted with ethical principles. In each meeting the researcher explained the purpose of the study. A permission was asked from the interviewed persons in order to collect the data for research purposes and the respondents agreed on being observed.

The meetings were done online via Teams and by having an outlook calendar appointment. The respondents gave a permission for the interview by accepting the invitation. Overall, the participation was voluntary. Confidentiality was maintained by not recording the meetings and not revealing the respondent’s identity and their representing organization. The participants were chosen by their position and the years of experience in the given subject matter.

5 FINDINGS AND DISCUSSION

The interviews were held with two objectives: to improve understanding the respondents' work field and their opinions on artificial intelligence projects. The second objective was to co-create a tool or solution for integrating AI into the innovative setting.

This chapter focuses on the results from co-creation modelling with the experts utilizing the design thinking method. As there were two different fields of expertise involved in the interviews, the insights and opinions are categorized by the field of expertise. The sub-chapter comprises the respondents' expressions on the subject matter.

Interview		Design thinking Stage and meeting date	Findings
1	**Artificial Intelligence expert interview**	Empathize Feb 8th, 2021	Clear data points are a must for a successful project.
2	**Innovation leader**	Empathize Feb 19th	Innovation Culture as an obstacle for many initiatives. Tools like design thinking and service design are highly common. Fostering Internal relations is important
3	**Artificial Intelligence expert interview**	Define 2021 March 31th, 2021	Challenges in Organisational differences and categorized data needed, change management and feedback are important
4	**Artificial Intelligence expert interview**	Define April 20th 2021.	Text recognition for customer validation, Change management skills are essential for integrating a new solution.
5	**Innovation Leader expert interview**	Define April 19th, 2021	AI could be beneficial in the ideation phase. Especially, in ideation and validating customer data, external/internal
6	**Innovation Leader interview**	Define May 31st , 2021	Extracting more data needed for commercial validation of a new product, AI coaching and supporting the project for non-business users by forecasting profitability and revenue potential
7	**Innovation Leader Interview**	Prototype April 4th, 2021	Utilizing AI for discovering not only customer segments but also partnerships and patent search.
8	**Tech & Innovation Leader**	TEST October 5th , 2021	AI in product design.

Empathize

In this first stage, two interviews were held. One with an AI expert and the other with an innovation leader in order to understand better the line of work and what the most challenging parts in the field are.

The first interview was held with an artificial intelligence expert in order to understand better the technical aspects and capabilities of AI. The respondent had previous experience in integrating AI in very similar processes. As the metrics, goals and objectives are different in organisations, the respondent mentioned that the data points need to be very clear. Also, channelling and validating the data points will need a careful analysis. Validating data points is the cornerstone for making AI work in the innovation tool.

The common answer was that in order to create AI project, data points need to be carefully gathered. Furthermore, data needs to be clearly defined and clean. This is the most challenging part in a project for integrating AI properly. It takes time and careful analysis to build the right metrics and values. Also, it is important to note what the average data point for the model is.

The second interview was held with an innovation leader who had experience working on a global scale and was involved in many innovation projects. According to the respondent the crucial part is to have innovation culture in the organization. There is a lot of uncertainty involved in innovation work and many departments are working in silos. Another challenging part mentioned is to have a brave organization culture with enough resources for the long run and exceptional change leadership.

As an example, from the respondent's previous experience, innovation funnel in a global corporation might have five hundred ideas of which a hundred were going forward and evaluated. From those one hundred some between 10 -15 were funded and moving in the process. In a global corporation transparency is important. Also, having a multitude of experts from different departments involved in the innovation work is essential. Design thinking methods or similar are used.

Define

The purpose of the second stage was to find how AI could be adopted in the innovation work and what part of the innovation could be seen as the most potential one for AI integration yet, taking into consideration the main challenges from the empathy stage. The define stage had two experts' opinions from the field of AI and two from the innovation leaders' perspective.

The interview with the AI expert clarified that it is important to know what the median point is for the AI project. The data needs to be classified and modelled in order to make the AI work. Making sure that the AI is minimizing the volatility in the tool is important, this also ensures a reliable solution. It is possible with AI to make estimations and predictions for any innovation tools in real-time. The model can update itself so that innovation leaders can see the changes live. Innovation patterns are easier to follow if the information flow is more simplified, especially if there are too many data points. Then the AI model is much harder to build as reliable. The tools that were presented above (in Chapter 3, Figures 9-11) could be utilizing the basics, key-value pair and Time-series Analysis (R2.) *

**Key-value pair consists of two related data elements, one key defines the data set and another which is the variable. As an example: Color = Green (ExperienceLeagueAdobe 2020)*

According to Velicer (2003) one of the major characteristics of Time Series Analysis is that that the data sets results from repeated measurements over time on a unit. Time is taken into consideration when observing the data.

The respondent stated that some iteration process is always needed. The unrelevant information may be good to take out in order to make any tool work efficiently as the larger the dataset the harder it is to make sure that every piece is needed for the tool. The main theme is to have clear data with e.g. points in the range of 0-1. The quality of the data is more important than quantity. The main correspondent theme that was constantly mentioned in the interviews was that the data is the fuel for machine learning. The key factor is preparing data as a first important step towards building the AI in the innovation tool.

When analysing the Business model portfolio tool (Chapter 3, Figure 9), the first two points, Ideation and Discovery, it will be more challenging to collect the right data points compared to the next two points, Validation and Confirmation. If the tool is going to be implemented in different organizations it is challenging to make homogenous datapoints and metrics, as different organisations have different product categorisations, processes and metrics, not to mention goals and objectives (R 3.)

Another AI expert who had a lot of experience not only from the AI's technical standpoint but also from the business leader's perspective from industries, such as healthcare and government, stated that implementing and communicating a new tool is a challenge that

needs to be considered in these kinds of projects. According to the respondent, integrating the tool for different shareholders needs a lot of communication between the users and leaders in the organization. Digital strategy is currently a very common theme in organizations. New technologies and applications are implemented and presented very often. There will be challenges presenting a new tool for departments and teams. In addition, there are different innovation styles and methods used in organizations so the innovation tool can only be suitable for a specific group. One respondent noticed that many specific innovation tools are probably useful in larger organizations. The respondent noticed some similarities in the innovation tool presented (Figure 9-11) with one organization which was using a similar innovation method.

Forecasting innovation based on previous history can be quite hard for making machine learning work properly. As innovation is quite a creative and iterative process combined with a very rational system, machine learning can be quite hard to integrate. For this reason, when building the solution it is important to ask feedback as much as possible from the users and making sure that the tool is equivalent to all requirements given.

Another respondent stated that iterating and modifying as much as possible in the beginning is important as the requirements and ideas can change while building the solution. Most projects usually have a clear reporting on a regular basis and communications between all the stakeholders. Everyone needs to be clear with the vision and review the progress. Integrating new digital tools creates a lot of work in developing the capabilities within the employers. Change management should start from the top as the leaders need to adapt and embrace the new approach. Innovation leader's comments need to be carefully analysed to construct the AI.

After defining the limitations and implications of AI the innovation leader was interviewed at this stage. The respondent had over ten years of experience working as a technology and innovation leader in different global organisations. As for Artificial Intelligence in innovation, most needs could be recognized according to the respondent in the ideation phase. Utilizing it for customer data and validating with machine learning. Also, experimentation data and validating the innovation included, AI could be a potential tool for pattern recognition and customer demand analysis. As for the other innovation parts, Artificial Intelligence was not seen as relevant due to the nature of innovation decisions which need more human decisions rather than Artificial Intelligence.

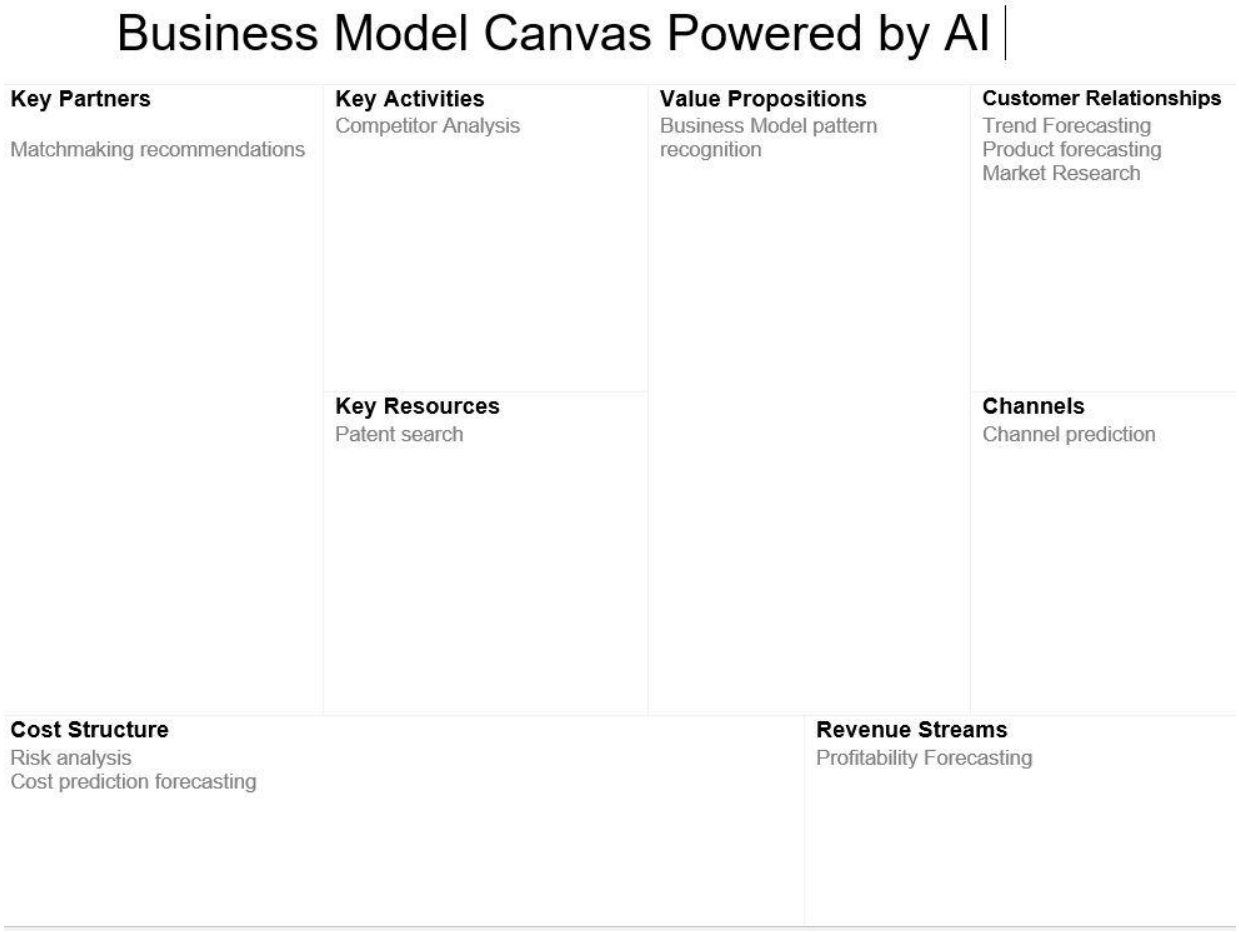
There is a lot of customer data in organizations, internal and external, but it is not utilized to its full potential. One of the biggest challenges for many organizations is to get all employees

involved and engaged to do innovation work and harvest the data that comes from the customers.

According to a respondent who had previous experience managing innovations in a European company with much high-tech innovation in the industrial industry the following: Artificial Intelligence was seen as a potential tool to help engineers and other professionals who do not have a background in business for understanding and forecasting revenue and risks. Both respondents mentioned that business model canvas could be helpful to start modelling with AI in order to get ideas where to focus and what things to consider. Especially, to help teams to discover and design ideas that are innovative but profitable from the business perspective. Artificial Intelligence would be the most beneficial in the ideation phase e.g. coaching and supporting a business case by asking the right questions considering business decisions, projections, profitability, and market space. Business model canvas integrated with AI could be a potential tool if connected right. At least it can monitor all the important pieces for a successful business idea.

Prototype

In the prototype stage, AI integrations were modelled into business model canvas shown below. This information was presented in the next interview. It helped to visualize in which areas AI integration could be possible. As from the previous stage, AI in innovation could be most beneficial in the discovery stage of business ideation and validation. An interview was held with an innovation leader from an organization that cultivates innovative solutions globally. The respondent noted that that the model can give some areas where organizations could focus on. Furthermore, the respondent pin-pointed the importance of open innovation. Artificial Intelligence was also seen as a possible tool in the future to help finding the right stakeholders, as many open innovation programs contain a network of start-ups and universities. AI could help to find the right organizations with the similar area of interest, timeframe and culture in order to join the organization’s innovation ecosystem. These ideas were added in the key partners section as matchmaking recommendations.



TEST

After all stages, an interview was done with a technology leader to find reliable solutions and new ideas. The ideas that were captured from the previous interviews were shown in the meeting with the same figure. The respondent said that these are the very basic elements that AI can potentially do and matchmaking recommendations are utilized e.g. in E-commerce business. Usually, recommending specific products are given for the user based on the previous purchase data. Also, most of the elements are utilized in some way already and said that most lucrative to research next could be cognitive AI where the product design could be done almost fully automated by the AI mimicking human decisions. AI could potentially package all the information from the canvas and make a product design. The respondent stated that there are organizations that offer AI solutions that can build the product from scratch based on existing data. Also, this is the main problem that almost all organizations are currently having; the data is too scattered or too low for AI to work properly.

5.1 AI Experts' and Innovation Experts' views

According to the interviewees the most important part for successful innovation is having a clear innovation funnel, focusing on evaluation and validation. Also, innovation work needs effective leadership skills and processes in place. Especially, when the innovation work is done globally.

As an example, from a previous experience, innovation funnel in a global corporation had 500 ideas which 100 were going forward and evaluated. From those 100 some between 10 -15 were funded and moving in the process. In a global corporation transparency is important. Also, having a multitude of experts from different departments involved in the innovation is crucial. Design thinking methods or similar are used. (R2)

Different tools are utilized from design thinking to agile methods. Experimenting is a common way to prototype and find white spots in the market. A typical way is the double diamond where you first discover and define then narrow it to develop and deliver. According to a respondent (R4) service design methods should be utilized more often and from different departments in order to extract more information from the marketplace and done more customer-centered.

The crucial part that all the respondents have mentioned is to have innovation culture in place. There is a lot of uncertainty involved in innovation work and many departments are working in silos. According to all interviewees, the challenging part is to have a brave organization culture with enough resources for the long run and exceptional change leadership.

Native digital organizations, as an example Amazon, are breathing innovation and have a tendency towards innovation work. Companies that are working in traditional industries need a lot of effort for making innovation work as a daily habit. (R6)

According to the respondents, as for Artificial Intelligence in innovation, most needs could be recognized in the ideation phase; utilizing it for customer data and validating with machine learning. Also, for experimentation data and validation AI could be a potential tool to pattern recognizitions and customer demand analysis. As for the other innovation parts, Artificial Intelligence was not seen as relevant due to the nature of innovation decisions which need more human decisions rather than Artificial Intelligence.

There is a lot of customer data in organizations, internal and external, but it is not utilized to its full potential. One of the biggest challenges for many organizations is to get all employees

involved and engaged to do innovation work and harvest the data that comes from the customers.

According to a respondent (R4) Artificial Intelligence was seen as a potential tool to help engineers and other professionals who do not have a background in business for understanding and forecasting revenue and risks. Two of the respondents (R 6 & 7) mentioned that business model canvas modelling with AI could be a beneficial tool: especially, help teams to discover and design ideas that are innovative but profitable from a business perspective. Artificial Intelligence would be the most beneficial in the ideation phase, for example coaching and supporting a business case by asking the right questions considering business decisions, projections, profitability, and market space. Business model canvas integrated with AI could be a potential tool if connected right.

Artificial Intelligence was also seen as a possible tool in the future to help finding the right stakeholders, as many open innovation programs contain a network of start-ups and universities. AI could help to find the right organizations with the similar area of interest, time frame, and culture in order to join the organization's innovation ecosystem.

5.2 Results of the findings

The following sub-chapter comprises the results of the discussions and a framework for adopting AI in innovation management. The table below has three parts in order to analyze and understand the limitations and opportunities. The first arrow shows the limitations and implications needed in order to build an AI driven innovation method or tool. The second phase consists of the challenges that Innovation teams are having. The third phase is giving recommendations in the given circumstances of both AI and Innovation.

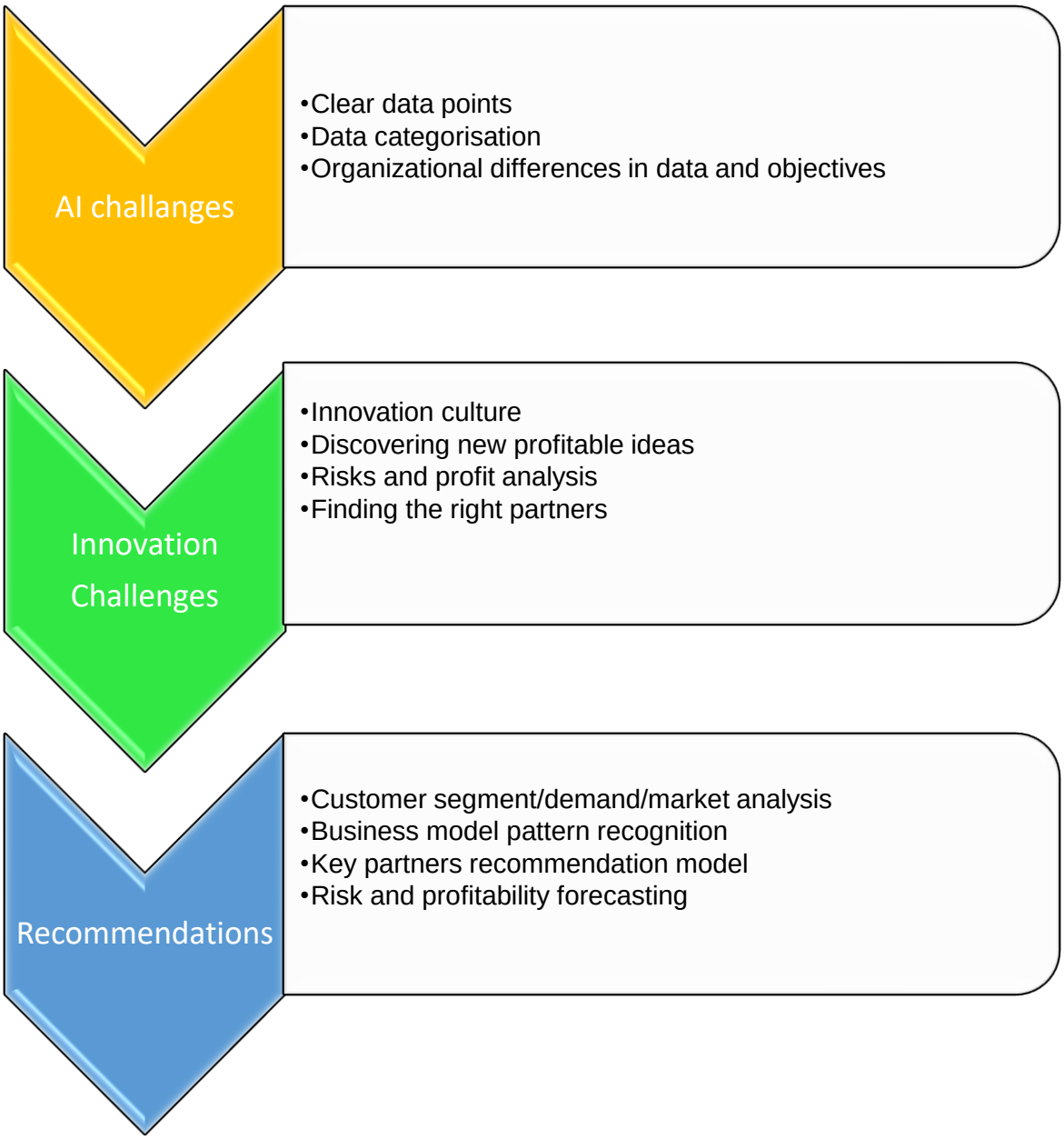


Figure 16 Findings of AI and Innovation Management

5.2.1 Insights from Innovation Experts

Building an excellent innovation culture is a challenge. Especially so for organizations that are in more traditional fields. Building an organization where every employer is committed to innovation needs a lot of resources and work. Utilizing service design or design thinking methods and commitment to discovering new solutions for customers is something that most innovative leaders are looking forward to.

Also, in many organizations innovation tools and methods are in place. Experimenting and exploring are typical but finding winning concepts takes many ideas. Innovation funnel is important and organizations can easily get trapped in an innovation theatre where innovation is done without any meaningful business impact.

As for artificial intelligence, it can be too early integrated into innovation process or management. Many saw AI as a potential tool for discovering new initiatives or helping teams to find ideas which have impact in business, forecasting future risks and profits. AI could help in the future make in-depth analysis of the customer demand or finding the potential customer segment. Also, AI could be helpful in finding the right partners that share common goals, as e.g., in Open innovation program.

5.2.2 Insights from Artificial Intelligence Experts

Integrating AI into similar management processes is not new. The challenges for AI in innovation is that organizations have different metrics, goals and objectives, not to mention that innovation is currently based mostly on human decision making. Also, there are different product categorisations and processes. Making new AI solutions needs clear data points, validated and classified in order to minimize the volatility and maximize the estimations and predictions. In addition, preparing data for the machine learning takes time and resources and it is important to ask feedback from the users while prototyping so that it meets requirements.

6 IMPLICATIONS AND RECOMMENDATIONS

This chapter presents recommendations of how AI can be integrated into innovation Management. A previous study was done by Yams et al. (2020) with a very similar approach interviewing 14 subject matter experts with the same subject as the objective of this paper. The insights from the previous study will work as a base and a reflection point. This is followed by the insights from the design thinking method analysis in order to give practical implications and recommendations.

6.1 Previous study results

According to Yams et al. (2020) the research on utilizing AI in innovation management is fresh and and lacks a systematic overview. Previous research has shown that the range of applications of AI can be quite wide. There is a lot of potential that AI could change the way we innovate but organisations are focusing on quality improvements rather than AI transforming innovation.

Yams et al. (2020) created a maturity model called AI innovation maturity index which shows that there are five stages of AI integration in organisations. Only a few organisations reach the last stage of maturity level: e.g. Google and Amazon. Most organisations are currently in the first stages, foundational or experimenting in AI integrations.

Innovation context	Innovation leadership	Innovation operations	Innovation support	Innovation performance
Scan external environment AI can be used to scan large amount of macro data & trends, industry & competitors data, identifying pain points, in-time recognition of customer/stakeholder needs and prediction of future needs **Scan internal environment** AI can be used to scan internal data and processes, supporting alignment with org values (e.g. to increase inclusion, participation & diversity) **Innovation culture** AI can be used to understand culture/ identify patterns in human behavior that would not be seen through common questionnaires (for example, pattern identification in analysing internal communication) **Innovation ecosystem** AI can be used to support matchmaking with the right innovation partners, assessing their innovation capability	**Innovation vision and strategy** With improved AI-supported sensing of weak signals of change, organisation can become better at sensing future possibilities and possible new lines of business, developing a better data-driven innovation vision and strategy **Organisation for innovation** Data-driven organisation can democratise innovation and enable a more non-hierarchical organisation with distributed and innovative data-driven decision-making on all levels. AI could be used to enable more cross-functional interdisciplinary teams and support a matchmaking and recommendation system within organisation depending on the type of problem/challenge people work with **Innovation roles** AI can be used on one hand to act as assistant to innovation managers better support them in their work through data and insights, and on the other hand it can help them distribute innovation work and capacity across organisation by enabling each employee to become better at identifying pain points and needs of stakeholders they interact with, spotting signals of change that create opportunities for innovation within their own expert domain **Innovation portfolio** AI can be used both for tracking different ideas and their development status in organisation, for merging or connecting them, and as a support to evaluate innovation potential of different ideas	**Identifying opportunities** Data-driven product and service development through identification of pain-points, needs and opportunities with complex AI analytics. **Concept creation & validation** AI can be used to go beyond tunnel vision in the innovation process, identifying unexpected correlations between different concept ideas and broadening concepts by connecting them to other fields. **Solutions development** AI can be used for verification and testing of solutions, analysing trouble reports, and proactively predicting possible failures/defects **Solutions deployment** With a virtuous circle of data you can enable continuous improvement of products and services with iterative loops of feedback data and fast improvements. As development of AI processes and features requires a data-driven experimentation / evaluation cycle, other solutions can get a direct benefit from reusing their experimentation platform	**Attracting & retaining talent** AI supported talent recruitment tools can be used to increase diversity and create a better fit, which increases also retention **Knowledge management** AI can be used for automating and optimising KM, e.g. automated note taking in meetings and making personalised knowledge sharing recommendations **Time & budget for innovation** AI can release extra time and financial resources for innovation work by automating more routine tasks and freeing up more resources for innovation which can thus become a core task of everyone in organisation **Physical & virtual infrastructure/innovation methods & tools** AI-supported innovation tools which can augment human creativity with insights and artefacts from analysing complex and diverse sets of data **Innovation competence development** AI can be used to enable personalised learning (adjusting timing and training methods to specific needs of employees)	**Measure/evaluate performance** AI can be used to track complex sets of innovation performance related data, not only analysing what is happening today but predicting what might happen tomorrow to better manage potential risks and embrace uncertainties, increasing potential for radical innovation **Plan and act for improvement** With the help of predictive analytics, a more proactive (instead of reactive) approach to continuous development of innovation system is enabled, helping organisation not only incrementally improve its IMS, but potentially disrupt it

Figure 17 Yams et al. (2020) Mapping AI support to different aspects of the Innovation Management System

6.1.1 Recommendations from the design thinking method

As most organisations are in the foundational stages of Integrating AI, many could benefit from starting from a small use case. Here are some guidelines from the design thinking method used showing what things to consider when starting a new AI project and use case ideas for innovation.

Key Partners

AI can help organizations to find the right partners such as Universities and Start-ups. AI can find similarities of the organization's interest in external news and content to give a suggestion for the organization to partner up. Also, recommendations depending on a potential partner's location and characteristics may be found.

Key Activities

AI can help to keep track on trends in the industry and help the organization to identify new growing opportunities as well as act as an intelligence which models or platforms to use.

Value Proposition

AI can help to identify which customer needs to satisfy by utilizing internal and external data, such as giving recommendations on which model to utilize, e.g. customers who are demanding for easy-access, performance or price points.

Customer Relationships

Artificial Intelligence can forecast the market and products by utilizing internal and external data, for example internal data of the sales data, reviews and marketing data, in addition, external data from social media, news and other third-party data. Artificial Intelligence can help with the market research of a new product by automating surveys and polls as well as help the organization analyze which product performs the best and which worst.

Key Resources

At the rate of growing numbers of IP patents AI can enhance the patent searching instead of the manual search. Deep learning and neural networks can automate the process of searching high volumes of data and classify patents that are similar.

Channels

Similar to customer relationships AI can forecast the demand of the channel and give recommendations regarding which channel provides the most value. For instance, forecasting previous history of the most promising channels of the organization or utilizing external data to forecast which channel has the most traffic flow for a specific solution.

Cost structure

AI can help to predict costs and risks for different industries, as an example, by evaluating how much time and resources are allocated, prices of other commodities, seasonal trends, interest rates and economic health.

Revenue Streams

AI can help to assess from the internal data which products are likely to sell or predict the future pricing patterns. It can help to analyze the customer behaviours, history data, retention rates or revenue model recommendations.

6.2 The back-end of AI

AI can deliver results by facilitating open innovation and helping in innovation ideation phase by extracting external data. This is mostly done by text mining online communities, patent data based and crowdfunding/innovation platforms. AI algorithm can help to recognize patterns and new inventions in totally different industries from external databases by searching specific words or phrases and identifying problems that can be helpful for creating a solution.

In the development phase of a new product or service AI can detect and analyze features and help to give alternative solutions for the design, e.g. product shape. As another example, Moderna company created an algorithm that automates and optimizes the Covid-19 vaccine mRNA sequence design in order to find the best possible fit for the production. (MITSLOANREVIEW 2021.)

AI algorithms can help to optimize the early production lines and forecast failures. Utilizing machine learning techniques e.g. linear regression or classification and regression trees. Furthermore, AI can help to find new customers for a product by text mining and utilizing natural language processing which helps to find customer bases with a specific problem. AI can also help to gather live-data from its users and iterate the product by itself utilizing natural language processing and text to speech recognition.

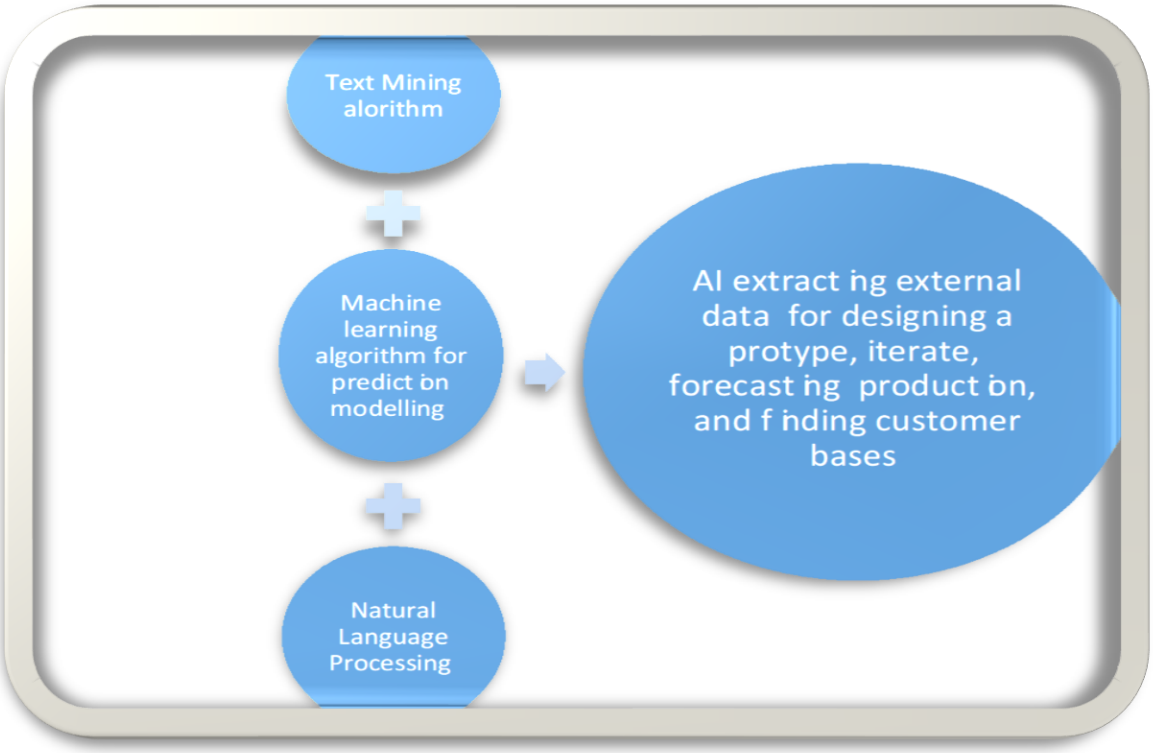


Figure 18 AI Implications

6.3 Project implementation

There is much more uncertainty in AI projects compared to traditional software development. AI projects need a great deal more robust systems in place as data is the fuel for AI in order to make it successful. Technology is changing fast so hiring the right talent is important as well as. Focusing on finding the right AI use case gives the best outcome and return on investment as well as taking into consideration how much time allocations and external partners and risks are involved.

Finding the right use case for innovation starts by understanding the basics of AI as for what it can produce, understanding what it needs and defining how we can measure the impact. Also, will AI help to reduce risks or team-efficiency and what will be the benefit instead of doing it manually? It is good to take into considerations what the costs for maintaining the AI system are and how much time from manual work it can take. Making clear timeline for

project is important. Machine learning projects need a lot of preparation for cleaning and preparing the right data.

It is recommended to start with a project that is manageable and easier. AI needs a lot of labelled data so it is better to start with a project that can be done with internal data instead of buying the data. Also, data requirements are usually the main reason for failure in machine learning projects. There are three main points in data requirements:

1. Relevance
2. Quality
3. Quantity

Firstly, relevance is an important part: Does the data provide a clear correlation to real-life situation? Secondly, data needs to be in good quality, one can ask e.g. How recent is the data or are there many errors in it? As data is the fuel for machine learning there needs to be data points and one should ask whether there is a possibility to collect even more.

As for selection process for the right use case to start with, the itinerary below can help to determine which one could be the most lucrative one. Identifying what input data could be already utilized for the organization as well as what concrete challenge to solve would be the most valuable step for the organization. Assessing by scoring the use cases could be helpful by categorizing it into two parts: difficulty level (data input, time input) and business value.

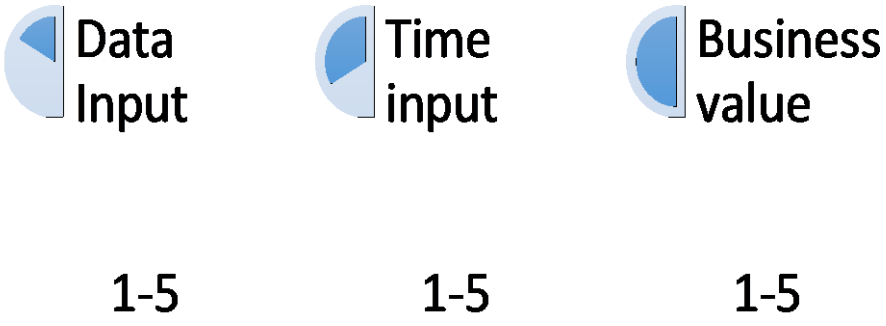


Figure 19. AI use case assessment

6.4 Summary of the findings

The adoption of AI is still in progress in many organizations. Innovation work requires a lot of creativity and human based decision making. AI is still utilized in many assignments and processes. Innovation leaders see some potential in AI as a tool for making better decisions and helping innovation team to move forward. It is still too early in many organisations for the full experience that AI can provide. It requires a lot of capacity, work allocations and change leadership. The subject matter is an interesting topic for many organisations and innovation leaders are open-minded for new ways of delivering value for organizations and their customers.

This problem space was challenged with the help of Design thinking methods to seek for a solution that provides a new tool or a new way of working innovations in the organizations. This study provides an overview of the current innovation work and of what AI can offer for a department that relies on teamwork, creativity and human-based decisions. The challenge for many organizations is adopting new and seeing the risks as worth of taking rather than as a failure.

The main objective of this research was to give an answer to how the future of innovation management works and could AI be a potential partner for the innovation work. The interviews and secondary data gave an in-depth understanding of what the barriers are and clarified the potential of AI in innovation. There are many tasks that AI can help with to free-up time allocations of manual work, including predictions and forecasting to see the risks

and profitability. This requires internal and external data input. Many organisations already understand the value behind data. We can see in the future more and more inventions that are compelled by analytics and data. Yet, it is still too early for AI to be fully adopted in innovation work and management. All in all, the interest for utilizing AI as a tool is highly lucrative for many business leaders.

6.5 Limitations and recommendations for future research

As this study was related to a case study and qualitative techniques the methodological limitations are unavoidable. The methods deployed in this study call for qualitative data but the emphasis is highly related to the context space. The small amount of respondents limits the transferability to different researches. Therefore, the study in this phase gives a descriptive framework for deploying AI in innovation processes and can be utilized for further research as an effort for finding tangible and workable solutions that provide value for innovation work in organisations. Furthermore, it might be possible to gain even a deeper understanding of the subject matter with a qualitative data-gathering method where the researcher could gather information by setting up a guided discussion of the topic in the form of a focus group. That in turn would examine what factors there are that can be highlighted as most important for developing a successful innovation process. Such a group would be small as well, comprise up to 8-10 people, but as a method it would discover trends or patterns in data as the participants could be exchanging ideas on the topic with one another.

The design thinking method gave great insights and background for further studies as defining and ideation were utilized with the professionals. Solution space needs more adequate information and data of the possibilities that AI can deliver for an innovation team. Also, innovation processes and methods vary in different organizations. It is vital to understand that there is diversity in every spectrum in a contemporary society. Collaboration in diverse, multidisciplinary teams is a characteristic of design thinking in action. Moreover, external and internal data are different in organisations and this fact makes it hard to deploy AI as a one-size ‘fits all’ solution. Yet, design thinking is a co-creative and solution-focused approach and as such a project-based technique for innovation and for creating solutions

to problems. It was the hope of the researcher that the elements of design thinking would combine to form an iterative approach to try out and adapt to suit the needs of the study.

REFERENCES

Accenture. 2020. Artificial Intelligence Summary. Retrieved 23 June. Available at: https://www.accenture.com/fi-en/insights/artificial-intelligence-summary-index

Bekker. A. 2019. Types of Artificial Intelligence. Retrieved 23 June Available at: https://www.scnsoft.com/blog/artificial-intelligence-types

Blank, S. 2017. How Companies Strangle innovation.Retrieved on 17 June Available at: https://steveblank.com/2017/09/14/how-companies-strangle-innovation/

Blank, S. 2018. How to make innovation program deliver more than coffee cups Retrieved on 17 June. Available at: steveblank.com/2018/06/05/whats-next-for-getting-stuff-done-in-large-organizations-the-innovation-stack/

Braintrust consulting group, 2021.Learn about Scrum. Retrieved 18 june. Available at: https://www.braintrustgroup.com/learn-about-scrum/

Bughin, J., Hazan, E., Ramaswamy, S., Chui, M., Allas, T., Dahlström, P., Henke, N., Trench, M., 2017. Artificial intelligence: The next digital frontier? McKinsey Global Inst. Retrieved on 14 June. Available at: https://www.mckinsey.com/~/media/mckinsey/industries/advanced %20electronics/our%20insights/how%20artificial%20intelligence%20can %20deliver%20real%20value%20to%20companies/mgi-artificial-intelligencediscussion-paper.ashx.

Chesbrough, H. 2003. Open Innovation: The New Imperative for Creating and Profiting from Technology. Retrieved 18 October. Available at: https://books.google.fi/books/about/Open_Innovation.html?id=4hTRWStFhVgC&redir_esc=y

Cockburn, I., Henderson, R. and Stern, S. 2017. The Impact of Artificial Intelligence on Innovation.Retrieved 22 June. Available at: http://www.nber.org/papers/w24449.

Daugherty, P., Wilson, H.J., 2018. Human + Machine: Reimagining Work in the Age ofAI. Harvard Business Review Press, Boston. Retrieved on 14 June. Available At: https://books.google.fi/books?hl=en&lr=&id=wpY4DwAAQBAJ&oi=fnd&pg=PT14&ots=Ku8uvYaLEP&sig=SQU5DuAupIAAHNsLcJr80YSmAVk&redir_esc=y#v=onepage&q&f=false

Design Council. (2017). The Design Process: What is the Double Diamond?. Retrieved on 18 June Available at: http://bit.ly/2fSMSPs

ElementsofAI. 2020. The types of Machine Learning. Retrieved 23 June. Available at: https://course.elementsofai.com/4/1

Elgammal, A. 2017. AI is blurring the definition of Artist. Retrieved 28 June. Available at: https://www.americanscientist.org/article/ai-is-blurring-the-definition-of-artist.

Fountaine, T., McCharty, B. and Saleh, T. 2019. Building

the AI-Powered Organization. Harvard Business
Review, Retrieved 22 June. Available at: hbr.org/2019/07/building-the-ai-powered-organization

von Krogh, G., 2018. Artificial intelligence in organizations: new opportunities for phenomenon-
based theorizing. Acad. Manag. Discov. 4, 404–409. Retrieved 21 June. Available at: https://doi.org/10.

5465/amd.2018.0084.

Haefner, N.,Wincent, J. Parida,V. Gassman,O. 2021. Artificial intelligence and innovation management: A review, framework, and research agenda. Retrieved 28 June. Available at. https://www.sciencedirect.com/science/article/pii/S004016252031218X

Heale. R. 2015. Validity and reliability in quantitative studies. Retrieved 11 July. Available at: https://ebn.bmj.com/content/18/3/66

Herrera. S. 2016. Case study method. Retrieved 11 July. Available at: https://www.sciencedirect.com/topics/computer-science/case-study-method

IDEO.2021. Design Thinking Overview. Retrieved 29 June. Available at: https://www.ideou.com/pages/design-thinking

Johansen,N.,Quon,G. scAlign: a tool for alignment, integration, and rare cell identification from scRNA-seq data. Retrieved June 28. Available at: https://genomebiology.biomedcentral.com/articles/10.1186/s13059-019-1766-4

Jones, J.N., Cope, J., Kintz, A., 2016. Peering into the future of innovation management. Retrievedon14June.Availableat:https://www.researchgate.net/publication/305264401_Peering_into_the_Future_of_Innovation_Management

Kolko, J. 2015. Design Thinking comes with the Age. Retrieved on 18 June. Available at: https://hbr.org/2015/09/design-thinking-comes-of-age

Mateo, J. 2017. A Complementary Approach in Software Development: How to Combine Design Thinking, Lean Startup and Agile Methodologies for Outstanding Innovation. Retrieved 18 June. Available at: http://bit.ly/2tR4TAt

MITSLOANREVIEW. 2021.AI and Covid-19 Vaccine : Moderna’s Dave Johnson. Retrieved on august 31st . Available at: https://sloanreview.mit.edu/audio/ai-and-the-covid-19-vaccine-modernas-dave-johnson/

Ng, A. 2017.Artificial Intelligence is the New Electricity.Retrieved 28 June. Available at: https://www.units.it/sites/default/files/media/documenti/futuri-studenti/presentazioni-corsi/intelligenza_artificiale_e_data_science.pdf

Oriel, A. 2020. TOP 10 ARTIFICIAL INTELLIGENCE INVENTIONS IN 2020. Retrieved 28 June Available at: https://www.analyticsinsight.net/top-10-artificial-intelligence-inventions-in-2020/

Osterwalder, A., Pigneur, Y., Etiemble, F. & Smith, A. 2020. The Invincible Company. First Edition. New Jersey: John Wiley & Sons

Petersen,M. 2018. The impact of store design. Retrieved 28 June. Available at: https://outlier.ai/weekly-outlier/how-data-analysis-for-retail-discovers-the-impact-of-store-design/

Raisch, S. and Krakowski, S. 2020. Artificial Intelligence and Management: The Automation-Augmentation Paradox. Retrieved 22 June. Available at: https://doi.org/10.5465/2018.0072

Ries, E. 2011. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. 1st ed. Retrieved on 18 June. Available at: https://www.academia.edu/6418358/The_Lean_Startup_How_Today_s_Entrepreneurs_Use_Continuous_Innovation_to_Create_Radically_Successful_Businesses

Saunders, M.N., Lewis, P., Thornhill, A. and Bristow, A., 2015. Understanding research-philosophy and approaches to theory development. Retrieved 11 July. Available at: http://oro.open.ac.uk/53393/

Unemyr, M., 2018. Monitor business data for anomalies with AI Retrieved 22 June Available At: URL. https://unemyr.com/ai-business-data-outlier/

von Krogh, G., 2018. Artificial intelligence in organizations: new opportunities for phenomenon-based theorizing. Acad. Manag. Discov. 4, 404–409. Retrieved 21 June. Available at: https://doi.org/10.

Yams, N.Richardson,V.Shubina,G.Albrecht,S.Gillblad,D. 2020.Integrated AI and Innovation Management: The Beginning of a Beautiful Friendship Retrieved 20 October. Available at: https://timreview.ca/article/13