

The Relationship of Leadership and Artificial Intelligence in Construction and Development Industry: A Mixed Methods Research

Abstract

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Title of publication The Relationship of Leadership and Artificial Intelligence in Construction and Development Industry: A Mixed Methods Research		
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Modern residential construction and development industry has remained relatively unchanged for decades - industry is well-known for its reluctance to transform. Throughout the past five years or so, artificial intelligence has once again become a talking point and cause of hype, resulting in widespread adoption across industries. However, construction and development linger in the follower's position while other industries have gained a strong head start. Author wishes to shed light on the current role of leadership and AI amongst mid-sized construction and development businesses; what is their current level of adoption with AI, how widespread is its use within a business, how successful is the adoption and what are differentiating factors between successful and failing relationship? While management is a well-researched topic, its relationship with artificial intelligence has received relatively modest amount of attention, especially among MSE's in the field of construction and development. Early stages of AI adoption and the general novelty of available AI information is to blame. This research is a multilevel examination, focusing on a mixed methods approach. Quantitative parts comprise of a global survey intended for 1215 executives of the said industry – only one upper management member per company was allowed to partake. Only companies from 50 mill to 1 bill USD annual revenues had the eligibility to participate. Following the survey comes the qualitative section where select few of these leaders were personally interviewed, to gain a deeper outlook of the global situation. Final level, and part of the qualitative research analysis, were the review interviews with AI and construction experts from several recognized institutions. This levelled, mixed methods approach was used for gaining the maximal cohesive understanding of the status quo. The main purpose of the research was gaining intimate knowledge of the path and best practises companies using cognitive technologies, resorted to. As a result, author presented conclusions based on theoretical and practical observations and findings emphasizing recommendations for companies planning to implement the use of AI, or for those failing to see financial benefits and value in their operations implementing AI. This research should offer the reader valuable insights on the named themes and respond to questions companies face in the early or mature stages of AI adoption. The coverage of this research is 54 survey replies from at least 20 countries with a combined revenue bracket from 14.9 bill to 24.6 bill USD of these respective businesses. This translates to approximately 0,33-0,56% of the global residential construction market. All respondents were part of the upper management teams of their own businesses or were representing them (CEO's, Owners, Managing Officers, Board Members, and other upper management teams members).		
Keywords Artificial intelligence, cognitive technologies, leadership, management, building construction, development, residential, Deep Learning, Supervised Learning, business strategy		

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List of Abbreviations:

AI – Artificial Intelligence

MSE – Medium Sized Enterprise

MSES – Micro and Small Enterprises

CEO- Chief Executive Officer

USD – United States Dollars

SMB – Small and Mid-Sized Business

KPI – Key Point of Interest

ROI – Return of Investment

GDP – Gross Domestic Product

IoT – Internet of Things

BIM – Building Information Modelling

AGI – Artificial General Intelligence

SEO – Search Engine Optimisation

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Glossary:

Data strategy - data strategy is a process supporting the procurement, organization, analysis, and production of data in support of business objectives

Big Data – extremely large data set used in computational analysis

Machine Learning – a sub-field of artificial intelligence

C- Suite – executives level managers

General contractor – main party responsible of oversight of construction site, vendor management, trading, and communication in a building project

Stakeholder – party of interest in business such as an investor

IT Strategy – long term plan in the context of technology environment

Digital Business Strategy – application of digital technologies to business models to create novel capabilities

Knowledge-based Systems – a sub-field of artificial intelligence

Computer Vision – a sub-field of artificial intelligence

Optimisation – a sub-field of artificial intelligence

Natural Language Processing – a sub-field of artificial intelligence

Automated Planning and Scheduling – a sub-field of artificial intelligence

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1 Introduction

The history of artificial intelligence (AI) is decades old but only in the past few years it has made its way back to the spotlight in business life: due to technological advancements and abundance of data, it has become possible to utilize this technology effectively in business. Many industries have been busy adopting AI but only few have made significant financial gains with it, even less so in the field of construction and development, known for its reluctance to change. While AI has seen a growing number of articles and research, it has not received as much attention in the specified field of industry. Predominantly, adoption of AI begins top down from upper management – the process unravels an interesting research gap for exploration. Leadership and AI have been addressed in many scientific journals and business magazines but in respect to construction and development, hardly any publications exist – the large construction conglomerates have already begun using AI and issue has seen some coverage in mainstream media, however, MSE's have not been separated from the group. They are likely to witness the next wave of AI adoption. Some may already be in the early stages with cognitive solutions thus making aforementioned timely and appropriate theme to observe closely. To adequately narrow down the field of research, only companies in residential building construction and development are approached.

In this thesis, author shall explore this relatively untouched topic in detail by employing mixed methods research and directly approaching the upper management executives of construction and development companies. As local markets offer rather limited research prospects, it is arguably better focusing to a global level of approach. Before shifting to the empirical research part, author attempts to build up a theoretical structure upon themes: leadership, AI, and business strategy. Based on the findings from theoretical research, the said executives will be surveyed and interviewed followed by results analysis. This analysis is done in unison with the help of outside expertise. To sum up, research consists of theoretical part and empirical research covering a wide survey, semi structured interviews, and data analysis. If successful, conclusions should dictate various effective practices with AI adoption with regards to leadership. As an equally important aspect of research, useful insights, and observations visible in the industry are decrypted.

1.1 Background

Over the course of recent years, the hype for AI's utilization in the field of business has soared. It has regained interest of the public as a direct result of abundance of new breakthroughs (Tecuci 2012, 4). A Global survey conducted by McKinsey Analytics suggested that approximately fifty percent of research participating companies have adopted AI as a

component of business ventures (Balakrishnan et al. 2020, 2.) The scientific research community and the public currently converse about terms such as companies' *data strategies*, *Big Data*, *Machine Learning* and *Deep Learning* – terminology relevant to understanding the topic sphere. As an example of the vast emphasis AI already has on society, a report called *State of AI in Finland 2020*, disclosed that AI would become official item of Finland's national strategy, in an aspiration to recover growth opportunities for technology sector (Törnroth et al. 2020, 5). Currently, businesses, and people alike, are facing a situation where adaption to the new technology is imminent and inevitable, whether they like it or not.

The increases in computing power and excessive amounts of data have established the grounds for AI to evolve where it sits today (Rockwell 2017). The overwhelming trend is that an organization fully assimilating AI, as part of corporate strategy, employs higher chances of turning this relationship into tangible profits. Yet, only a meagre eleven percent of adopters reported significant financial benefits according to survey by Ransbotham et al. Currently, the most efficacious strategy amongst business leaders employing AI is where it recommends business actions while human remains in charge of final decisions. A grand total of 87 percent of participants reported success with this approach, closely rivalled by AI created insights that human element used in process of making decisions (Ransbotham et al. 2020, 10). How does the relationship between AI and upper management manifest itself and how it could shape out when AI becomes superior, or equal to humans? What approach yields appropriate results with contribution of leadership strategy toward business efforts? These questions are relevant to business leaders who have AI in place or are considering utilizing it soon. However, one thing is certain; if an organization neglect having an AI strategy, it will set out to be a technological laggard.

1.2 Field of Industry

The focus of this study lies on the role of leadership and AI, in the field of construction and development industry. Author has chosen specifically residential construction and *development* industry to be under observation during this thesis. Construction itself is one of the largest industries in the world, with an estimated net worth over thirteen trillion US dollars, in 2021, depending on the source (Business Wire 2022). The purpose of this thesis is to offer the reader tools and knowledge understanding AI and effectively approaching both the adoption and implementation of it.

Additionally, it was found as an interesting observation that the industry is still dragging behind everybody else, even though it is such a large vessel in global economic sphere. Moreover, changes required for a significantly more efficient work processes, business models and strategies are desperately overdue. What is the reasoning - for and against AI,

for those who have adopted it and for those who have opted the side-lines approach? Chui et al. (2018) suggest that one hinderance in human-AI interaction is the lack of trust – it is difficult for a human to put faith on the results a machine algorithm provides because they first need to understand how the results came to be (Schia et al. 2019, 908).

While other industries were up for comparison, choosing the field of construction felt the most natural option, as most other industries were relatively mature with the adoption of AI. This would have limited and narrowed the research prospects a lot whereas now there were more liberties awarded and arguably more gains to be achieved, as many findings would potentially be first of their kind. Furthermore, construction industry's premise to transitioning to AI savvy is inherently distinctive from other industries due to its current state thus posing unique challenges.

2 Objectives and Delimitations

The ambition of this research stands at gaining original insights for predicament that AI is presenting to businesses globally. To that end, determining parity of AI and business leaders after which main emphasis lies on discovering prevailing appearance of business leadership strategy: how unilateral is the decision-making process with machine as part of the equation? Lastly, prospecting opportunities in AI, businesses might have overlooked by examining existing theory and comparing it with research findings is something this paper strives for. These are some of the guiding objectives of the research.

After due consideration, building construction and development industry is the sole target segment that shall be explored and examined. The companies themselves are not required to be established internationally but must exceed certain minimum requirements on size and capability, mostly on their revenue bracket. Research demands global approach, and all the companies should derive from various geographical locations. It is reasonable to assume that geographical concentrations of AI might exist and knowingly focusing to these areas should be avoided. Suitable executives will be surveyed and interviewed properly once the theoretical research process has concluded.

Other limitation is found in the methodology that will be strictly limited to AI, excluding Knowledge-based Systems, Computer Vision, Robotics, Optimisation, Natural Language Processing, Automated Planning and Scheduling and other relatable concepts apart from Machine Learning with its sub-categories Deep Learning and Supervised Learning. The reason for exception that they are quite thoroughly explored in literature. Some exceptions are made but covering the entire sphere of AI would be pointless. Additionally, closer examination on Supervised Learning will be conducted. Terminology on both will be explained later in the paper. Furthermore, these excluded terms and concepts may be utilized for descriptive purposes exempting them from deeper examination. To this end, approach has been chosen to limit the commentary in the analysis section. Key words are simplicity and meticulousness.

Between management and leadership, recognizable differences will be explored thoroughly. With that in mind, the attention is directed towards *leadership* which has a very broad spectrum of accepted definitions in literature. Therefore, it is more sensible to contribute on this less researched category than management. Moreover, leadership is recognized as the more modern option albeit it too is facing a process of changing with AI, as administrative duties slowly die out (Noponen 2019, 47; Chamorro-Premuzic et al. 2018, 2-3).

In terms of scope of the study, organizations located in all continents are applicable if they meet the criteria for eligibility. Preferably, the participants should be dispersed widely in geographical terms thus offering a versatile representation of the sample collected. Beyond that, is difficult to look for versatility. The research should be about the data reliability rather than finding a definitive answer to questions encircling AI - or rebuttal of existing findings. With that in mind, the reader has the possibility to make own judgements, based on the findings. These findings are supported by asserted argumentation that can be used as reference point. The narrower the objective of the study the more credible its findings should become - and more easily analysable.

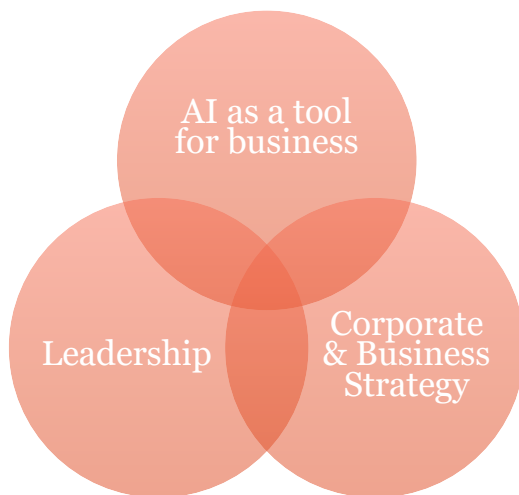


Figure 1. An illustration of research themes. The focal point where these themes interlink

2.1 Research Questions

2.1.1 Existing Knowledge

What comes to artificial intelligence's presence in construction and development industry, it can be said that first steps have been taken. Notwithstanding, the role of leadership in the given field,

information is sparse. Gartner (2017) research indicates that 32 percent of surveyed 118 construction SMBs utilize AI. Out of the same populace, 26 percent are planning to use it within the next two years and 23 percent are in the process of evaluating it. While numbers are not dreadful, they are still far from cross industry outlook. When Deloitte made their *State of Cognitive Survey* on the same year, only 2 percent of cross industry respondents had no AI implemented (Maffeo 2018; Davenport et al. 2017, 6). Clavero (2018) and Wu et al. (2017) say that emerging trends in construction are job site safety and activity monitoring, along with engineering risk analytics (Gayatri 2019, 6). From these relatively complex implementations it can concluded that AI has penetrated the field of construction and development to some extent, and that more progress is likely to soon follow.

Ransbotham et al. report that in 2020 research, only 11 percent of companies have significant financial benefits from the use of AI (Ransbotham et al. 4). This research sets out to find answers to why so few succeed with AI, and if this trend is visible in the context of leadership and business strategy. Furthermore, it is worth exploring whether the poor success ratio has causation with the AI maturity level of the companies or is it, perchance, an issue of general competence. There are several studies that reflect current situation with AI

adoption differentiating factors between successful and unsuccessful adopters: *The 2020 Artificial Intelligence Global Executive Study and Research* by MIT Sloan Management Review, *AI Adoption in the Enterprise 2020* by O'Reilly, and *Global survey: The state of AI in 2020* by Mc Kinsey & Company, to name a few (Ramsbotham et al. 2020; Magoulas & Swoyer 2020; Balakrishnan et al. 2020) The key question is whether or not these differences and observations can be developed into solutions suiting the unique needs of construction and development companies struggling with AI.

2.1.2 Missing Information

As mentioned earlier and hereafter, the role of leadership and AI has been explored to large extent by Noponen, Wingard, Chamorro-Premuzic, Wade & Jordan, and Thomas, for instance (Noponen 2019, Wingard 2019, Chamorro-Premuzic, Wade & Jordan 2018 and Thomas 2016). The foundational difference is the lack of material engulfing construction and development specifically, and in detail. Why has AI not seen widespread adoption then? Because construction industry has a unique position compared to other industries; it lacks digitalization, de-escalates change and is very risk conscious. All qualities that repel AI. Therefore, it is worthwhile to investigate the nuances that remain industry and segment specific. To that end, the commonplace role of leadership and AI held in the field, is worthwhile to map, as similar surveys have been conducted on yearly basis covering industries in general.

Construction has seen a limited amount of change during the past hundred years and the way buildings are erected pertain, like methods decades in the past. Compared to automobile industry that has perfected efficiency, quality and mass production, construction industry strikes as old-fashioned, and one can only wonder if this is an obstacle for perfected AI adoption. Can building construction & development catch up without re-imagining the way it operates? It surely possesses huge potential as what comes plausible gains with AI. Lack of academic material regarding AI in construction and development could be one reason why the trade has remained so unexposed to the issue. This combined with possible unwillingness to learn could potentially be a KPI in this research and serve as justification for current situation. Empirical research shall be used for verifying this assumption, at least to some degree. Similarly, accessibility of AI could be an issue as lack of qualified personnel has been named as one reason for hindered progress (Koutsogiannis 2019).

Additionally, emphasis should be laid on the general accessibility of cognitive technologies: are they readily available to leaders or do they find themselves in a situation where considerable efforts are needed to access cognitive technologies? Companies might have to construct custom made solutions for their respective purposes and then find themselves in

trouble, scouring for off-the-shelf AI products they can use instead. Either way, employing AI effectively requires far more effort than just purchasing the tool or hiring talent.

Presumably, some success stories with AI in construction and development exist – even on MSE level. Is there a profile of these companies such as the ones displayed in existing studies? Moreover, can these characteristics be expanded for mainstream appropriation or is success tied to some other factors? If they are factors that are not directly tied to the company itself, how can they be translated to tangible instructions that others can utilize? This research hopes to uncover answers to at least one of these questions.

2.1.3 Motivations

After tedious orientation towards the subject of artificial intelligence, in the context of leadership, gaps in the general knowledge have been discovered regarding their co-existence. Based on these learnings, the leader of the future will look a whole lot different than the ones seen now – leaders can finally focus on the leadership aspect of their jobs rather than administrative work (Chamorro-Premusiz 2018, 2-3). It looks like there are lots of unknowns in play and the change-up is already in motion.

Now, it seems that only large companies are taking advantage of AI based technologies leaving SME's to be the next line of new adopters. As most industries have already adopted AI and have done so from a very different standpoint, it is interesting to observe and investigate how this process is turning out in the field of building construction and development. This industry is old-fashioned and trailing other industries in technological savviness and general business practises. The industry is nearly unchanged and is soon forced to go through radical digitalization, encompassed with the artificial intelligence. What makes the transition especially intriguing is the unique starting point – many other industries were already efficient and productive prior re-emergence of AI.

Furthermore, there seems to be a missing input to what makes some companies succeed and some fail. Research has shown that while companies apply a few recommended measures, it does not automatically translate to success. The aim of this research is finding further patterns, correlations, and causations between high and poor performing AI adopters. One method of approaching the issues is utilizing similar research tactics than existing studies show and complement them with mixed methods approach.

Main Questions:

What is the prevailing relationship between a construction or development organization's leader and AI?

What are the prospects for superior utilization of AI in businesses' leadership strategy?

Why such a minority of businesses manage to create tangible value with AI?

What foundational changes does construction and development industry must execute, before beginning adopting AI?

Sub-Questions:

How does a successful symbiosis compare against a failing one; what are differentiating factors?

How can we make AI more accessible for business leaders?

Can success stories in construction and development industry be scaled up for mainstream, and how?

3 Theoretical Framework

During this chapter, the reader will be acquainted with main topic supporting theories and methodologies; additionally, author discusses extensions to the main paradigm. Purposely, this main chapter relays the reader with means of understanding the core viewpoints. Furthermore, a brief discussion appertaining to status-quo of business and AI abide. This thesis asserts an assumption where functional relationship between AI and leadership yields measurable, financial benefits to host company.

3.1 Methodology and Research Methods

Before de facto deciding a suitable research method, there needs to be a proper amount of consideration on data acquisition strategy for conducive results – they should be benefitting the research agenda and providing information of value. It is imperative since disparate types of research portray results in ways that may not conform. In the following sub-chapters, a deeper insight on research requirements is discussed.

The two major categories, from which abundance of detailed research methods derive, are quantitative and qualitative methods. Both portray distinctive features: in a quantitative method, emphasis lies on copious amounts of data whereas in a qualitative method, it stays on the essence of data itself. Quantitative data is about observing a larger phenomenon whereas qualitative is about process and meaning (Ikävalko 2019, 3-4, 7-9; Vian et al. 2016, 33-35). Collecting an adequate data sample supporting the research is what author zealously strives for. An option is reserved for supporting assemblage of qualitative information. It is up to the process to determine whether both methods are implemented in the end. Vian et al. argues that applying mixed methods – a combination of quantitative and qualitative method - yields mutually supporting characteristics which result to considerable advantages over using one or the other in isolation, says Creswell (2003) (Vian et al. 2016, 35).

As this study fixates around leadership, it only makes sense that both research types are directed towards business leaders, prioritizing ones in the C-Suite. The reason for narrowing the field is the limited ability of the middle-managers to display cross-operational leadership. Targeted approach towards the upper management should prove more fruitful as each reply reflects each company as whole. The downside is the likelihood of diminished reply rate. The value of individual replies is multiplied as they represent the very top end of the decision chain of command.

To support survey following stage of research process, quantitative data is amassed. The data sample may support the interview process, as interviewees can reflect on the findings

and help filling the research gaps. Once both quantitative research and interview phase finish, the analysis of results may take place. Additionally, opting to participate to AI related business conferences and other events should provide a useful stream of information. To further the richness of data, author takes notes and makes observations during event participation, with full references attached. However, this part is optional and may be discarded if the rest of research process is prolonged.

The general idea behind the research structure is combining process with a story: each stage of research yields a new dataset that will then be analyzed and reflected in the following leg of the research. Mixed methods approach should provide trustworthy results and compensate the potentially low reply rate of the quantitative research by providing an extended data source. The quantitative and qualitative data sets supplement each other. Furthermore, outsider expertise will help bringing creditability for the research. Theory collection may be regarded as crucial part of research structure albeit not addressing a scale required by purely theoretical paper. Aim is to create a comprehensive picture of the situation and present as many sources as possible, for the reader to consider.

3.2 Literature

An empirical research, preceding search for literature about AI's and leadership's conjunction is proving less fruitful than might have been expected – many publications, reports and conferences come across as rather general and vague. Typically, the literature avoids spanning into particulars, or is out of date. AI's comeback began as lately as midway to 2010's which is why older literature might not be suitable. Finding suitable theoretical material is burdensome but not impossible; one reason might be the relative novelty of the subject in academic environment - it has only been a few years since latest AI hype began. With that in mind, AI has been around for decades but only in the last few years, a larger audience has revisited it – including the underused construction and development industry. This allows author to explore a wider research angle. Luckily, quite a few large-scale reports have been orchestrated recently about the state of AI in business – additionally, private research papers and journals are accessible online.

The existing, recent studies administered indicate that AI is a dilemma even for sizable enterprises; for example, obtaining adequate personnel resources may turn out challenging if a company chooses to experiment and implement the use of cognitive technologies in organizational functions, as the international demand for AI expertise soars (Magoulas & Swoyer 2020, 5).

3.3 Research Methods

For this research per se, it takes priority to resort mainly to quantitative data and build the rest of the process revolving the issue. Purposely, a large sample helps in observing the phenomenon. The fundamental problem of how to obtain this sample, remains a problem. The gathered information could be showcased in a form of a regression analysis, where the relationship between leadership and AI is demonstrated with mathematical precision and graphical illustration. As Sarstedt & Mooi write, the regression analysis can be used for prediction and comparison of both independent and dependent variables which act quintessential for study such as this (Sarstedt & Mooi 2014, 194). Identifying correlation between items can bring about exceptional value.

Additionally, author believes using qualitative method is more appropriate for supplementing the findings from a survey or a questionnaire. Alvesson (1996), Bryman et al. 1996, Conger (1998) support exploiting qualitative methods when exploring complex phenomena such as leadership (Antonakis et al. 2003, 54). In case, the quantitative study seems to deliver enough content to the research, there exists the option to scale down and exempt the qualitative part. Ideally, two methods would be combined seamlessly and therefore offer guidance in results analysis (Malina et al. 2010, 6; Vian et al. 2016, 35). However, keeping in mind that questionnaires or surveys provide only suggestions for actions rather than being able to directly answer the research problem spaces, among other limitations. To that end, they can still build the backbone of research (Kirk-Smith 1998, 2). Both options should support one-another in a way that weaknesses are diminished whereas strengths are highlighted according to Johnson and Onwuegbuzie (2004), who iterate each other (Vian et al. 2016, 35).

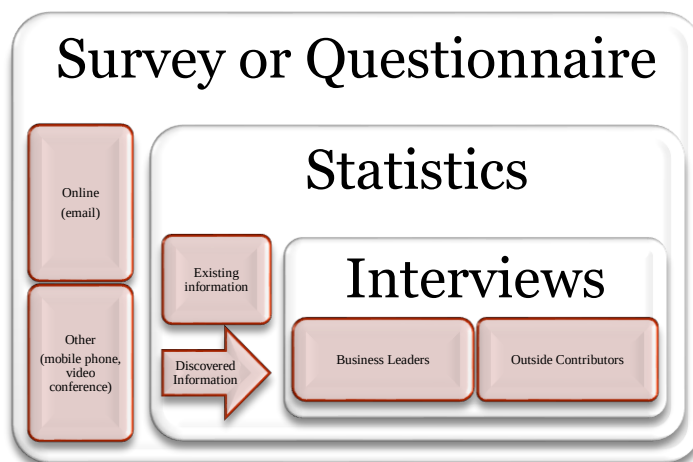


Figure 2. Empirical Research Structure

3.4 Analysis Methods

Theoretical literature and expert assistance are required for structuring the backbone of the research. While the ongoing pandemic is limiting the access to traditional literature to some extent, author recons using The Internet, a far more suitable vessel for finding reference material for this research; scouring for information is efficient, targeted,

for finding reference material for this research; scouring for information is efficient, targeted,

and easier to cross reference. Additionally, material is usually contemporary. Due to the re-emergence of AI, there is surely a fine amount of suitable online literature available. Older publications are a feasible option, but technological leaps could have rendered them outdated, and therefore unsuitable to use. Hence, older material should be used with due consideration. After preparing research data for scrutiny, author offers his own perspective-based discoveries made throughout the thesis writing process.

As aforementioned, author has negotiated with AI researchers, professors, and other experts of the named industry, to provide contribution with the thesis data analysis process and preparation. Their function is bringing creditability, contradicting opinions and new insights to the research material while maintaining an objective approach. In addition, they can offer in-depth views from the standpoint of AI.

For finding resolve to thesis questions, inferential statistics will be used for establishing relationships between phenomenon and statistics. Quantitative and qualitative data will be compared, reflected, and finally interpreted as Creswell has demonstrated (Vian et al. 2016, 37). The step-by-step data collection and analysis will help the reader understand the logical path towards conclusions and recommendations of this research.

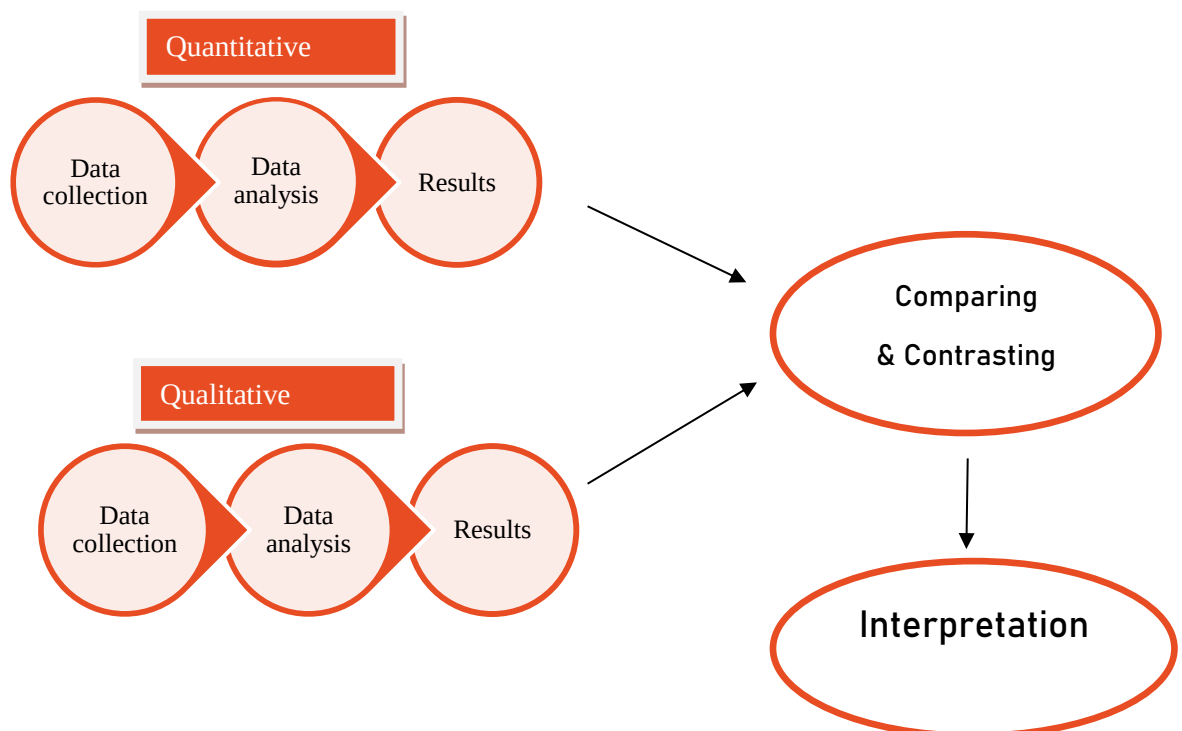


Figure 3. Triangulation mixed method design, adapted from Creswell (2012) (Vial et al. 2016, 37)

3.5 Data Acquisition Strategy & Implementation

From a wide selection of proficient data gathering strategies such as interviews, focus group discussions and questionnaires, it is difficult to choose the best practise. Bazeley (2004) and Naoum (2007) underline the usefulness of mixing methods in research to gather a transcendent understanding of the problem (Vian et al. 2016, 40). On this thesis, author has chosen to put main emphasis on the quantitative data set, shifting it towards surveys and questionnaires which are ideals for large samples. Qualitative methods, particularly semi-structured interviews, on the other hand, complement viewpoints gained post quantitative phase (Vian et al. 2016, 40). Interviews serve a smaller research sample better and offer more detailed outlook on the key issues. Existence of both methods requires an interlap period between stages - a quick assessment of the first phase results. Only after this can the next stage begin.

Kirk-Smith argues that the psychology of the questions plays an important role; investigator bias, context and previous experiences with surveys may influence the outcome of the research (Kirk-Smith 1998, 6-7). Taherdoost claims that negligent selection of the question sample can effectively ruin a study by creating biases and an ill reply-rate. To avoid absence of replies, Taherdoost suggests handing out an incentive to respondents that outweighs time spend on answering the questionnaire. Additionally, creation of trust and offering the promised reward is crucial. Samekh and Levin (2011) iterate that questionnaires' structure should be comprised of simple, not easily misunderstandable, and non-threatening questions (Taherdoost 2016, 38, 39).

The data gathered through the survey, interviews and observations should be broken down into numbers and visualised to promote easier interpretation of collected information. Such interpretation may be demonstrated as tables, graphs, or other visual aids for analysis, post-research, and broken down into academic commentary. In case, some results prove inconclusive, additional questions may be directed towards the respondents during interviews, or the forementioned outside experts, for finding clarity to uncertain variables. The very least, author should verify the results are replicable and easy to comprehend, even for a dilettante.

Furthermore, the survey is established on a paid survey template called *SurveyKiwi*, to ensure a professional, yet somewhat casual outlook. Author chose this site after considering other similar options but deemed *SurveyKiwi* would best demonstrate professionalism and casualness. This survey platform allows a researcher to create various types of questions such as multiple choice, ranking, scaling, and open-ended questions. There is even an option to choose several question types for one survey. In addition, the surveyor can track the progress in near real-time, among other recordable parameters (SurveyKiwi 2021). Due to

issues with confidentiality, a limited data set regarding respondents' demographics is collected.

As there most likely will be a sample size of over two thousand respondents, amounting potentially to several hundreds of responses, all of them must be neatly organised. Conveniently enough, the platform collects most of this data automatically, saving author a considerable amount of time. It even creates tables and graphs automatically and can filter results for speedier analysis and comparison. Finally, surveys can be easily sent to all over the world via email or social media accounts (SurveyKiwi 2021).

3.6 Interview Structures and Layouts

To support the interview data collection process, transcripts of interviews will be recorded for further analysis but will not be disclosed as appendices due to nature of the information, as it may be containing business secrets. It is essential to recollect, as the theoretical part of this study progresses - the template may evolve, even to a vast scale, as new discoveries are made. Above all, it needs to portray information reliably, even if there would be minor adjustments along the way. While conducting the research, it is likely that people are replying at random times of the day and with different mental states thus affecting the way they reply. Both factors may or may not influence the responses. An equal possibility is that respondents misunderstand the questions, or they have no time to explain themselves further. The number of variables is numerous and should be accounted for if such issues start amounting to considerable proportions. The total number of interviews is unknown at this stage of the research.

Open-ended questions are a major part of the interview form – they limit the choice to reply vaguely or too condensed. Furthermore, the interviewee will have a chance to prepare for the questions beforehand. Some exceptions can be made if the question would reveal data from the survey results. If there subsist issues with confidentiality, the researcher provides confidentiality clause according to LAB University of Applied Science's standards. All the questions follow repetitive template, which is shown in detail later in the thesis. However, there may be an incentive to accompany some company specific questions, regarding decision making processes and clarity. These follow-up questions are asked on the spot depending on the way interviewee replies. They have the option to steer the discussion to certain directions. The interview template should follow the guidelines of Standardized Open-Ended Interviews displayed by Gall, Gall & Birg (2003) report on qualitative interview design (Turner 2010, 756).

4 Structure of the Thesis



Figure 4. An illustration of the structure thesis content

4.1 General Information

This thesis has been divided into eleven main chapters according to a typical master's thesis style – see Figure 4. above. By reading through this chapter, the reader will have a structurally coherent picture of the main themes of the research. Fundamentally, it should apply to LAB Business Administration submitted standards in appearance, language, and structure (LAB University of Applied Sciences 2022). This should help the reader to achieve an optimal reading experience, provided by logical framework and adequately simplified timeline. Academic style in writing, governing Harvard referencing system is used, due to their internationally recognized standards in academic community.

4.2 Structural Layout

The introduction chapter will serve as a foundation for introductory video presentation to thesis where thesis supervisor may ask questions regarding the topic and implementation. Furthermore, he scrutinises author and the topic thoroughly. The purpose of the presentation is peer reviewing the thesis: investigating flaws, raise questions on topic selection, and the entirety of thesis research process. It is noteworthy to mention that in the beginning of

the thesis writing process, instructions differed from the ones currently abided by. This is because of the Lahti and Lappeenranta campus had changed their standards while schools merged.

Chapter two will provide the details regarding the studied subject with its subtopics and demonstrates the limitations for the study. Also, a closer look at the theory and data collection process is taken. A comparison between existing knowledge and missing information is part of the process. Furthermore, motivations leading towards topic selection are introduced.

Third chapter, along with fourth, are the core of the thesis's theoretical part: they provide the documentation and structure that the thesis' argumentation and layout is based upon. Furthermore, they underline the concrete research process. As a closely related chapter the Data Analysis will be thoroughly interlinked with the previous two and conjoins empirical research. Research and analysis methods paired with data acquirement strategy are additionally discussed.

Fifth chapter is equally important for the data analysis as this chapter touches the themes of *AI*, *leadership*, and *construction* in detail. It is all about the collective theory findings: what is known and what is important regarding these elements. Newly discovered information has a lot of influence on the empirical research and the general approach on the study. These findings will have heavy influence of the empirical research and analysis cross referencing.

Chapter six neatly combines both quantitative and qualitative research under one umbrella: the approach is close to a storyboard where the research process is linear, followed by results analysis. It is the largest section of the study and covers the preparation, data collection and data presentation of the survey stage. To sum up, this chapter encapsulates the entirety of survey thus building the foundation for the rest of the thesis. Logically, this chapter is followed by Theoretical & Empirical Research findings. These findings are categorised according to the research elements: AI, Leadership and Business Strategy in the context of construction and development.

Before final conclusions take place, a couple of short chapters covering semi-structures interviews and mid-research analysis is introduced. These chapters provide layered support to theoretical and empirical survey findings. All three are being utilized for next chapter Summary & Conclusions.

At the very end, the reader finds a Summary and Conclusions. This chapter compiles the most relevant findings of the project. Followed by reflections on findings and a likely

recommendation for future studies and research - highlighting, the importance of empirical research findings. This chapter is followed by an in-depth list of references, and appendices as separate files.

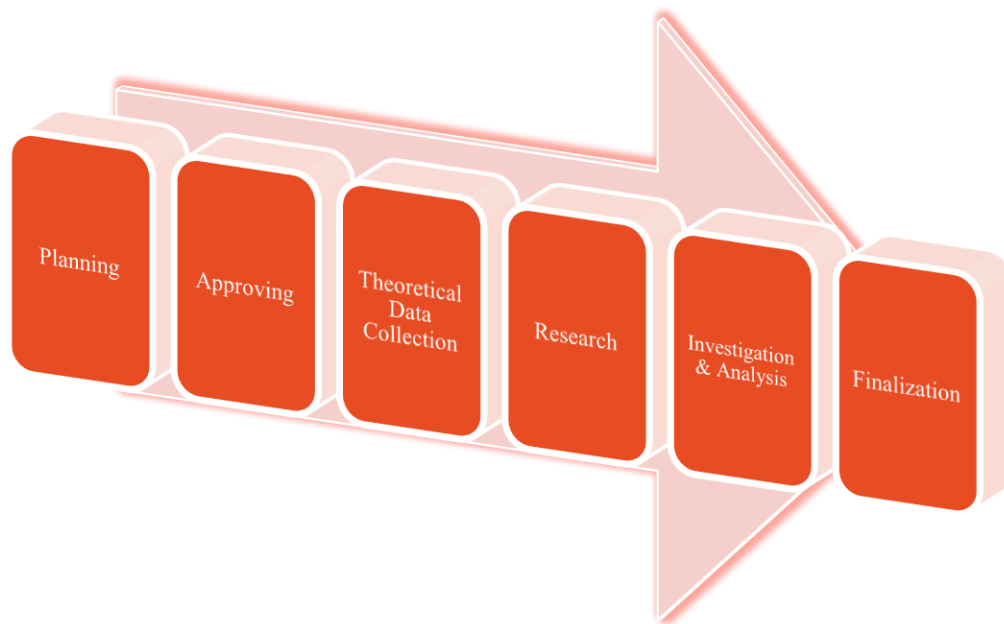


Figure 5. Thesis completion process

For author of this thesis, the goal is to graduate by the end of the year 2021, however, this is somewhat flexible goal as author does not wish to sacrifice the quality of the paper for speed and has therefore prepared to extend the graduation timetable to the late spring of 2022, if needed. At first, the focus remains on theoretical research and creating a proper framework for the thesis research. During late spring 2021, the emphasis shifts towards structuring the final version of the survey and the interview materials after which the summertime is then used for searching suitable candidates and conducting interviews. For the first empirical research stage, author will reserve a period of two to three months of constantly sending out surveys, for construction & development business leaders, everywhere in the world. Once this stage has finished, by the end of the summer, the goal is to begin analysing results and using the autumn period for finalising the thesis work. However, if the survey and interview stage is prolonged, there is no obstacles for moving the analysis to spring 2022. Earliest by December 2021, author hopes to submit the thesis for final evaluation and scrutiny. If deemed inadequate, author will continue to finetune and hone the paper until it has reached a satisfactory level agreed upon with the thesis supervisor.

4.3 A Preliminary List of Surveyed & Interviewed Companies

The search for questioned companies for survey participation should begin only after theoretical part of thesis is close to being finished. Only then, eligible companies for interviews should be considered thus ensuring the approach of the study is cohesive. There are some constraints that apply to all companies considered applicable. For one, they should be medium sized, and by internationally accepted standards. MSEs are large enough to display an impact on societies they operate in – leadership choices affect large audiences of employees and sub-contractors. These choices also have indirect effects on the communities said companies operate in.

Suitable companies follow this process: firstly, they face a verification where their status as residential construction and development enterprises is confirmed. Secondly, a single executive from each company is contacted. Thirdly, all eligible company executives are surveyed online. Finally, a small portion of them, pass through a selection process to determine if they are eligible and willing to participate semi-structured interviews. Ideally, they should be experienced and successful with AI adoption. In case, there are not enough candidates to interview, the spectrum of viewpoints can be expanded to cover all relationships with AI. What is more, they have adequate resources to make changes, as opposed to MSES, and are therefore serve as realistic candidates to utilize the research findings in the future.

All companies should be neatly listed into an Excel-file that display all individuals who have been approached. The purpose of this is to keep track of the progress and avoiding inter-lapping between companies – some companies and people might be part of same corporate families and should not be approached twice to avoid data corruption. A categorised file makes it visually easier to track progress and monitor the share and contribution of each country. It also ensures each person receives same number of contact attempts and allows accurate data labelling.

4.4 Source Criticism

Nowadays, world is full of information and the key to reliable data is source criticism. For this study, all sources are listed at the end of the thesis, as List of references with standardized format - see chapter 4.1. When using references, author will only look for public sources such as reports, publications, and other well-known channels, expressing heavy emphasis on academic materials that have been written by professionals with transparency and credentials. Heaviest emphasis will be directed to reports, journals and material written by reputable establishments with adequate level of reference details available. Some material is likely oral, and this should be clearly indicated in the text, differentiating direct quotations

from indirect. Additionally, background information of oral contributors should be provided. Video materials are not counted as oral material, as they will be recorded and can be re-visited by author. If author doubts the creditability of the source, he will demonstrate this in the text or will refrain from using it entirely. Opposing views are a welcome, good part of credible research and reflect other viewpoints on discussed issues.

The results of this study would, to a certain point, help the reader promote understanding how the phenomenon is seen in this industry. While keeping in mind the limitations of size and scale of the study, the findings should be inspected with some level of scepticism and judged accordingly. The research could, help discovering further needs for study and some weak trends that are visible at the time of replying. If the procedure of answering survey questions is brief and clear enough, it should, in theory, reduce the margin of error and help grasping the key issues of the topic. The reader should remember that those results of the empirical study represent personal, subjective opinions of leaders and cannot provide indisputable evidence of a certain phenomenon. As overwhelming majority of surveys are carefully targeted and sent to selected individuals, it is fair to assume that results are quite accurate and outsiders unlikely to meddle with the research.

For argument's sake, survey results will be treated as credible academic research findings at least to the point where they are analysed together with experts of the topic. The reason for such decision is the fact that all information is first-hand. Theoretical sources are as trustworthy as their reputation – there is no way to measure the accuracy of information beyond that. Author will provide a validation system in the chapter Summary & Conclusions thus helping the reader to weigh the reliability of the findings.

When conducting the interviews face-to-face, the bias may come from the interviewer's side – he or she may not understand respondent correctly, or vice versa, or does not ask relevant sub-questions thus unintentionally affecting the results. Therefore, all findings from them should be treated with a little reserve. To avoid these biases, the interview structure should be very clear and repetitive, and it must be recorded so that interviewer can fact check it later or even request clarifications from respondents. Transparency is considered, as all interviews are recorded and respondent names listed in the thesis, unless specifically requested otherwise. All things considered, interviews should be used as extensions to survey and support information discovered there; follow up questions, asking personal views, filling in on gaps in information or perhaps challenging the viewpoints of respondents.

The collection of both theoretical and research data builds bridges between contexts and increases creditability. In the end, the reader is the one judging the content and must be presented with as much fact filled information available, seconding with opinions of parties

that have a stake in the business – such as the interviewees. Inconsistencies in data should be brought to reader's attention. To have more trustworthy baseline, the information collection process should be very logical: first theoretical part, then surveys and finally interviews after which occurs the data analysis with the experts. Each level should support the next, as author hopefully will gradually understand the subtle nuances and trends better in the relationship between AI and leadership. Purposely, the entire process is educational, not only for the reader but for author too - a process of discoveries.

5 Theoretical Background

5.1 Description of AI

The concept of AI is a vast, multi-layered entity where the term artificial intelligence means and covers a lot of ground. The term and concept have been existing since 1950's when computers were in their early stages - lack of funding and data prolonged the progress of AI development for decades - until recent years. After 10's AI had become universally useful, due to excessive amount of data available and a leap in computing power - both key enablers for progress. One other thing hindering progress earlier was lack of understanding in AI programming (Tecuci 2012, 2-3). Now, that too has become the thing of the past.

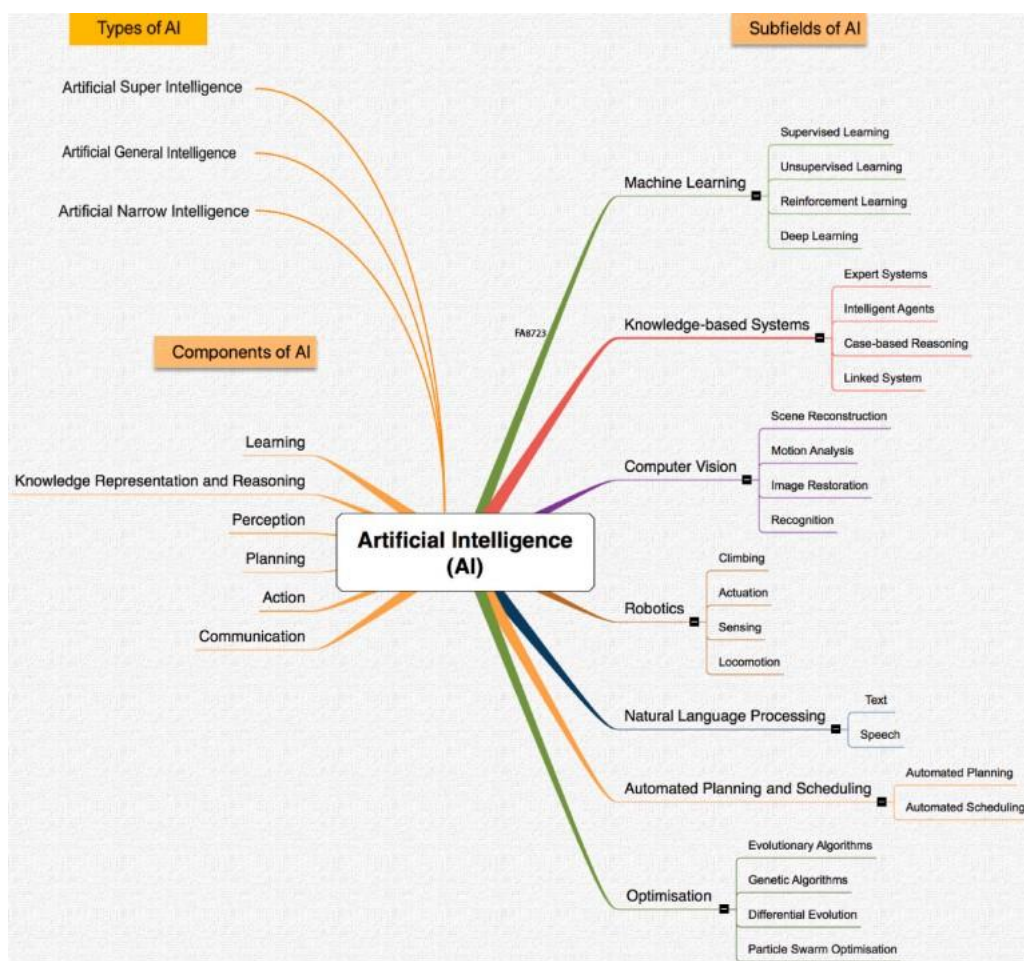


Figure 6. Components, types, and subfields of AI (Abioye et al. 2021, 3)

Commonly, AI has been said to cover computers and robotics, but in truth, it engulfs other areas such as psychology too. Deloitte has defined AI as making computers do tasks that normally would require human intellect to execute (van Duin & Bakshi 2017). Though, there are many definitions all have some things in common; AI displays characteristics in learning, planning, reasoning, action, sensing, perception and communicating the learning forward.

(van Duin & Bakshi 2017; Marr 2018; Abioye et al. 2021, 3). It can be organised into many sub-categories such as weak and strong versions, as Sharma writes - the weak represent typical chatbots that do not really display much intellect whereas the strong represent intellect equal or higher to human brain – General or Super Intelligence (Sharma 2020, 3; Abioye et al. 2021, 3). All of them have one thing in common; they need vast amounts of data heuristic methods to operate (Tecuci 2012, 13).

This thesis will focus on the aspect that is perhaps most widely recognized; cognitive intelligence in computers (van Duin & Bakshi 2017). Taking the sub-focus only on the most popular Machine Learning technologies listed by Magoulas & Swoyer in O'Reilly report from 2020. According to it, Deep Learning and Supervised Learning were the most popular solutions among both self-acclaimed mature users of AI, and newcomers alike (Magoulas & Swoyer 2020, 10-11).

5.2 AI: Narrow Intelligence

As it can be determined from Figure 6., there are three main types of AI: Artificial Super Intelligence, Artificial General Intelligence and Artificial Narrow Intelligence. This paper will focus solely on artificial narrow intelligence. Super Intelligence is the highest form of AI – utopian fantasy now - and even simpler General Intelligence is far from being reality. Experts have estimated its emergence to be around 2060 (Joshi 2019). However, all AI components listed in Figure 6. are plausible parts of the research.

5.2.1 Deep Learning

During an introduction lecture to MIT's new course on Deep Learning, it is being described as a subset of Machine Learning, a subfield of AI. Deep Learning is an automated system on neural networks that discovers patterns in data sets (Amini 2020). It is essentially an artificial set of neurons much like human brain, with each neuron serving a specific purpose (Larochelle 2016; Hordri et al. 2016,1). The strengths of Deep Learning lie in scouring through unlabelled, extensive data and learning from it (Hordri et al. 2016, 1). As a technology it has been existing for a while but only after price decreases of required hardware and increased availability of data, there has been real progress. Currently, Deep Learning can be utilized commercially (Mishra & Gupta 2020, 67).

Understanding basic principles of Deep Learning is paramount, as it is becoming exceedingly popular among businesses and steadfast progress is happening. Arguably, the largest gains from AI soon will be adopted using Deep Learning, as it is one of the most advanced

of the available solutions. It is not far behind in popularity against Supervised Learning which is another subfield of AI (Magoulas & Swoyer 2020, 10-11).

One of the widely known examples of Deep Learning technology are Amazon Alexa and Apple's Siri – they are personal assistant software utilized in daily lives of common folk. Both have heavy emphasis on speech recognition; an area where Deep Learning prevails. Another task that says Deep Learning all over, is image recognition – Deep Learning is at a point where it can even spontaneously create images (Larochelle 2016).

The main take away from Deep Learning is its quickly developing nature, surrounded by pro-innovation community willing to see it developed (Larochelle 2016). Albeit being complicated, there are clear incentives to evaluate Deep Learning as a potential AI solution for business purposes. One must acknowledge its status as a developing technology with more risk factors than in Supervised Learning - the topic for next chapter. However, ROI is arguably higher with Deep Learning. Hopefully, this study will shed some light on the prominence of these technologies for near future, in the field of building construction and development.

5.2.2 Supervised Learning

Supervised Learning is one subfield of highly capable AI. According to survey conducted by O'Reilly in 2020, eighty percent of companies mature with AI, prefer using Supervised Learning as their main tool for business (Magoulas & Swoyer 2020, 10). As the name might imply, Supervised Learning is less intelligent cognitive solution compared to Deep Learning – it requires a great deal more human interaction, hence it cannot work independently. It merely recognizes, predicts, and classifies data (Rimoi 2020; Bengio 2017). It makes sense that businesses are the most interested in this method of AI learning since its superior counterpart, Unsupervised Learning, is still decades away from being perfected (Bengio 2017). Unsupervised Learning would be something close to superintelligence – a concept in the distant future as Joshi wrote in Forbes (Joshi 2019). Logically, Supervised Learning makes a safer choice for them unaware of the full potential of AI. It pays to investigate why this method is more popular than Deep Learning which comes across superior with financial results and how it fairs with leadership. The core difference between them, in favour of Deep Learning, is the prerequisite for labelled data which the AI then processes according to programmers' instructions (Rimoi 2020).

David Teich, a senior contributor for Forbes, argues that when a simple solution is accurate enough, one should stick with that method – in this case Supervised Learning (Teich 2020). It makes sense to a lot of organizations to begin experimenting with the less complicated choice, even if it may consume time from their behalf in training and yield more modest

returns. Large companies with enormous amounts of data and higher level of organizational complexity might benefit more from greater automation and Deep Learning suits that purpose perfectly. With that in mind, Supervised Learning requires governance and supervision as the name implies and only labels data knowing the end results (Teich 2020).

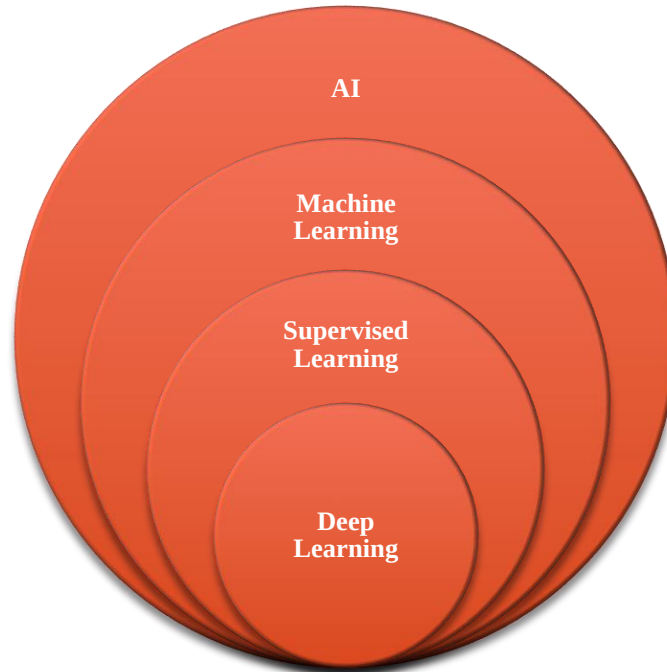


Figure 7. Deep Learning is at the core of modern AI

5.2.3 Supervised Learning versus Deep Learning

As we determined from the previous chapters, Deep Learning is indeed, superior AI to Supervised Learning. More important, however, is the way an AI solution is deployed and utilized. A highly sophisticated technology will not serve a purpose if applied inadequately and ineffectively. By inadequate an ineffective author means that the tool should be used for suitable, high impact purpose, not just randomly applying it, and hoping for best results.

Later, it should be reviewed how construction industry, more specifically, mid-sized residential contractors and developers are unlikely to see many benefits from AI, as their technological capability is still limited. Inherently, AI requires a substantial level of digitalization as technology relies heavily on data and needs to be constantly fed with it. Those companies who have resources could venture directly to using Deep Learning but only after adequate level of digitalization. In fact, for companies in the process of evaluating AI, Deep Learning has already passed Supervised Learning in popularity (Ransbotham 2020, 10).

Supervised Learning is a compelling option for first contact with AI for construction companies: the companies can be more actively part of the process and learn with AI whilst slowly

trying to master it. Arguably best option would be to try using both simultaneously thus ensuring a human element is present and reaping the benefits of multiple methods approach (Rimoi 2020; Bengio 2017).

Construction and development industry is far behind many other fields of business in AI adoption (Blanco et al. 2018). Therefore, it would prove disadvantageous for most companies to begin with the most complicated approach. For a high-end finances company that has all the data, resources and knowhow, Deep Learning will surely be more effective tool but for a late adopter construction firm, taking careful steps seems more viable option even if it means that ROI is slower to accumulate.

5.3 AI as an Organization's Driving Force

Already in 2019, Forbes identified AI as one of the modern driving forces of any organization (Tucker 2019). Similar outcome can be seen in Deloitte's article from the same year as Mittal et al. writes:

...becoming an AI-fuelled organization will likely be more than a strategy for success - it could be table stakes for survival (Mittal et al. 2019).

Surely, these implications must mean that AI has the urgency to be an organization's driving force. Balakrishnan et al. reported top performers investing more to AI than their counterparts (Balakrishnan et al. 2020, 5). The accuracy of these statements is to be investigated in the research part of this thesis. Investigation will consist of several measurement scales which will be used to cross reference practise with theory. While theory may support the premise of AI driven organization the reality may be slightly more complicated. Technological progress is something to follow but does AI need more attention than any other new technological iteration? Referring to views of Fountaine et al., AI is facing organizational and cultural barriers that hinder its progress. Companies who can offset the impact of these barriers can see more benefits to AI (Fountaine et al. 2019, 63).

5.3.1 Organizing AI for Scale

On the side of the soft skills, a leader must demonstrate dedication towards change inside company structure and install a positive attitude even when AI initiative fails. This happens through humility in organizational learning and conversing with employees and asking questions. The purpose here is flattening the hierarchy for the benefit of the company (Fountaine et al. 2019, 72).

All this can be summed up to notion that there does not exist a single right strategy to handle AI in business. There exist a series of best practices that should be adopted to large extent along with fundamental changes in leadership and business practices. These ingredients do not guarantee success but increase the chances considerably.

Harvard Business Review has written an article *Building the AI-Powered Organization*, regarding the issue. Said article has great insights on how one should go on about scaling up AI to organizational level. There are three things to undertake: first, transforming working environment from constrained to interdisciplinary, switching from experience driven to data driven decision-making processes and from risk avoidance to exploratory and agile ideology (Fountain et al. 2020, 65).

From constrained to interdisciplinary

When AI can be developed by people from mixed backgrounds, it has the most influence. Employees from business and operational functions of the company should co-operate with analytical department thus making sure issues AI solves are top organizational priorities, instead of isolated matters. The overall involvement of the workforce ensures that aspects of successful adoption are considered from wide perspectives (Fountain et al. 2020, 65).

From experience to data driven decision-making processes

Traditional hierarchy regarding decision-making may impede efficient work with AI. All employees within an organization should use AI as an augmentation for their work and skills – they need to trust input human and machine provide them. AI provides the data and human makes decision based on its suggestions, by reflecting it to personal expertise (Fountain et al. 65).

From risk avoidant to exploratory and agile

Instead of thriving directly for fully employable solution, organization should implement pilots and learn from the feedback, mistakes, and problems they reveal. This allows companies to avoid minor issues turning into costly problems later. This shift in thinking should speed up the entire development process from pilot to product. The changes required derive from the leader's ability to instil change in attitude and practise (Fountain et al. 2020, 65).

5.3.2 Modes of Interaction

There are several different modes that can be used when applying AI to business processes; they are divided into AI dominants and human dominants. Research by MIT Sloan Management Review and BCG has shown that the one where both exist in harmony is able

to deliver the best results. In fact, the least effective method is form where AI had power over both decision and implementation – again a clear indication to the distance towards Artificial General Intelligence (AGI). By contrast, the best combination was AI recommending a solution and human making the final decision – 87 percent success rate was discovered with this method. These methods used in the research were listed as follows; AI recommends and decides, AI decides and human implements, AI recommends, and human decides, AI generates ideas that human uses in the decision-making process and finally, human generates, and AI implements (Ransbotham et al. 2020, 10).

However, the companies that were using up to five modes at the same time were almost six times as likely to report financial gains from the use of AI compared to the utilization of just one (Ransbotham et al. 2020, 10-13). Only a total of eight percent of all companies apply it (AI) to core functions backing wider adoption which might in turn explain low success rate (Fountain et al. 2019, 64). All these findings correlate the consensus of higher level of general immersions with AI and business – the deeper and wider the application AI has with a company, the better the results. Judging by the rising popularity of Deep Learning, it would be logical to assume AI's own decision-making process becomes enhanced over time. For now, the most effective combination is with the human element.

Everything comes down to effectively applying human or AI decision making – if the human element would impede decision making process for instance on conveyer belt, as Carl March (2020) explain, it would be counterproductive as automated process would be considerably more effective: If a problem of defect that computer vision picks up is more complicated, human element is invited to observe and evaluate the issue more carefully (Maggoulas & Swoyer 2020, 10). In this example, using human element on a speedy work process would not make much sense – the same fundamental principle of using different elements of decision making suiting the use case can mean difference between profit and loss.

5.3.3 Role in Business

As it has been established in the previous chapter, said cognitive technologies are a complex matter, portraying several forms that possess unique applications. What is important, is to understand how AI will serve business as a cohesive entity; what are its main traits and functions for financial incentive? TEDx contributor Hans-Cristian Boos summarises those implications in his brief presentation Artificial Intelligence and the Future of Business; AI brings efficiency, and it works tirelessly freeing time for creativity and innovation within a company (Boos 2018). A similar presentation from Volker Hirsch, from year before, indicates that not adopting this new tool in technology means becoming a laggard and every job that can be replaced, will be replaced (Hirsch 2017). However, this does not mean

cutting down workforce is a healthy solution for companies. According to Capelli there is no proof of such measures benefitting business results (Capelli 2020, 60). Deloitte research from 2017 even claims bullish AI early adopters have enlarged their workforce and experienced only little job losses, at most (Davenport et al. 2017, 2). The substance from both presentations implies that AI's forthcoming is an inevitable event, much like digitalization during its time – the resistant will be left behind the masses and suffer the consequences.

An AI index report from 2018 and 2019 Edelman AI survey report suggest that public attitude towards AI is shifting - as many as thirty percent of articles in media have positive undertone, whereas only a few years back the percentage was significantly lower. Additionally, the number of neutral articles has curbed respectively. The negative articles have lingered on a marginal level throughout the research period (Shoham et al. 2018, 43; 2019 Edelman AI Survey, 3). The sudden change in public opinion from neutral to positive may suggest that more people are willing to venture into the field of cognitive technologies with the intention of trialling them for business. It is noticeable that many, borderline attention-seeking publications, seem to have collected a larger audience than counterparts.

AI should be used as an enhancement for business, rather than a replacer of things, at least when it comes to jobs that cannot be fully automated by AI. Surely, some jobs will become extinct, but most will be more effective and new titles will emerge, leading to more positions available (Stahl 2021). The progress is irresistible as machines do not tire or take sick leave – they usually complete the same tasks with the fraction of the cost and potentially increase revenues in the process. McKinsey & Company reported that top performers credited up to 20 percent of their earnings to AI (Balakrishnan et al. 2020, 2). After such a discovery, it is no wonder why AI has such an appeal on businesses. However, it needs to be remembered that AI is far from actual *general intelligence*, and it requires still plenty of work to operate properly thus leaving room for *human element*.

AI can analyse a lot of data faster than a human brain and can be able to create the course of action through possible insights, which can be used to improve organizational decision-making processes (Zahrani & Marghalani 2018, 5)

– a quote from research *How Artificial Intelligence Transform Business* which summarizes the most common application of AI in business.

5.3.4 Successful Iterations

Artificial intelligence is speedy – time consuming, repetitive, simple jobs are in the past. It can calculate predictions, patterns, and organise variables into categories in mere seconds when for a human, similar task would take considerable time and effort. This is where AI

excels. The augmented speed can free up time for other aspects that are less managerial and more about leadership – such as motivating and inspiring subordinates. For sake of clarity, AI should not be expected to create a new business strategy from scratch or solve construction industry's productivity issues with a push of a button. It is more of a process of small things combined – AI analyses data across company branches and fields, to find patterns that can be used to create insights or suggestions for action (Ransbotham et al. 2020) AI can scan images, automate planning and scheduling together with processing language, among other things (Abioye et al. 2021, 3). AI can also develop existing products, optimize operations, both external and internal, help improving decisions and bolster employee creativity (Mittal et al. 2019).

5.3.5 Unsuccessful Iterations

The nature of AI is based on the data it is being taught with. It is leader's responsibility to feed AI data that suits its task and does not result to biased solutions. All and all, leaders should focus on analysing the results AI produces. Even if on the outside data seems uncorrupted, AI has been known to discriminate certain variables (Marr 2021). It is up for the human element to both justify and verify the results. Blindly trusting everything the algorithms tells is a road to failure as one must understand why AI calculated given results. Anyhow, once the results are verified uncorrupted, they should be trusted as it has been established earlier in the text (Fountain et al. 65). One way to prevent these results being biased is to look at the calculations, indicated opportunities or options, until they are proven legitimate by understanding the algorithms of data collection process. In the end, leader should be the responsible party when AI's verdict is harmful.

5.3.6 Risks of AI

While this research is pro-AI-adoption and immersion in the context of construction and development industry, opposing arguments should be recognized and evaluated. According to Balakrishnan et al. most recognized AI risks companies are working to reduce are cybersecurity threats, regulatory issues, personal privacy, explainability, reputation and shifts in personnel, to name the most prevalent ones (Balakrishnan et al. 2020, 9). Regulatory issues were also recognized in *2019 Artificial Intelligence Survey*. The same survey quizzed leaders about other threats AI could impose and found out that segregation between wealthy and poor would likely grow as direct result. Furthermore, these leaders believed AI to deteriorate human cognitive abilities, among other negative impacts (Edelman 2019).

5.4 Description of Leadership

Before inspecting the prevalent relationship between AI and leadership, it is crucial to establish what leadership stands for, in the context of this thesis. For the sake of clarity, it is important that author and readership make the distinguishment between management and leadership, as there exist several contradicting views how these two co-align - if they align at all (Shamas-ur-Rehman 2011, 2). For this research, they are considered separate entities despite the academic dispute; here management represents the administrative part of being a manager - including daily routines, holding status quo, and maintaining hierarchy. Whereas leadership represents a considerably more delicate art - promoting change, personal relations, and subordinate empowerment (Shamas-ur-Rehman, 9-10). The latter, stands for encouraging one's subordinates to realize the organization's vision and motivate them pursue towards it. Anyone can manage, but not everyone can lead; that is the key predicament. This thesis focuses namely on the leadership and how AI affects it, and vice versa.

5.4.1 Relationship with AI

In business newspaper Forbes, in an article regarding AI and leadership, their senior contributor Jason Wingard argues that even if leaders are aware of the potential AI can offer their respective businesses, they might not understand the full gravity of operational changes adopting it requires. This implication came from the acknowledgement of recent studies by Deloitte (2017) and BCG/MIT (2019) which indicate that hype towards AI accumulation is not necessarily fuelled by know-how and appropriate actions (Wingard 2019). These findings seem reasonable, as assumably, most of the leaders are not experts on computer engineering, nor AI, and must make definitive decisions sometimes based on inadequate level of understanding. Humility was named one important characteristic of a leader in the AI age, by Chamorro-Premuzic et al. – leaders need to be aware of their limits with knowledgebase (Chamorro-Premuzic et al. 2018). It would explain why such a small number of businesses have made significant financial gains from this technology (Ransbotham et al. 2020, 4).

Wingard continues that business leaders believe that the final judgement in decision making will not likely be replaced by AI anytime soon. However, the true beneficiaries are leaders themselves, as AI driven algorithms grant them abilities to make informed management decisions leading to a well lubricated organization (Wingard 2019). Essentially, AI should free time from managerial duties to soft leadership skills and their application. Sintonen and Auvinen (2009) even claim that the definition of leadership is becoming increasingly blurred

– one reason being a shift of power structure between man and machine (Noponen 2019, 47). This might indicate the topic is yet to receive widespread attention, even though it has been reality for many companies decided to embrace AI. Noponen concludes that the senior managers are ones who will be most likely seeing the augmentation of their tasks rather than mid- and low management – AI might replace mid-managers entirely soon. According to Amara (1991), ultimately leadership can be split into two paths; revolutionary and evolutionary where the first implies that most jobs will be transformed by AI whereas evolutionary highlights the skill complementing nature of it. Either way, the change is likely to occur in the next decade (Noponen 2019, 48).

Leadership can become inflexible at times when organizational structure is not flat; the societal distance between CEO and common construction worker is immense. Even next managerial stage down may feel disconnected from upper management. How can a leader improve leadership approach when all first-hand responsibilities are tied to stakeholders, not to employee's well-being? Broader courses of action call for self-evaluation especially when dealing with AI.

Brynnjolfsson (2018) concludes that it is mostly large companies who have cognitive technologies in-place. Some companies have so little understanding on the topic that their leaders do not even realise they are already using AI (Knight 2020). What counts as AI in disposal of a business? Is Google Translate, which uses Deep Learning algorithms for SEO, a tool that is *in use*? Most likely, if given liberal enough criteria, all companies are using AI without realising it. The difference is whether they are paying for the service or not - with sole purpose of using AI for enhancement of business.

In 2016, Accenture set up a study on how AI will shape leadership in the future. This study was produced by Robert Thomas who is their director of research on leadership, management, and workforce effectiveness. In this chapter a closer look at this study's findings is made and pivotal elements are closely examined with respect to *artificial intelligence*. Thomas has divided these elements into six segments visible below:

Experience of membership and shared purpose is the first on the list; in the future, organizations need to convey workforce of a shared higher purpose for functioning, when organization is no longer just a workplace, and it is the leader's job to enable corresponding changes (Thomas 2016, 10). It helps to bring everyone together while leader portrays a clear vision of the direction company is headed to, thus creating a sense of purpose for employees (Chamorro-Premuzic, Wade & Jordan 2018, 3-4).

Collective agility is a term that translates to promoting working in unison within fast-paced environment; a team must deliver results quicker, and leader must see through the process

from start to finish. This essentially encapsulates leader's ability to assemble people for a group task, work efficiently and then disband everyone back to their normal routines, while still maintaining efficiency. Similarly, it is important not being merely adaptive but rather willing to change an opinion and perspective if deemed ill-effective (Thomas 2016, 10; Chamorro-Premuzic et al. 2018, 4).

Embracing openness is another key element to future of leadership with AI – information flow is supersonic and therefore reaction times need be equal (Thomas 2016, 11). This quality has been mentioned many times over in other publications, as AI cannot work effectively if restrained, working with outdated business models. Awakening to strategically significant action can derive from anywhere when AI is poking around organization's data - a leader should be prepared for that.

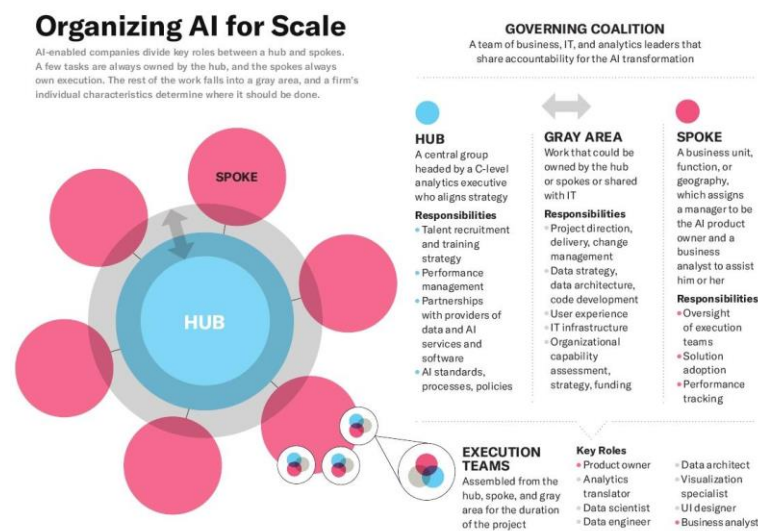
Growing trust and engagement. According to Seidman, as customers have data collected on them - and nowadays employees alike - the flow of information should be a two-way street. Employees should understand that information being collected is utilized in creation of a better organization – this constitutes to transparency (Thomas 2016, 11). Engagement remains equally important from - the side of the leader. An informed one can spot weak signals around, using them for the advantage of the company (Chamorro-Premuzic et al. 2018, 4-5).

Reinvent organizational operations. Traditional high hierarchy and slow decision-making processes may prove ineffective in the age of AI. Instead, organizations should invest on continuous monitoring of workflow thus highlighting it for everyone involved (Thomas 2016, 12; Fountaine et al. 2019, 65). Marr agrees on the restructuring of the business strategy as there is no point using AI for automating outdated business functions but rather change them to support AI (Marr 2019).

Leadership Continuum. Leaders should take an initiative towards better networking in the future; sparking new conversations and innovation throughout social networks may be beneficial for business. Sharing leader's own thinking is considered beneficial as well, as it may stimulate fruitful reasoning from subordinates, keeping in mind that the network of trust should be expanded beyond leader's comfort zone and expertise (Thomas 2016, 13-14). It may be important to acknowledge that a subordinate might be more qualified to oversee some issues and recognize this fact in the decision-making process (Chamorro-Premuzic et al. 2018, 3; Milo 2017). The decision-making part becomes important according to Tortop et al. (2017) since leaders tend to avoid difficult decisions. The ones who use AI as a supporting tool may overcome this obstacle (Canbek 2019, 178). AI's interference will allow faster decision making, enhanced thinking, promoting testing of business decisions; all at

the fraction of a cost of traditional methods. Soft skills will be integrated more into leadership – leaders should be able to make people from different attitudes, backgrounds, and ethics work better together (Thomas 2016, 15-16; Fountaine et al. 2019, 65). Dewhurst and Wilmott had already mentioned the importance of soft skills back in 2014 (Dewhurst and Wilmott 2014). However, the likelihood of fully AI assigned decision responsibility might take time realizing, in more complicated business networks.

As if to quantify the importance of study about leaderships and AI's co-existence, author has had some troubles finding adequate research or data regarding the role of these two elements. Many publications discuss leadership and AI but lack elaboration on the topic. Correspondingly, similar observations can be made from video materials available. Author should focus driving the agenda to an in-depth analysis about the nature of leadership and AI in construction and development industry.



5.4.2 Leadership Strategies with AI

Figure 8. AI powered organization structure (Fountaine et al. 2019, 68)

As it has been determined by research, the strategy revolving around AI in business must not be limited to a narrow field or singular purpose

for achieving remarkable benefits from it. In fact, the key to success is change of business processes, multiple methods of AI-human interactions, and mutually learning with AI (Ransbotham 2020, 13). Fountaine et al. implies cultural change being important for the successful adaptation (Fountaine et al. 2019, 64). Wallenberg highlights that strategy with AI and learning its basic principles should flow from top to bottom, throughout the organization (Wallenberg 2018, 94). Furthermore, Blanco et al. emphasize the importance of ecosystem-based thinking (Blanco et al. 2020).

AI must be perceived as a long-term strategical investment that does not award, immediate results, especially if its implementation is only marginal in terms of pilot programming. Assessing time frame for ROI must be aligned with the tasks AI is doing, one cannot expect

instant gains on all AI initiatives but rather think how different timeframes support one-another (Fountain et al. 2019, 64, 68-69). C-Suite leaders' participation is essential in internal processes to enable AI adoption, according to Blanco et al. (Blanco et al. 2020). AI has been said to excel in *driving growth* as opposed to *cost cutting*. For the best results, strategy is built with the requirements of AI, not vice versa – as discussed in the chapter *Organizing AI for Scale*, similar attributes are equally relevant to leadership aspects of AI adoption as explained by Fountain et al. (Fountain et al 2019, 65).

Many literature pieces and conferences regarding AI make it appear black and white – it will take away jobs and control the world. The first part is true, to some extent, erasing boring repetitive jobs is unavoidable but new roles will be emerging (Hirsch 2017). Researchers emphasize that the number of jobs will increase over time due to AI. Therefore, a leader must let his or her subordinates know the benefits of AI adoption will bring to the table and instil trust instead of fear towards it – this includes middle-managers as well. To ensure a frictionless transition, a considerable portion of dedicated budget should be diverted both to integration and new technology (Fountain et al. 2019, 66-68).

5.5 Corporate & Business Strategy

AI introduction differs tremendously from a typical shift in business structure – in fact, many influencers in AI and leadership have called it fourth industrial revolution, and with a good reason: throughout the theoretical framework of this thesis, a discussion has been leading towards an AI driven mindset where AI becomes the essence of change. Differentiating corporate and business strategy will become increasingly difficult as the line between the two blurs along with increased connectivity provided by AI and hub mentality. To find remarkable differences one must look business from vision standpoint because anything narrower has already broad ties to AI.

5.5.1 Corporate Strategy

Corporate strategy is the long-term overview and plan of direction where company is headed. It consists of a company mission, goals and objectives, acquisitions, and growth options and market plans, according to Pryor (2001) (Kurien 2004, 6). This thesis will touch on the issue of corporate strategies in the age of intelligent machines, but the focus revolves around relationship between leadership and AI. The influence of AI may be less obvious than on business strategy and day-to-day decisions. As company shifts towards an equilibrium with AI, it may find itself in a situation where changes in corporate strategy have occurred organically. Shapiro claims AI is about to enter the world of corporate strategy when the popularity for predictive tools for management is at its all-time high. He reminds that the

automation of corporate strategy has been around for a while, but modern solutions should improve these processes within business (Shapiro 2019).

5.5.2 Business Strategy

Business strategy refers to method of reaching required milestones and objectives for realising the corporate strategy. Essentially, it is the next level down. One could refer to other as theory, and other as practise. Both are relevant for thesis due to their interlinked nature with leadership. This issue will be more closely observed in the research part where AI's impact is observed and recorded.

An effective business strategy calls for the interlap between business and IT strategy according to Kitsios & Kamariotou (Kitsios & Kamariotou 2021, 7). Nasiri states that IT strategy has been reformed into digital business strategy where digital environment and business strategy direct each other (Nasiri 2022). Purely AI based strategy has been referred to as cognitive strategy by scholars (Kitsios & Kamariotou 2021, 7). Digital leadership involved with digital business strategy allows smoother digital transition (Nasiri 2022). This could incidentally mean adoption of AI, for instance.

In this research, the nature how presence of AI affects business strategy is closely scrutinized. What area does AI have an impact on? How do the business strategies evolve during the adoption process and what is the leadership's role in all this? These are some of the questions that will be addressed directly or indirectly throughout the research.

5.6 Prospects

Anyoha Rockwell from Harvard University sees the inevitable direction of AI progress eventually reaching a higher level of intelligence than humans possess (Rockwell 2017). In the meantime, one can only guess how long it should take when increasing number of companies are investing in AI (Magoulas & Swoyer 2020, 4.) Should companies directly pursue the next level of AI, also known as Deep Learning, or develop themselves with other solutions? A study made by Deloitte (2017) indicates that those who were willing to risk more with AI were more satisfied with the results than those more reserved (Davenport et al. 2017, 2). It seems that Deep Learning is getting more traction and becomes close to surpassing Supervised Learning in overall popularity. Predominantly, companies still in the stages of evaluating AI are already using more Deep Learning as opposed to solutions where human is part of the loop. However, Supervised Learning remains the most popular option for mature users of AI (Magoulas & Swoyer 2020, 10-11.)

Soon, AI will reshape management and affect the way leadership portrays itself in organizations – an extensive study with over 1700 managers, conducted by Harvard Business Review stated that 54 percent of said managers' work time is spend on administrative tasks. This would free time for duties that only humans are able to perform - such as design thinking and judgement (Kolbjørnsrud et al. 2016, 3-5). Main message is that the role of the leader will change – a view that has also been agreed upon by Dewhurst and Willmott already back in 2014 (Dewhurst & Willmott 2014).

What comes to construction, it is likely that robotization, AI and IoT will be making the industry significantly more cost effective (Rao 2022). Increased savings can quickly turn into increased profitability. AI, paired with other technologies is great prospect for solving construction industry's age-old problems. The progress could lead to exponential growth in investment towards digital solutions soon, highlighting AI.

5.7 Residential Construction & Development Business

5.7.1 Brief Overview

Construction industry is one of the largest industries in the world, employing a major part of population, constituting up to 13% of the global gross domestic product (GDP) which, depending on the source, translates to approximately ten trillion USD. Despite huge growth prospects, industry is suffering from lack of capable workforce and productivity issues to name a few.

Due to overwhelming complexity and unchanged working environment this field has been slacking behind other industries, both organizationally and technologically. The way houses are built has changed, but rather slowly in the past decades. AI procurement and usage are downright sparse. The arrival of ground-breaking cognitive technologies and diminishing, capable workforce is forcing this old-fashioned industry to adapt to a new situation. During this chapter reader learns the current situation of global residential construction industry and what is its relationship with AI.

5.7.2 Current State of AI within Construction & Development

Katleen Walch, a managing partner and principal analyst at AI research and consultancy firm Cognilytica writes in Forbes that AI's utilisation in construction is moving with similar fashion as in of other industries. It searches for patterns and executes mundane, and time-consuming, repetitive tasks. Additionally, it has been used to enhance construction site safety by monitoring variable streams of information relayed by censoring grid established

with IoT (Internet of Things). Walch argues that in the future this technology will make the industry more efficient, generally improved, and increasingly profitable (Walch 2020). As an example, in Germany, only five percent of mid-sized companies utilized AI in 2018. Similar numbers are visible in KPMG's Future Ready Index below. The small number of companies can be explained by lack of existing digital strategy, mental obstacles, and shortage of skilled workforce to handle new technology (Kiefer & Ulmer 2019, 71).

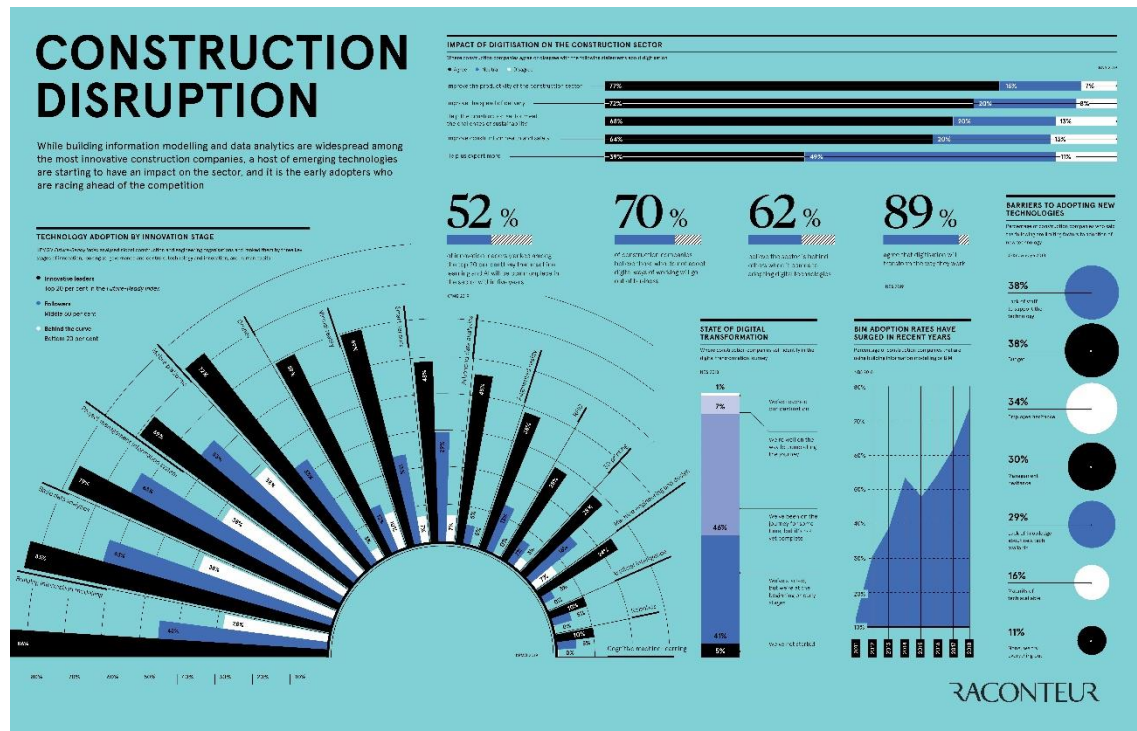


Figure 9. Visual Capitalist (KPMG's Future Ready Index) depicting the adoption of different technologies in construction. Full resolution image can be found through a link in the List of references (Jones 2019).

So far, only 10 percent of the top *innovators* (20% of all construction companies) have AI technologies in place, according to Future Ready Index. In comparison, solutions such as BIM (Building Information Modelling), basic data analytics, project management information systems and mobile platforms are quite common. For the *followers* the number is 5 percent. For *laggards*, AI's presence is non-existent (Jones 2019).

Blanco et al. from McKinsey & Company confirms that even though there are existing, working applications in the industry that are creating tangible benefits such as increased ROI, they have not yet translated into mainstream adoption of AI. The leaders, when measured by estimated spending and application of AI on core business functions, are financial services, high tech, and telecommunications companies whereas construction has the lowest position on spending (Blanco et al. 2018). One aspect of the research is to investigate the

reasons for the low expenditure: is it about accessibility, risk, lack of information or something entirely different?

Currently, AI's market share in construction is valued around 997 million USD in 2021, by Market Watch, and is projected to grow to seven billion by 2028 (Market Watch 2022). Fortune Business Insights (2022) estimates the global AI industry to grow from the current 387 billion USD to well over trillion dollars by 2029 (Globe Newswire 2022). While the share of construction is minuscule now the potential to grow is vast. Both estimates on AI and construction industry adoption growth imply changes to be on their way. It is fair to assume that as the barriers of entry are somewhat high with cognitive technologies, the construction business adoption is frontloaded - large enterprises who have the resources to experiment with new innovations can overcome these barriers (Knight 2020). It is plausible that AI will break through with mainstream soon, as it only took five years or so for BIM to become popular. What is more, technologies closely tied to AI have already seen widespread adoption hence easing the transition and closing the gap in digitalization requirements.

5.7.3 Practical Applications

Currently, AI has many applications in the field of construction and surely many more are on the way. In this sub-chapter a few practical examples will be introduced for the reader. Witnessing practical examples, makes it easier to realize just how much untapped potential lies in this arena – options are nearly limitless. Here are few examples of ways to employ AI in construction:

Construction management

According to Elhouar et al. AI could help make complex construction management projects more effective: real time analysis of construction site could help increase safety and train crews more efficiently than before. Moreover, the general ability to keep the project intact and under control, are the key merits of AI for construction management. Strukova and Liska (2012) say access to stored information is another key benefit (Elhouar et al. 2020, 6; Phaladi et al. 2022, 3).

Replacing labour shortages

Boyd and Holton (2017) say that using AI technologies can be a great way to replace missing talent as machines that incorporate cognitive technologies can do similar tasks as their human counterparts thus decreasing rate of error (Phaladi 2022, 3). It is justified to use robotics enhanced by AI to replace workforce as many construction companies are having trouble to recruit new workers to replace retiring employees.

Predicting cost over-runs

AI is known for masterful calculative power which is why it can be deployed to predict future (Phaladi 2022, 3). Imagining a project of large scale that typically exceeds planned costs - through predictive modelling, missing or needed resources such as materials and training staff can be allocated to match changing circumstances (Rao 2022). Weather conditions, politics and other variables could be used to predict price surges in materials.

Risk aversion

As it is soon established in the upcoming discussions with construction industry professionals, risk mitigation is an important asset to any successful construction firm. AI's job is to take care of that. For example, a main contractor can focus its resources to address the highest risks and counter them by right actions (Rao 2022). This could make construction site operations more streamlined and safer. CastroLacouture (2009) says that AI will take over the design phase too, reducing errors - an issue for the construction site as information will more accessible (Phaladi 2022, 3). Deep Learning neural networks can be applied to cut down decision making processes by modelling structural models matching ones in BIM (Blanco et al. 2020).

Productivity increase

Since construction is ill-known for its productivity, it is sensible to assume that AI would be utilized to raise productivity where it is needed the most. Nowadays, machines can manage repetitive and simple tasks such as ditch excavation, brick laying and welding, among other tasks, both on- and off-site (Rao 2022). Some companies have managed to build entire blocks of flats with 3D-printing.

Quality control

Balaguer and Abderrahim (2008) say artificial intelligence can be leveraged to inspect quality of the building and detect flaws which have been a common cause for headache in the industry (Phaladi 2022, 3). Superior quality helps to maintain the reputation of the firms and cut the costs of reconstructing flawed parts. Later, savings from claims over faulty structures made by customers can be allocated somewhere useful. Similar aspect to quality control is design optimization where Supervised Learning powered solutions recommend structural solutions (Blanco et al. 2020).

As implied earlier, the spectrum of AI is not limited to the examples above but goes way beyond them. The key takeaway is that each business has unique in capability and needs

for AI, therefore every matrix of solutions works differently depending on the user. It is the leader's, job to find the suitable combination.

5.7.4 Potential Future Use cases

There are many applications of AI already in use - some more widely utilized than others. Popularisation of existing technologies and solutions is likely upcoming. In an article from Journal of Engineering, Abioye et al. discuss the future opportunities of AI in construction. Here are some of them; Deep Learning as a tool for estimating cost and time, Deep Learning for health and safety prediction, AI fuelled construction contract analytics and AI chatbots for various purposes, to name a few examples. These are possibilities that lie in AI, for construction and development industries, in near future. They derive from existing solutions but are more refined (Abioye et al. 2021, 7). Blanco et al. says that drone imaging and combining worksite safety could be one additional iteration of AI in construction site (Blanco et al. 2020).

A construction company that has amassed data streams and adopted technologies such as AI and advanced analytics might look like this according to Deloitte:

A connected construction company is expected to be able to: improve operational processes by optimizing time and resources; enhance construction project performance with near-real-time visibility into progress; manage construction assets (including equipment condition and maintenance) more effectively; and streamline the design change process with more efficient procurement and faster access to resources (Velasco et al. 2020).

They remind the reader that simply acquiring new technology is not equivalent to success, but it calls for strategical structural changes too (Velasco et al. 2020).

Robotics, AI, and the Internet of Things can reduce building costs by up to 20 percent.

– Gayatri on the future of construction (Gayatri 2019, 10).

5.7.5 Known Inhibitors of Adoption of AI in Construction and Development Industry

LetsBuild.com lists some of the barriers of adoption with cognitive technologies in construction sector. These barriers are culture, aging workforce, cost, data collaboration, legislation, and data security according to Gantly (Koutsogiannis 2019). Most of them are common to other industries, as we have learned during previous chapters of this thesis. Possibly, culture is the most distinctive to construction as it is one of few industries who do not have

many proven applications with AI and has a reputation of being a *follower*. By culture, Koutsogiannis means mistrust of contractual relationship being used to preserve existing habits. Additionally, long connection between management and construction site efforts seems to hinder new technology adoption processes. The same article suggested that the industry is rather disconnected from people working in it (Koutsogiannis 2019). Probably a direct result of a large network of separate companies working on each constructed project. The factuality of these inhibitors will be addressed in the surveys and interviews, later in the paper.

According to Magoulas and Swoyer, the single biggest reason for a company being unable to adopt AI is the lack of institutional support (Magoulas & Swoyer 2020, 6). This may be considered as a cultural factor - perhaps companies overlook possibilities and resent new technology or change in general. Famously, construction industry is seen, on many occasions, as outdated and stuck to its habits which could explain why such an attitude prevails. Author sets out to find confirmation to these claims, in the survey.

The second biggest hinderance is the problem identifying use cases for AI technologies. Pre-research talks with a former Stora Enso Director of Supply Chain Components, Juha Kirjalainen reveal that construction industry leaders might be clueless, to some extent, on what AI stands for and what it is truly capable of (Kirjalainen 2021). This statement causes author to question the underlying reasons for this industry to neglect AI. How can the leader figure out use cases if they do not even understand the basics of the technology? Further discussion with Kirjalainen suggest that the whole industry would need a hefty revision to find itself in a space where it could yield tangible benefits from AI (Kirjalainen 2021). The call for structural and foundational changes is also acknowledged in MIT Sloan Management Review by Ransbotham et al. - learning with AI may result in drastic changes business processes, instead of minor tweaks in specific functions (Ransbotham 2020, 13).

Next, Kirjalainen names the lack competent staff to deal with AI as one notable hindrance adoption (Kirjalainen 2021). The larger companies can afford to pay higher salaries attracting skilled talent to their pool, but SMEs cannot. The re-education would be an option, but aging workforce is difficult and arguably pointless to train if they are going retire soon anyways. According to Kirjalainen, the appeal on construction industry as a workplace is declining, making it even harder to recruit new talent (Kirjalainen 2021).

One other key reason delayed progress is the lack of data to feed for AI (Kirjalainen 2021). For an average construction company, this should not pose a problem as the construction process is so multi-layered and disrupted, it is bound to have processed enormous amounts of data. However, perhaps the highest impact data is yet accessible because there have

not been methods to create or record it. As pondered earlier, limited digitalization may have a role in it too.

Lastly, one large obstacle is the lack of infrastructure. Money and investment can solve this. Construction companies have plenty of disposable assets compared to many other companies and should therefore theoretically be able to invest in the required infrastructure (Kirjalainen 2021).

All in all, these obstacles are common to many industries. In construction, there underlay several issues with efficiency, backward procedures and general business models that should be updated before attempting to use cognitive technologies with reasonable expectations. This assumption is based on the theoretical findings regarding AI's optimal performance. The empirical research should contest these claims of Kirjalainen and existing theory – these may not be the only reasons for AI's slow emergence in construction.

5.7.6 Where Are the Current Pain points?

A survey by Koutsogiannis identified the main cause for construction and development industries' stagnation to be the power of habit and mistrust towards new technology. Also, this survey indicated that over 29 percent of respondents believed AI's breakthrough to be over fifteen years away (Koutsogiannis 2019). If many industries have already mainstreamed this technology, why is construction industry so reluctant to realize change and adapt to it? According to Velasco et al. from Deloitte Madrid, the process of digitalization in construction is hindered by non-digitized processes, decentralized project execution, deployment and treating each project as unique (Velasco et al. 2018, 18). Usually, manufacturing has aimed to standardise production in the name of efficiency, and consistency in quality. A good example of such production is automotive industry which has optimized most processes of the business – cars are built on assembly line with a repeatable process.

6 Quantitative & Qualitative Research

6.1 Introduction

The purpose of this thesis research is to identify root causes to why such a small number of businesses prevail financially with artificial intelligence. Considering the potential that lies within AI, surely there should be more success stories within construction and development industry. These companies are urged to step up and share their experiences with AI in the form semi-structured interviews. Author also hopes that survey can procure success stories and best practices. Justification for the lack of wider adoption may lie in the scarcity of academia and publications, regarding the subject - while there exists plenty of research on the topic on general level, not many, if any, touch on construction and development industry per se. Especially, medium sized companies persist as a rather untouched group. Are these companies using cognitive solutions, to what extend and how successfully? And what is the role of leadership in this equation?

A comparison over sample companies shall be conducted to determine how they cope with AI. Next stage is the search for successful symbiosis – companies who have adopted and mastered the use of AI. Do certain characteristics of leadership dominate with the *high performers* or are *AI-employees* working as siloed entities with no real ties to upper management? Searching for patterns and distinguishable features takes priority but will not overshadow other observations. The recording of any other significant findings will take place, as well.

To perfecting the survey and ensuring a high number of replies, author has discussed in advance with several experts of both AI and construction. The combined effort should prevent addressing irrelevant topics, both in the survey process and later during the interviews. Moreover, these discussions should support establishing credibility for the whole process while showing respect and dedication towards said business. The result should be a professional, yet approachable research that gains momentum among construction and development executives, both pre- and post-study.

Discussion with professionals and general findings have strongly suggested that construction industry is, despite some modern technologies, still quite out-dated segment with much to improve before cognitive technologies can be implemented to their fullest capacity. This survey will attempt verifying if status of the industry matches the learnings and presumptions by reflecting the attitudes of leaders towards AI, change management and current state of construction. Moreover, author hopes to discover new and confirm known pressure points

hindering the change. New discoveries will be weighed parallel to existing literature and opinions of scholars.



Figure 10. AI specific question spheres targeted towards high and low performers. Model based on The Global Survey: State of AI in 2020 by McKinsey & Company (Balakrishnan et al. 2020, 7).

6.2 Structure of the Research

First step is designing a survey or a questionnaire, objective in nature. It must be short enough not to appear too pushy or unappealing. For this purpose, a reduced number of questions is suggested – it should make it less of an effort to reply and should thus diminish error margin while retaining high rate of replies. Similar conclusions on effectiveness were made in the research paper by Moloo & Pudaruth on online surveys; the survey should be short enough to keep respondents interested and contain mainly multiple-choice questions (Moloo & Pudaruth 2011, 448).

Once the survey has been designed, finding suitable companies is next logical move. Companies will be observed and evaluated according to their suitability towards the research – acceptable candidates will be collected to an Excel-file with the required contact details for later use. This process is estimated to last up to several weeks or even months. Appendix of companies is not provided, as the list contains sensitive data, such as personal email addresses. The survey itself stores a considerable portion of the data set – this data is public, again excluding contact details of said executives.

After collecting a small sample of candidates, the contacting process may begin: the search for new companies ought to continue during this part. If a fault in the survey or methodology of approach is recognized, a corruption of data can be thus avoided or minimized. Small adjustments will be made as the survey process moves forward. Each company leader should receive at least one contact attempt but preferably up to three before finishing the contacting rounds. This may change according to existing circumstances. Ideally, after each round the respondents would acquire certain response period prior to continuing rounds.

Especially, after the final round, extra time should be allocated, in case some people are absent or on holidays.

When all contacts have received the survey request and reply period has expired, is time to start building interviews' framework for a select few. These questions should reflect important topics in the survey results by offering collective, in-depth-look at them. The nature of interviews allows the interviewer to ask supplementary questions if needed.

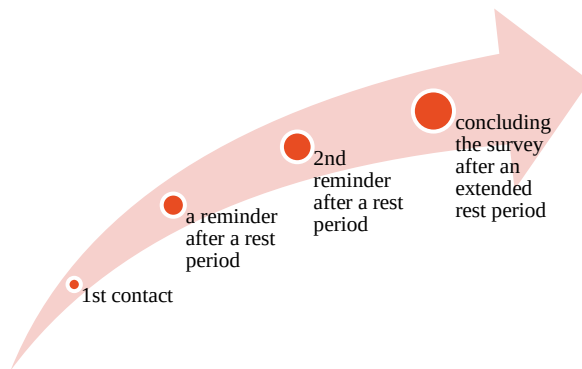


Figure 11. An illustration of the survey process

Lastly, a stage of interviews with academics, AI, and construction specialists should be orchestrated. The purpose of this is to determine if author's pre-analysis of the results is accurate and what further observations can be made. Three different sources of data should create credible research paper and leave the reader room to make personal judgements based on the material provided.

6.3 Limitations

To gaining reliable and cohesive information from this survey, it is crucial to apply few rules of participation and classification. As the objective is to explore mid-sized construction companies (MSE's or Midsized Enterprises) there would have to be denominators of what is considered average in size. Two commonly accepted metrics are number of employees and yearly revenues. This survey will resort to using the latter; from 50 million USD annual revenues (sales revenues are equally acceptable) to 1 billion US dollars, is considered medium by global standards (Gartner 2022). In terms of number of employees, this research will not put in place any limitation for the sake of simplicity. In practise, businesses with thousands of employees are likely to be part of a large conglomerate entities and are therefore not eligible to participate even if they would fall into suitable revenue range, unless confirmed to be a parent company. It will be later explained in the ownership criteria why such decision is made.

Another limitation is language; author can only deliver the survey in English. The decision for using English is logical and practical – it minimises translation errors and offers equal grounds for all recipients as it is most widely recognized and influential language in international business and academic environments (10 Most Important Business Languages in Global Market 2022). This, however, does not limit the process, as even companies with no English websites will be approached. Assumption is that there are at least some English speakers on the upper management level of larger companies, albeit their websites may be targeted to purely domestic markets. Obvious downside is the fact that some of the recipients may not be able to reply to the survey due to language barrier. As author is a native Finnish speaker, for some recipient's translations can be offered in Finnish. However, in all formats, questions should be using the same language. Only exception can be made in the interviews and pre-discussions as some of the interviewees are native Finnish speakers and it would not make much sense conversing in English. However, all questions will be introduced to them in English, to avoid misunderstandings.

Obviously, construction & development covers a vast area of business from private housing and public infrastructure to heavy civil construction. In this research, however, the focus lies on residential construction for the sake of simplicity. Additionally, its considerable size within the industry is a deciding factor. Beyond that, no other division is made – companies may build apartment buildings, houses, row houses, duplexes, student- or workforce accommodation. Even military housing is considered acceptable. Furthermore, there are no restriction on building production methods: traditional on-site building and modular, prefabricated housing are both equally acceptable.

As the management and project leadership goes top down, it is more beneficial to explore the main contractors who run the operations of construction projects, and development at the highest level, instead focusing on sub-contractors who merely follow the lead. What comes to development companies, they usually share the highest authority in a building project while rarely participating in the actual building process. This significantly limits the number of suitable businesses for participation and makes it more challenging to scour for suitable candidates.

There are no age nor maturity limitations for companies. Their geographical locations are equally irrelevant too - unless one location is overtly represented in the study. Then their share must be manually limited. Furthermore, companies must be privately owned organizations, yet they are not required to have specialisation in residential construction if they have at least intentions for building in that sector. This intention needs to be clearly visible

as a category of operation on their website or mentioned in their *capabilities*. Ownership structure of business is the least strict of the limitations, due to the complexity of the issue.

To avoid inflicting statistics unconsciously, the countries represented should reflect the actual global market shares as closely as possible. Later in the research, author realised that this was nearly impossible criteria to follow which is why it was only used as a loose guideline. Certain areas do not have information readily available on construction and development companies which could alter the significance of some countries or companies as part of the research.

6.4 Discussions with Juha Kirjalainen, Former Director of Stora Enso Supply Chain Building Components

As previously mentioned in the text, the informal discussions with various construction business professionals took place before the survey was first sent to respondents. Kirjalainen was the first contact who shared his expertise from his career in construction and introduced author to former colleagues who then helped in establishing comprehensive picture of the industry. The deeper purpose of consulting Kirjalainen was to establish multilateral understanding of the nature of construction industry and its culture. This was needed as author did not occupy previous experience in the field. In the following chapter are his reflections and thoughts of the current state of the industry. Author specifically asked Kirjalainen to list pain points and negative implications, unique to construction companies in the context of AI adoption. Noteworthy to mention that none of the quotations are exact nor conclusive but rather flow of thoughts and insights. The conversations were conducted by phone. Below is the summarized collection of these discussions offering some premise for the research.

From the beginning, discussion was directed to the pain points and bottlenecks of the industry, as these were one of the KPI's of the research. It was about the ability to operate AI. Some of these inhibitors have already been discussed earlier in the text and are therefore left out from this chapter.

The construction process is re-learned each time a project begins, as each building is so different from one another and the teams building them are rarely the same as in the previous project (Kirjalainen 2021).

As established earlier, many construction firms still build each project as unique instead of replicable products.

As an opposing example to traditional construction, prefabricated houses are speedy to construct – on and off the assembly line. A direct outcome of repeatable work process (Kirjalainen 2021).

The re-learning is a reference to traditional construction-site oriented building. Modular housing has managed to offset some of these issues. Traditional, complex construction paired with switching teams is the opposite of efficient. Kirjalainen summarized that these factors in construction pose as hindrance for making the process into a repeatable, efficient task.

Too much fragmentation in the contracting process – so many subcontractors, suppliers and other parties make a project hard and inefficient to manage. When a project has potentially a hundred companies involved, from start to finish, everything becomes difficult to manage and tardiness of one party can derail the scheduled timetable (Kirjalainen 2021).

This trend was also recognized in Deloitte report from 2020 (Velasco et al. 2020, 18). The problem is not the number people involved but the fact that most of them derive from separate companies with varying standards and levels on involvement. Increasing number of participating number of companies increases the variable factors of the project and complexity alike – construction management is struggling to keep project intact when potentially dozens of companies with hundreds of workers operate on one project.

With the contribution of Kirjalainen, author manages to get in touch with many of his former colleagues and other associates who had unrivalled experience in the field of construction. These discussions occur post haste to one with Kirjalainen and are also conducted by phone. These individuals shall remain anonymous as their permission to be referenced directly in the thesis was never officially requested. They know that they are contributing for a thesis research project regarding AI in construction. Alike with citations from Kirjalainen, these are also indirect quotes that reflect the general idea of associates' viewpoints on AI and the nature of construction business.

One of these associates suggested that AI could be used to connect all companies working under one project umbrella:

It (AI) could handle flow of information and real time risk analysis. Company culture, long careers and being used to working with old fashioned methods and general reluctance to invest in change paired with stubborn leaders are things that prevent innovation (Associate X 2021).

Kirjalainen, like many others, saw the industry as stagnant and unwilling to change:

A mentality of anti-change exists and there is not enough devotion to business development (Kirjalainen 2021).

Corresponding theoretical findings prior to discussions reveal this statement likely to be accurate. One thing that could enforce change faster are legal obligations to utilize some specific technological solutions, such as AI. Kirjalainen uses metals industry as perfect example of how an industry should develop when facing transition periods.

Metals industry has adapted, and uses modern technology, processes, and refreshed strategies because it had to change to survive (Kirjalainen 2021).

He uses metals industry as an example since he has personal career experience from the that field too. Judging by his answer, construction industry has yet to see environmental pressure to go through this change. Blanco et al. iterates understanding methods of other industries is crucial for construction when facing forced change (Blanco et al. 2020). It may also be excessively down to existing company culture. After, progressing further in this thesis reader will understand that company culture is synonymous for fear: employees are afraid that replacing boring repetitive jobs will render them useless for their company (Schlögl et al. 2019, 8).

Also, decreasing skill levels at practical, hands-on experience are a big issue as workers do not need to challenge their skillset as much as before – they rely more on machines which has led to degeneration of skill and craftsmanship (Kirjalainen 2021).

According to Kirjalainen, the priorities of construction are on cost cutting rather than profit creation. Companies rather find places to save money than invest in new sources of revenue.

Only things that matter are minimized risk and high volumes. It is surprising that companies typically having revenues in millions are not prioritizing other issues (Kirjalainen 2021).

This is especially peculiar since many of these businesses have huge resources to deploy and still avoid using them. Kurien had recognized this risk averseness in her thesis research, as well (Kurien 2004, 58).

Lack of standardised materials, bad logistical processes, and high loss of materials (Kirjalainen 2021).

Above, Kirjalainen lists more bottlenecks. Every material a building uses varies depending on the supplier. This slows the process of building a lot when certain parts misalign or are incompatible. Meeting these issues repeatedly causes loss in materials and delays which

then translate into loss in profits. Even with prefabrication production lines, machines are slowly configurable, and every customer has individual needs (Kirjalainen 2021). Upside is the increased compatibility of parts and diminished loss of material.

At least in Finland, strict regulation on construction is a hindrance for progress (Kirjalainen 2021).

6.4.1 Associates of Kirjalainen

These are just some examples of the issues of which many were tackled in the survey questions. Additionally, to discussing with Kirjalainen, author spoke with many of his former associates as mentioned before. These conversations occurred in the late May 2021 before empirical research process had begun. Here are more undirect quotes from them:

Artificial Intelligence is already present in many construction companies, in the form of BIM (Building Information Modelling). However, systems that accompany it cannot converse with one-another. Another example of AI is SOLID system which is used in verifying that a structure follows regulatory guidelines and structural integrity, among other things. This application checks compatibility as the building is planned and warns about errors right then and there (Associate X 2021).

Balaguer and Abderrahim identified quality control as one of the use cases of AI already back in 2008. However, they mentioned such endeavours after the project had been completed (Phaladi 2022, 3). Currently, AI grants the possibility to conduct quality control during construction process.

Low ROI of construction industry is an incentive for bad quality, in hopes of saving money – margins are low, and volumes are high, making timesaving on the expense of quality appealing (Associate Y 2021).

One professional claimed that construction businesses prefer to have strong law divisions to fight claims, as opposed just building better structures – it is cheaper to fight in the courtroom (Associate Z 2021). This could lead into issues with brand and reputation which have significantly high influence on the revenue streams in the future.

AI is used in the design and planning process a lot, but it is in its infancy, in the construction yard – AI could connect all involved parties better together (Associate X 2021).

- a clear nod to BIM, leaving room for future construction site application, which is apparently minimal, in Finland at least.

Also, contractual jargon limits the use cases of AI beyond main contractor's business (Associate X 2021).

Construction business is mainly about tendering, selecting material suppliers, work-force, designers, marketers, and administration (Associate V 2021).

This quote relates to the general outline where cost cutting takes priority over profit growth, in fact, profits are directly bound to the tendering process.

The cheaper the offers the higher the profit margin. The business model is extremely simple – building costs minus expenses equals profits and construction time is defining measure between expected, higher, or lower than expected profits (Associate V 2021).

6.4.2 Future of Construction According to the Associates

Could AI predict the profitability and plausibility of a project in advance (Associate Y 2021)?

As it was established earlier in the text, it is indeed possible but at the time of discussing was yet to be recognized as an issue. Likewise, predicting viability of a project based on weather forecasts and materials price estimation could be useful in the future.

Modular building solutions are believed to be the future (Associate V 2021).

Many professionals saw the potential in assembly lined construction, in the future. It would speed both manufacturing and assembly as part of construction process. Kirjalainen obviously agreed with this statement as he once led such a production establishment. However, he raised concerns on the size limitations of modules - so far, the size cannot exceed what can be hauled to construction site via road networks. He added that for the highest benefit the assembly line should be flexible and have ability to change rapidly without long stops in production process (Kirjalainen 2021).

Money is always the number one concern – could it limit the viewpoints of leaders for potential future earnings (Associate X 2021)?

An interesting statement, as usually initial capital is required in process of growing profits. Leaders are not willing to risk anything unless they have guaranteed success. An attitude such as this puts companies in a position where they let the innovators take a head start – this approach could become pricier in the long run when businesses must catch up to early movers. Construction industry is known for being a follower in technological advancements (Jones 2019).

The industry has not seen remarkable changes in the last 50 years and suffers from productivity issues (Associate V 2021).

-if AI could solve them, it would be extremely alluring for contractors.

When productivity is increased, the profits will surge at same time (Associate V 2021).

These are just some outtakes of the lengthy discussions with the associates of Kirjalainen. On top of the discussions, they assisted with the survey structure and question line preparation. Many helped to determine factors enhancing appearance, appeal by sharing tips for maximising reply rate. Also, other experts helped in the process - Heikki Ailisto, a research professor from VTT (Technical Research Centre of Finland) assisted, especially with this part, and advised to keep the language appropriate and demystified for the audience (Ailisto 2021). He was chosen because he had extensive experience with researching AI.

Once the survey had been constructed, it was evaluated by thesis supervisor and Kirjalainen, after which, adjustments were made according to their instructions. Throughout the process of sending surveys, the framework and approach were under constant scrutiny by author himself and the result turned out surprisingly different from the recommended approach. Final product was determined through trial and error – small adjustments yielded a higher reply rate than the ones based on professional tips resulting in a hybrid approach based on theory and practise.

6.5 Data Collection

To ensure a holistic data gathering process, the core structure of this research supersedes a pre-planned strategy, divided into three main parts. First, there will be a survey aimed for business leaders. Second, an interview process with selected leaders. Third, another interview stage with AI experts prompting analysis of the results research yields, to that end, making the narrative richer and more purposeful.

For the interviews, both for leaders and experts, it has been predestined to make a short profile of the interviewee. The purpose of this is for a reader to understand what their significance to the research is. Naturally, they will be credited accordingly, unless they hope to remain anonymous. Anonymity is to be expected from the leaders as they are sharing potential business secrets and core AI strategies whereas for academics, situation is the opposite. They usually wish to be credited. Even while staying anonymous, short information will be provided without revealing the identity of interviewee.

Originally, the survey and interview process were a carefully considered, multistage effort with plenty of interlapping between the two but due to practical and timetable issues, it was

executed with the most straightforward method. There was no clear separation between survey's internal processes, besides conducting repetitive rounds. These rounds did not interlap in a way it would have much affect an individual respondent. As the process of acquiring new contacts to survey proved unexpectedly time-consuming, both research and dispatching survey were simultaneously performed. Moreover, a possibility to introduce a pilot survey was considered, after which expert guidance would have led the process onward, followed by an analysis stage. Eventually, this capstone would have involved a final third survey round with new experts. Due to complexity and other limitations, pilot survey idea was discarded. Instead, a small sample of surveys were sent, and adjustments were made according to the observation made along the way.

Not to cut corners, but to manage time more efficiently, a simple strategy was conceived. Alternative would have involved even more stages as part of the process and next level of complexity. Arguably, the results would have thus showed a higher level of maturity, but trade-off with newfound simplicity could compensate that. Also, doing interviews beforehand, as originally suggested, would have made an interesting approach but it would have been difficult to design the questions and find willing participants without a *hook*. A *hook* is referring to the promised Executive Summary; a summary of the results with some analysis, for those who were willing to fill out the main survey. Such an approach was recommended by Ailisto (Ailisto 2021).

6.6 Main Survey & Secondary Survey

An online survey platform was chosen to be a vessel of conducting the research due to its convenience, price-quality relation, and schedule, much like Moloo & Pudaruth have recommended in their research paper (Moloo & Pudaruth 2011, 447- 448). An online survey was convenient to fill out and manage and was not bound to the timetables of respondents' nor researchers. Moreover, it is accessible to overwhelming majority of sample population. In addition to time, such a survey is not tied to geographical location but allows almost a global coverage of the market if needed.

Early in the survey sending process it was evident that the reply rate would be on the low end. To counter this, a secondary survey was conceived. Its purpose was to gather even a small piece of information regarding the widespread of the use of AI, in case the main survey would fail to deliver adequate sample. Secondary survey only required executives to reply survey email with a single number if they felt the main survey to be uninteresting or too cumbersome.

6.6.1 Preparation

The main survey was the single most important part of this research – the survey itself was conducted through a paid survey platform called SurveyKiwi. It turned out to be a great substitute for more widely known, Survey Monkey. This platform provided an outlet to create appealing, well-structured, and stylized query at the same time looking casual, yet professional, coupled with simplicity. It had to be easy to use, despite skill level or age. All what those respondents had to do was to click the link sent to them and answer the questions, and they were done. Other criteria for choosing SurveyKiwi were the accessibility through any mobile device, in fact, more than 24 percent completed the survey on their cellular phone, instead of a laptop (SurveyKiwi 2021). Lastly, the survey's length was pre-evaluated to be in par with importance with everything else – it should not be too long, to avoid *survey fatigue* – too short, and it would fail to deliver enough usable data

Another key to remember was the fact that not all respondents had necessarily English as their first language: the survey had to avoid technical vocabulary and display clear and concise language. Author provided his contact details and was readily available if any of the respondents needed help filling the survey. None of the respondents requested help in this process, indicating that the survey was simple enough to complete by themselves.

What is your current role in your company?

This is a multiple choice question. You can choose more than one option - in most cases. If there isn't a suitable option available, type it yourself by clicking 'Other'.

CEO

Member of the Board

Managing Officer

Owner

Other

Next Select one or more

6% completed

^

v

Figure 12. The first question of the main survey (SurveyKiwi 2022). On the left-hand, lower corner is the completion level of the survey. On the right-hand corner, navigation arrows – respondents could navigate the survey after replying to questions, in case the wanted to reconsider their answers. Usually, questions were followed by instructions. Some questions were skippable but for most, one or more options had to be selected, by clicking them. After choosing a suitable option they needed to click 'Next' button to move forward in the survey.

As secondary preparations for survey, the email which it was sent with, had to be polished to perfection by peer reviewing it endlessly and adjusting during the research process – preparations took approximately a month. Author had interviewed numerous professionals from construction industry to determine the ideal layout for the survey and to design the email approach. The largest Finnish construction business association Rakennusteollisuus, in English, The Confederation of Finnish Construction Industries RT, even allowed the use of their logo as a means of symbolic support - no financial support was ever requested. The use of logo was crucial as the association involvement would help bring credibility for the research. The association is an interest group for construction companies thus highly relevant to target group and maybe relatable to foreign companies alike. This association's representative even requested to receive the results once the project was completed. He wished to publish it on their private forum of tech forerunners. Picture of the logo depicted below.



Figure 13. An edited version of the official logo of The Confederation of Finnish Construction Industries RT (CFCI) also known as Rakennusteollisuus. The text above was added so that foreign respondents would understand the meaning of logo's presence. The purpose of it was to help establish trust and credibility in the eyes of recipients – a construction industry related association was supporting the survey.



Figure 14. LAB University of Applied Sciences official logo which was used as part of emails sent to leaders. Again, the purpose of logo was to show the email and survey was of academic origin (LAB University of Applied Sciences 2021).

Using the official logo of the university was also carefully considered as most likely recipients realized that message had no alternate purposes beyond academic and would therefore consider answering it, instead of treating as spam. Links to appropriate websites, such as university homepage, were provided for credibility reasons. It was known that recipients would receive dozens, even hundreds of emails daily and the right appearance and

feel would set author's message apart from the rest. To support all this, a student email was used for delivering all messages during the thesis writing process.

These preparations were not limited to just survey and email but also to social media, most notably LinkedIn. Many participants received a contact attempt through *InMail*, in LinkedIn and their personal email. Assumedly, some of the potential participants would look for the profile of the person contacting them which is why author's own profile was also updated to suit the purpose of attracting the right kind of attention. Arguably this method was effective, as author gained over 150 upper management *connections*, all from construction and development companies across the globe.

6.6.2 Aftermath

In hopes of achieving scientifically and statistically viable results, the research scope was stretched beyond a typical master's degree scale – downside of the stretch was increased workload and problems with time management. Upside was the fact that the sheer scale of the study could potentially serve a public interest – some media publishers might be interested to mention the existence of the study thus paving way for supplementary research.

The survey process stretched over a period of nearly eight months, starting in late May 2021 and finishing on the 5th of January 2022. During summer months' holiday season, the progress was slow but re-accelerated during early autumn. As there were no readymade lists available with suitable company details, they had to be collected and inspected one-by-one taking a considerable amount of effort. This was happening simultaneously with other survey activities. At first, author tried to look for companies in neatly categorized lists but later figured out searching for companies' country by country was the most efficient approach, after all. Some lists seemed to exist, but they were up for purchase listing upwards of thousands of dollars. This proved problematic as the research had no outsider funding.

During the latest stages, two paid email prospecting tools called Rocket Reach and Apollo IO were deployed to aid with increasingly cumbersome search process. Rocket Reach was a general email prospecting tool that sped up the process of searching new companies – filters could be applied to search businesses categorized by revenue, field of industry or by location (RocketReach 2021; Apollo.IO 2021). Through these programs, many companies that would have been near impossible to discover were now possible to find. Apollo IO was like RocketReach but focused solely on LinkedIn where it could be used to prospect email addresses. Both were deployed in the later stages of the study and were utilized in the verification of some existing contacts on author's list. Despite being paid services there were

still contact emails that were incorrect and unverifiable hence unstable (Apollo.IO 2021; RocketReach 2021). Efforts were made to reach these individuals through LinkedIn.

Initial target was reaching more than 2000 companies but soon turned out to be an unrealistic goal, even with the help of prospecting tools. Author settled for a little over 1200 companies, it still being many times larger than typical master level research. The main reason for settling was that finding suitable companies was exponentially slower the more sizeable the existing data set was. If the criteria would have allowed researching also smaller companies such as sub-contractors, the original goal would have been much easier to reach. There would have been an option to scale down the number of companies to less than 300 which would have been typical for master's level. However, the elusiveness of the respondents discovered early on, was the reason for the chosen scale. Otherwise, the sample would have been too small to have any real significance.

To double the effect of the survey and receive more replies, an effort to network with leaders on LinkedIn was made coinciding. Many of them were contacted through both email and LinkedIn profiles as mentioned earlier. This seemed to boost the survey reply rate, as now they could see for sure that a real person without malicious intents was trying to contact them instead of spamming. It was also a method of making sure the right person was reached. Many construction company websites had the names of the upper management listed, along with pictures. After leaders approved connection requests, they were approached again with the survey in case they had not previously participated. The purpose of repetitive contacting enabled higher chances for a leader to see the email/message and react to it. To ensure adequate visibility, author was advertising the survey on his personal LinkedIn account.

Many executives or companies, especially in developing countries, had not provided an alternative contact method on company homepage or other medias which is why they had to be approached using company general email or contact form. These methods proved very unsuccessful as there were many people in between the message and the person of interest. Furthermore, each time a message had to be written from scratch. Everyone else, who were more available, received three messages: initial request to participate survey and two reminders. Each round incorporated a secondary survey for those who did not have interest or time to fill out the lengthy main survey. The secondary survey was introduced as a backup plan as the main survey response rate was subpar. Soon, the need for the secondary survey was questionable but arguably benefits surpassed the negatives and it was kept as part of the project.

Here is the final version of the email/InMail message layout used for contacting potential respondents. After continuous updating, this version that was deemed the most effective in receiving replies:

*Dear ******

*As you are the CEO & President of the Board at *****, I'd like to know if you'd be willing to participate my thesis survey intended for construction/development industry management teams (one person per company)? I am a student from Finland doing my master's in International Business Management.*

The survey takes 5-10 minutes to complete, and you'll receive an Executive Summary of the results.

https://ottokirjalainen.surveykiwi.com/pky1xsbmrv_1

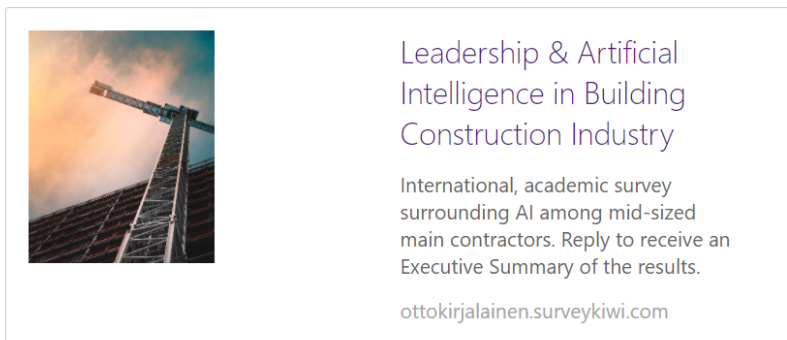


Figure 15. Link to the survey

If this is not interesting to you, please choose any of the options below and message me the number. That helps a lot too.

- 1)** *My business is using AI (Artificial Intelligence)*
- 2)** *My business is planning to use AI*
- 3)** *My business is not using AI*
- 4)** *I am unaware of the current situation with AI, or I lack understanding regarding it*

Above is the secondary survey with four questions.

In Collaboration with
Finnish Confederation of Construction Industries RT (CFCI)



Rakennusteollisuus

With kind regards/Ystävällisin terveisin



Figure 16. Greetings and supporting logos

For future opportunities, connect in LinkedIn through link below.



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Figure 17. Contact details with a photo and links to social medias

As it can be seen from the final version, it has

evolved quite a bit from the original: the overall approach is more personal and targeted. Every message even contained the respondents name and his or her title to really catch their attention. Additionally, more emphasis on the visuals had been utilized – large link to the survey with logos was introduced. Each message had to be constructed individually which made the sending process a very time-consuming effort, as student email did not allow templates with pictures. Personal email, instead of an institutional one, was therefore not a viable option. This had to be done, to avoid being rejected by email spam filters and standing out from other messages. It needed to be as personal as possible, not to be mixed with advertisements for example.

6.6.3 Observations During the Survey Process

The process of collecting suitable companies proved to be infinitely more laboursome effort than originally considered. In most cases, companies had to be looked up individually and official websites had to be rapidly browsed for establishing the eligibility for participation. Author was prepared to find more databases of centralized intelligence about construction industry, yet only few were discovered.

More time was then consumed on identifying and locating the people in charge, as sometimes this information was not public. Once the members of the upper management team were discovered, the second challenge was finding their personal contact details. This was

especially problematic in many Asian countries, Japan, and Russia above all: Japan had more than enough companies but dozens of these websites were not designed for foreigners and proved difficult to use for approaching the companies. Then again, Russians did not share enough details of company finances and the companies in general where in short supply. Japanese companies did not clearly indicate the level of involvement in the construction industry – they were extremely vague at times which translated into more time spent analysing a company and loosening the criteria. This loosened criterion transformed the survey to cover some development companies as well.

Surprisingly, also South Korea had a deficiency of companies available. Author suspected that problem was not the volume of them but the fact they were difficult to find. Even with translation tools and searching in Korean, provided little results. Many Asian countries neglected sharing details about their executives, even when searching through many outlets such as social media or email prospecting tools. Perhaps, these individuals wished to hide their identity or were listed on medias not common in western societies. African continent had its problems too, it seemed that there were not many suitable companies around except for wealthier North African nations and South Africa, that both stood out from the rest. Could the revenue scale have been too high for African nations? An overwhelming portion of replies were received from North American and European companies. They were the ones with also the most information provided. People in charge were rather highlighted than hidden. Same pattern applied to Australia and South America, even though latter had room to improve on the quality of the websites. South American companies, especially development companies, did not clearly indicate their core business functions thus many potential candidates had to be left out from the survey.

Another, rather curious find was that most construction companies within one country had inexplicably similar website designs and structure. This only confirmed what experts had said about reluctance of trying new things. It seemed these companies sought to blend in, rather than stand out – a confusing prospect when in every other industry a company would try to stand out from others. Also, a notable number of businesses had been family owned where descendants of the original founders were still managing the company, or still part of the management teams themselves.

Lastly, author's expectation was much higher on the response rate of the survey: the percentage was extremely low for those who were contacted. However, 62 percent of those who started the survey finished it. Yet, there were a respectable number of replies once finished, even though survey was lengthy to fill out. Nearly 80 percent of *main survey and secondary survey respondents* were using AI within their businesses. There exists a faint

change that the survey was more appealing to those who have the technology applied as Jones implied similar market coverage percentages with AI (Jones 2019).

6.6.4 Complications & Changes

As already mentioned, the survey did not include a secondary version at first but was then added to compensate bad reply rate, at the time. However, in hindsight it would have not been necessary as the number of replies was more than adequate in the end. There were nearly half as many construction company executives as in similar research by Gartner from 2017 (Maffeo 2018). All things considered, the decision to incorporate it was the right call because it provided the recipients a lower bar for participation. It was figured that even little information surpassed potential situation without any data at all. Drawback was a longer email which could have resulted in people skipping to read the message.

At a point, different sources such as email prospecting tools, Google Search, company websites and even WhatsApp were employed in the search of the contact person. Most successful turned out to be LinkedIn the prospecting tools mentioned earlier. Without the use of multiple search tools, the survey would have been prolonged needlessly and the risks of not finding all companies, with their respective executives, would have grown making the sample size significantly smaller and the results less credible.

As the research progressed, the qualifying factors for eligible companies were expanded to cover development companies, as they were close relatives to pure construction businesses. Otherwise finding enough companies would have been jeopardized. The limiting criteria was that they had to be supervising and managing construction site processes themselves. For example, consultancy companies that lacked building capability or simply managed the processes were discarded. The reason was they did not have similar table stakes on given project than development companies. There were surely some firms that were not eligible but due to language barrier and ambiguous websites, were still allowed to part take. However, the number of these occasions was kept to a minimum. The structure and question line of survey served as an additional filter – if company was substantially different, it would have been evident in the process hence making them detach from the survey.

At first, the emails that included the survey link were sent at random times of the day - it turned out that timing them to evening hours, early mornings or lunch periods was the most efficient way of securing replies. The logic was that these slots were less competed by distracting emails, or other activities of respondents. Every message was sent according to recipients own time zone to hit the bracket of active responsiveness. Sometimes, the contact person had to be switched as the messages were not passing through due to heavy

email filtering. Doing this every time an email bounced was considered too time-consuming and uncertain – other employees could have same filters. To compensate, a person of interest was approached solely through social media opposed to most other candidates.

Originally, a parent company was the only eligible option to survey but soon it turned out finding enough companies with this criterion was close to impossible. Therefore, also subsidiaries were accepted, but preferably from smaller corporate families. If they were too big, the results would have been distorted due to possible overlapping between companies in the same corporate family. There was no time to closely observe each company's background or ownership structure. Dun & Bradstreet, a commercial data and analytics provider was utilized frequently as it showed key personnel, revenue data and ownership structure of almost any given company (Dun & Bradstreet 2021).

At a later stage of the survey process, author realised that more than 30 percent of respondents did not finish the survey but rather quit during certain question. This question was removed as it was suspected of being too intrusive and therefore scaring people off, even though the survey was proclaimed anonymous. The questions inquired respondent's company main markets geographically. However, after removing it, the same trend pertained, and it was determined people were just curious to see the survey. Nevertheless, a completion rate of 62 percent was achieved and at least 87 individuals, or 7.2 percent, of the 1215 companies had opened the survey. Most likely, many more had seen the emails and messages.

Some additional qualifying factors came into realisation once author noticed suitable candidates in less traditional fields of residence construction. The modular buildings for permanent living, employee, or student housing, to name a few. Also, military housing, if permanent, was considered acceptable. These exceptions apart from student housing represented a small percentage of the companies. Housing for seniors was excluded as it was considered assisted living, a bit too close relative of hotel industry. Furthermore, companies that were clearly in the field of civil engineering were left out.

A few Japanese companies were discarded afterwards when their websites did not allow contacting them in other than business related matters. However, this was almost exclusive to Japan and was only noticed after collecting a large sample of these companies. Another set of companies had to be discarded due to various reasons, but excluding Japan, these numbers were marginal.

6.6.5 Statistics

ITEM	Amount
Businesses contacted	1215
Countries of company origin	64
Participants (main survey)	54
Participants (secondary survey)	21
Participant who opened but did not finish (main survey)	33
Countries participated (main survey)	20
Countries participated (secondary survey)	11
Total amount of participating countries	24
Secondary survey participants	21
Companies using AI (main and secondary survey)	43
Companies not using AI (main and secondary survey)	27
Companies planning to use AI	4
Low or Medium performers (with AI)	31
High performers (with AI)	8

Table 1. Key numbers from main and secondary survey

Other statistical observations

- the average time of survey completion was 39 min 19 s, however author suspects that some participants have left the survey open thus lengthening the time – the time used to hover below ten minutes on average
- revenue coverage (main survey) from 14.9 bill USD to 24.6 bill USD – the combined revenues of companies participated which translates into approximately 0.13-0.22% of the entire global construction market coverage which was 11.5 trillion USD in 2020 according to BusinessWire (BusinessWire 2022). It is worth mentioning that this number covers all construction; residential, civil, and other. From solely residential global construction industry, similar number would be 0,33-0,56% referring to data from Research and Markets summary (Research and Markets 2022)
- duration of the survey was approximately seven months
- three contact rounds were made: one initial message and two follow-up reminders
- completion rate was 62% of those who opened the survey
- total reply rate was 4.44% ($54/1215 \times 100$) for main survey
- total reply rate with secondary survey 6.2% - according to this survey, AI adoption rate was approximately 3.5% of the total sample of 1215 companies when the whole industry had 5% coverage in 2019 (Jones 2019). Numbers have likely grown in two years

- Of the companies completing the main and secondary survey, 79.6% were using AI while rest were not using it – similar numbers were documented by Magoulas and Swoyer (Magoulas & Swoyer 2020, 1)
- **Participating (main and secondary survey) countries that are known (not all participants requested an Executive Summary and remained anonymous):** Australia, Belgium, Brazil, Canada, Chile, Czech Republic, Egypt, Finland, France, Germany, Ghana, Ireland, Italy, Nigeria, Norway, Portugal, Saudi Arabia, South Africa, Spain, Sweden, Turkey, United Kingdom, Uruguay, United States
- **Countries that were approached:** Angola, Argentina, Australia, Austria, Bahrain, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Czech Republic, Denmark, Egypt, Estonia, Philippines, Finland, France, Georgia, Germany, Ghana, (Hong Kong), India, Iran, Ireland, Israel, Italy, Japan, Jordan, Kuwait, Latvia, Lebanon, Lithuania, Malaysia, Mexico, Mozambique, Netherlands, New Zealand, Nigeria, Norway, Oman, Pakistan, Papua New Guinea, Peru, Poland, Portugal, Qatar, Romania, Russia, Saudi Arabia, Singapore, South Africa, South Korea, Spain, Sweden, Thailand, Turkey, Uganda, United Kingdom, United Arab Emirates, Uruguay, United States, Vietnam
- the single largest group of replies (main and secondary survey) came from the United States (22.2%), second position was shared by Germany, Turkey, and United Kingdom (7.4% each), third position was shared by Ireland and Canada (5.5% each)
- despite being a well-established and known user of AI, China was left out of the study due to difficulty in finding information about companies. If the partial results would have been used it would have distorted the data.
- it should be mentioned that despite of having considerable portion of companies from Japan on the contact list, there was not a single known reply from them, perhaps due to different contact method (they were contacted using contact forms as other information was inaccessible). This was only known after collecting a large sample of companies. Otherwise, Japan would have probably been discarded as an option too.

7 Theoretical & Empirical Research Findings

The survey consisted of 30 multiple choice questions which were divided into groups according to category. Another segmentation was present with question types; *select all suitable options* and *organise from most to least important* – all variations of multiple-choice questions. Most questions portrayed an option to type an answer according to respondents' own preferences. In similar fashion, if the respondent did not know the answer, he or she could choose an option 'Not sure'. There were certain conditional questions leading participants answering different paths of questions. More than three available routes were possible. Each candidate answered far fewer than the total amount of questions. In the following chapters, the survey is introduced to reader by observing some of the questions in detail. It has been divided into sub-chapters to ease the reading process.

7.1.1 Leadership

After starting page and forewords, the actual survey began.

2. What is your current role in your company?

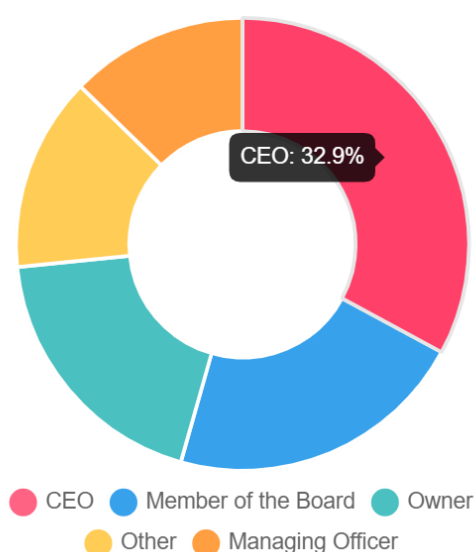


Table 2. A pie chart screen shot from Survey-Kiwi website. Chart above represents the status of the respondents: 32.9% CEO's, 21.5% Members of The Board, 19% owners, 13.9% other upper management team members and 12.7% Managing Officers. Out of 79 people answering this question, 54 continued to fill out the whole survey (SurveyKiwi 2022).

In these question type, much like many others, respondents could choose more than one option.

Some individuals had introduced themselves claiming multiple titles, such as CEO/Owner. The option 'Other' was reserved for CFO's, Vice Presidents, and other members of the upper management team – a respondents had the option to type their title. Only limited number of options was provided to keep the reply process simple. It is crucial to remind the reader that only one participant per company was admitted.

3. Please select your company size measured in yearly revenues. (USD = US dollars/year)

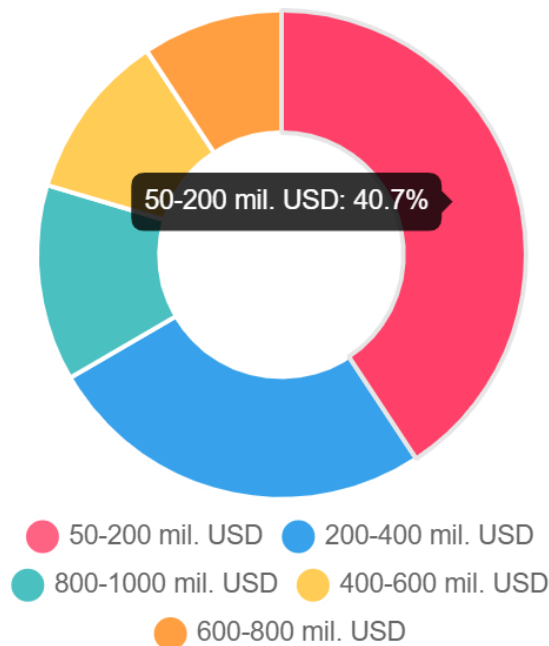


Table 3. Chart above indicates the dispersion of companies participating by their revenue bracket: 40.7% 50-200mill. USD, 25.9% 200-400 mill. USD, 13% 800-1000 mill. USD, 11.1% 400-600 mill. USD and 9.3% 600-800 mill. USD (SurveyKiwi 2022).

The first two questions aimed to categorize respondents: one implying main market location and other their leadership status. Former was later dropped due to suspicion on being too

intrusive, see chapter 6.6.4. Question number 3. above was intended to observe if there were correlation between size of the company and AI adoption. All groups available were exhibited in the survey. Overwhelming majority of them were in the smallest revenue bracket. Interestingly, the top three categories were almost evenly represented.

Then, next three question were leadership oriented and measured the maturity of the business and leadership within a company. As illustrated, measurements to these, and many others questions were purely subjective. Each question presented a scale from one to ten where respondents had the chance to select one option signifying their position. For questions 4.-6., the most popular answer was number seven. There was no significant portion of replies positioned below average which was number five. The question 6. was chosen to highlight vision as Chamorro-Premuzic et al. emphasize its importance regarding leadership (Chamorro-Premuzic et al. 2018, 4).

4. Please rate how advanced your company is, in terms of business strategy, leadership practices and technology.

5. Which management method is closer to your personal style?

6. How have you managed to carry out your strategy and vision with your subordinates?

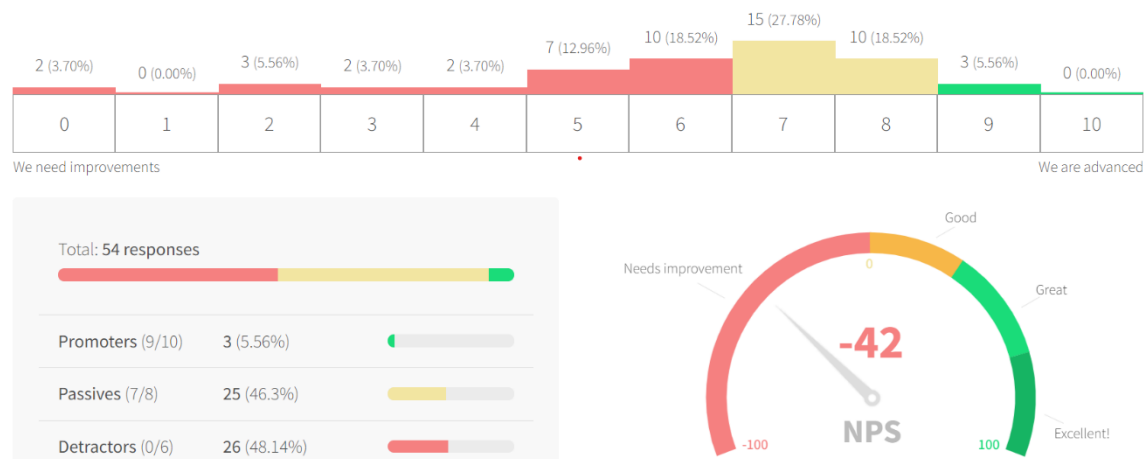


Table 4. A scale chart representing the question number 4. One of the most typical examples of survey question types. A scale from '0' to '10' where participants could select their stance – when referring to a scale this is what author is citing. Above, participants were asked to evaluate how advanced their company was in terms of *business strategy, leadership practices and technology*. Survey collected the data automatically, transferring it into an easy-to-read format allowing a smoother analysis process. As can be seen above, 27.8 percent share of respondents replied number seven which was the single most popular answer. Percentages above number brackets indicate how many respondents chose the specific option. Colour scheme and breakdown into *promoters, passives* and *detractors* is misleading and should not be observed too much in the survey. Author only used the NPS-meter to compare charts when differences were not clearly visible. Only the chart will be portrayed later in the thesis (SurveyKiwi 2022).

7.1.2 Artificial Intelligence

The question 7. was the first question about AI. It was the first crossroads in the survey diverting respondents to different paths according to their replies. Choosing option '0' from the previously mentioned scale jumped the respondents directly to question 29. as these respondents could not contribute to questions intended for AI users. If they selected any other number, the survey proceeded to the next question in numerical order and assumed

them as active users of AI. Extreme ends of knowledge base were equally marginal – the intermediate knowledge seemed to be represented the great majority. Only 1.9% of all respondents chose '0' indicating nearly all had at least some understanding about artificial intelligence contrary to assumptions of Kirjalainen (Kirjalainen 2021).

7. How familiar are you with artificial intelligence (AI) solutions?

8. Please rate your personal attitude towards AI.

Question 8. had similar scale as the previous questions. Most respondents had above average or very positive outlook towards artificial intelligence. Even when not using it, 50 percent had above average positive views about AI. Out of the entire sample, 73.5 percent had above average positive views and 7.6% were 'Very positive' opinion. None selected option 'Very negative'.

9. How many AI technologies/solutions you have in place in your business?

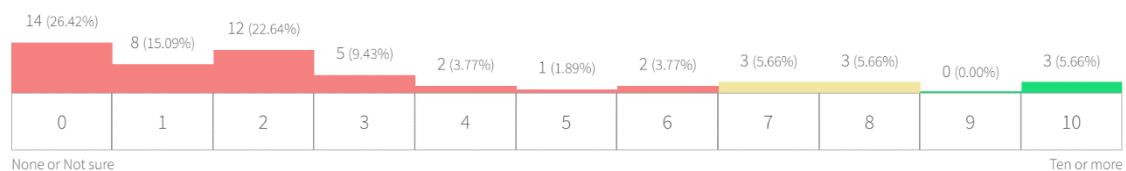


Table 5. 'How many AI technologies/solutions you have in place in your business?' (SurveyKiwi 2022)

Yet another key question in the survey. Those who replied '0' were directed to another question path to determine root causes and were treated as non-users of AI. Those who replied anything above zero were continuing to questions 15. As seen in the table, many companies are still working with only a couple of AI solutions as opposed to minority that have five or more application in use. It was later discovered many of the companies were not mature users of AI. By popularity '0' equalling to 'None or Not sure' was the most chosen option by 26.4 percent share. The opposite end 'Ten or more' had only 5.6 percent share. Most of the replies indicated well below five AI driven solutions in use. Total amount of replies was 53.

10. We would like to know why?

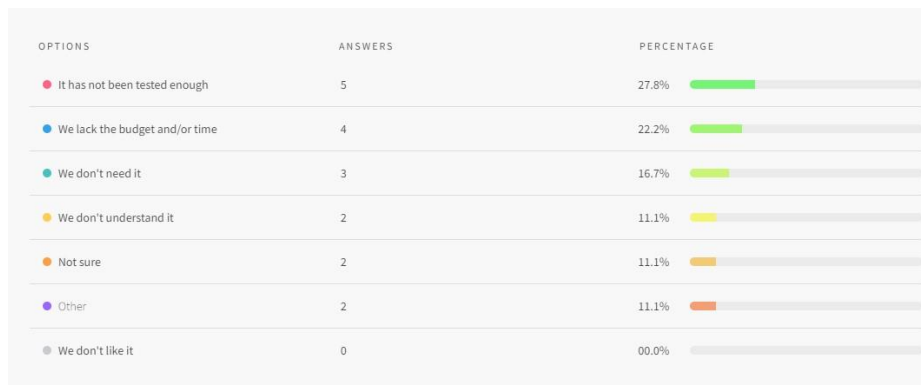


Table 6. Question 10. How replies were divided among possible options.

Questions from 10. to 14. were reserved for those who did not possess AI technology or did not know if they had any. The most popular answer for not using AI was 'It has not been tested enough'. The close second was 'We lack the budget and/or time'. 'We don't need it' took third place. Other reasons shared the fourth place. Only one company out of fourteen replied 'We have tried AI once but failed' in question 11.

11. Did your business try using AI before this survey?

12. What were the main reason(s) for aborting AI?

13. What about the future?

The reasons for aborting AI were 'Complexity', 'Higher expectations' and 'Not sure'. Despite failing, AI was not entirely cancelled out from the future. There was supposed to be a logic jump after this question taking respondents directly to question 29. but it was failed to add to the survey even after rigorous testing. Luckily, it had next to no effect and seemed that survey was working somewhat alright. Instead, the question jumped the respondent to number 14.

14. Why so?

After this question, the survey jumped to question 29.

The main route of the survey was from question 9. after which it jumped to question 15. and resuming until to question 31. – the path diverted in the process depending on the replies. Nearly all respondents replied to all questions prior to question 9. By main route, author means a path for AI users, as they are the target audience of the survey. Almost equally important was the path of non-users which had entirely different content: their route continued from question 9. to question 14. After which it jumped to questions 29.,30. and 31.

15. Has your company seen financial benefits from the use of AI?

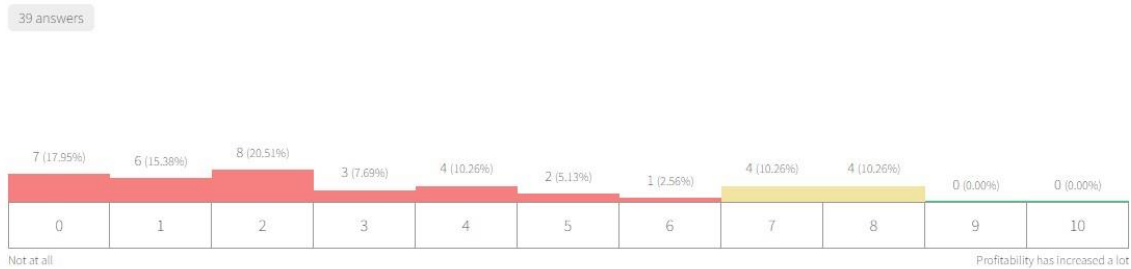


Table 7. One of the most intriguing questions of the research: ‘Has you company seen financial benefits from the use of AI?’ As can be seen from the scale, only select few had increased profitability above average levels and none had reached the very top end of success. Coincidentally, 11 percent of companies were successful with AI according to research made by Ransbotham et al. (Ransbotham et al. 4). For comparison see how only 10.3% had the highest rate of success according to this survey. Majority had poor or below average performance (SurveyKiwi 2022).

This question was arguably the most important one in the entire scope of the survey – in the end, all companies are in a business of making money and whatever promotes this goal is relevant. Finding the *high performers* with AI was the primary target of the entire project. There was no-one in the very top of the performance scale. Highest score was eight out of ten. Here diverted respondents once again: this time into three pathways: *low performers*, *medium performers*, and *high performers* – from now on, referred to as *Lows*, *Mediums*, and *Highs*, for short. Performance level indicated how good financial benefits each group had achieved with AI. Low and high group were directed to question 19. and others to question 16. As Lows were chosen everyone who selected ‘3’ or below, as Mediums everyone from ‘4’ to ‘6’ and as Highs ‘7’ or above. Largest group, by crushing majority with 61.5%, where Lows, second largest were Highs with eight respondents, and as close followers’ Mediums with seven respondents. Nearly 18 percent of all AI users failed to see financial benefits from its implementation. The reader should keep in mind that these businesses are likely at different stages with AI.

16. How would you rate your company learning progress?

17. How would you rate your working process with AI?

Question 16. and 17. measured the learning experience with AI as a whole. Progress was tilting slightly above average. There were no replies in the very low, or top end of the scale, in *the need of improvement*. Working process, other other hand, was mostly below the average – 28.6 percent reported above average experience. These question were only

offered to Mediums. Reader should keep in mind that in the following questions respondents could choose more than one reply option even if they had replied 'Not sure'. Author, however, assumed in his calculations that when option 'Not sure' was selected no other reply was chosen, of course depending on the nature of the question.

18. What are your strategic expectations from AI?

26 answers



OPTIONS	ANSWERS	PERCENTAGE
Efficiency	7	26.9%
Time Saving	4	15.4%
Growth	3	11.5%
Cost Savings	3	11.5%
Improved Risk Management	3	11.5%
Increased Productivity	3	11.5%
New Business Strategies	2	07.7%
Increased Safety	1	03.8%
Nothing	0	00.0%
Not sure	0	00.0%
Other	0	00.0%

Table 8. Question 18. 'What strategic are your strategic expectation from AI?' Total amount of replies was 26 and multiple choices were allowed (SurveyKiwi 2022). Most chosen answer was 'Efficiency'. Only Mediums faced this question. It is noteworthy that 'Cost Savings' were a more popular option than 'Increased Productivity' which has usually seen as an equivalent to increased profitability. On average, each person chose three options.

After previous question, medium performers were directed to question 28. Below is the path for high and low performers.

19. Where is AI being used in your business?

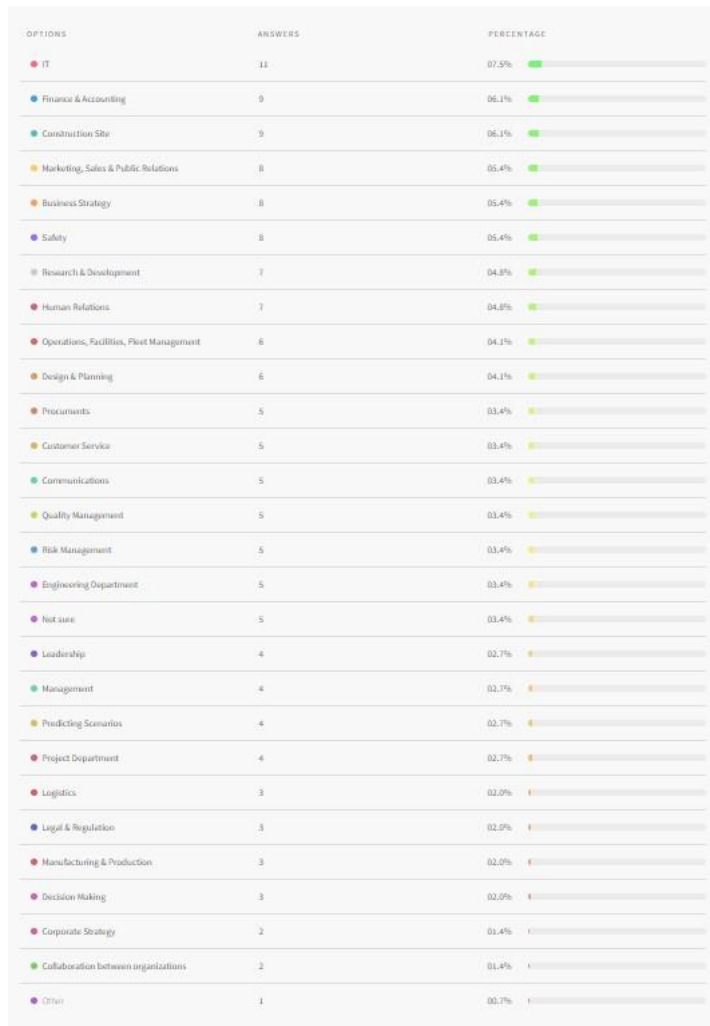


Table 9. Unsurprisingly, Highs and Lows and had different emphasis on the use cases of AI. Out of *all* replies three most popular options were: 'IT', 'Finance & Accounting' and 'Construction Site'. Their share out of 147 votes casted amounted to 19.7 percent.

20. How do you work with AI?

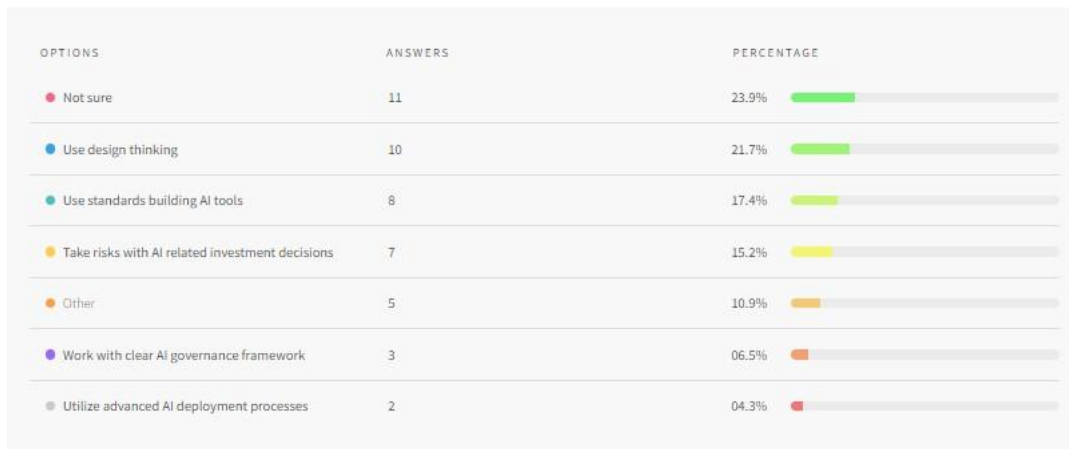


Table 10. A total of 28 percent of respondents using AI claimed they did not know how they worked with AI whereas 25.6 percent had chosen as 'Use design thinking' as at least one suitable option – it took the second place out of most chosen replies. The percentage are counted as follows: number votes divided by total amount of companies using AI (mediums were not participating this route so they may affect the accuracy to some extent). Total number of selected options was 46.

21. What strategic variables are you utilizing with AI?



Table 11. A total of 35.9 percent chose the option 'Not sure' and on average people had chosen only one answer. The next most chosen option was 'We have a plan to create value with AI' with nearly third of the selection dedicated. Total number of selected options was 44.

22. Which of the following method(s) you use in AI adoption?

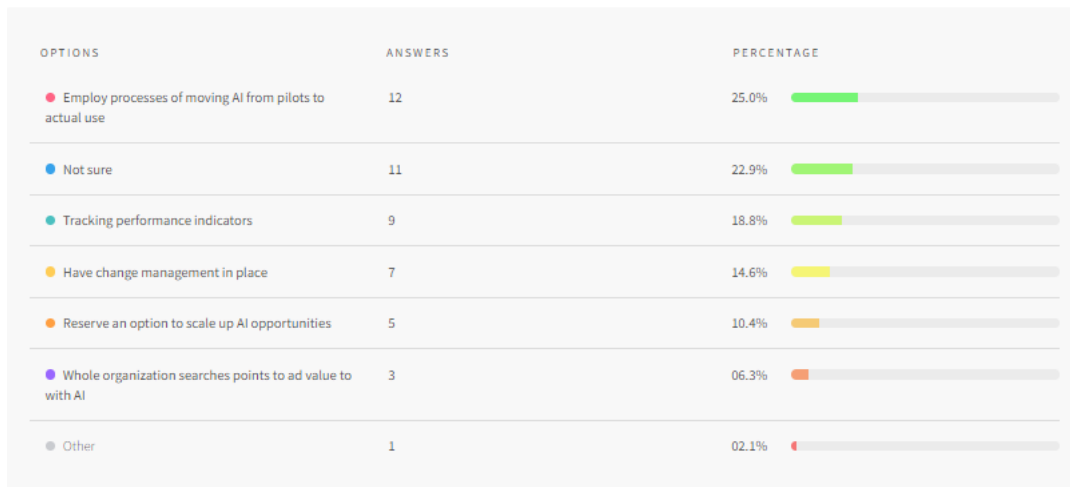


Table 12. It seems that most companies are in the process of moving AI from pilot to actual use as a 30.8% had chosen this option. Once again, a considerable share of respondents chose 'Not sure'. Nearly one-fourth percent had performance indicators in place, signifying result-seeking orientation.

23. In your opinion, which are the highest impact functions for AI?

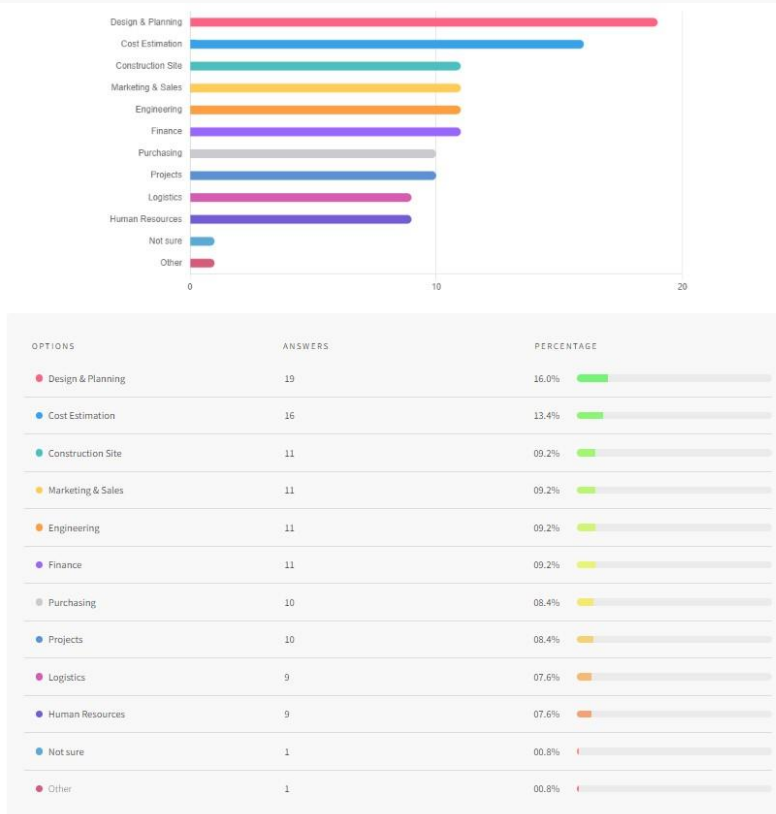


Table 13. On average, respondents chose three options each. The most favoured was Design & Planning which could be synonymous to BIM paired with AI. Total number of replies was 119 for 32 respondents. Later, as Lows and Highs are compared, clear differences are discovered.

24. How did you learn to use AI?

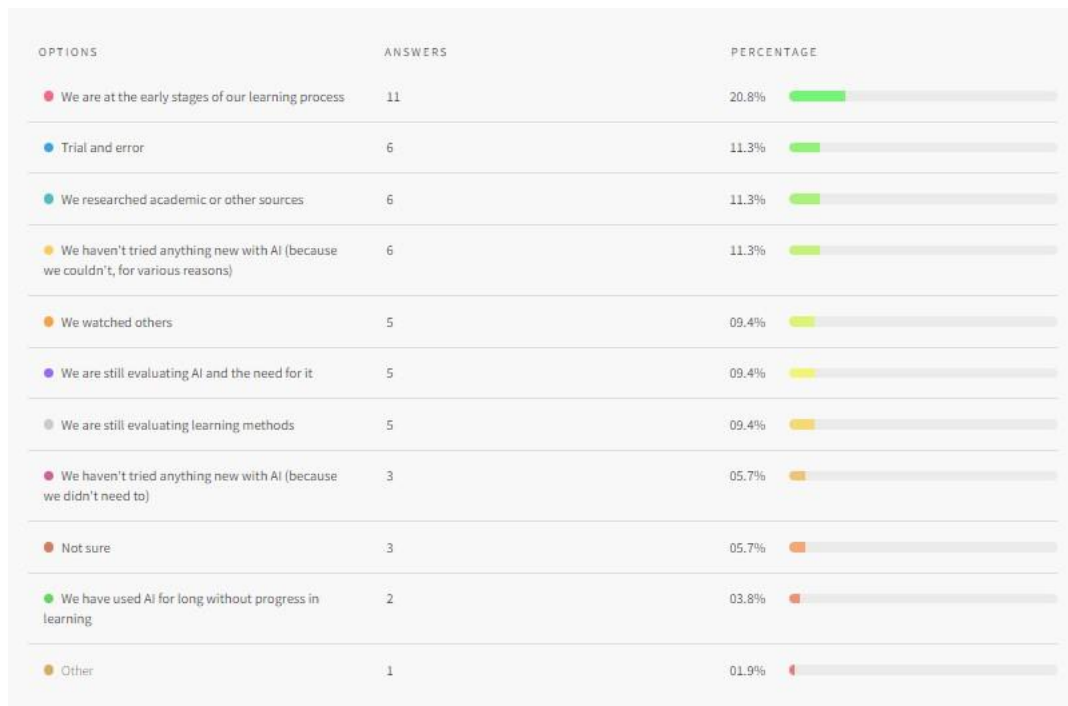


Table 14. As suspected earlier, many of the respondents are still in early stages with AI with 28 percent share against 12.8 percent share of those who are still evaluating the need for it. There is likely some overlap between the reply to options.

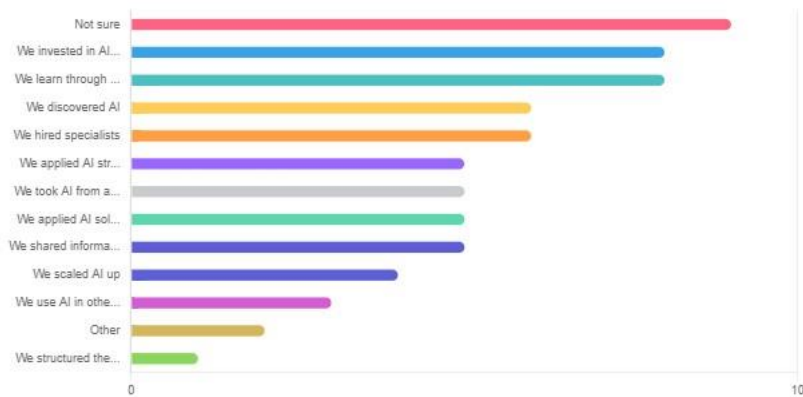
25. How was your organizational learning process with AI?



Table 15. Organizational learning process of respondents. Total number of selected replies 37. Employing multiple methods was considered beneficial for business, according to survey by Ransbotham et al. (Ransbotham et al. 2020, 8).

26. Please select all options that apply to your business.

67 answers



OPTIONS	ANSWERS	PERCENTAGE
Not sure	9	13.4%
We invested in AI infrastructure	8	11.9%
We learn through collective knowledge and adapt accordingly	8	11.9%
We discovered AI	6	09.0%
We hired specialists	6	09.0%
We applied AI strategy	5	07.5%
We took AI from an experiment trial to organizational use	5	07.5%
We applied AI solutions effectively	5	07.5%
We shared information between human and AI	5	07.5%
We scaled AI up	4	06.0%
We use AI in other fields beside automation	3	04.5%
Other	2	03.0%
We structured the modes of interaction between humans and AI	1	01.5%

Table 16. This table shows the stages AI users have achieved during their adoption process. Table 24. indicates the difference between Highs and Lows and shows the progress in more logical manner. Total number of replies 67 and average amount of selections per respondent was two.

27. How many modes of interaction does your company use with AI?

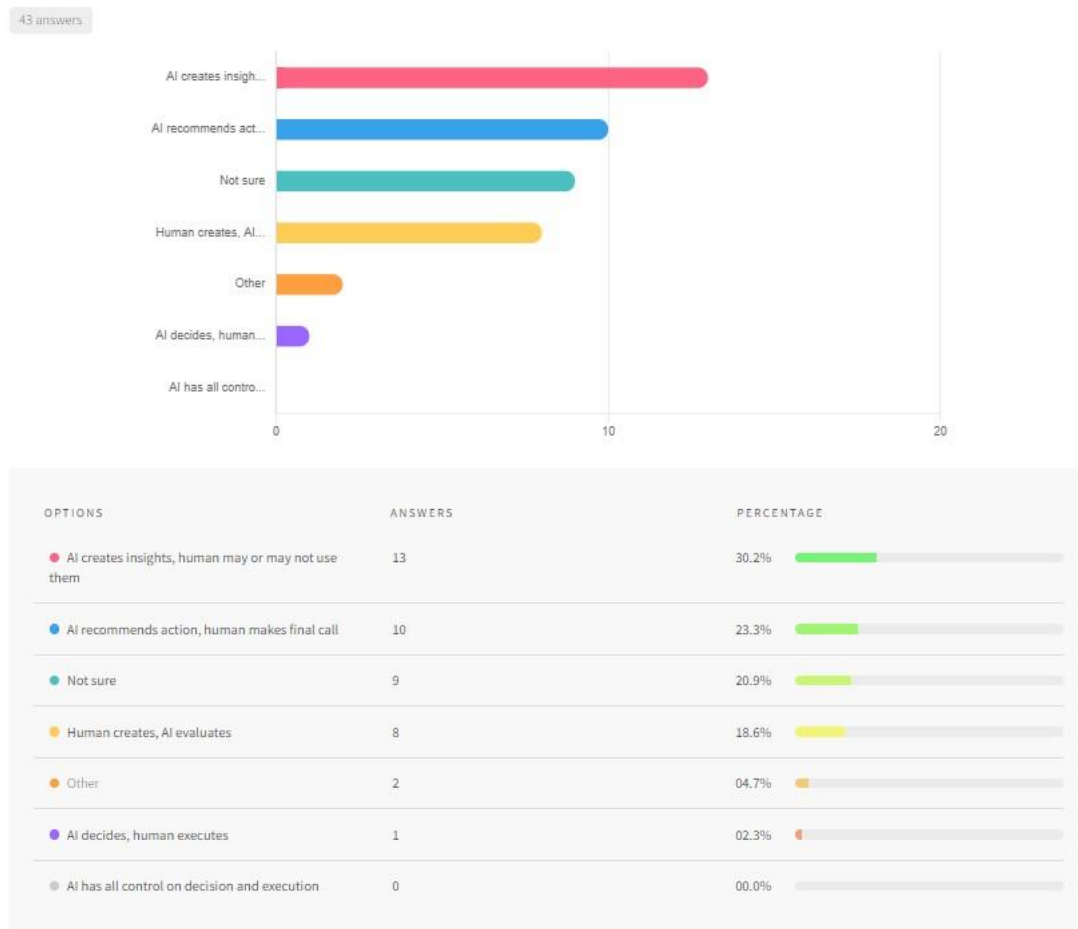


Table 17. As Ransbotham et al. had described, the more modes of interaction had in place, the likelier the success with AI was (Ransbotham et al. 2020, 10). On average, each company had only one method in place. The most popular option with 33 percent share was the option 'AI creates insights, human may or may not use them'.

The question queue for poor and high performers was the longest in the survey because there was a great interest identifying differences and similarities between the two groups. These findings could shed light on the age-old question with AI: Why only so few succeed with AI? After question 27. they would finish the survey.

7.1.3 Construction & Development Industry Review

28. Is your company moving closer to AI, or further away from it?

This question was only available for Mediums. It was interesting to find out whether average success was enough to push this group to experiment more with AI. The results showed

that businesses were mostly undecided and seemed to portray a neutral stance on the matter. There was, however, a hardly noticeable lean towards moving closer to AI.

29. Please organize options from most important to least important, in terms of functions to update in building construction industry.

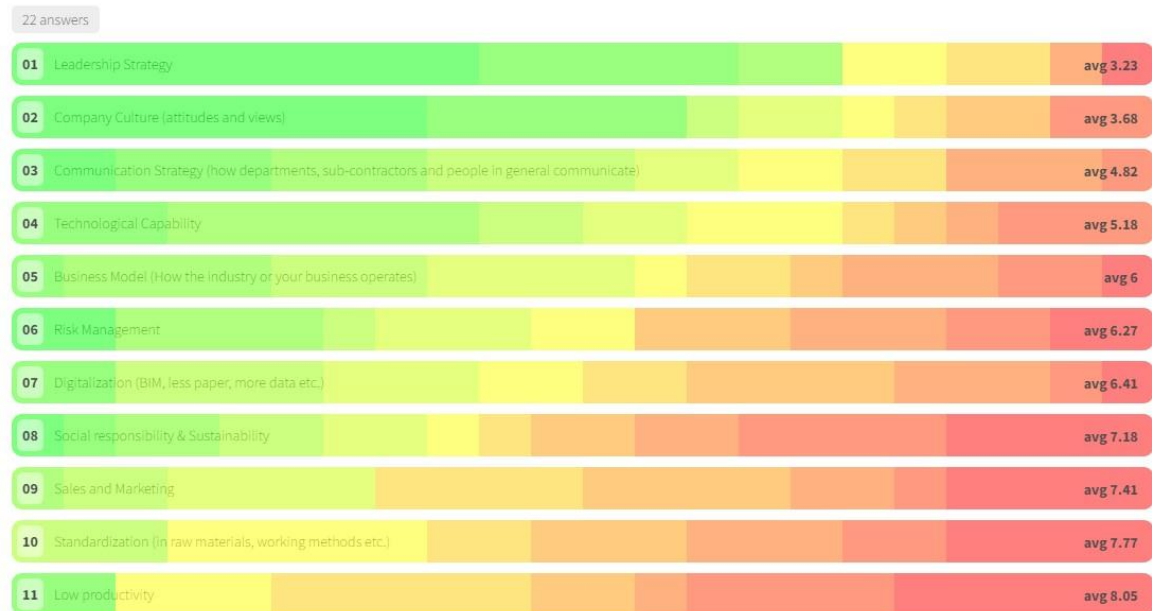


Table 18. Non-users of AI, those who did not understand AI, and Mediums were asked to organize a list of pre-selected items, from most to least important. Number 1. signifies most important and the right hand side numbering tells the average selected position of an item. Some items were chosen based on known pain points and some were chosen more randomly. 'Leadership Strategy', 'Company Culture' and 'Communication Strategy' were most prioritized items on the list.

30. Please rank obstacles to AI adoption in building construction industry, from most to least important.

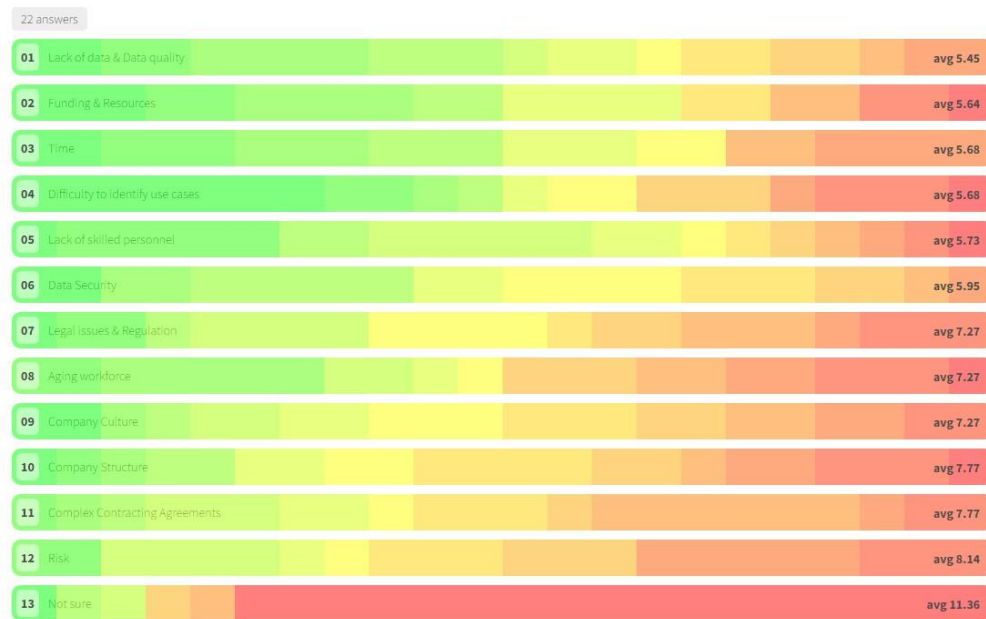


Table 19. What are identified as most considerable obstacles for AI adoption in construction industry, five most popular answers. This question was replied by non-users, and those who did not understand AI, and Mediums. 'Lack of data & Data quality' was the most prioritized option. Average position was 5.45 which indicates distortion in the results and lack of unanimity as its true median position is far from the indicated in picture (SurveyKiwi 2022).

31. Please rank obstacles to AI adoption in your company, from most to least important.

After this question, the questions for this group were finished.

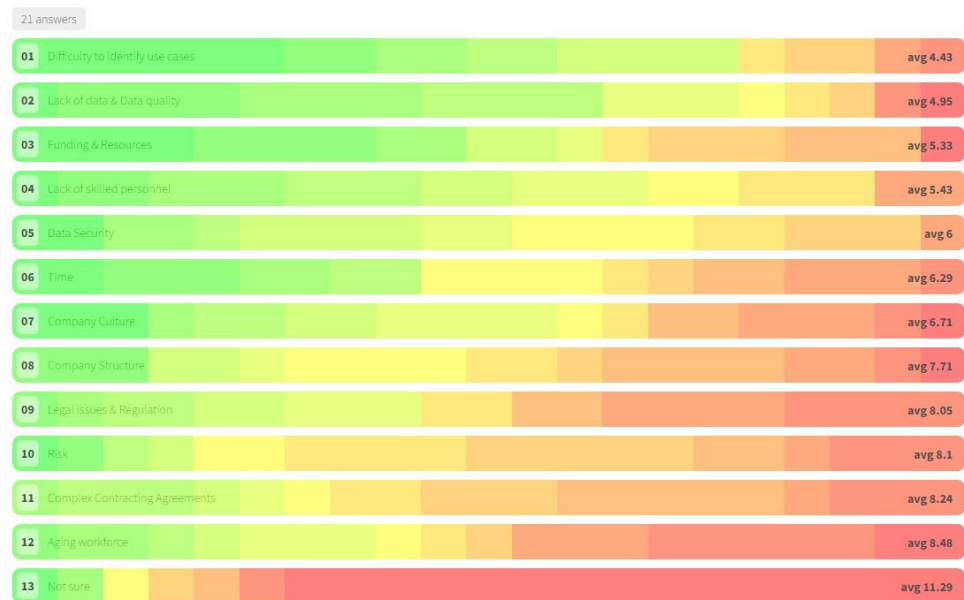


Table 20. What were hinderances of AI adoption in respondent companies. Half on this list were those who did not use or understand AI. Differences in priority start to form once comparing users and non-users later (SurveyKiwi 2022).

8 Data Analysis: First Stage

To properly analyse the data this research has rewarded, it is best first to describe what transpired, and how. In short, the quantitative part of the research was the email survey targeted for over 1200 building construction and development company executives worldwide – most of whom were directly contacted by either email or LinkedIn, and sometimes employing both. Concurrently, author grew his network of executives and likely nurtured and bolstered the desirability of the survey by appearing more approachable – many leaders had opted to join his network.

Exceeding the goal, a grand total of 54 replies was received – each respondent had to answer a plethora of specially dedicated questions requiring understanding about the nature of leadership, AI, and business strategy. The survey process was composed of three parts and divided into two subcategories: in the first part, each email was sent individually and was carefully targeted to its receiver by addressing them with their name, title, and company. In the second part, the target was reminding participants of the email/message they had previously received and encourage them to reply. Lastly, the third part was the last reminder for participation. The two subcategories were main survey with 30 multiple choice questions and secondary quick survey with 4 options to choose from. None of the respondents had to answer the total amount of questions, each followed a shorter customized path. Most of the 1215 company executives received both email and LinkedIn message – some who could not be reached, received only a contact request.

8.1 Data description

This survey was exclusively intended for members of upper management teams in construction and development businesses. This way distorted and skewed results were less likely when only one tight demographic of leaders were participating. They were also considered to be the ones who had the best overall picture and responsibility over their respective businesses. Contradicting, middle managers usually do not attend general strategy and vision related affairs and their field of responsibility is too narrow. Only one candidate per company was requested to participate the survey. If the candidate required assistance filling out the survey, the permission was granted.

There was no clear quota for each country - if they fit the set criteria of eligibility they were accepted. Efforts were made to produce truly international and diverse research – also developing countries were searched despite assumption that AI might have been too advanced and pricy technology to utilize – it was more important to determine the situation of

the industry globally. Despite these efforts, western nations embodied most of the participants.

8.2 Descriptive Analysis

This chapter contains the first level of analysis. Author compares theory and survey results by listing the most major connections and contradictions spotted. At this level, no further conclusion about trends and phenomena are made – their existence is merely stated. Descriptive analysis is used as basis for second stage where findings are further compared with what was discovered in the Leader Interviews. Only after reviewing findings with experts can final inference be made.

Not to a huge surprise, it was being discovered that AI had yet to make a grand break through within the mid-sized construction businesses. As statistics revealed, only 3.5% of the whole sample were using AI – the same percentage for those who completed the main and secondary survey was 79.6. The modest number of replies could indicate minor level of AI industry wide adoption.

It must be acknowledged that survey was targeted to, most difficult to reach and busiest executives in the upper management teams of the given companies which could have affected reply rate to some degree. Nonetheless, findings in theoretical part of the research, could suggest this is soon to change as construction leaders' attitude was strongly leaning towards positive (Shoham et al. 2018, 43). Same results were confirmed in the main survey - in fact, only a few of the respondents had negative implications towards AI. Largest portion of them were Chief Executive Officers (CEO) which means that they were people who held the highest authority in their companies. This in mind, each response was far more valuable than one from a worker or middle manager. Out of those 54 respondents a small minority were successful with AI and managed creating new revenue streams or bolster the efficiency of the existing business. Similar trend could be seen from theoretical findings.

Contradicting what Brynnjolfsson (2018) said, not only large companies had AI in place - MSE's had adopted AI throughout the revenue scale depicted in the survey (Knight 2020). Furthermore, it was discovered AI's strong points are efficiency and time saving in mundane resource consuming tasks. The survey indicated the industry was well informed about that too – they saw 'Efficiency' and 'Time Saving' as main strategic expectations from artificial intelligence.

Surprisingly, many respondents had a very positive attitude towards AI but did not know how many applications they had in place or if they even had any. Reasons for not choosing to use AI were rational as expected but at the same time seemed that leaders had not

researched it adequately. They were unable to recognize use cases for it. See Table 6. Possibly because of this, companies said their financial performance was very poorly enhanced by AI, only a few had above average performance. Businesses had many fields represented with AI but observing at single companies, the results were not promising overall. Many did not fathom how they implemented AI and had a very thin understanding of the whole concept of it. Curiously enough, many appeared certain of the high impact functions for AI.

Much like Balaguer and Abderrahim (2008) said, quality control, albeit here in a more active role, was recognized as AI use case by the survey (Phaladi 2022, 3). Associate X had similar conclusion about quality control. He had experience of active quality control in the design phase of a project. However, when looking at industry as a whole 'Design & Planning' was not so high regarded section even when BIM was recognized as one major application of AI, in theoretical research (Associate X 2021). When looking at the overall sample, places to apply AI had some correlation between theory. As Elhouar et al. stated, AI has a place on the construction site (Elhouar et al. 2020, 6). It was third most popular place to utilize AI among all respondents. According to theory, safety was regarded as an upcoming use case for AI. Despite this, survey showed that many were employing AI in measures concerning it already.

Culture, aging workforce, cost, data collaboration, legislation, and data security according to Gantly were the main barriers to wider AI adoption (Koutsogiannis 2019). These were only partly recognized as major obstacles for it, by survey. Only costs and data security had high or relatively high priority. While theory recognized lack of institutional support as the single biggest hinderance, survey only showed the funding to be a major issue considering institutional aspects (Magoulas & Swoyer 2020, 6). Contradicting to what Kiefer & Ulmer implied, survey proved that construction and development industry did not see mental barriers and lack of skilled workforce as major obstacles to AI adoption (Kiefer & Ulmer 2019, 71). Non-users of AI and Mediums pointed out that 'Lack of data & Data quality' where the most prioritized obstacle for AI adoption. This could be connected to level of digitalization in the said industry.

Kirjalainen suggested that many construction companies would not be aware what AI and its nature truly is. According to survey less than two percent where in this category. Author should remember that almost eighty percent of respondents were using AI and there is a high change that those not employing AI and not participating survey, could be unaware of the technology.

Even though theory regarded it as essential part of the industry, 'Risk Management' was not prioritized as updatable feature. Rao had claimed it to be one of the most effective methods to utilize AI construction industry (Rao 2022). The survey found that 'Lack of skilled workforce' was only considered an obstacle when executives looked AI from the perspective of their own companies but not on a general industry level. Even stronger contradiction was found between the need to fix the low productivity of construction and development industry. Associate V recognized low productivity as an issue when discussing the pain points of construction (Associate V 2021). There exist methods to improve productivity using AI, but results do not seem to support the idea of employing these methods in practise. Additionally, contrary to claims of Kirjalainen, construction industry did not recognize 'Standardization' – of work processes and materials as an updatable feature (Kirjalainen 2021). Its ranking was well below average.

According to theoretical research, modes of interaction where AI recommends and human makes final decision was the most effective of the options available (Ransbotham et al. 2020, 10). Survey indicated that this was the second most popular option. First place was reserved for *AI gives human insights – human could choose to use them or not*. This was recognized also recognized by Zahrani & Marghalani (Zahrani & Marghalani 2018, 5). The average employed methods was only one per company despite Ransbotham et al. has discovered a considerably higher rate of success with the use multiple modes of interaction (Ransbotham et al. 2020, 10-13).

Just like Fountaine et al. had recommended, the industry has clear emphasis on moving AI from pilots to actual, usable products according to the survey as over forty percent were in the process of doing so (Fountaine et al. 2020, 65). A considerable portion were actively trying to put AI to good use.

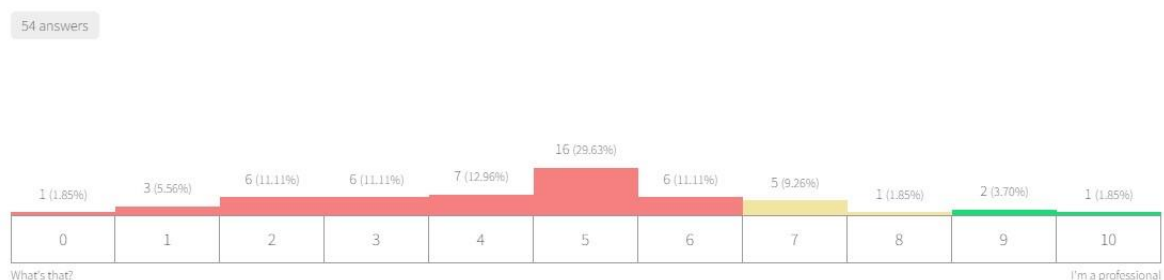


Table 21. 'How familiar are you with Artificial Intelligence (AI) solutions?' (SurveyKiwi 2022)

Most common answer was that "We are in the early stages with AI", when it comes to learning progress and process. By contrast, several companies were relatively far with the AI adoption process but had yet to scale it up. It looks like the relationship to AI is neutral at moment, no considerable movement towards it or the opposite way.

AI was clearly the main theme of the survey, supported by construction industry and leadership issues. Business and corporate strategy became more of a background motif rather than core structure. The reason being, making the survey with too many dimensions would be cumbersome and tiring to fill out. Also, receiving enough data is jeopardized if not all questions are replied with concentration. Finally, from authors standpoint, result analysis would have proven difficult.

In the next four chapters, respondents are divided into groups depending how they replied to the survey. Highs and Lows were completing the same path which is why it is reasonable to compare the two groups. Furthermore, author hopes to discover patterns and trends that distinguish the group from one another. These observations will be taken to next level of analysis by the end of the chapters. Mediums and non-users of AI will be correspondingly compared. Their paths differed from Highs and Lows. In the data analysis stage two, Mediums will represent average performer with AI and their viewpoints will be weighted against the ones of not utilizing AI.

8.2.1 High Performers

The most obvious observation from this group was their representation from the sample – only 20.5% of all respondents using AI answered their financial benefits from AI had increased well above average. Surprisingly, Mediums were the minority in the survey at 17.9%. Selecting '7' or above classified respondents as high performers. This was by far the most relevant and interesting group to statistically dissect if their success could be analysed and repeat with those who performed poorly.

There were no distinguishable differences in the demographics besides some variation with revenue bracket – both groups had all brackets represented with varying emphasis. Highs had other members of upper management team as most common responders whereas for Lows they were the least common – their most common respondent was CEO.

First pattern can be seen in the question 4. where leaders were asked to evaluate their company advancement level. Highs were more optimistic about their companies when compared to Lows. Only one response was below average. If anything, it would have been expected the difference to be more radical. Equivalently close were the leadership styles of the two groups – Lows were more leadership oriented than Highs. It seems that high had more effective leadership strategy than Lows had. Highs had significantly better methods of delivering strategy and vision to their employees.

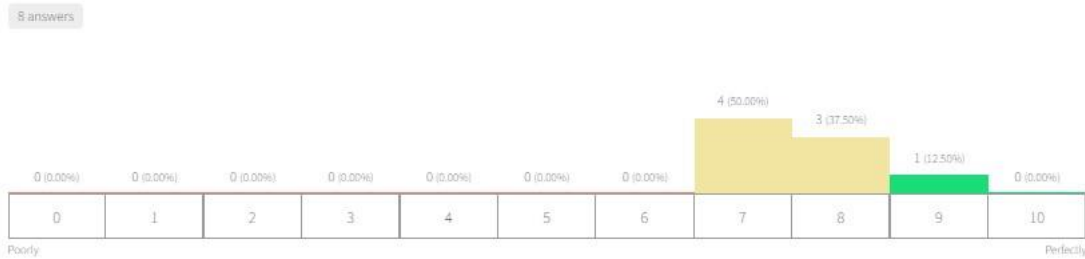


Table 22. 'How have you managed to carry out your strategy and vision with your subordinates?' This table represents the Highs (SurveyKiwi 2022).



Table 23. Same question as in table 22. but with Lows (SurveyKiwi 2022).

Highs were not experts of AI when asked how familiar they were with it, but they still had a noticeable advantage compared to Lows. Once again, it would have been expected the difference to be more clearly visible. On the scale, all Highs were positioned at average or above while Lows had wider spread. All other sub-groups were positioned at average or slightly below it. However, correlation was not as strong as expected - every single replier knew at least the bare minimum about AI. This issue will be addressed during interviews with AI specialists. Below the difference between low performers and high performers can be observed. First are high performers.

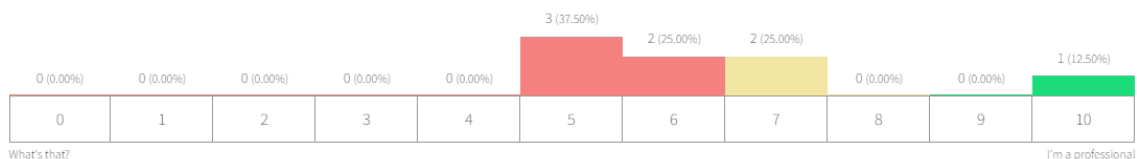


Table 24. 'How familiar are you with Artificial Intelligence (AI)?' High performers (SurveyKiwi 2022).

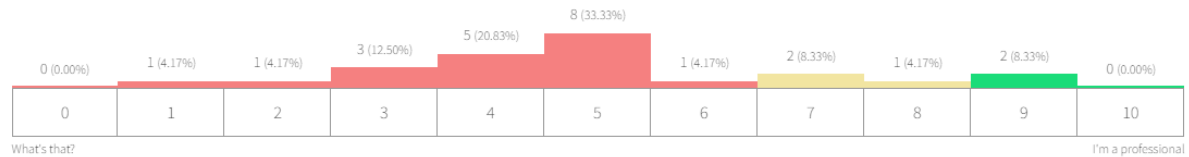


Table 25. Low performers on their familiarity over AI (SurveyKiwi 2022). Attitude towards AI had comparable aspects, Highs had positive or very positive attitude whereas Lows were not equally contented.

Half of the high performers taught AI and half had autonomous AI in place. It is hard to say whether some of them had both options simultaneously active. There is still room for improvement in the number of modes of interaction with AI – couple of options were completely left out. First chart below represents high performers (20.5% of all companies using AI). Second everyone else (79.5% of all companies using AI). Numbers in the charts indicate the amount of AI technologies/solutions in use. An exception was made and both Mediums and Lows were stacked against Highs. The reason for such a decision was the highlighted similarity between the two groups – Highs had considerably more solutions in place than Mediums and Lows. None of the high performers had less than five solutions in place.



Table 26. Amount of AI technologies/solutions companies had in place. High performers. Total number of replies was eight. (SurveyKiwi 2022).

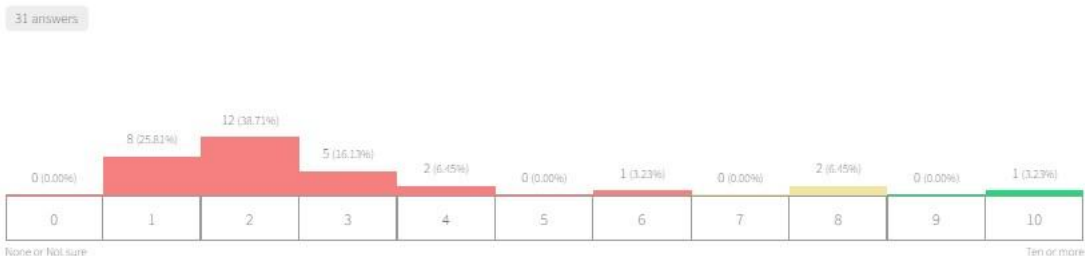


Table 27. Medium and low performers. Same question as in table 26. Total number of replies was 31 (SurveyKiwi 2022).

83 answers

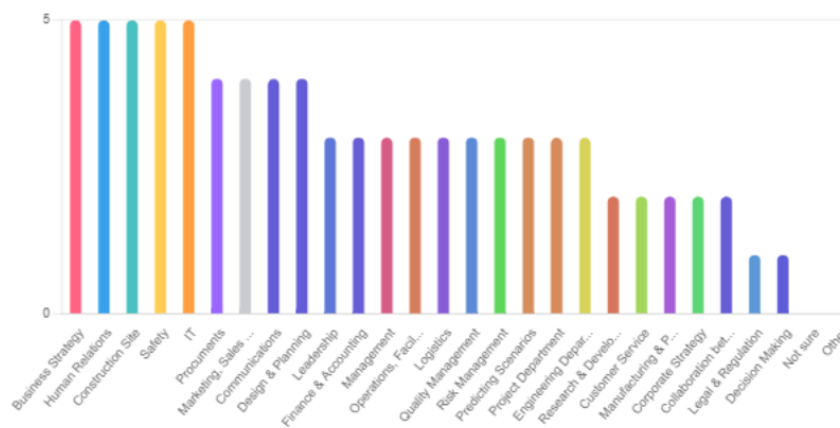


Table 28. 'Where is AI being used in your business?' High performers. The different graph style is used so all available function are clearly visible. In most questions, such as this, options were randomized to avoid wrongful patterns (SurveyKiwi 2022).

64 answers

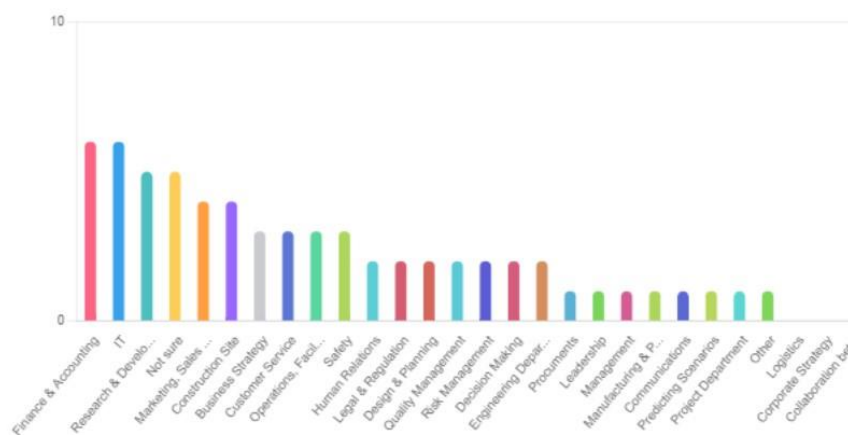


Table 29. Same question with Lows (SurveyKiwi 2022).

When moving to question 19, where respondents were asked to name active use cases for AI within their business, more unambiguous differences were visible. Despite being nearly four times smaller group, high performers had 84 options selected from the list whereas larger group, low performers, had selected only 64 options. Also, the priority of answers was different as indicated in the pictures below. Highs had ten active use places for AI while Lows only two – there were eight high performers and 24 Lows in survey. 'Business Strategy', 'Human Relations', 'Construction Site', 'Safety', and 'IT' were the five most selected options – they represented 30 % of all replies. The first five for Lows were 'Finance & Accounting', 'IT', 'Research & Development', 'Not sure', 'Marketing, Sales & Public Relations' with 40.6% of all replies. Each respondent could choose as many options as they liked. It is worth mentioning that none of top options of Lows had been highlighted for the use of

construction, in theoretical research whereas Highs had at least two option which had been mentioned – ‘Construction Site’ and ‘Safety’.

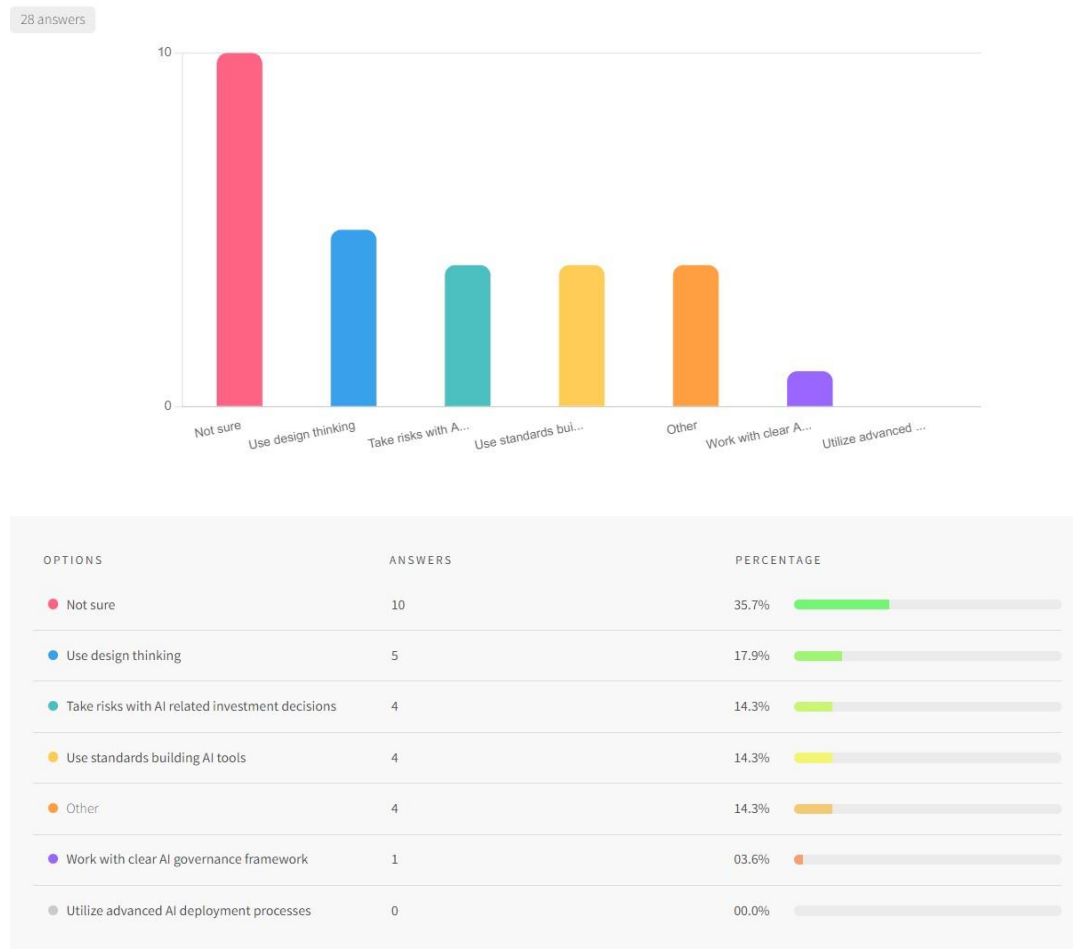


Table 30. ‘How do you work with AI?’ Low performers (SurveyKiwi 2022).

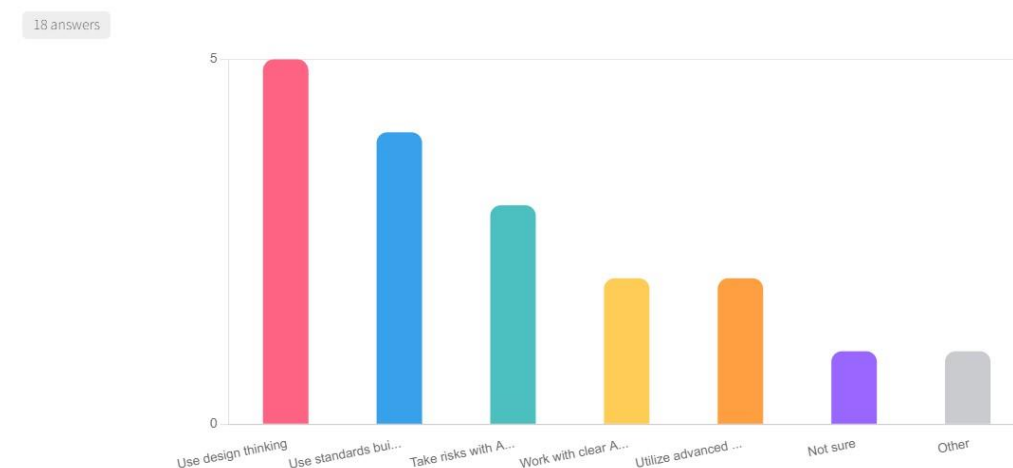


Table 31. The same question as in table 30. but with Highs. Highs had two working methods employed while Lows had one (SurveyKiwi 2022).

In the question 20. more differences are showing - more than third of Lows, when given options on typical ways to work with AI, they replied 'Not sure'. For Highs same answer represented only 5.6% of the total. 'Using design thinking' was the most popular answer for both groups beyond forementioned observation. A few respondents seemed not to understand question correctly. This was the first, slightly more technical question about AI.

In the following two questions there was a clear discrepancy in trends when asked about strategic variables of using AI and its adoption methods. The most popular answer for Lows was 'Not sure' with a large margin while Highs really seemed to know their tool and had more spread on replies, too. They had AI devoted managers and strategy and most importantly, a plan to create value with AI. Lows had the plan too but failed to show equally dominantly involvement in strategy. With AI adoption methods, there were not so many differences beyond the lack of knowledge of Lows – nearly half replies 'Not sure'. Both groups were doing pilots, tracking performance indicators and searched points to add value with AI. All replies can be seen in the appendices.

Despite seeing quite significant financial benefits from AI, Highs there was still some undecidedness over AI's usability. Highs had 35.7% replies for academic and other sources when asked on how they learned to use AI. Lows' most popular answer was that they were still in the early stages of the learning process – yet another indication of timing issue. Lows could become soon better performers but the differences in other practices indicate needs for drastic changes instead of staying in remission. Also, Highs said to have been using AI long without progress in learning whereas Lows had zero replies with this option – they must have been trialling with pilots or other methods before finding success.

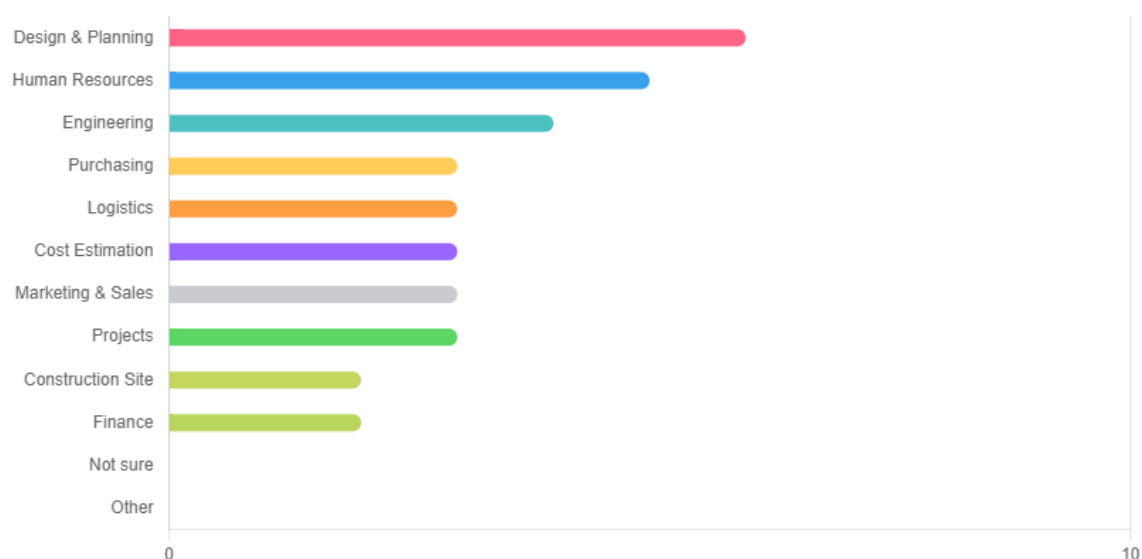


Table 32. 'In your opinion, which are the highest impact functions for AI?' High performers (SurveyKiwi 2022).

These were the priority list for Highs. Most popular answer at the top and least at the bottom. Graphs between the two groups neglect to show much difference in shape but rather option popularity. This could suggest that most of the respondents are at stage where they have identified next direction they should be taking with AI. Choosing the high impact functions for maximised effects is crucial part of great AI strategy said Blanco et al. (Blanco et al. 2020).

When asked about highest impacting functions with AI, the most popular answer for both Highs and Lows was 'Design & Planning'. Besides that, groups did not share any options besides 'Projects' that 8th most popular option. 'Design & Planning' could be a nod towards BIM which has been known to be a great vessel for AI as discussed with associates of Kirjalainen. Also, Ausserhofer confirmed his company, UnionBau's sole touch base to AI was through BIM (Ausserhofer 2022). It still was not considered to be in the top selection of high impact functions. Probably the most notable difference was that 'Human Resources' were a high priority for Highs but not for Lows. Additionally, 'Logistics' had significantly higher popularity with Highs. Surprisingly, Lows had 'Cost Estimation' and 'Construction Site' as high popularity replies. Highs were still heavily invested in using AI at a construction site while not showing indication of it being high impact function. 'Human Relations' then again were ranked on top of both lists – used function and high impact. Earlier, Highs had construction site as more emphasized active use case. Perhaps, they use AI to manage people on construction site rather than site itself as the 'Human Resources' – reply seems to suggest.

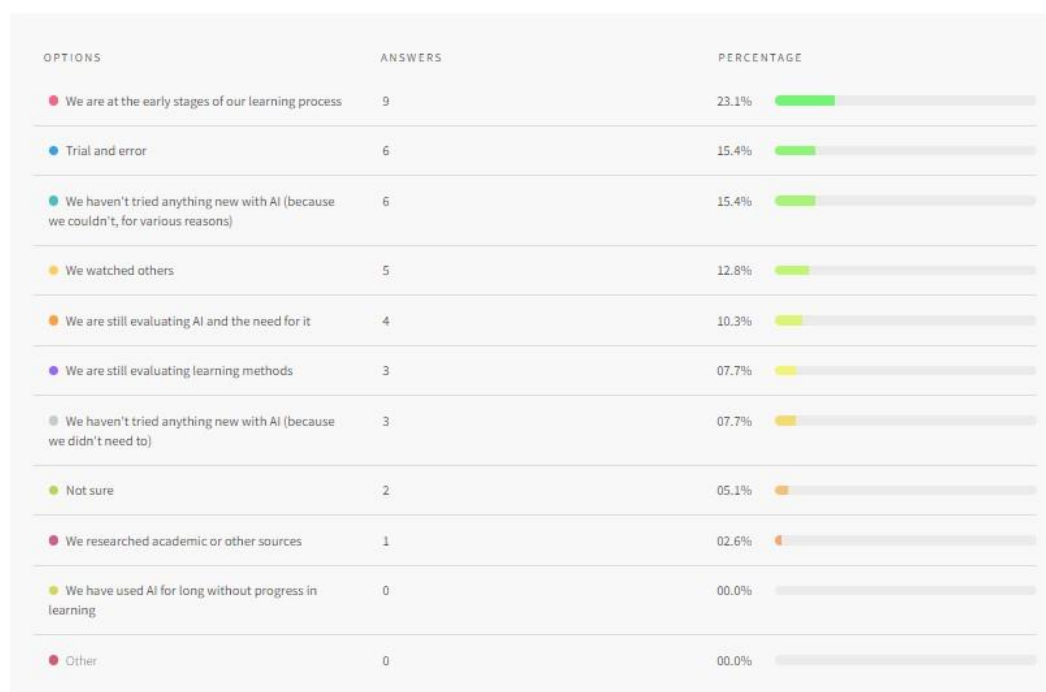


Table 33. 'How did you learn to use AI?' Lows (SurveyKiwi 2022).

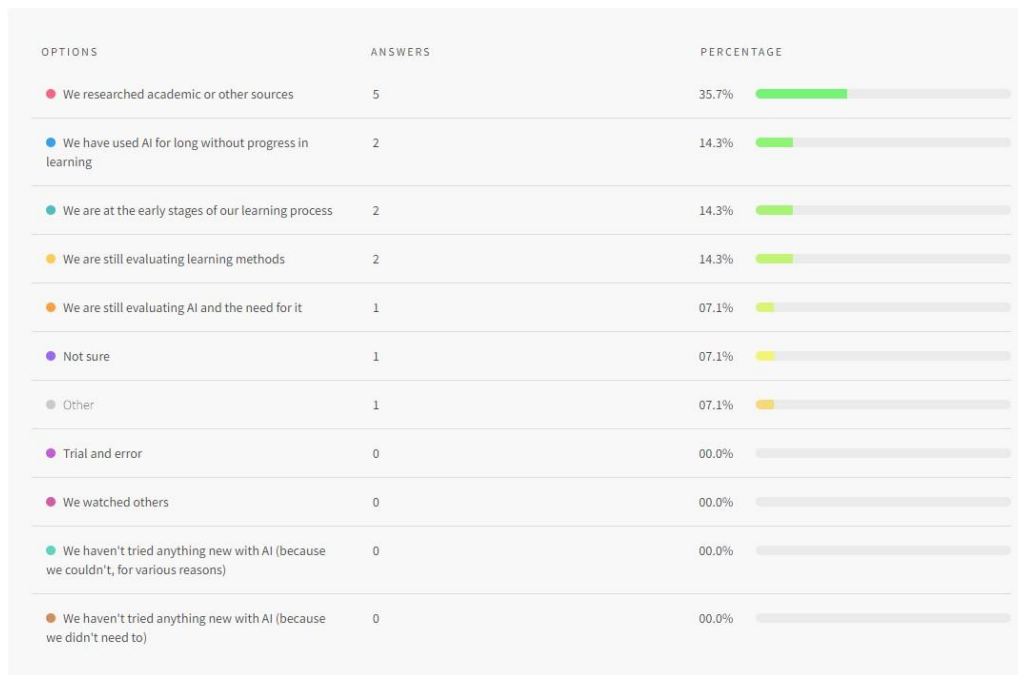


Figure 34. How high performers learned to use AI. A good example for others to follow. 62.5% of the respondents researched academic and other sources instead of blindly trialling with AI (SurveyKiwi 2022).

A total of 37.5 percent of Lows were early adopters of AI as they replied to be in the early stages of the learning process. The same number for Highs was quite high considering how well they were doing – 25 percent claimed to be in the early stages of learning process. However, the same amount said they had been using AI long without progress in learning. Even with great success, some were still evaluating the need for AI – it could be an issue with reply amount as Lows reported 16.7 percent rate for the same issue. The most considerable difference was that Highs used academic sources instead of watching other or 'Trial and error'. When asked about organizational learning processes with AI, more differences in replies are displayed between Highs and Lows: Highs taught AI and it learned automatically whereas Lows' most popular answer, by 42.3% share was again 'Not sure'. Next most popular reply with them was 'We taught the AI' but after that, the third most popular options was 'We don't communicate with AI'. This could strongly indicate problematic issue – why not communicate with advanced technology that's sole purpose is to help one perform better and still expect results? Half of Highs said they taught AI, or their AI learned autonomously. Without looking at individual replies, it is hard to say if there is interlaps between the answers. One respondent said AI was teaching them. In chapter 5.2.3 it was determined that Supervised Learning was indeed the most popular method to educate AI among all companies like Magoulas & Swoyer had also studied (Magoulas & Swoyer 2020, 10).



Table 35. As discovered earlier, the majority of AI user had slightly different priorities but even with high performers, there is room to improve. On average they were still using only one solution per company. The structure of the question was largely based report by Ransbotham et al. 2020, 10).

According to previous research the more learning methods the better. The most effective method was AI recommends action, human makes final call (Ransbotham et al. 2020, 10). In the next question, where respondents were to name their modes of interaction with AI, there was quite a bit of distortion. Nearly same percentage of replies was diverted to most popular option. For Highs it seems that AI had a more dynamic purpose when Lows used it for mind mapping purposes and insight creation. For both, human had the option to use the recommendation. Neither had truly autonomous AI making decisions and executing them.

8.2.2 Low Performers

Contrary to high performers, this group represents most respondents, a total of 61.5% of them. Large numbers are performing poorly or even failing with AI and not seeing any returns of their investment. When asked to state their level of financial performance with AI

on the scale of one to ten, the most popular answer was number '2' while replying '0' meant no financial benefits at all. More than 29% of low performers did not see any profits from using AI – that translates to 17.9% of all AI users. There are indications that many businesses having recently began using AI are misusing it. The fact that there are so many patterns of differences between high and Lows indicate a need for change but also encourage those struggling with it. Success is bound to something else beyond coincidence. Furthermore, it seemed that many low performers were new adopters.

Question 26. Is the only one that could help determine at what stage different performer are at, by level on adoption. Those companies who have more AI pierced organization are likelier to have worked with cognitive solutions for some time than those who have not. There will be a thorough analysis of the adoption stages of Highs and Lows in chapter Data Analysis: Second Stage.

Lows have had significantly less business silo and organization piercing strategy. As Wingard had implied, some companies do not understand the level effort and resources AI requires for to be successfully employed (Wingard 2019). They also had many occasions where they did not seem to possess in-depth knowledge of their own AI solutions and strategy.

8.2.3 Medium Performers

Medium performers were the minority of the entire sample of 54 respondents with only 7 executives/companies. Their selective field was slightly tighter than for Highs and Lows due to technical reasons – they had three slots to position themselves upon group categorization instead of four reserved for others. None of them part of the two largest revenue brackets – 42.9% were part of the 50 mill USD – 200 mill USD bracket. As discussed before, this group had a very different path in the survey. Now a deeper examination into their replies is in order, along with a search for keys points of interest that separate them from high performers. Curiously, there were no businesses from two highest revenue brackets. In the survey, it was asked if medium performers are moving closer or further from AI – while relatively balanced, this group was still slightly leaning towards it. Still, it seems that there persists a strong indecisiveness. For comparison, it would be interesting know if the same applies for high and low performers. Nonetheless, these results are surprising – after all, this group has enjoyed better success than many others and still feels uncertain whether to continue. Root causes should be explored. Perhaps, they do not know what they can potentially achieve or lack the resources to move further with AI. One trace could be the overtly problematic work process with AI – maybe they have not successful with streamlining or experience trouble shaping it to an efficient version of itself and that is slowing the process

of learning. Furthermore, they rated their company learning progress to be slightly above average but working process was leaning heavily below average. Some exceptions were visible, but no exemplary processes were identified.

Mediums' strategical top five expectations from AI were: 'Efficiency', 'Time Saving', 'Growth', 'Cost Savings' and 'Improved Risk Management'. All are except 'Cost Savings' are well known strong points of AI. Most of them had been mentioned in the theoretical literature and seem to be rather universal in nature.

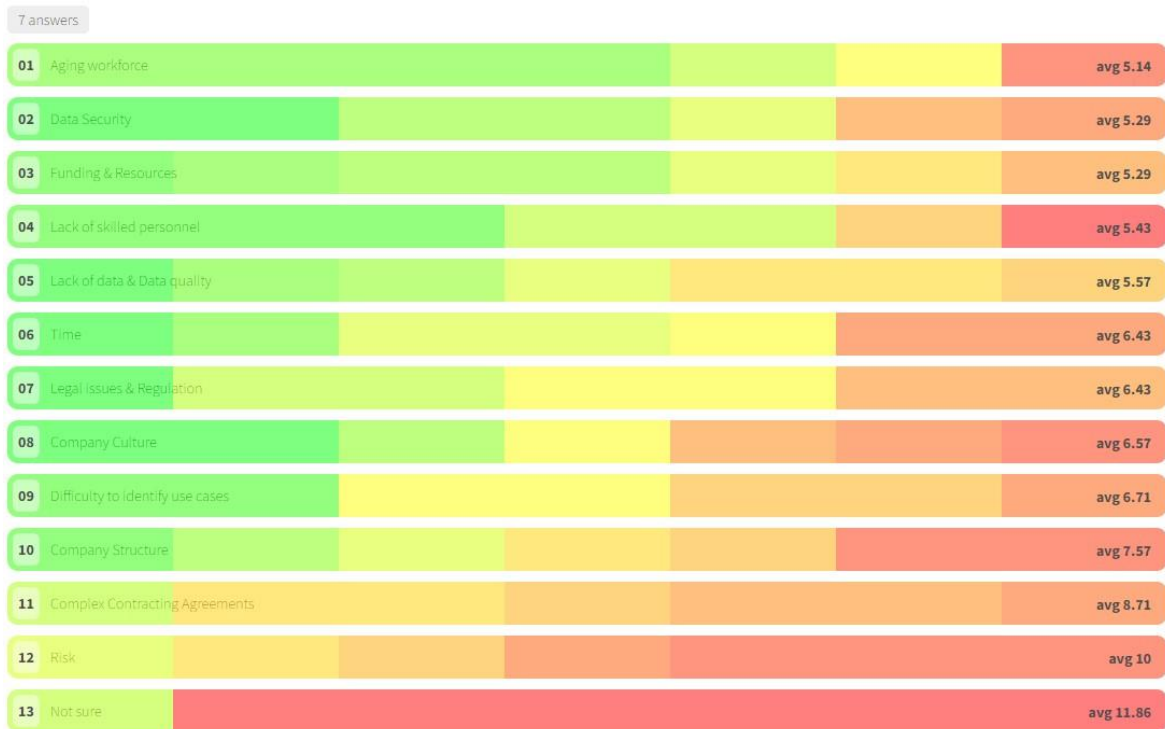


Table 36. How Mediums saw AI obstacles in the construction industry. Only 'Funding & Resources' and Lack skilled personnel' was in the top five lists of Mediums, non-users and the unaware.

Theory revealed that organizational and cultural barriers are hindering the forthcoming of AI (Fountain et al. 2019, 63). The survey revealed that only organizational barriers such as 'Lack of skilled personnel' and 'Time' were seen as obstacles by active user of AI. For instance, 'Company Culture' was not highly prioritized. Curiously, for non-users, the most prioritized barriers were not organizational apart from 'Funding & Resources' that was the second most popular option for their own businesses.

Curiously, Mediums' most common answer in strategic use of AI was 'Efficiency' and 'Time saving' just as chapter 5.3.3 had established (Boos 2018). Only Mediums faced this question in the survey, and it seems that they have already realised what the main purpose of

AI should be for them to achieve more with it. We can only assume that high performers have somewhat similar priorities as they are not far ahead. Mediums represented nearly 18 percent of the entire sample of AI users.

Familiarity with AI had a correlation between the two groups, Highs seemed to be blossoming compared to Mediums, while they too, had room for improvement. Personal attitude towards AI was slightly more positive with Highs but both still were at upper bracket. This issue will be addressed more closely with expert interviews.

8.2.4 Not using AI

So far, there had not been clear trend for the size of the businesses using AI but for non-users' 64.3 percent of businesses, were in the revenue bracket of 50 to 200 mill. USD annually. Same number for companies using AI was 33.3 percent. Notably, 37.5 percent of high performers were from the same group which could indicate that issue of AI adoption is more of an attitude problem instead of a resource based one. Could AI be so pricy that mostly larger companies use it, or do they simply offer more functional working environment, more data and existing, adequate level of digitalization? Interesting observation is that the knowledge base on AI does not have significant difference between AI user and those who do not utilize it. As suspected, the personal attitude towards AI was way more positive on the user side.

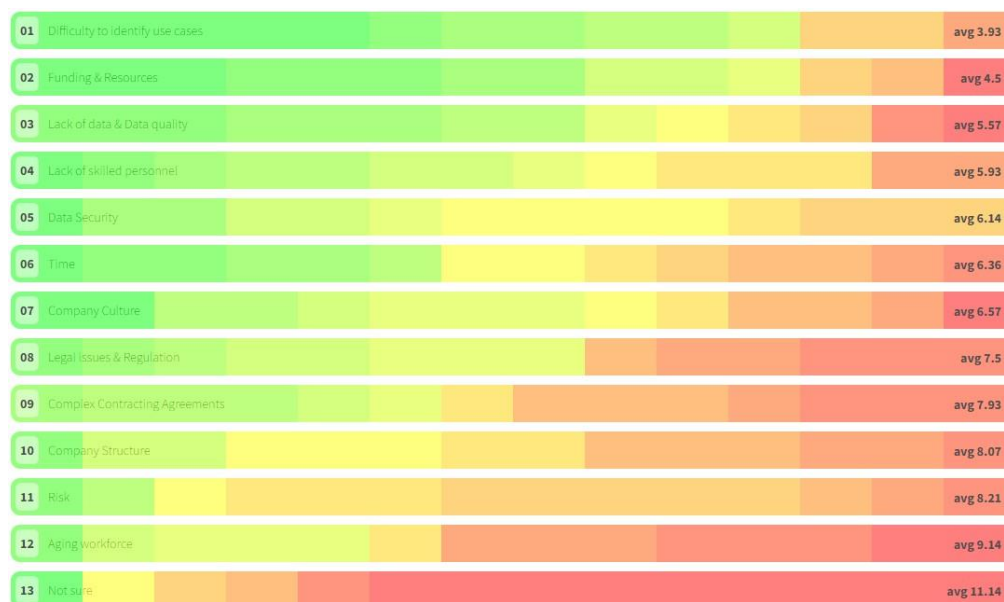


Table 37. Obstacles for AI use for non-users (SurveyKiwi 2022). How non-users of AI prioritized their obstacles on adoption in their own company. The difficulty to identify use cases as one the top bottlenecks for adoption was recorded by Magoulas and Swoyer, too (Magoulas & Swoyer 2020, 6).

It seems that they require more knowledge of the potential of AI to allocate resources to it. Earlier in the text, LetsBuild.com named most common obstacles to AI adoption (Koutsogiannis 2019). Interestingly, the priorities seem to change according to respondent's status with AI. Non-user priority list was very different from the LetsBuild.com one, but Mediums' list then followed the pattern of the LetsBuild.com quite neatly (Koutsogiannis 2019). These results go almost opposite with theoretical assumption made earlier in the text – the main reason to not use AI is not the company culture as theory suggests but ability to figure out use cases (Magoulas & Swoyer 2020, 6).

8.3 Leadership

In terms of leadership, the recipients seemed to be quite cohesively leadership oriented instead of leaning towards management. When self-evaluating, most people ranked themselves and their company way above average. A positive trend accordingly to the theory part of this study – however abandoning management completely is not suitable either as only the combination of both can help achieving organizational goals (Shamas-ur-Rehman 2011, 10). According to the leaders the management strategy and vision was effectuated to their subordinates well above average levels. Fountaine et al. supported the soft skills and highlighted the importance of leadership and flattening the hierarchy (Fountaine et al. 2019, 72). Contradicting to author's assumption, leadership structure in the industry seemed to be significantly flatter than expected. A great direction which will later make managerial duties shift from administrative to leadership oriented.

Earlier in text, it has been established that it requires fundamental changes to organizational layout to see significant changes from the use of AI, according to Wingard (Wingard 2019). Ahmed claims these changes should not be based on past when considering transformational leadership (Ahmed et al. 2016, 6). The considerable differences between low performers and high performers indicate that the only Highs had made the required changes, whereas Lows, did not. Not only is the lack of changes to be blamed but also lack of understanding – low performers most answered option was 'Not sure' when questions matured into more specifics about solutions they had in place. In the same chapter, it was established that hype around AI is not necessarily fuelled by know-how (Ransbotham et al. 2020, p. 4). Low performers had amassed more management style leaders than Highs and displayed more problems with in-house communication between employer and employees.

There was no clear difference between high performers and others regarding the leadership style of the person in charge. Similar findings as discovered interviewing leaders. Equally, a clear difference with how leaders managed to drive their strategy and vision with their subordinates, could not be seen. At this point seems safe to rule them away from

differentiating factors as there were not enough distortion between answers from the three groups. According to Dansereau, Alutto, et al. (1984) and Klein et al. (1994), complexity of leadership analysis comes from its multilevel cross-section, despite of this the only focus will be on the highest levels, organizational and industry because the research has no relevant data in the levels below that (Antonakis et al. 2003, 63).

When high performers were replying to leadership-oriented questions in the survey, it seemed that this group had its orientation in the modern leadership style. With only one exception, all leaders replied to be leadership oriented in their management style. Additionally, they were well in touch with their subordinates, in terms of vision and strategy. Leadership was also quite popular place to apply AI to. When compared to other groups, no mentionable difference can be found distinguished in leadership-oriented question. Leadership was not a popular place to apply AI among poor performers – Mediums were not answering this question. Verhezen highlights AI leader's characteristics and one of key qualities happens to be inspiring the workforce. Ahmed agrees on the verdict that successful transformational leaders manage to create aspiring visions of the future (Ahmed et al. 2016, 6). Furthermore, using AI as a tool to enhance competitive edge is recognized as a valuable quality (Verhezen 2019, 19)

Mediums placed high on the scale towards leadership-oriented management style, as did high performers. They also managed to carry out their vision with subordinates well. When asked to prioritize functions to update in construction industry, leadership was on the was sixth most prioritized issue – about middle stages in the list of options. A curious observation was made regarding the leadership style between Mediums and Highs. Leadership oriented style was stronger in medium group than it was in high group – this was unexpected as it had been widely recognized to be the more effective than management-oriented method. Perhaps, success with AI is not so strongly related to leadership style. It seems that the issue is a deeper one as the high performers reported considerably better connection with their subordinates than Mediums.

8.4 Business & Corporate Strategy

'Business Strategy' was in the top five of the use cases of for AI when looking at entire sample. For Highs, it was the most used option. However, corporate strategy had a noticeably low priority in comparison for all respondents. It is peculiar considering how usually these functions are tightly connected to each other. Perhaps, AI has not yet reached the highest awardable status but is on its way there. Later, in the questions, AI has embedded itself deep within overall strategy of high performers. For low performers, business strategy

had lower priority in their business and corporate strategy was completely missing from the list.

Additionally, to what has been discovered, it seemed that when it comes to AI, strategy does not play an equally important role as it does with high performers. None of the respondents said they were devoted to AI strategy and only one said to have clear vision and strategy with it. Kolbjornsrud, Amico and Thomas (2016) and Wallenberg (2018) all agree that an AI strategy must be implemented for best results (Eriksson & Djoweini 2020, 27). Business and corporate strategies were not questioned from Mediums as their survey path was different from the rest.

9 Interviews with Leaders

9.1 The Interviewed Leaders

Subject A

Name: redacted

Title: Managing Director

Company: redacted

Country: Germany

Status with AI: medium performer

Company Revenues: 200-250 million USD/annum

Subject B

Name: Kobus Marais

Title: Chief Executive Officer (CEO)

Company: Phenix Architecture and Fitout, formerly known as Phenix Construction Technologies

Country: South Africa -> Nigeria

Status with AI: non-user of AI

Company Revenues: turnover approx. 20 million USD/annum, other sources cited determined adequate revenue range for the study, albeit accurate number is unknown.

Subject C

Name: Christoph Ausserhofer

Title: Owner & Managing Director

Company: UNIONBAU SPA

Country: Italy

Status with AI: low performer

Company Revenues: 60.41 million USD in 2020

Subject E

Name: Daniel Liehner

Title: Sales Manager, he represented his company's upper management team both in the survey and interview

Company: WeberHaus Gmbh

Country: Switzerland/Germany

Status with AI: high performer

Company Revenues: 469 million USD in 2021

A few more respondents desired to be interviewed but they were not reached even after several attempts, partially because some of them failed provided contact details.

9.2 Questions for the Interviewed Leaders:

1. How do you see the future of AI shaping the construction industry?
2. Has your company developed any new AI technologies specifically for construction? What kind?
3. Why has AI not provided financial returns for so many construction companies?
4. Has AI changed your company's hierarchy structure and your leadership style? How?
5. Has AI affected your leadership strategy or vice versa? Why so?
6. What were the processes and measurements when you started to see and measure the benefits of using AI?
7. What were the determining factors in why your company was successful with integrating AI to the company operations?
8. As a leader what are the critical personal attribute that you found important when integrating AI for your company?
9. For non-users of AI, most prioritized obstacle in AI adoption was 'Difficulty to identify use cases'. Why do think so?
10. What challenges do you think directly affected the adaptation and adoption of AI in other companies, so they might not have been as able to directly benefit from AI?
11. According to theoretical research and the survey you completed, the more company has AI technologies/solutions in place the more successful it is. What is your opinion on this?
12. What is the next step for your company with AI?
13. How long before AI becomes mainstream in construction?

9.3 Interview Structure

9.3.1 Introduction

Earlier, it was established how poorly known is the relationship between leaders and AI which is why this topic was introduced both in main survey and interviews for said individuals. The purpose of the interviews is to complement the survey results and the discovery of new intelligence regarding research topic. This chapter has summarised the most important quotes from the interviewed executives, paired with metacommentary and observations

from author. None of the quotes are exact and should be treated as such – they are adaptations of the subjective opinions of the said individuals. The value of them comes from the first-hand information. They may provide support or opposition towards theory and survey.

In addition to the survey project, a considerable portion of time was reserved for face-to-face interviews with construction and development industry executives. This period incorporates the preparation for interviews and decrypting received data from the survey and theory and building it to easy-to-read format which then was transformed into interview questions.

Entire set of interviews were conducted using Zoom or Microsoft Teams video call services, with both video and audio connection. Moreover, every interview was recorded but the recordings and transcripts themselves have been redacted from the thesis due to confidentiality issues. Each meeting took place on a mutually agreed timetable, lasting up to forty minutes each. Each interviewee will be referenced with their own name or using ‘Subject A, B, C...’ et cetera. A direct quote will be highlighted and may be slightly adjusted for smooth reading experience. Nevertheless, content remains unaltered. One of the interviewees requested that he would fill out the interview form with the help of an assistant, due to language barrier – permission to proceed was granted and an option to send follow up questions was reserved, just like in face-to-face meetings. Each of these meetings followed conversational style using questions. In couple of occasions some on-the-go adjustments had to be made. Here are the questions paired with some of their replies.

9.3.2 Interview Contents

How do you see the future of AI shaping the construction industry?

Daniel Liehner, Subject E

From our point of view there are two different parts in construction process – premanufacturing and then assembly on-site. We are building premanufactured houses: lots of the work happens at a factory, one of the best places to implement AI. It is just a matter of time when 90 percent of the process will be carried out by AI.

Subject E saw future potential in prefabrication as platform for AI and believed the residential multifamily buildings will become more common through prefabrication. However, AI moving to construction site will be increasingly challenging objective to complete – AI there might be a game changer. Limiting factor for international progress has been regulation and legislation issues (Liehner 2022).

It seems construction industry sits at a tipping point where movement towards AI powered industry 4.0 could happen so that cognitive technologies adapt to the tailored needs of business, or a major structural change could occur, reshaping everything known to an entirely novel direction. If the latter occurs, the very fundamentals of how buildings are erected would change forever. A house would become a replicable assembly line product or perhaps modular parts would see common standardisation. For those who are willing to spend extra for individual homes, traditional construction would still retain its rightful place but become a niche segment.

Subject A and Ausserhofer (Subject C) saw the future to be strongly connected with BIM (Building Information Modelling). Subject A even claimed the AI to be the basis for all digital processes in construction. Subject C believed the infrastructure required plenty of investment before it could serve them with AI (Subject A 2022; Ausserhofer 2022). Only Marais (Subject B) did not see AI making a significant impact, he believed the hands-on work in brick-and-mortar construction would be difficult to replace (Marais 2022). Noteworthy is the fact that all subjects agreed on the evident change to arrive at some point in time – they simply had differences with assumed timing.

Why has AI not provided financial returns for so many construction companies?

Subject A and C recognized an issue of being unprepared and not investing for progress. Subject A brought into focus the requirement of proper hardware, software, and cross company digitalization. It also comes down to transparently educating and convincing workforce of benefits change may offer (Ausserhofer 2022; Subject A). Subject E had a very contrasting angle, he saw the focus on construction site redundant and achievable benefits superior if these companies focused more on the preconstruction processes – in his opinion the whole process is fundamentally old-school and dated thinking ensues (Liehner 2022). Subject B suspected the lack of information to be one key prospect for poor performance (Marais 2022).

Kobus Marais, Subject B

If you take away manufacturing and engineering, leaving only the hands-on construction. I'd be surprised if AI could be applied to more than one percent (in construction) (Marais 2022).

Marais has a great point here; many applications of AI are directed to construction site, but it seems to be the last outpost of non-digitalization. Whether this is fundamentally irrelevant, remains to be seen as the development of construction likely finds a natural path of evolution soon. It is possible, likely even, that that traditional construction where houses are built

in abundance from ground up, will be replaced with high paced assembly projects of pre-fabricated modules. Perhaps only complex, one-off projects like airfields, shopping courts and movie theatres will be erected as customized structures but even they would be using some standardised modular pieces. This change requires huge investments and only the most capable companies can pull it off in a relatively short time.

Subject A, on what personal attributes were helpful in integration process of AI:

Be a pioneer yourself - take away employees' fear by setting a good example: communicate motivated, purposeful (with clear focus) but also critical views to employees - share honest, authentic experiences/views. Show confidence in employees/technical staff/technology and the company's individual path (Subject A 2022).

Clearly, staff buy-in has been an important part of the transformation process. They are eventually those who must operate with knowledge engineering first-hand. This relationship will not work unless the leader can show how the process works and do that with confidence. Eventually, this confidence should transfer to employees.

Subject E, on the same question:

Be open-minded. You need to convince your employees that it is not about getting rid of good staff but doing a better job as whole (Liehner 2022).

Chamorro-Premuzic et al. 2018 supports this mindset where the leader must be willing to re-think his or her decisions as sometimes right course of action is changing the current heading altogether (Chamorro-Premuzic et al. 2018, 4). The leadership issue has been a little bit stagnant affair among the leaders who were interviewed. The true changes made by AI are yet to be seen. At most, passive changes in the way of thinking and approaching problem spaces has developed, but nothing groundbreakingly peculiar was discovered. Author will be raising this issue with the second round of interviews of specialists and compares the results of the survey to their responses.

Subject A, on how has AI changed leadership style and structure?

Not yet - but structures will inevitably change in some way. The manager in the digital age is more than just a supervisor. He or she is also a coach and mentor. New, disruptive changes create uncertainty in everyday business and among employees. That's why the company's management need to create an open culture. The more AI comes, the more the management level needs to model communication, trust, and transparency (Subject A 2022).

The survey or these interviews cannot seamlessly determine whether the leadership is changing on itself or because of AI. There would be an incentive here to research this issue more in detail. So far, only general competence as a leader seems to be correlated with relative success with AI whereas causality is yet to be identified.

What were the determining factors in why your company was successful with integrating AI to the company operations?

Subject A

Here, the first steps were to identify, collect, structure, and maintain data. Over time, databases must be expanded accordingly. Data proportionally limits the usable possibilities of digitization and especially of AI (Subject A 2022).

– still a relatively early stage with the adoption, as presupposed with many who participated in the survey. This company is evidently laying the foundation for a great AI by structuring and collecting data to feed it. Wallenberg also identified Data Inventory as part of the checklist in preparedness for AI adoption (Wallenberg 2018, 100).

Subject E

We did the changes with our staff, not against it (Liehner 2022).

– the success does not necessarily always derive directly from the technology itself but how it was implemented and received by the workforce. In the main survey, high performers had the whole organization looking for ways to benefit more from AI. Liehner said the re-educated their elderly workers, who were anyways soon retiring, to work with the robots inside their factory thus minimizing workforce loss. As Davenport et al. had concluded, AI does not have to take away jobs (Davenport et al. 2017, 2).

For non-users of AI, most prioritized obstacle in AI adoption was ‘Difficulty to identify use cases.’ Why do think so?

Subject E

Maybe, for us it is easy to find profit in AI because we are in a mindset of organised and logical working due to prefabrication process. Perhaps, other companies do not know this kind of thinking. The building industry is very old-school and anti-modernisation (Liehner 2022).

Some companies are working on houses like they are prototypes each. Many companies treat buildings as prototypes instead of a finished product that can be produced in high volumes (Liehner 2022).

Velasco et al. 2020 identified the same mentality in the Deloitte report – each project is unique and lacks replicability (Velasco et al. 2020, 18). Furthermore, discussions with Kirjalainen confirmed the same problem space (Kirjalainen 2021).

After a long discussion with the thesis supervisor, author came to realization that indeed Liehner was onto something here: AI could probably work in some aspects of construction but just as theory has indicated, the best utilization calls for re-mapping the entire business model to suit the technology and not vice versa. The existing business model could probably work but it would make sense to change all protocols at one go and reap the benefits afterwards.

According to theoretical research and the survey you completed, the more company has AI technologies/solutions in place the more successful it is. What is your opinion on this?

In this matter, author noticed a strong correlation in the survey results and theory which is why he chose to address this finding with highlighted emphasis. The reader should keep in mind, the questions does not differentiate, for instance, the level of experience with AI, just the number of technologies at disposal.

Subject E said he would not be surprised by this and would absolutely agree on this observation (Liehner 2022). Subject C had similar views on the matter (Ausserhofer 2022).

Subject A on the same question:

If a company knows how to handle AI, it has a gigantic market advantage. AI and, above all, the right handling of it can increase productivity enormously. This means that expertise can be deployed in a more targeted and efficient manner. You can focus better and save a great deal of effort, which the machine can manage more easily and more accurately than humans, but every company and every sector should use AI sensibly. Sometimes it is not (yet) necessary - it does not always make sense to do everything that is (theoretically) possible. Success comes through sensible application in the right measure - as in every area of life (Subject A 2022).

According to Subject E, the AI powered robotization has been an effective choice for them; their robot can optically distinguish different types of wood such as oak, pine or spruce. This robot then assorts them into groups for assembly line, effectively saving the workload of twelve people. Image recognition that this robot is using, is part of one AI subfield called Computer Vision (Abioye et al. 2021, 3). They developed this robot in collaboration with robotics provider (Liehner 2022).

With the help of AI, we have managed to increase our house production by 15 percent, from 650 houses to 750, per year. This was achieved with less staff and same premises as before (Liehner 2022).

WeberHaus Gmbh kindly provided this thesis a YouTube video of their robotized factory in action. Captions are suggested to be turned on as the video is in German. It is noteworthy that robotization must have had a huge impact on their profitability already without the assistance of AI but adding intellect to these robots allowed them to go even further in automation and productivity.

A smartPrefab – a vision becomes reality

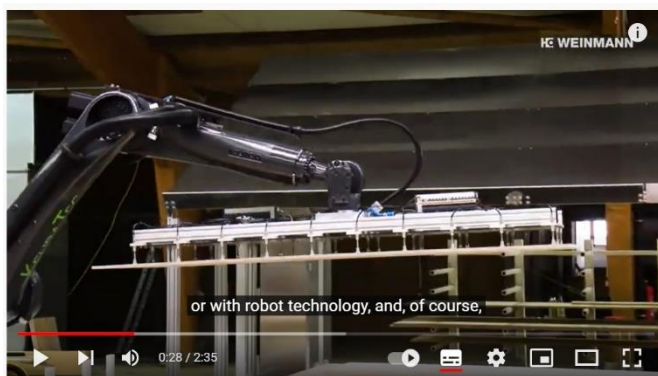


Figure 18. A screenshot from WEINMANN Holzbausystemtechnik video where WeberHaus' cutting-edge robots are introduced (Weinnmann 2021). AI powered robots paired with prefabrication was recognized as an opportunity McKinsey & Company, too (Blanco et al. 2020).

Link to the video: <https://www.youtube.com/watch?v=UiDibXovkVc>

What is the next step for your company with AI?

Subject E is focusing on developing solutions for logistical problems with house maintenance – they are working with an AI solution provider to construct a system that directs their employees on optimal routes, avoiding traffic jams and other obstacles when meeting with customers – an iteration of AI, recognized by Blanco et al. (Liehner 2022; Blanco et al. 2020). Just as in table 14. WeberHaus is scaling up AI and moving beyond automation. Subject A is focusing on database build up; they plan to digitize all information flow. Additionally, training staff and helping them accept change is crucial part of their process. Progress with AI itself is made with implementing small step with help of piloting (Subject A 2022).

Subject B, on what is the next step with AI in your business:

I would like to understand and know about it more. The more I can understand, the more there are uses cases to be seen. I am willing to use it then (Marais 2022).

How long before AI becomes mainstream in construction?

All respondents agreed that it would take at least few years for AI to truly make its breakthrough, in construction. Subjects C and E were the most optimistic and spoke of only few years. Subject A recognized that AI has already appeared in few segments of construction, but cross-industry adoption still is few years away. Only subject B spoke of much longer time frame, in the context of his geographical location (Marais 2022; Ausserhofer 2022; Liehner 2022). It should be noted that Global Construction survey from 2019 indicates that those who are technologically far ahead are likelier to see the change occur in the next 5-10 years. More than half of top 20 percent believed AI to become mainstream in five years – that was nearly three years ago (Armstrong et al. 2019, 23). Contradicting, McKinsey & Company research from 2018 pointed out that many construction companies still lack personnel, processes and tools required for successful adoption (Blanco et al. 2018).

Subject E

I'm sure we'll have a different landscape in ten years' time – either you have AI, or you might be gone (Liehner 2022).

In the later chapters of this paper, the rest of the responses will be addressed to further detail while comparing the results of the interviews to one from survey and then analysing these results together with AI and construction specialists.

9.4 Data Analysis: Second Stage

This chapter provides the second stage of analysis – the results from theory, survey and executives interviews are compiled here and assessed. Only issues that have been covered in theory, survey and interviews are observed. Here author has actively reflected the findings and aimed to find patterns and trends. Observations here are countered against specialist review in the next main chapter.

Despite theoretical suggestions on changes in leadership role, both surveys failed to pick up any remarkable progress indicating active change. However, a correlation between being well in touch with needs, fears and training of workforce was identified both in survey and interviews. Communication between management and subordinates was effortless and vision was carried out to them flawlessly. It seems that exceptional leadership yield better results with AI adoption – this could be direct effect of flatter organizational structure too.

Similarly, to low performers, Mediums had low numbers of AI technologies/solutions in place whereas Highs had many. Same pattern was seen with Highs and Lows. It is not possible to determine whether this has crucial role in success, but theory, survey and interviews

seem to lean towards it being important. If done right, surely having multiple solutions is not harmful for business. If early adopter could be compared with mature users, then it would be easier to make conclusions. This topic shall be addressed together with specialists.

It seems that poor performance cannot be explained without a doubt here as respondents are at different stages with the technology adoption - a large portion of learning with AI is dealing with failures. Anyhow, it is interesting that Lows did not know much of the details with their AI technology. Would be interesting to research and compare how long both parties have been using AI to make better conclusions.

Use of AI can be linked to financial success but as identified in theoretical research and survey it is reserved for only the few, so far. Interviews suggested huge leaps in profitability for a high performer. It can be confirmed, without a doubt that AI can offer profitability increases but more interviews should be conducted to confirm its rarity.

Devotion to AI and AI strategy is supported by theory, survey, and interviews. Author noticed that determination and clear vision precedes success. AI must also be applied effectively according to theory, survey, and interviews. As we have learned while AI is efficient, it is also dumb. To apply it use it effectively talented specialists should be hired. These individuals happen to be in the short supply which partially explain the rarity of considerable success with AI – perhaps companies cannot expand AI functionality due to lack skilled workforce.

Most of respondents had a positive attitude towards AI which cannot indicate anything particular in name of success or failure. Comparing all three, no significant differences could be found. Findings correlate with theory where it was learned that public attitude towards AI has been shifting to positive in the recent years (Shoham et al. 2018, 43). Supporting theory and practise, AI users spoke rather positively about the technology in interviews. Curiously, even with relatively poor performance respondents had overtly positive views, according to survey. This could signify that they are still in early stages with AI and are waiting for results. Maybe they see that rewards lie in the future - AI needs time and patience. Third option is that they are part of the AI hype and are now suffering the consequences.

10 Technology, Engineering and AI Experts Interviews

10.1 Interviewed Experts:

- Theodore Haupt, Research Professor, Mangosuthu University of Technology
- Tomasz Mucha, Doctoral Researcher, Aalto University School of Science and Technology
- Heikki Ailisto, Research Professor, VTT Technical Research Centre of Finland & FCAI Finnish Center for Artificial Intelligence
- Hannu Toivonen, Professor, University of Helsinki
- Anonymous (referred to as Researcher X), Project Researcher, a University in Finland, researching AI's impact on management

10.2 Introduction

This chapter contains references to discussions made with the specialists of artificial intelligence, engineering, and technology. Only one of them had clear specialization with construction or development thus findings must be assessed in the light of that. Most of them had purely academic background. These discussions were direct reflections of previously addressed topics in both the survey and leader interviews. Furthermore, the purpose of this chapter is to either confirm, deny, or question author's own observations and conclusions to establish credible arguments of the results. The final analysis will take place in sub-chapter 10.4 Data Analysis: Third Stage. Conclusions will be part of a separate chapter.

A total of five interviews were conducted as part of the empirical research. They took place as online meetings, each lasting up to an hour. Each specialist received most of the questions beforehand and therefore had time to prepare for the interview - the question line for them was considerably altered from the ones prepared for leaders. Questions that revealed findings from the survey were introduced upon interview to avoid bias in replies. Most of them agreed to share their name, title, and position at their current establishments of operation. Each of them represented expertise in their own fields and all derived from respected establishments that most had educational background. In the end, the research was given an entirely new and quite possibly profoundly changing viewpoints that directed the course of the study.

This chapter is similarly structured as leader interviews and involves some metacommentary from author. The quotes may or may not be exact but are based on video recordings, just like with the leaders. These recordings are discarded and will not be visible to the public for the same reasons. Below, the reader can observe the specialist's question line:

1. Are leadership choices connected to progress with AI in the field of business?
The leaders who make achievements seem to have better touch base with AI and modern leadership itself.
2. What is going to take for AI to become widely adopted in construction and development industry? What is the pathway?
3. Is success with AI tied to management and/or leadership? To what degree?
4. A significant difference in knowledge based on AI was recognized between low and high performers, during the research. What are the most common intentions businesses have with AI and how does this difference in know-how affect those intentions?
5. How does one move to a mindset that AI based business model requires to function ideally?
6. How and where could you facilitate your learning more effectively with AI?
7. What are the challenges in obtaining results with AI? What are the underlining reasons?
8. How should construction industry change its business strategy and business model to best cater AI?
9. Can and should AI be promoted down the supply and sub-contractor chain to gain maximal benefits of AI? Are collaborations and partnerships essential for success?
10. Does piloting and fully employing AI give an edge to companies compared to those who do not use it? Why so?
11. According to theoretical research and the survey that was part of this research, the more company has AI technologies/solutions in place the more successful it is. What is your opinion on this?
12. What advice you would give to companies considering AI or at the early stage of adoption?
13. How choices, for example, concerning working methods, learning process and utilization shape relative success with AI?

10.3 Interview Contents

When asked about reflections requirements for wider adoption in construction and development industry, most experts were unanimous that these companies would want to see tangible examples of successful utilization of AI before pursuing to employing the technology

themselves. Heikki Ailisto, a Research Professor of VTT and contributor to State of AI Finland 2020 report, pointed out that development companies are likelier to benefit from this technology as their entire business model is less materialized compared traditional construction, tightly revolving around data. Furthermore, it would require digitalization of the business processes to an adequate level all these solutions are compatible with AI (Ailisto 2022). Tomasz Mucha, a Doctoral Researcher from Aalto University School of Science and Technology saw third party vendors of cognitive solutions as one possible route to mainstream adoption. His other perspective was that in fear of becoming a laggard, companies would be forced to adopt AI as part of their business, eventually. However, not out of hopes of gaining competitive advantage (Mucha 2022).

The students that are now in the process of to be educated in field of construction are not being introduced to AI and therefore not bringing in new viewpoints when they enter the industry. Furthermore, the availability of studies and courses focused on AI are limited, at least in the context of construction (Haupt 2022).

– Theodore Haupt, Mangosuthu University of Technology, South Africa on same question. Hannu Toivonen, a research professor from University of Helsinki, had similar outline and called for the need for more courses in the field of AI with low threshold of entry, especially for construction business.

The appeal for learning would assumedly be higher if the learning material is dedicated to the business (Toivonen 2022).

After the discussion moved to the leadership relationship with AI, the experts were not so united: they saw several pathways where one approach would require heavy involvement from the top management – this was a total opposite where management would end up with very little involvement towards AI adoption process. It all came down to if the adoption was deep or shallow and if the AI solution would be outsourced as off-the-shelf solution or customized. There would not likely need to be so much participation from upper management, according to Toivonen and Mucha. (Toivonen 2022; Mucha 2022).

If there is one solution (AI based) that is ready made for construction industry and for a particular purpose, it does not require anything else besides the purchase decision - but if AI is seen as something grand and novel, I'd think management involvement would be beneficial (Toivonen 2022).

– Hannu Toivonen, University of Helsinki. Later, he pointed out the trend is leaning towards customized solutions because of the emergence of advanced tools. These tools in program

libraries allow working with AI without in-depth knowledge of its methodology (Toivonen 2022).

Next, the experts were asked to give guidelines towards an AI based business model as multiple, broad changes on business processes were recorded to increase likelihood of financial success (Ransbotham et al. 2020, 13). Surprisingly, all of them disapproved of the basic assumption of the question, in the sense that there perceives no real necessity to build business around AI but rather use it to solve individual tasks thus helping in value creation process as Mucha cleverly formulated the basic idea. He saw it disadvantageous to overuse AI when simpler technologies and methods can do the same job quicker and with less effort (Mucha 2022). It is interesting that experts had completely contradicting viewpoints with the research material author had reviewed and cited prior to empirical research.

There are three loops in learning with AI: first, the models of AI that can be trained to learn by themselves. Second, people who are driving and developing the technology are learning insights and abilities to customize and improve it. Third would be the user end. The user needs to learn how to operate the AI tool properly. Challenge is aligning these loops. It all requires capacity to reflect on what is happening and that's where you need managerial support because the process is resource consuming (Mucha 2022).

– Tomasz Mucha, Aalto University School of Science and Technology.

Each specialist had a little bit different focal point regarding common challenges obtaining results with AI. The only theme that stood out from the mass was data, its quality, amount, and vessels for using it. Chui et al. (2018) recognizes this issue especially troublesome for construction industry (Marte et al. 2019). Ailisto highlighted the compatibility between systems, processes, and data. In addition, commitment of staff was another KPI (Ailisto 2022). Separating from the rest Doctor Haupt presumed the lack of information to be primary reason for most mediocre experiences with AI. He believed that pockets of excellence exist, but widespread success comes down to these successful companies sharing their experiences with the industry. The fact that construction industry is a follower in many technological advances, does not speed up the process (Haupt 2022). Mucha iterated that companies might be struggling with moving AI from pilot stages to actual usable products due to multiple reasons such as data labelling, budget restrictions or creditability issues - as hypothetical examples (Mucha 2022).

According to researchers, there does not exist a dire need to make drastic changes with business models or business strategies to gain maximal results with AI. Their respective

viewpoints differed quite a bit from existing literature. However, it may be that prior research findings have been misjudged or the fact their experts' position is academically inclined compared to commercial ideology.

It is more about long-term vision and plans

– researcher X on the same issue (Researcher X 2022). Ailisto talked about general management of supply chains and timetables as an example for change but agreed that AI is not intrinsic value for construction industry. Researcher X supplemented his previous statement:

...adoption requires daring attitude, seeing AI as an investment with appropriate actions. It may take several years with relatively bad success rate, but the payback is in the long-term timeframe. Changing the manner of operating is probably easier for new companies than for those who have been in the business for a while. The hinderance derives from human elements. Even with drastic changes a company should be brave enough withstand the process long enough (Research 2022).

Toivonen offered his viewpoints regarding the same question:

I would be very careful with promises and hype regarding AI changing everything in its path. My personal feel and guess would be that AI can change a lot in business but so can other factors – it is simply an element among others (Toivonen 2022)

In the next question experts were asked if they saw the collaborations and partnerships beneficial for promoting AI adoption. An example of general contractor and sub-contractor relationship was given. Ailisto suggested that main contractors could provide a platform for AI, that sub-contractors could join into. This would enable, for example the prediction of bottlenecks in the supply chain or workforce requirements, when information flows freely between companies (Ailisto 2022). Predicting talent shortages and supply chain issues was also identified by Blanco et al. (Blanco et al. 2020). Toivonen added that vertical and horizontal movement of information could potentially help in speedy problem solving (i.e., replacing or fixing the supply chain for a missing tool or resource). Overall picture of a construction site becomes far easier to manage (Toivonen 2022).

If you look at the way industry is structured, the whole supply chain is largely dependent on outsourcing and partners, in terms of sub-contracting, supplying, and manufacturing. The benefits are only going to be seen if the entire supply chain uses AI (Haupt 2022).

When comparing companies using AI to those who do not, it is difficult to tell if the technology is the sole reason for assumable success. Mucha pointed out that one study indicates correlation between technology and better success across industries, however, one must keep in mind it is different from causation:

We cannot say, without doubt, if it is the technology per se making companies more successful (Mucha 2022).

He added that companies do not necessary acquire competitive advantage from technology but neglecting the *progress* and *inaction* can lead to falling behind everyone else (Mucha 2022). Balakrishnan et al. came to same conclusions as their report demonstrated success with AI to be tied with overall better performance of a company (Balakrishnan et al. 2020, 5). Toivonen on the same question:

...it's not about the general use of AI but using it effectively... (Toivonen 2022).

Researcher X supplemented these comments by adding that he sees AI as a tool among others - working effectively on specified tasks it has been trained to do (Researcher X 2022). Ailisto highlighted that AI could be potentially used for honing a competitive advantage – viewpoint shared by Verhezen - once a sufficient level of digitalization has been reached in construction (Ailisto 2022; Verhezen 2019).

All interviewees were asked to give advice for AI newcomers on how to proceed during the first steps:

Listen to the ideas of your employees, regardless of their status in company. Additionally, provide training where it is most useful. Once the knowhow on tools has been accumulated the success will eventually follow (Researcher X 2022).

I would promote discussion between people who understand the business, construction industry and those who have expertise on AI. The purpose of this discussion is to determine potential use cases and possibilities with AI. Additionally, a quick testing with off-the-shelf AI product pilots, to see what's the reality is something I'd promote (Toivonen 2022).

Digitalization should be at an adequate level. Afterwards digitalization, AI should be directed to support strategical vision or special characteristics of a company (Ailisto 2022).

Bite the bullet. As we know, high risk equals to high return. Stop being conservative and stop being a follower, be bold. Go where angels fear to tread, and lead (Haupt 2022).

Maturity in digitalization matters. To get a bigger impact they should move to certain level first. It's important to educate people. Even when using outsourced vendors, in-house competence is important (Mucha 2022).

The following question unfortunately failed to deliver the results it intended, as author had summarized one section of the survey too tightly, due to time restrictions. Each expert understood the question a little bit differently:

Question 13: How choices, for example, concerning working methods, learning process and utilization shape relative success with AI? This question had overlap with leadership knowledge base. Researcher X said that understanding regarding AI is not a necessity, but the further business progresses into future, the more difficult it will be to achieve profits without any understanding over AI or other technologies (Researcher X 2022).

Next three questions were focused on the survey results and were introduced upon interviewing, as they revealed data from the survey. First, experts were asked if they thought leadership choices affect success with AI. Ailisto presumed this to be true (Ailisto 2022). Toivonen agreed on the fact that knowledge is power when it comes to understanding where to put AI to good use. Also, Mucha saw benefits to understanding the basics of AI from business perspective (Toivonen 2022; Mucha 2022).

An extra question: What companies hope to achieve with AI?

Increased profit, increased efficiency, and increased market share. More investing to research and development after working with AI. New perspective to recruitment policies; exposure to AI. AI possibly increases job satisfaction and loyalty (Haupt 2022).

Toivonen and Ailisto said that knowing AI helps to determine the best use cases for it (Toivonen 2022; Ailisto 2022). Researcher X said that the pre-set where AI users have different vision on AI adoption obstacles compared to non-users, is hard to debunk (Researcher X 2022).

When discussing about the amount of AI technologies and solutions in place Mucha seemed to agree on the correlation - the more solutions, the more success. The reason being companies who have multiple solutions likely have more experience and larger budget to test multiple solutions thus have mathematically higher changes to create success (Mucha 2022). Wallenberg reminds that applying a high number of AI solutions can be a double-edged sword as AI ill performs when the task is too easy. Sometimes, existing solutions do the trick just as well as AI but with less of a hassle (Wallenberg 2018).

If a company has the budget to try out one pilot with 50 percent success rate and they fail, it is likely they will stop their testing but if a company does 20 pilots and then with same success rate, they will obviously be more successful (Mucha 2022).

Toivonen suggested that it could be more about being advanced and a forerunner as company than about number of AI solutions, or AI in general. Ailisto seemed to be on the same line with Toivonen, it is likely too early to say if there is a causality rather than correlation (Ailisto 2022; Ailisto 2022). Researcher X was a little bit more undecided and said issue could be either way (Researcher X 2022).

10.4 Data Analysis: Third Stage

10.4.1 Validation of Results and Findings

Here is the collective analysis at its final stage. Author assumes the more sources of validation the more credible the finding. Not all findings were contested with each level what the level will be acknowledged. Validation levels begin from two-level version and go up all the way four-level validation. A finding was considered relevant or somewhat accurate with the minimum requirement of two levels albeit still needing further confirmation for absolute certainty. It is up to the reader to judge whether some results are seen as trustworthy. Some issues were not contested on multiple levels which affects by highlights some issues over others.

Two levels of validation

- both theory and survey confirmed success with AI to be scarce. According to theory success was even more elusive than survey implied. This issue was not addressed in interviews
- places to apply AI were somewhat similar between survey and theory, there were a couple of unexpected examples. Successful respondents used similar use cases as theory had implied. These issues were not addressed in interviews
- working and adoption methods, strategic variables utilized with AI were in par with theoretical research. Many of the questions were based on existing research and therefore and strong theoretical connection albeit not directly addressed in-text. These issues were not addressed in interviews
- learning to use AI was at least partially similar process as theory described. Again, not directly addressed in text but author based his questions on existing research materials

- AI had acquired a larger organizational foundation among mature, successful users compared to low performers. Significant differences between the two groups were visible and documented. The issue was not addressed in interviews
- discussions with Kirjalainen and Liehner confirmed that business growth with AI was hindered by regulative and legislative issues – data legislation is struggling to catch up with the needs of AI (Kirjalainen 2021; Liehner 2022)
- prevalence of prefabrication was seen evident part of future developments of construction and development industry by Kirjalainen and Liehner – the latter emphasised that AI was likely a driving force for change. Furthermore, both saw traditional construction methods inefficient (Kirjalainen 2021; Liehner 2022)
- theoretical research, Subject A and Ausserhofer concluded AI to be considerable financial investment to become effective – experts were not unanimous about the topic, opinions were for and against this (Subject A; Ausserhofer 2022)
- fears of being replaced by AI were obstacles to adoption, identified by theory and leader interviews. Does company culture equal to fear, in this case?
- resource allocation for AI was seen as important based on theory and indirectly through survey (Balakrishnan et al. 2020, 5)
- identifying use cases for AI, seemed to be tied up its use and understanding according to survey and expert interviews. Furthermore, differences identifying obstacles to adoption were visible among users and non-users.
- staff dedication was crucial to success according to survey and both interviews
- theory and expert interviews indicated that labour shortages and construction management could potentially be addressed with AI
- knowledge base on AI matters regarding success according to survey and experts

Three levels of validation

- lack of information regarding AI might be a cause for low general adoption levels, as stated in both interviews – author's struggles with finding detailed literature about AI in construction support this. Interestingly, high performers had learned to use AI primarily through academic articles
- theory, leader, and expert interviews confirmed one starting point for successful AI adoption to be adequate – adequate amount of quality data (Wallenberg 2018, 100).

- BIM was seen as an important factor in the future of construction and development by theory and leader interviews. Theory confirmed BIM to be an existing vessel for AI deployment. From the survey point of view, it was subject to interpretation.
- theory, survey, and expert interviews were confirmed that efficiency, growth, and profitability were the most common expectations from adoption of AI. Survey addressed profits and cost savings.

Four levels of validation

- the importance of leadership and guidance towards workforce was highlighted by all levels – only Experts Interviews were not unanimous about its significance to success as it was depending on the level of involvement with AI
- the number of AI solutions/technologies was considered important according to all levels while theory supported the idea indirectly. Leaders believed it to be connected to success while experts agreed on the correlation but concluded it is not necessarily a causation to success

10.4.2 Post-Validation Analysis

Only two items out a long list of discoveries had four-fold validation: guidance of employees and number of AI solutions/technologies in place. Even with minor efforts to adopt AI, workforce needs education and guidance with it except for off-the-shelf solutions. When adoption becomes more widespread, the involvement of management is crucial for success. A leader must instil trust and confidence towards new technology and display this to subordinates. Better overall leadership of the C-suite was reported being typical for the best performing adopters of AI (Balakrishnan et al. 2020, 5).

The high number AI solutions clearly correlates with success, but it is not certain if it a catalyst for progress. Theory supports wider cross business adoption which leads author to believe that *effectively applying* multiple solutions for business is beneficial. The more there is spread in functions and operations where AI is applied the better – unforeseen benefits may discover when silos between company segments are broken by AI.

Lack of information and ignorance where obstacles for wider adoption of artificial intelligence technologies in the field of construction and development. Ignorance or poor knowledge base on AI was considered one reason why some companies fail gain financial benefits from AI. As one expert mentioned, AI must be applied carefully and efficiently for the best results – blindly using AI will only consume the resources of company and will

ultimately lead to failure. Author agrees on both statements and highlights the importance of access to information.

The adoption of AI starts from digitalization: construction and development companies need to first focus their efforts to collecting data from all their operations. Author recommends the consult experts as data quality is equally important to its amount. The leader should be responsible for the unbiased nature of data and can weigh the reliability of data. When data is gathered the results AI calculates should be trusted.

All two-level validated issues should be peer reviewed before they can be blindly trusted. At most they can offer guidance on the issues what to pay attention to. These finding should be investigated and reflected to other sources. However, author believes that reader can do this personally as some answers are likely to be found within their organizations.

10.4.3 Further Analysis

In the theory part of the research, the general attitude towards AI was under discussion and conclusion was that attitude had changed from neutral to positive over the course of some years (Shoham et al. 2018, 43; 2019 Edelman AI Survey). This made an interest pre-set to inquire the same from field of construction and development which still was in its infancy with AI adoption. Surprisingly, the most favoured answer was number eight, signifying a very positive attitude towards AI. Again, most of the replies were well above average.

Author noticed that highest impact functions of AI did not correlate with high performers operational environment for AI. This could indicate two things: for one, even with exemplary performance, they could be still in the process of identifying best practices. Or perhaps they have simply identified the main source of impact but simply do not prioritize it over anything else.

In the question 27. when asked about modes of interaction with AI, yet another clear indication why some are more successful than others, can be identified; in chapter 5.3.2 according to Ransbotham et al., AI suggesting action and human making the final decision on whether act upon this suggestion the most effective method was (Ransbotham et al. 2020, 10). This theory was confirmed in the main survey as high performers' most popular answer was to use this exact method whereas with low performers it was only the third most popular option. According to the theory section, only eight percent applied multiple methods of AI interaction modes. This again could be the reason why others saw benefits while others did not (Fountaine et al. 2019, 64). However, main survey could not confirm this theory as low performers seemed to have more spread on their replies. Even comparing individual answers, it does not help in bringing clarity to this issue. Only thing that can be concluded is

that this is clearly not the key factor dividing success from failure – there is clearly more to the pattern.

Change in company culture was also identified as key aspect for successful adoption of AI (Fountain et al. 2019, 64). Similar results were vaguely visible in the interview section too. Curiously, the Mediums did not prioritize this issue in any of the questions. However, they have arguably passed the initial phase of adoption and could be referred to as successful adopters.

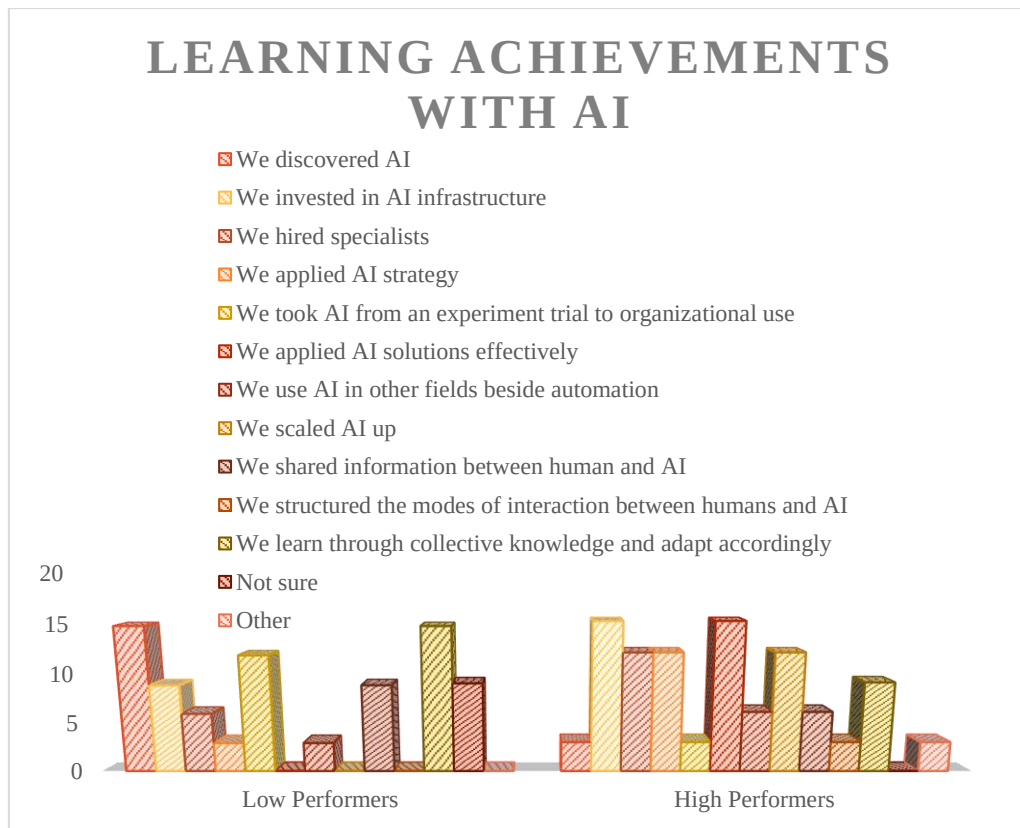


Table 38. Above can be seen the learning achievements of low and high performers according to MIT Sloan Management review methodology. From top to bottom, options reflect the level of progress in adoption. Colour code from top to bottom is same as from left to right. The topmost step is the first and lowest is the last stage (Ransbotham et al. 2020, 6). On the left hand are the number of individual replies.

Like this chart, many of this research's intelligence and framework was closely resembling large consulting firms preceding studies – such firms were Deloitte, McKinsey, and BCG, to name a few. The organizational level of learning grows, and the likelihood of success increases with direct correlation to the number of achievements (Ransbotham et al. 2020, 6). As seen in the chart, both groups have organizational level learning happening for the high performers the ingress is deeper and covers all possible achievements. Low performers

have several unlocked achievements. Noteworthy is the fact nearly 10 percent of the respondents replied, 'Not sure'. The numbers are percentual reflections to total amount of respondents of each group, for example 14.7 means that that percentage of that respondents group chose the given option. One of the most noticeable differences was the scaled-up AI on high performers: Fountaine et al. 2019 advice to scale up AI: first, siloed operating needs transform to cross functional. At next stage leadership should take a turn from traditional experience and leader-driven mentality to data-driven one. Lastly, corporate mentality needs to shift to agile, experimentative and adaptable – the results are faster minimum viable products (Fountaine et al. 2019, 64-65).

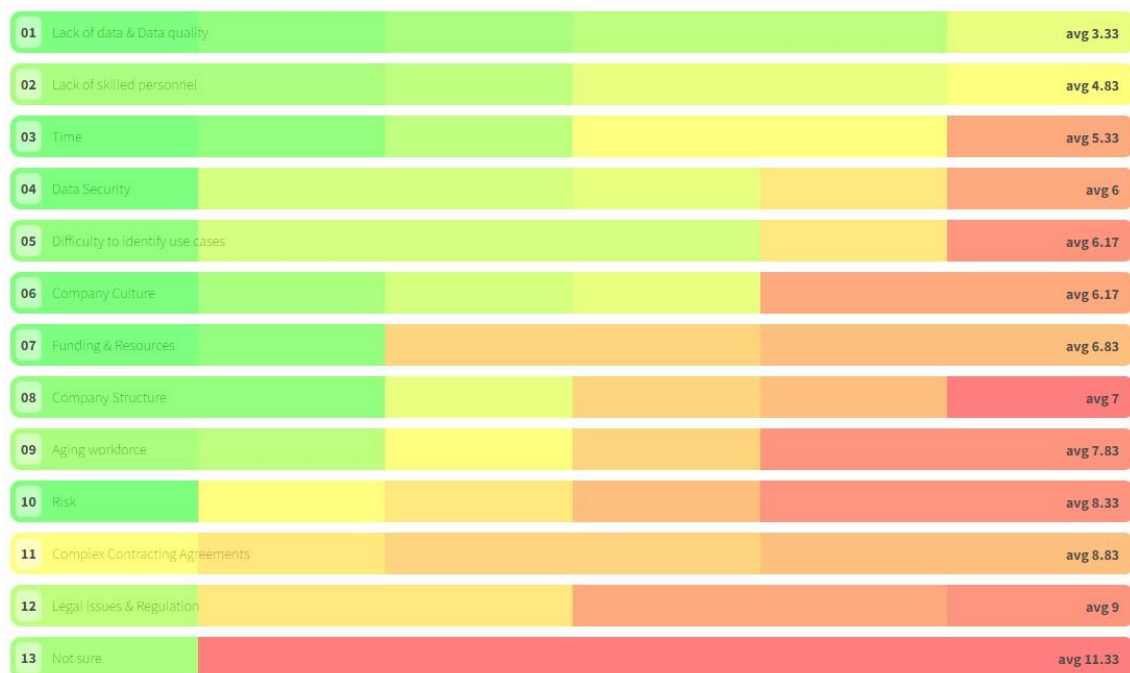


Table 39. Obstacles for AI adoption in medium's own businesses. They also reflected the whole sample of AI users (SurveyKiwi 2022). This how medium performers prioritized their main obstacles for AI adoption. It seems that progress has stopped to lack of data, skilled personnel, and time. As Rimoi has articulated, Deep Learning AI does not require labelled data, but Supervised Learning does (Rimoi 2020). Perhaps, this indicates laboursome efforts to make data usable from the point of AI, ill-effective. Another obstacle is the lack of personnel, as discussed in the theory section, Deep Learning can work automatically but requires more data and is poor starting point for a company whereas Supervised Learning is far easier but required more manpower to operate (Teich 2020).

In the eyes of Mediums, environmental and social issues were seen as priority over everything else when asked what functions in construction industry needed updating. Technology and digitalization were in the top five, but company culture was preceding them in the list. This could mean that attitudes and old-fashioned thinking, as discussed with Kirjalainen and

other Researcher X, are still a sizeable hinderance for true breakthroughs (Kirjalainen 2021; Associate X et al. 2021). The fact that only 6.2 percent of the entire sample of 1215 businesses replied to the survey likely suggests that at least in medium sized construction and development businesses have yet to see AI make its mark. For larger, enterprises, surely the situation is much more developed. Arguably, these companies have the resources to begin bringing in AI more aggressively thus speeding the process of learning and turning minimum viable products into actual business cases.

When all AI users were asked about priorities to update in the field of construction, a clear unanimity could be seen as ‘Leadership Strategy’ and ‘Company Culture’ where something to attend to – beyond that, other options were more mixed. For AI users, ‘Leadership Strategy’ was on the fifth place, but ‘Company Culture’ shared the second place. It seems that both groups suffer from the attitude issues. Perhaps, AI or other improvements have been under examination but resistance or lack education within the company has inhibited further progress. Earlier, budget and time were seen the main reasons for AI neglecting and now ‘Time’ had been chosen as largest industry obstacle for adoption. Funding and resources were the third most popular answer. Interestingly, risk was only seventh most popular answer even though some professional claimed that building construction is essentially just risk management business.

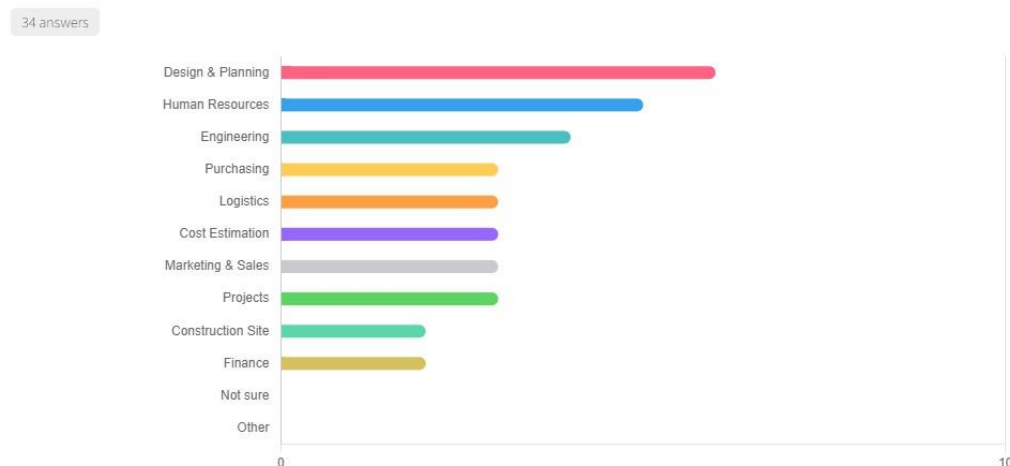


Table 40. What were seen as high impact function for AI from the point of view of Highs (SurveyKiwi 2022).

This chart paired with table 26. could indicate that better performance is acclaimed to improved coverage of AI – the more widespread it is within the company functions, the better. In addition, it could be a hint of company functions where AI excels. For confirmation, more study is required. Previous studies seem to support widespread of AI within a company, as an effective method for seeing results (Fountainaine et al. 2019; Ransbotham et al. 2020, 6).

Low performers had also a higher percentual concentration on the top five options compared to Highs. Why there is no stronger correlation between highest impact options and actual use? Is it a question of cost, efficiency, or something else? It could be an issue of question formatting – respondents could see this is a future affair which is why Lows seem to have a very small correlation between the two questions. Another option is that each company has their specific preferences, and one group just happens to represent, for instance, prefabricated housing which emphasises different aspect over others.

AI works best when it works alike spiderweb connecting everything, according to Fountaine et al. (Fountaine et al. 2019, 68). What is more, only Highs were having the option ‘Construction Site’ selected and given a high priority, perhaps indicating a field where gains can be made. This is significant because construction site is one of the least digitized parts of the industry. Furthermore, also corporate strategy was mentioned, even with a low priority whereas Lows had zero.

It is interesting that while both groups, Highs, and Mediums, had positive attitude about AI, only Highs had educated themselves much further about it. Perhaps, they were willing to risk learning more in hopes of gaining more. Surely, knowledge will give an edge to those without it but is really all it takes? Mediums seemed to feel satisfied or indifferent with AI as 42.9 percent of them were indecisive whether they were moving closer or away from cognitive technologies. The stand to moving closer was only slightly stronger than of those moving away, however, only a few embodied strong emotions on moving closer. Perhaps, they do not see a way forward as there are truly very few companies that are more successful than them or they have achieved their goals.

‘Aging work force’ was named as the most prevalent obstacle for AI adoption, identified by Mediums. This could mean several things at once; lack of properly educated work force, old fashioned attitudes or simply as issue with growth possibilities. Ironically, AI could be a cure to replace retiring workforce. When Mediums were requested to name the greatest hindrance for their company’s AI adoption, they chose the lack of data and its poor quality. Second most popular answer was lack of skilled personnel. Requirement for manual, hard labour and image might not be as appealing to young people as in the past.

Similarly, to previous question, ‘Difficulty to identify use cases for AI’ was number one reason why the leaders did not take up on AI themselves. Only after that was ‘time’ and ‘money’. It looks like these businesses could not see the potential in AI - if they had high success from the start, they probably would have time and resources delegated to this or they just were not prepared for the longevity of successful AI adoption process. Contradicting, those who used AI no longer prioritized time and money to such a degree. Curiously

enough, risk was one of the least prioritized reasons not to adopt AI. So, why they will not try it then? As one anonymously interviewed leader said:

If a company knows how to handle AI, it has a gigantic market advantage (Subject A 2022)

However, priority reason for not using AI was the lack of testing – it is unclear at this point if they mean by the industry or by themselves – at this point some industry specific data is bound to be available. The companies did say their second favoured reason to not use AI to be lack of budget and time. In this case, seems that the time was stronger of the two. Third most popular reply was ‘We don’t need it’ which is interesting when many professionals interviewed before the survey agreed that the profitability and margin were an issue along with efficiency which both could potentially be solved with AI. The spread of answers was not conclusive for a final verdict. A research paper by Schlögl et al. even suggests one the most popular reason for trialling with AI was just curiosity. Most reasons have been covered in this thesis already. However, ability to adapt to company specific needs was seen as the most popular reason for adopting the technology – companies saw benefits to a solution that could grow with them and adapt their peculiarities (Schlögl et al. 2019, 6)

Similarly, to many others, these people were evaluating themselves high on the scale of company advancement, as discussed before. Withal, a little bit contradictory they responded that they had poor knowledge of AI while claiming to be technologically advanced at the same time. Yet, their attitude was neutral or positive about it. It seems likely that the respondents were reflecting to the existing technologies they had in place at the time of filling out the survey. Nevertheless, the question is rather ambiguous and leaves plenty of room for judgement. By author’s experience, in construction industry, technological advancement is not necessarily synonymous to cutting edge.

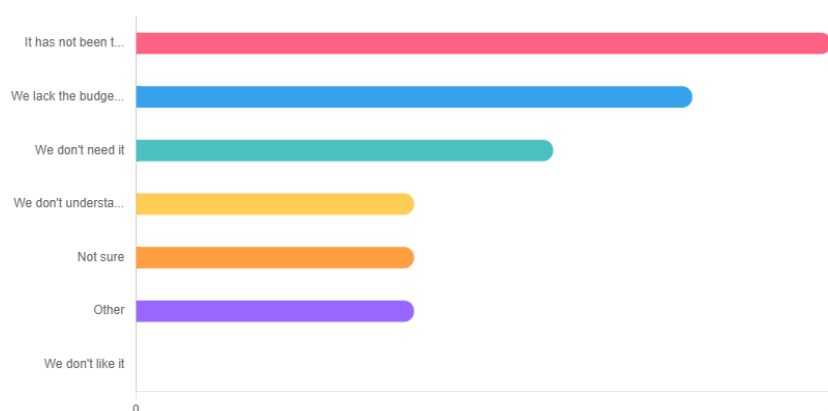


Table 41. Reasons for choosing not use AI as discussed in the chapter 7 (SurveyKiwi 2022).

Here are the reasons for not using AI: first reason seemed a bit outdated perspective considering how many have had at least minor success with AI; out of all using AI (main survey) 82.1% saw at least minor financial gains. For arguments sake, it cannot determine seamlessly if this counts as enough testing but promising indication to say the least. It is an impressive number considering the difficult reputation of AI. However, to make final conclusions, studies and publications would need to present actual numbers so it would be possible to determine actual financial prospects.

Of non-users, 78.6% had not tried or tested AI before. Only one company had tried and failed. Here their reasons for giving up on AI: because of 'Complexity', 'Higher expectations' and 'Not sure'. Since there was only one company it is hard to draw conclusions and results were far from conclusive. Many did not see how it could add value to their business or be used which is interesting because there are examples about the successful use of AI, even in construction industry. Is this an issue of lack of information, inability, or desire to search for it?

With the added involvement of AI and construction experts the original survey results and leader interviews have taken a new direction. All results point out that success with AI is not a matter of blind luck, but rather complex set of variables applied to right balance. While theory and research point to a highly AI driven construction industry the experts say that this is not the case, instead AI should be viewed as tool among others. The contradiction leads to believe that both elements of this research could prove factual: a company may experience major financial benefits from AI even without leadership participation and with relatively siloed approach with off-the-shelf cognitive technologies serving singular purposes. However, educating workforce from top down cannot be overlooked as AI solution providers are not able to simply optimize profits upon request – it requires more than that (Wallenberg 2018, 94).

The combined mass of multiple specified solutions should translate into higher profit margin. A fully AI fuelled strategy could work equally well as research suggested. In this scenario, a company must go through a ground-breaking change to cater AI and use it as the backbone of the business. Author suggests that this strategy should be reserved to new companies or ones with existing success with AI. Balakrishnan et al. wrote that companies performed were twice as likely to see benefits from the use of AI (Balakrishnan et al. 2020, 5). Furthermore, AI should not be viewed as a safety harness for a failing company but something to increase profitability if the company is already succeeding. This way, risk is reduced. The evolution of business strategy and model should go hand in hand with technological savviness and advancement. AI does to equate automatic success; it comes with high risk

and high reward methodology – a rather strange concept in construction but could help the industry break away from old fashioned thinking and modes of operation.

Building successful AI strategy begins from hiring specialists and actively conversing with them and introducing company peculiarities and needs to construct AI to best serve them. The first building block in digitalization; construction and development industry need to digitize their operations throughout, at least regarding functions feeding AI data. Further digitalization could offer new use cases for this technology. After this adequate amount of data must be collected. Once, high quality data, in sufficient amounts, is available the piloting may start. Companies need to be mentally and financially invested to withstand failure or poor success with AI up to few years and think of it as a long-term investment. The whole adoption process should be part of the training and motivation of the staff as they may have fears of being replaced or fail to understand the benefits of the technology. Furthermore, lack of in-house expertise could become costly in the long run as companies selling AI solutions or expertise may offer useless solutions with bad cost quality relation.

Once company starts seeing financial benefits and grows a higher success rate with AI it can begin focusing on scaling AI up and learning with it. Corners can be cut in the process, but it would be wise to prepare for a long course of action. One way the process could potentially be sped up is learning the basics of AI on management level. If the learning is neglected, a company risks becoming a laggard in the field of construction – chances are that many competitors will adopt AI catching up to their head start would become increasingly costly the more times passes. The very least companies should trial with AI, just so they have the understanding to proceed with it when the time comes. Obviously, most gains are to be achieved now when AI is still in its infancy in construction. The fewer companies experiment and use it, the higher the competitive advantage – still, one must remember risks are multiplied and plenty of discoveries are still to be made. Traditional construction companies should begin hastily digitizing their business and recognize their industry is outdated and act accordingly.

11 Summary & Conclusions

11.1 Foreword

This global research has been quantified on four levels: by theoretical research, surveying executives, interviewing leaders and experts. The multi-layered approach and the combination of quantitative and qualitative methods aimed for the maximal integrity and accuracy in results. These goals have been achieved and the results speak for themselves – the collected data sample has been “peer reviewed” twice and all conclusions are supported by theoretical and practical evidence.

11.2 Contents

First part of theoretical research was identifying the KPI's of the given topic – research questions were constructed to reflect readings and finding made during orientation to the world of AI and construction. These questions were based upon information vacuums that were discovered in the thesis preparation process. After this author concentrated on explain Theoretical Framework of the thesis which consisted of research methods, literature, analysis, data acquirement and implementation.

The framework transformed into laying grounds for thesis structure. It consisted of Theoretical research explaining leadership, AI and construction and development industry in relation to each other. Chapters regarding structure of the thesis and theoretical background were closely following. Afterwards study moved to empirical part which consisted of survey, leader interview, expert interviews and overlapping analysis stages.

Early in the theory part, it was being discovered what is the main difference between Deep Learning and Supervised Learning in the context of artificial intelligence. The general definition for AI was also conducted and pre-set for this study was established. Concept of leadership has been separated from management and the focus has been on the relationship between AI and leadership – it was being learned that hype and actions on AI are necessarily fuelled by knowledge. This same trend was recognizable in the survey as well. According to theory and survey, autonomous AI is far from being in everyday use – construction companies did not possess fully autonomous cognitive solutions. There persists a vacuum of information about leaderships and AI cohabitation and the subjective nature of this study confirmed that further research of key issues is still required for quantified understanding.

According to the survey and interviews with AI and construction experts suggest that efficiency was the number one strategic expectation from the use of AI. It was seconded by

time saving, growth, cost saving and improved risk management. Interestingly, the business categories had plenty of variation depending on the focus group.

Theory had suggested that the more AI modes of interaction company had in place the likelier was its success. The survey failed to show any correlation between the amount of modes interaction. If anything, the correlation was the opposite from suggested – low performers had utilised more available methods. The further observations led to believe that great numbers of solutions or methods have correlation. It was more likely about the effective use of AI and making it suit the purpose it was built for. Experts leaned to support this while they recognized a correlation between the amount of AI solution in use and success – many of them denied the causality as the phenomenon was too new in construction.

Both theory and research potentially support the idea of scaled immersion of AI within a business; high performers had significantly more active use cases of AI than those who performed poorly with it. However, experts did not support this ideology as they felt that AI does not require such vast penetration through business functions. This could have been an issue of subjectivity – they viewed AI from scientific standpoint where AI does not need that much to function, but the purpose of the study was to look for an optimal situation with maximised profits which could explain the controversy. Possibly, AI can work even to great extent well without immersion if the solutions are targeted and effectively applied.

Not using AI may have ill consequences for construction and development companies. They might become laggards and even cease to exist due to huge leaps in technological capability. Some of both leaders and experts saw ignoring AI a risk itself. It should not be feared thought, as it will bring efficiency to workplaces. Surely, it will render some repetitive simple jobs useless but will create a bunch of new positions in the meantime. Society and industries are still far away from completely autonomous AI, the current AI is still relatively dumb and highly specialized which means it will still long require the human element to function properly and ethically.

Construction and development industry is faced with aging workforce and significant development in technology making competition harder than ever. AI could increase efficiency and low profitability - the most common headaches of the industry. The theory and cold hard evidence from research and interviews suggest that AI has indeed done that – there are multiple examples of companies excelling with it and receiving considerable financial benefits from its usage. One could argue that construction industry, out of all industries, has the most to gain as its level of investment on AI is the smallest compared to others.

It seems that looking at just theory and quantitative data is not way when it comes to successful utilization of artificial intelligence. Theory describes a profound change a company

must conduct before entering the world of cognitive technologies. This is partly true; a business should have adequate level of digitalization and successful on its own merits before it can pursue AI. Medium performers saw many foundational issues as things to update in construction – albeit the question was not AI centred, some existing methods and attitudes may hinder optimal performance.

The survey has shown us that there indeed are those who are exceedingly great with AI, and they are a small minority, but it has not told us the whole story. The companies who succeed have invested more resources, time, and effort than the rest. Failing is an inevitable part of AI and success can wait itself for several years and requires persistence and risk taking. It is up to each business to explore AI and determine the effort they are willing to take with it.

Leadership may or may not have a great impact with AI, it all comes down to the level of adoption – the more complicated solutions and cross functional penetration, the more involvement from the upper management AI requires. For some individuals, off-the-shelf tools are enough and the higher-level management does not need have that much involvement, however, best results are received when workforce understands and trusts the importance of new technology. According to theoretical findings, leadership will become more focused on soft skills rather than management, but changes have yet to manifest themselves in practise. When it comes to the bare leadership, it is likely to face big changes soon. However, research could not verify scalable changes in present day, but theory and interviews point out that changes are on their way soon. The leader of future must portray softer skills to succeed; embracing openness, growing trusts, and leading by example are some of the top qualities expected to be in high demand. Also, changes in leadership could change the business operations themselves to a more AI friendly solutions – this research found some controversy around this issue. AI will potentially help reducing managerial duties thus freeing time for leading people. Partnerships and communication are going become more important as they will help AI breakthrough in the field of construction and will likely create scalable benefits in the networks.

Knowledge base over AI is insufficient among non-users but also with those who use it, at least to some degree. High performers are well educated with it whereas low performers are not, it is uncertain if this is a causality or just correlation – time will tell when industry progresses further with AI. Also, notable differences between recognizable obstacles for adoption were seen between users and non-users of AI. Predicament is that companies do not recognise where they can put AI to use air go, they need to be educated about the fundamentals of AI so they could judge if they need it or not. Now, there is not enough

information available for non-users to get excited about AI, in construction. Existing theory, research and experts' interviews all seem to point out that successful AI adoption and working process is tied to knowledge and understanding regarding it. The study found a strong correlation with understanding basic elements of AI and success – it is worth mentioning that it all comes down to the scale; if a company wants to try one simple off-the-shelf solution, knowledge does not count as much as in wider adoption. Even with extensive knowledge, there are no guarantees for success, there are best practices and good starting points offered in chapter 9 and 10. One must be ready to face failure and risk enough to truly assume the benefits on a remarkable scale – the more is risked, the higher the potential gains. Early movers and those closely behind will reap the highest gains (Blanco et al 2018). For some digitally savvy and resourceful companies going directly to work with Deep Learning might be way to go. Easiest is to begin with readymade solutions and start building AI driven company from there.

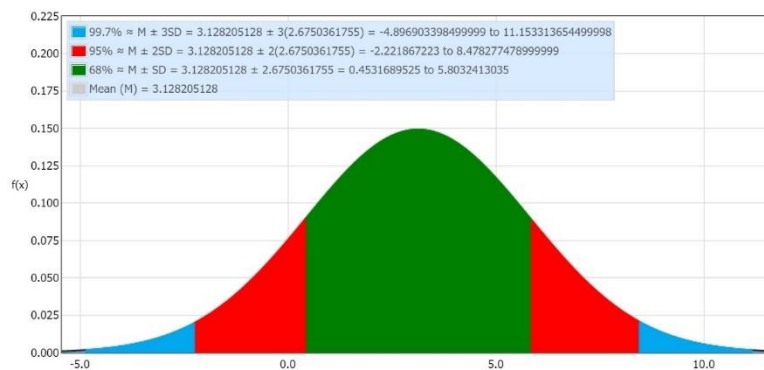


Table 42. Above is an Empirical Rule chart representing the population of AI users. Of course, in this case values below zero and above eight must be ignored as those where parameters of financial

benefits question – everything above is theoretical. The median was 3.1 on the scale of '0' to '10' when measuring success. As seen from the graph, the majority enjoys mediocre success at best and the exceptionally successful few are a small percentage of the sample.

11.3 Self-evaluation

Overall, author feels the research has been a successful endeavour, with few reservations. The theoretical part of the thesis is straightforward and meticulous covering all essential fields of AI, leadership, and strategy. He wished that the connection between business and corporate strategy towards empirical research would have held as high priority as originally planned. Strategy ended up being more of a side category than main storyline issue.

Using appropriate tools, careful preparation and endless peer reviewing of research made results credible and quite accurate. The amount excess provides ground for continued research; however, it would have interesting further analyse the nuances discovered in the survey. A large enough sample guaranteed that minimal distortion of results would only

occur, and they would be easier to analyse, for both author and readership. Targeting only contacted people meant that the likeliness of false respondents was narrow and the fact that most of them wanted the Executive Summary meant they had to share their emails as confirmation of personal participation. The structure and question line of the survey should have also axed unsuitable candidates – targeting one narrow audience from a particular industry segment prevented *amusement responses* along with somewhat considerable length of the survey.

For self-criticism, author admits that there were many occasions where he could have been more consistent: each round of the survey was overlapped with one-another and even with data collection process. Additional planning and structuring would have made the research process smoother. It would have been safer, though more time consuming, to separate these elements and secure an equally long break between each survey round. Also, the method of contact had some variation depending how available each survey candidate was. This could have been avoided by conducting a pilot survey and then determine the best practise for contact. The method of contact deviated from the example earlier in the text but within reason – the motivation for this was to cultivate the best possible method for maximised reply rate. Largest single exception was Japan which helped to ratify the effectiveness of personal or business email targeting, instead of sending the messages to general company emails. Japan's influence for the thesis was considerable which is why it was unfortunate there were no recorded replies from there. In hindsight, country's participation should have been contested during the data collection process.

Due to rather inconsistent timetable with the survey research process, there exists a possibility that a few replies were not received due to holiday season during which the survey finished. The allocated response time between rounds should have been more consisted and it could have influenced results to some degree. Author received few contacts post research.

The survey platform had the possibility to randomize reply to options. Author utilized this many times and it seemed that it helped to reduce the survey fatigue where respondents would have only chosen first few options from a given list, instead of thinking their replies – now they had to scour through the options and consider their answers. The nature of the questions themselves could have affected the results to some extent; many of the questions where subjective and entirely dependent on the respondents' personal views. Especially, in question measuring success with AI, it would have been more beneficial to have clear numerical ranges of certain percentual growth as now there is a chance that some respondents experience success higher than others even when mathematically they would be on

the same level. For this same reason, some of the questions with scales could be less vague and more description should be available for easier completion.

It is hard to say whether it was harmful but due to creativity issues author wrote few parts of the theory after the survey was finished. There is a slight chance it would have created bias in reference search but from the point of the reader, lack of transparency is not an issue. Each cited reference is open for readers scrutiny through List of references. To sum up, most of topics for criticism cannot fully jeopardize the results – at most, they can affect the scope and rate of replies but due to large sample and adequate number of actual replies, they should minimize these consequences.

11.4 Recommendations for Future Research

The relationship between medium performers and others would be interesting and beneficial to discover in further detail; what is the difference between a high performer and medium one? Mathematical analysis of the financial data of each company using AI would help either confirm or rebut the survey results. Furthermore, knowing the stages of adoption of each active user of AI would help categorising the results more clearly. It could potentially offer an effective roadmap for progress for those have just begun using AI – what are the main points of emphasis, milestones, and things to avoid entirely.

Each clear pattern that this research has acknowledged between different performances should be analysed to see if they are correlated with success of failure and to what extent. Some patterns and findings have been discovered and various levels of validation exist to support these elements, but thorough, less subjective approach is needed. This would also advocate constructing a baseline of success – what are the minimal perquisites to maximise chances of succeeding with AI upon start up. Where should a company direct its resources with AI? Assumedly, the learning process needs to happen and cannot be excessively sped up beyond a certain point.

Ideally, recommendations what this study has yielded should be applied in practise with a test group of newcomers. This testing paired with further interviews with successful AI adopters would help to shed light on some controversial issues emerged during this research. The results could then be cross-references with this study to claim verification or rebuttal.

It would make an interesting case study to see if the claims of Volker-Hirsch examined earlier in the text hold up; is there a measurable difference between AI adopters and with those who choose not to use it (Hirsch 2017). As experts said, it is too early to say whether using AI can bring a competitive advantage to those employing other novel business

strategies and technologies. Is the success with AI reserved only to those who already had successful operations prior to using it? Since a clear majority reported at least minor financial benefits it would make sense to assume so that they have at least a small edge to others. If the numbers are still as small as Kiefer & Ulmer suggested, the competitive advantage could be enjoyed before others catch up (Kiefer & Ulmer 2019, 71). Are construction and development companies who have adopted AI ahead of the laggards? Or does the weak performance margin erase the overall benefits in comparison to non-users. What about high performers and non-users?

Yet, another interesting cause of concern is that why so many companies do not see use cases for AI when there clearly are many and documentation for success, or at least successful peers. What makes a company take steps towards AI and begin experimenting with this technology? Is there truly not enough tangible evidence available to see the benefits of it? It is hard to believe those who have started to use AI have only done it out of pure curiosity and without any incentives.

11.5 Recommendable Developments

Judging by results of this research it is reasonable urge companies to test artificial intelligence if not only to gain competitive advantage but to not become a laggard in the industry's digital transformation. Blanco et al. claims early adopters and fast followers benefit in the entire spectrum of adoption timeframe as they will be guiding the trends of the industry (Blanco et al. 2020). With that in mind, this research cannot offer bullet-proof evidence that AI can offer benefits to companies who are already struggling to stay in business - AI should not be viewed as intrinsic for success but rather something to enhance business.

While AI's introduction to construction is in its infancy, there are benefits that can be achieved from it – it is unclear if these success stories can be multiplied using same strategies as high performers. The industry clearly needs these stories and hard evidence from AI utilization before widespread usage. Luckily, this research has proven, undeniably, that the success does exist out there – the very high end of it is reserved to select few while mediocre or poor success is more commonplace.

The very least, construction industry should begin its digital transformation management process and bring its infrastructure from digitized to a level where advanced solutions, in this case AI, can be meaningfully used. One must remember that AI can be just a tool among others and becomes inefficient if used improperly – tasks that can be achieved with existing technology should not necessarily be completed with AI, unless the process becomes speedier or more efficient.

Companies at the level of digitalization where they can start considering AI as a tool should begin their effort by discussing with AI experts and then start collecting raw data. These two building blocks do not guarantee success but offer the most solid foundations to build on. From that point on it is process of risk taking, discoveries, trial and error and growing with the technology.

Theory and practise are two different things: a company does not necessarily have to overhaul its business model and practises. Instead, it should collect targeted solutions to existing problems with AI piloting. The accumulated amount of small successes can lead to considerable profit increases. However, this requires that company is well balanced and successful on its own merits – AI is not the cure for low profitability, it can increase already existing success. First companies need to fix themselves and then reach forward. There is a clear difference in enthusiasm and expectation between users of AI and experts – the latter are more conservative and collected with their expectations. Theory holds the same viewpoint as userbase – overtly positive and even slightly hyping it.

If company is stagnant with AI and having hard time moving forward, it should consult experts, consider expanding the budget and timeframe, learn the basics from academic sources and think innovatively and take risks with AI. Construction company executives should look for tailored AI courses for educating themselves before ruling out the use of it – this also applies to those who have this technology in place. One should not look away from off-the-shelf products to gain confidence and creditability while bearing in mind that the level on success has correlation with the level AI immersion, according to the survey and theoretical research. Also, one must make sure employees are part of the changes and understand their role – they need to trust their leaders and see the benefits of using AI.

Those who are not trying or even considering AI, risk staying behind and have a lot of catching up to do later. The best course of action is to begin with conversing with specialists and rounding up high quality data through digitalized operations. Once data is in place, minimum viable products of pilot programs can be initiated to look for value and solutions to existing problems within business. For a successful process, a leader should not forget to educate his or her staff and inspire them of the benefits the changes will yield. If the AI adopter happens to be a general contractor, should they seek maximised benefits from partnerships and collaboration through their networks of sub-contractors. To end up with a favourable adoption, it does not require a complete overhaul of a business model and strategy – it is the maximised profitability and efficiency which arguably calls for more drastic changes. AI should not be feared as something ominous and strange but embraces and tested in practise as only so can the untapped potential be reached.

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Main Survey: All pathways

LAB-University of Applied Sciences
Master of International Business Management
2022
Otto Kirjalainen

2. What is your current role in your company?

This is a multiple choice question. You can choose more than one option - in most cases. If there isn't a suitable option available, type it yourself by clicking 'Other'.

79 answers

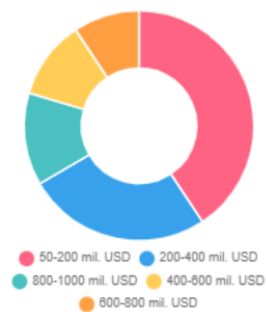


OPTIONS	ANSWERS	PERCENTAGE
CEO	26	32.9%
Member of the Board	17	21.5%
Owner	15	19.0%
Other	11	13.9%
Managing Officer	10	12.7%

3. Please select your company size measured in yearly revenues. (USD = US dollars/year)

Indicate your company size by selecting your most recent yearly revenue bracket. We are using GARTNER's definition of mid-sized business; 50 mil. - 1 mrd. USD revenues/annum.

54 answers

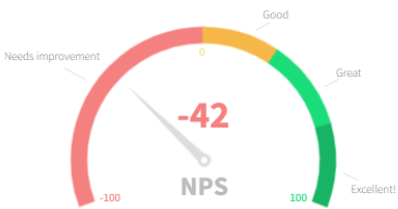
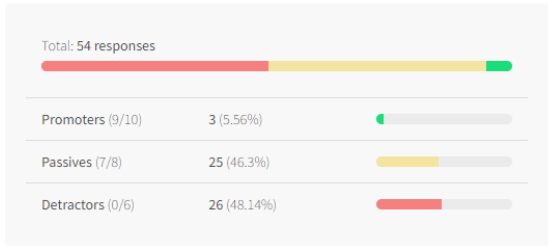
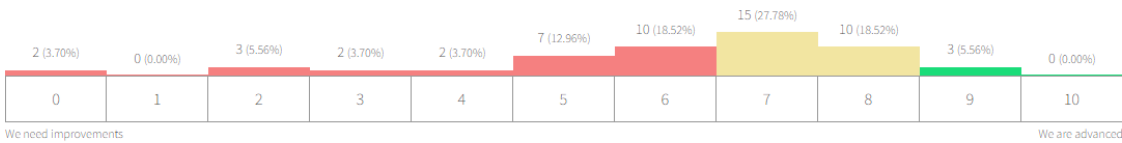


OPTIONS	ANSWERS	PERCENTAGE
50-200 mil. USD	22	40.7%
200-400 mil. USD	14	25.9%
800-1000 mil. USD	7	13.0%
400-600 mil. USD	6	11.1%
600-800 mil. USD	5	9.3%

4. Please rate how advanced your company is, in terms of business strategy, leadership practices and technology.

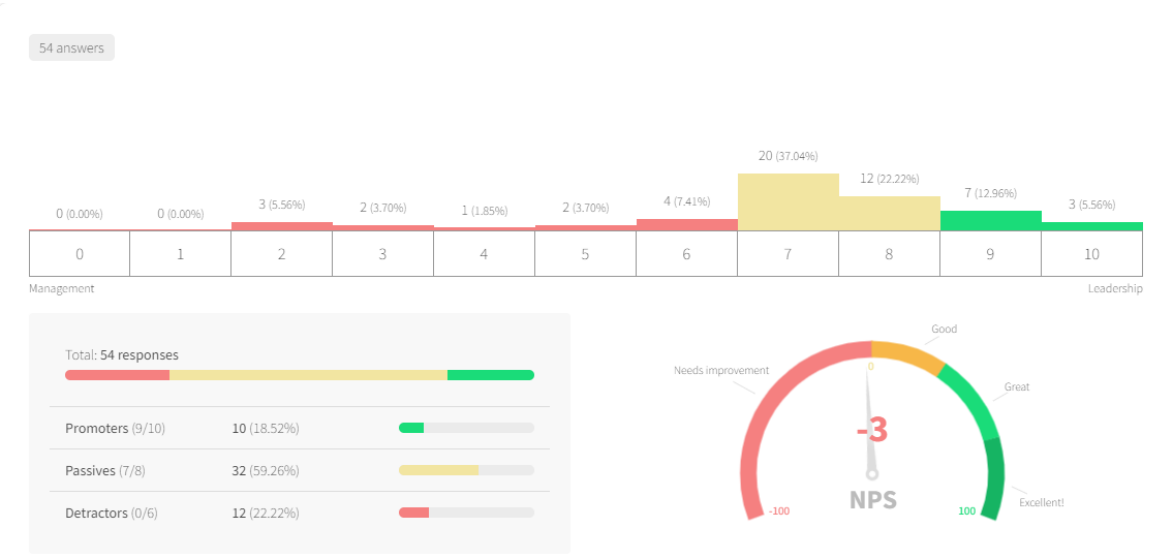
This is a ratings question where you can select a number from the scale as your answer.

54 answers



5. Which management method is closer to your personal style?

Please position yourself in the scale.



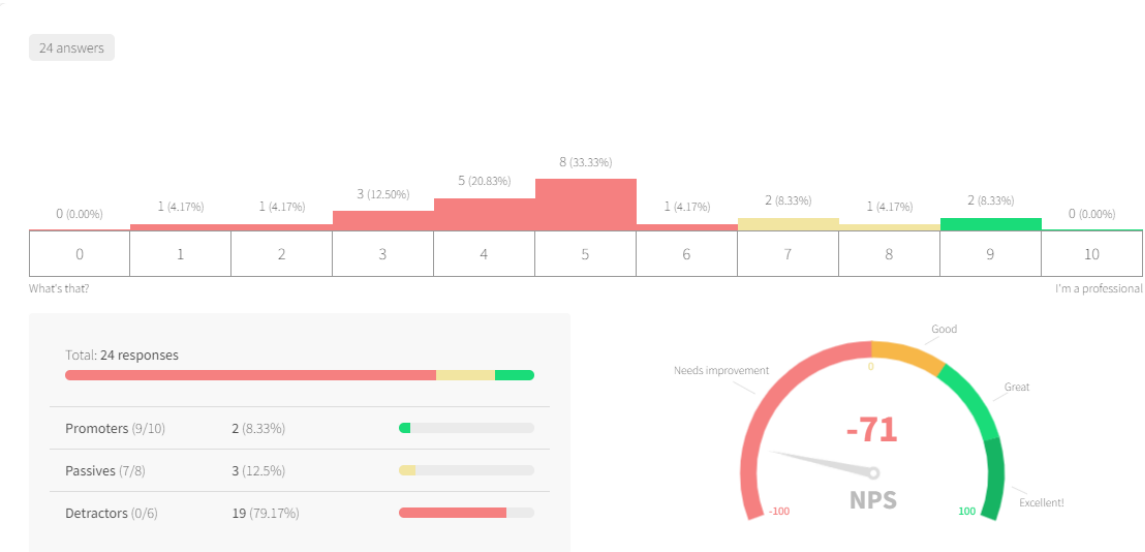
6. How have you managed to carry out your strategy and vision with your subordinates?

Do your workers understand your vision, utilize tools and strategies you offer them? Or do you feel disconnected from them?



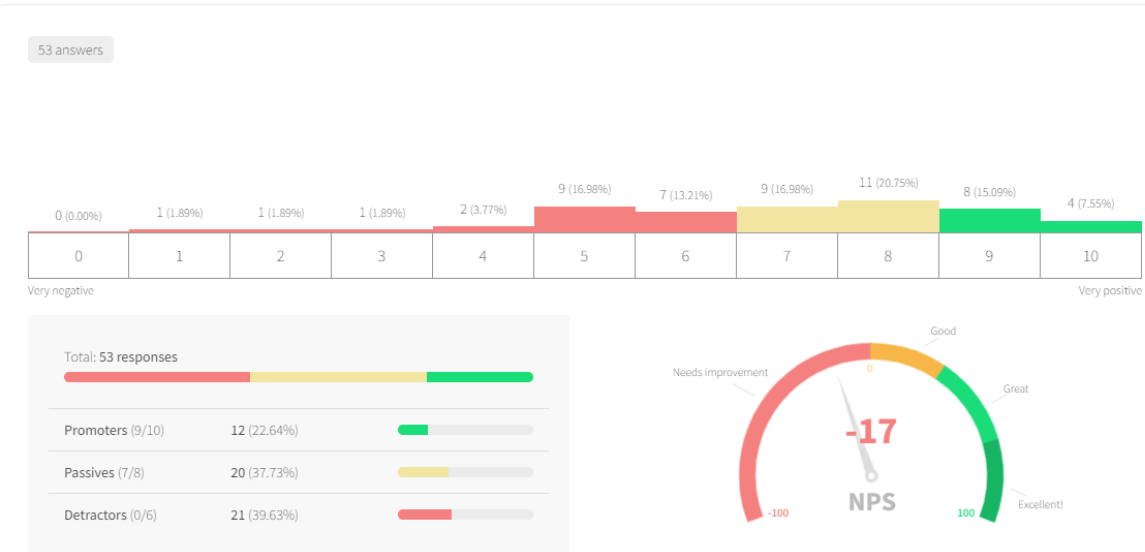
7. How familiar are you with artificial intelligence (AI) solutions?

Select a number signifying your level of knowledge.



8. Please rate your personal attitude towards AI.

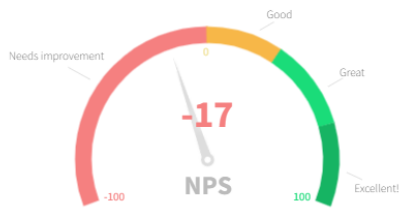
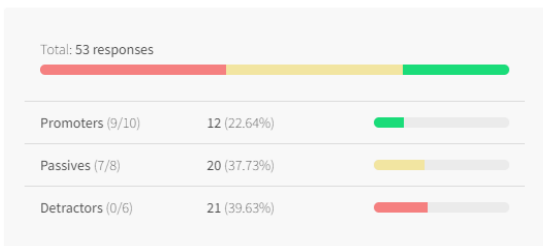
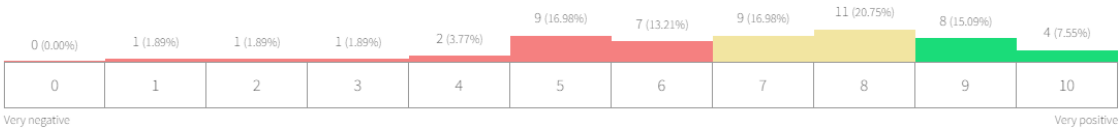
Select an option closest your current mindset.



9. How many AI technologies/solutions you have in place in your business?

If you don't know how many you use, just guess.

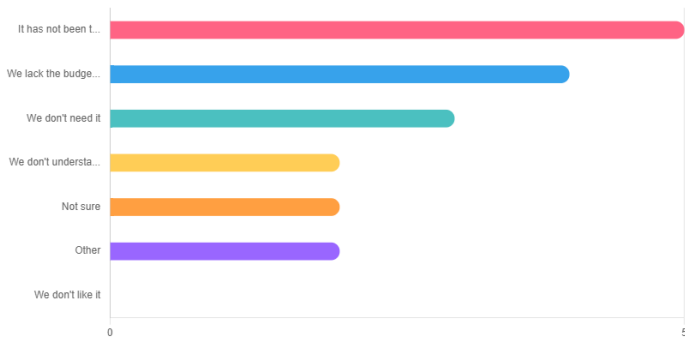
53 answers



10. We would like to know why?

Tell us what are your reasons for not choosing to use AI in your company.

18 answers



OPTIONS	ANSWERS	PERCENTAGE
It has not been tested enough	5	27.8%
We lack the budget and/or time	4	22.2%
We don't need it	3	16.7%
We don't understand it	2	11.1%
Not sure	2	11.1%
Other	2	11.1%
We don't like it	0	00.0%

11. Did your business try using AI before this survey?

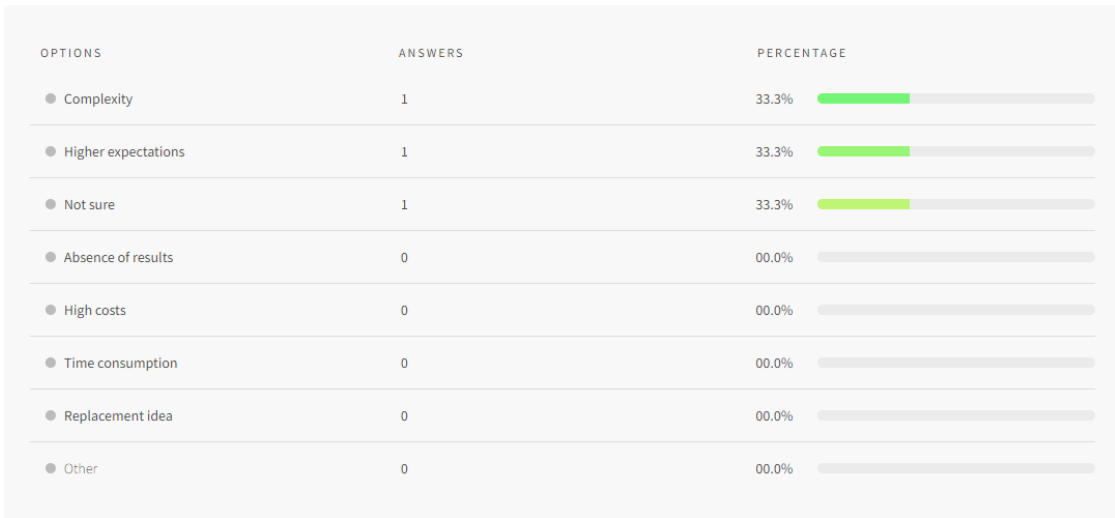
14 answers



12. What were the main reason(s) for aborting AI?

Choose as many as you like.

3 answers



13. What about the future?

Will you try again?

3 answers

OPTIONS	ANSWERS	PERCENTAGE
☐ No sure	2	66.7%
☐ We will try it again soon	1	33.3%
☐ Never again	0	00.0%
☐ We will try again after a long period of time	0	00.0%
☐ We will search for other suitable technologies	0	00.0%
☐ Other	0	00.0%

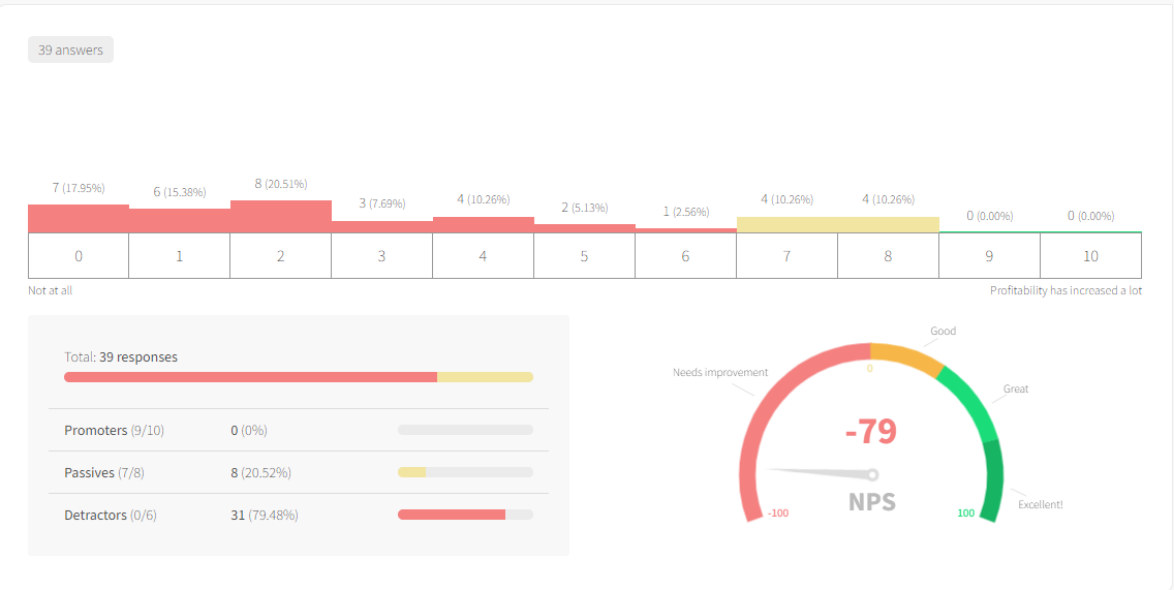
14. Why so?

14 answers

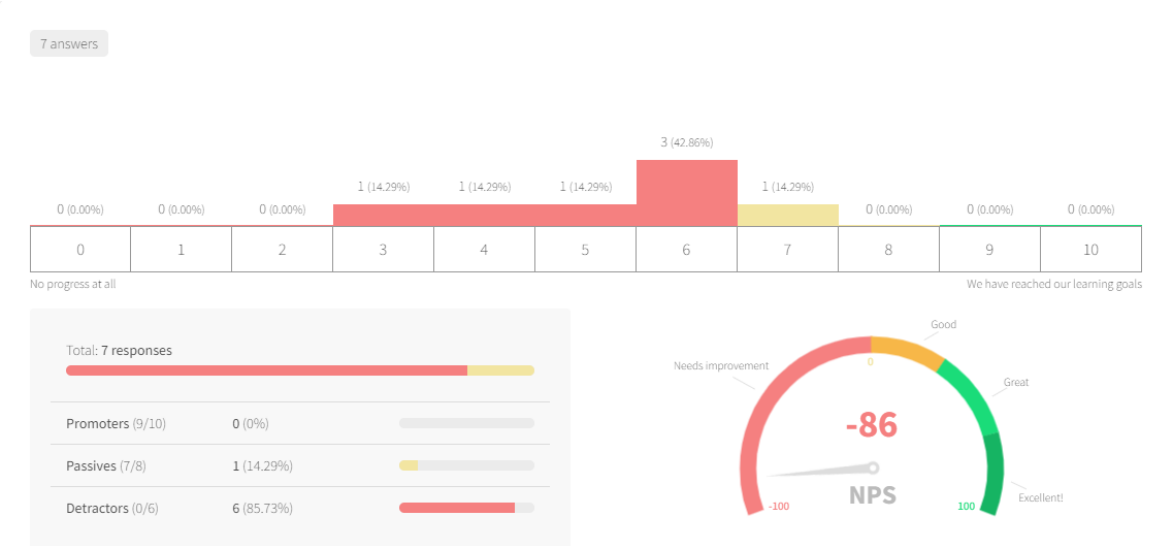
OPTIONS	ANSWERS	PERCENTAGE
☐ Other	5	35.7%
☐ No sure	4	28.6%
☐ I don't concentrate on IT stuff	3	21.4%
☐ Somebody else has the responsibility over issues like that	2	14.3%
☐ I am not interested	0	00.0%

15. Has your company seen financial benefits from the use of AI?

How much has your profitability increased with the help of AI?

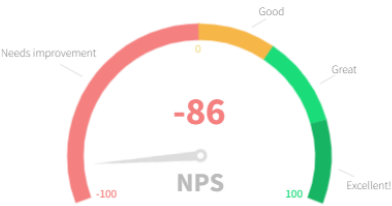
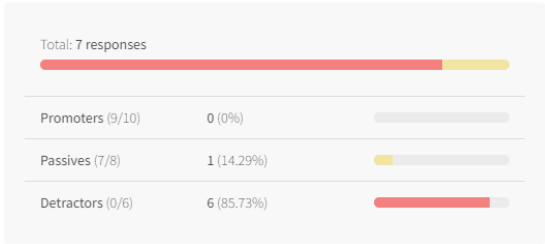
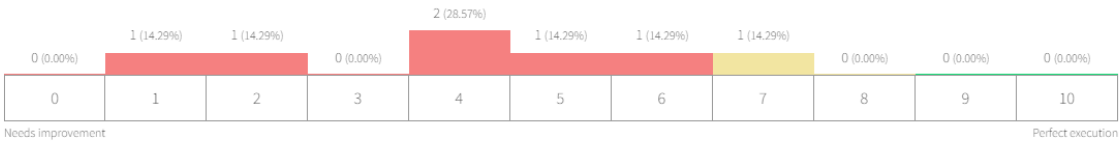


16. How would you rate your company learning progress?



17. How would you rate your working process with AI?

7 answers



18. What are your strategic expectations from AI?

What do you hope to achieve with AI? You can select more than one option.

25 answers

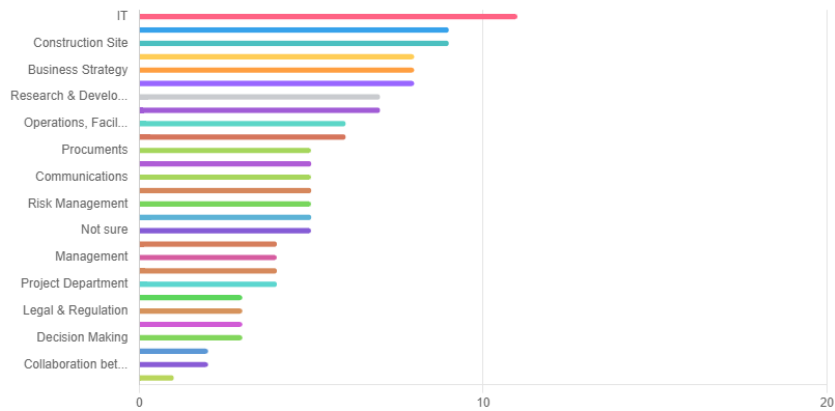


Options	Answers	Percentage
● Efficiency	7	26.9%
● Time Saving	4	15.4%
● Growth	3	11.5%
● Cost Savings	3	11.5%
● Improved Risk Management	3	11.5%
● Increased Productivity	3	11.5%
● New Business Strategies	2	07.7%
● Increased Safety	1	03.8%
● Nothing	0	00.0%
● Not sure	0	00.0%
● Other	0	00.0%

19. Where is AI being used in your business?

Please select as many business categories operating with AI as you are aware of.

147 answers



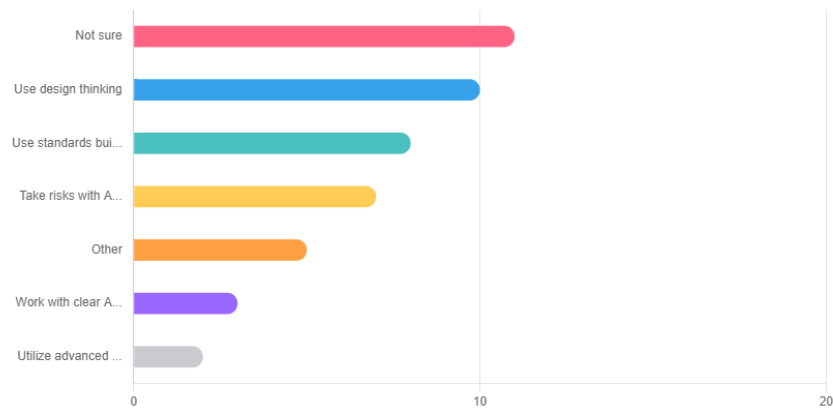
OPTIONS	ANSWERS	PERCENTAGE
IT	11	07.5%
Finance & Accounting	9	06.1%
Construction Site	9	06.1%
Marketing, Sales & Public Relations	8	05.4%
Business Strategy	8	05.4%
Safety	8	05.4%
Research & Development	7	04.8%
Human Relations	7	04.8%
Operations, Facilities, Fleet Management	6	04.1%
Design & Planning	6	04.1%
Procuments	5	03.4%
Customer Service	5	03.4%
Communications	5	03.4%
Quality Management	5	03.4%
Risk Management	5	03.4%
Engineering Department	5	03.4%
Not sure	5	03.4%
Leadership	4	02.7%
Management	4	02.7%

Predicting Scenarios	4	02.7%
Project Department	4	02.7%
Logistics	3	02.0%
Legal & Regulation	3	02.0%
Manufacturing & Production	3	02.0%
Decision Making	3	02.0%
Corporate Strategy	2	01.4%
Collaboration between organizations	2	01.4%
Other	1	00.7%

20. How do you work with AI?

Here are some known work methods with AI.

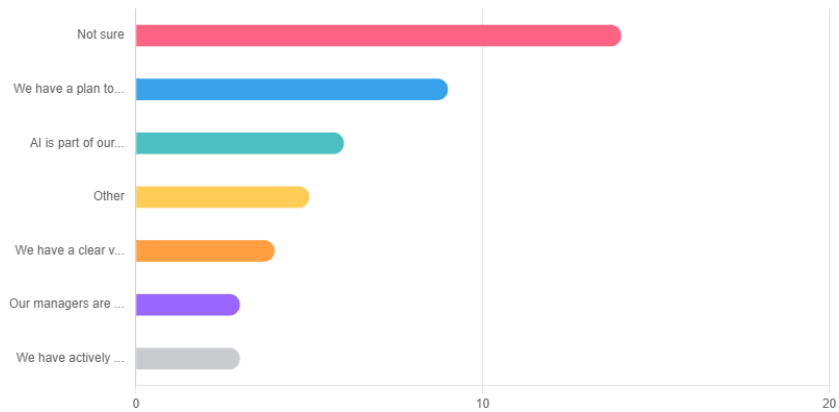
46 answers



OPTIONS	ANSWERS	PERCENTAGE
Not sure	11	23.9%
Use design thinking	10	21.7%
Use standards building AI tools	8	17.4%
Take risks with AI related investment decisions	7	15.2%
Other	5	10.9%
Work with clear AI governance framework	3	6.5%
Utilize advanced AI deployment processes	2	4.3%

21. What strategic variables are you utilizing with AI?

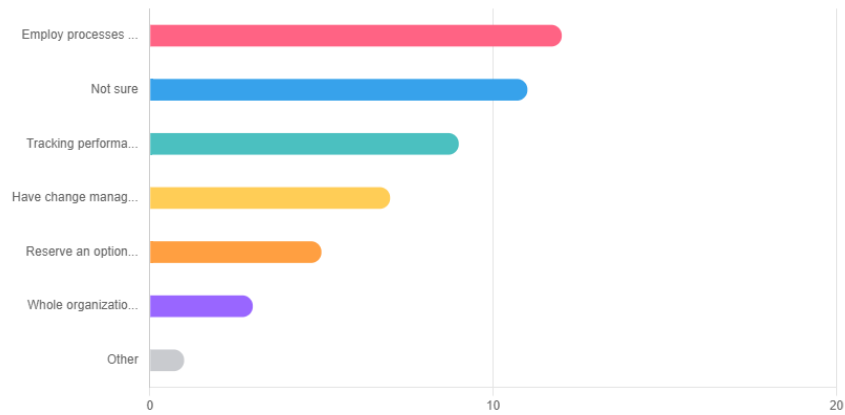
44 answers



OPTIONS	ANSWERS	PERCENTAGE
● Not sure	14	31.8%
● We have a plan to create value with AI	9	20.5%
● AI is part of our corporate strategy	6	13.6%
● Other	5	11.4%
● We have a clear vision and strategy	4	9.1%
● Our managers are devoted to AI strategy	3	6.8%
● We have actively developed partnerships within AI sphere	3	6.8%

22. Which of the following method(s) you use in AI adoption?

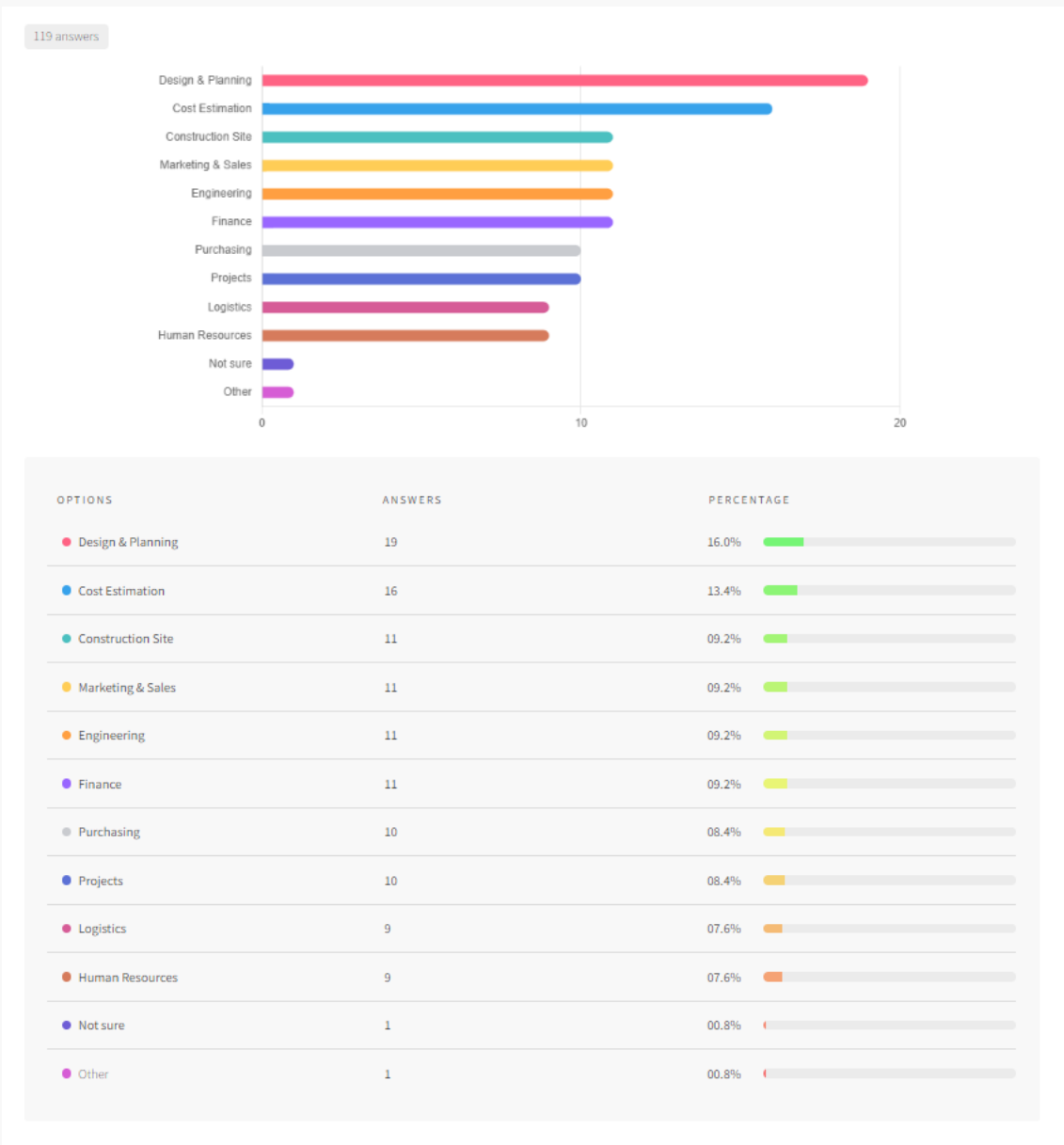
48 answers



OPTIONS	ANSWERS	PERCENTAGE
● Employ processes of moving AI from pilots to actual use	12	25.0%
● Not sure	11	22.9%
● Tracking performance indicators	9	18.8%
● Have change management in place	7	14.6%
● Reserve an option to scale up AI opportunities	5	10.4%
● Whole organization searches points to ad value to with AI	3	06.3%

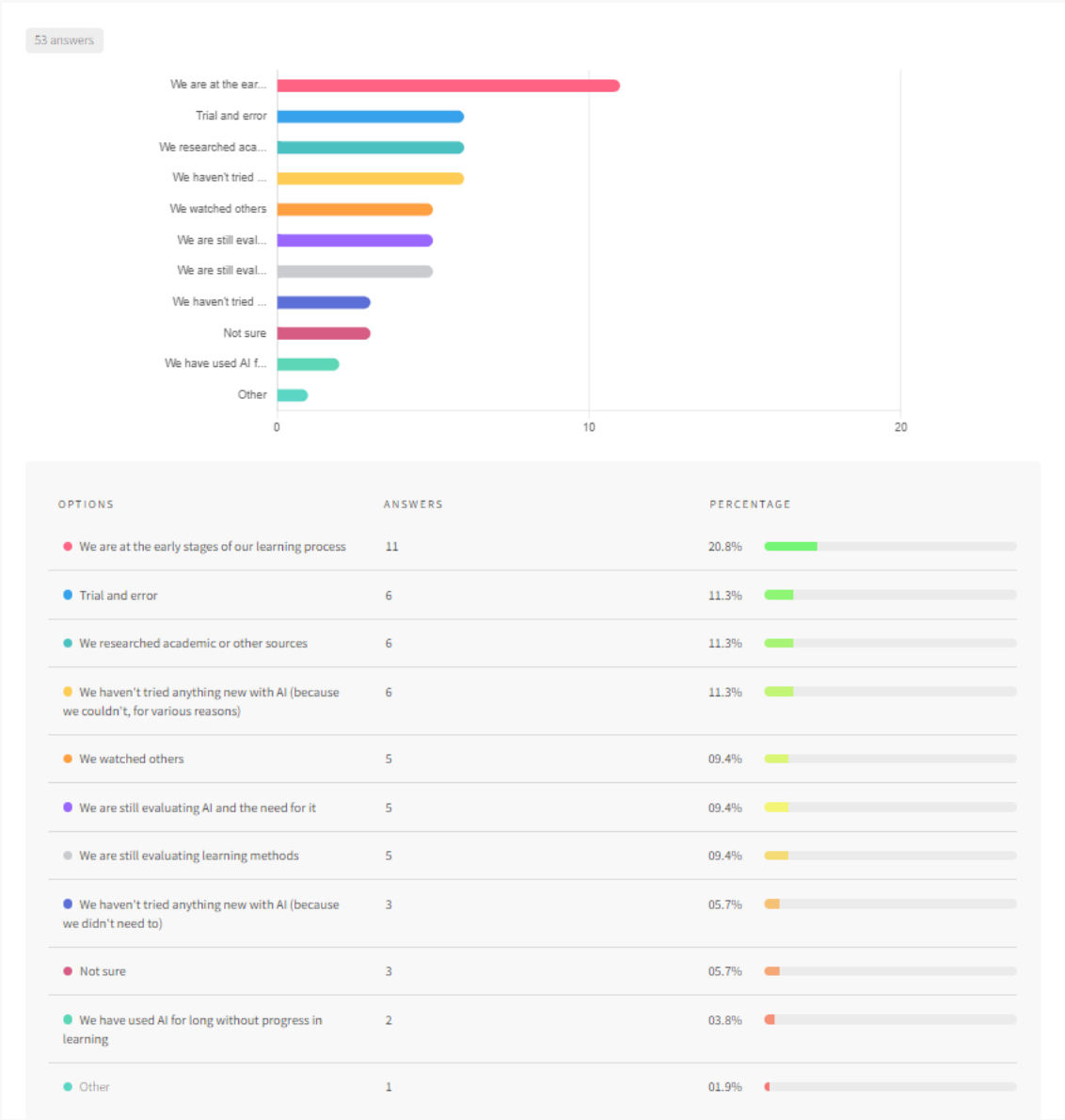
23. In your opinion, which are the highest impact functions for AI?

Where, in your opinion, are the most gains to be achieved?



24. How did you learn to use AI?

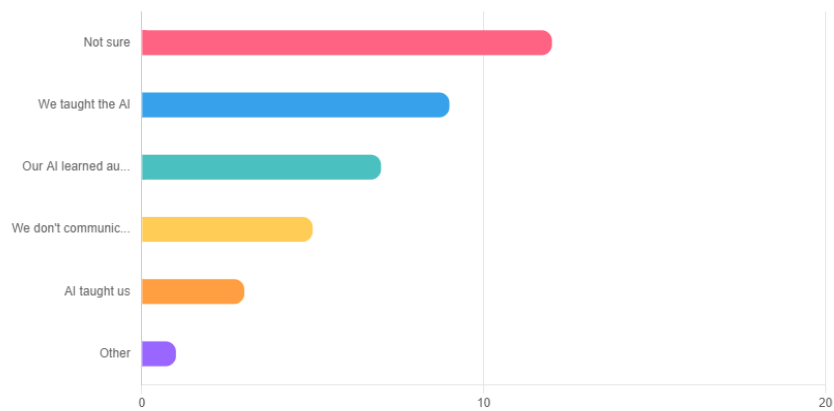
Please tell us how have you progressed with AI. If you answered either of the "We haven't tried anything new"-questions, please explain briefly by clicking also option 'Other' and type your reasons.



OPTIONS	ANSWERS	PERCENTAGE	
● We are at the early stages of our learning process	9	23.1%	
● Trial and error	6	15.4%	
● We haven't tried anything new with AI (because we couldn't, for various reasons)	6	15.4%	
● We watched others	5	12.8%	
● We are still evaluating AI and the need for it	4	10.3%	
● We are still evaluating learning methods	3	07.7%	
● We haven't tried anything new with AI (because we didn't need to)	3	07.7%	
● Not sure	2	05.1%	
● We researched academic or other sources	1	02.6%	
● We have used AI for long without progress in learning	0	00.0%	
● Other	0	00.0%	

25. How was your organizational learning process with AI?

37 answers

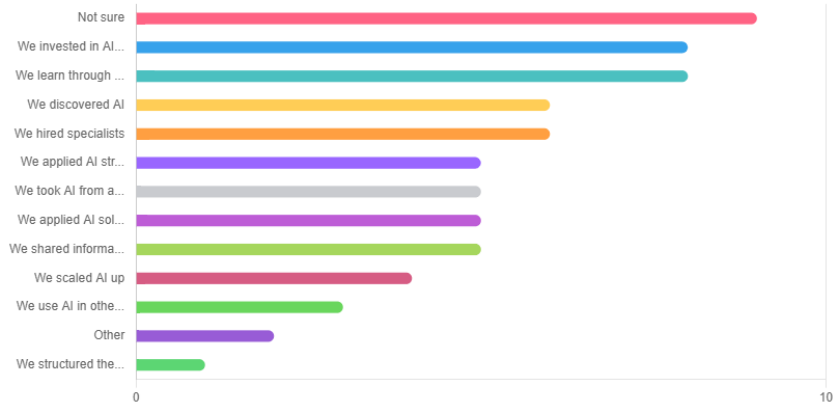


OPTIONS	ANSWERS	PERCENTAGE	
● Not sure	12	32.4%	
● We taught the AI	9	24.3%	
● Our AI learned autonomously	7	18.9%	
● We don't communicate with AI	5	13.5%	
● AI taught us	3	08.1%	
● Other	1	02.7%	

26. Please select all options that apply to your business.

This will help us determine at which stage you are with AI.

67 answers



OPTIONS

ANSWERS

PERCENTAGE

● Not sure

9

13.4%

● We invested in AI infrastructure

8

11.9%

● We learn through collective knowledge and adapt accordingly

8

11.9%

● We discovered AI

6

09.0%

● We hired specialists

6

09.0%

● We applied AI strategy

5

07.5%

● We took AI from an experiment trial to organizational use

5

07.5%

● We applied AI solutions effectively

5

07.5%

● We shared information between human and AI

5

07.5%

● We scaled AI up

4

06.0%

● We use AI in other fields beside automation

3

04.5%

● Other

2

03.0%

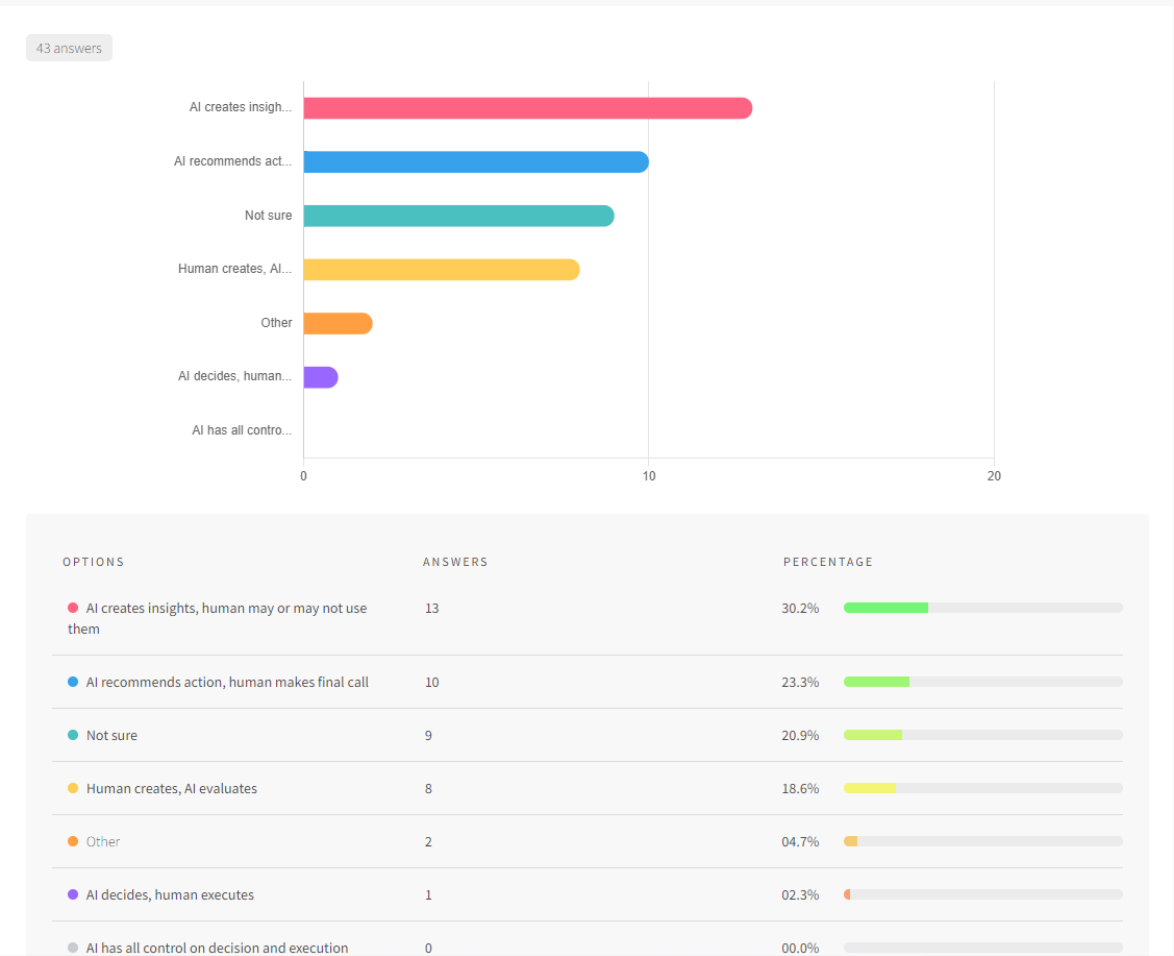
● We structured the modes of interaction between humans and AI

1

01.5%

27. How many modes of interaction does your company use with AI?

Select all that apply to you. Look at this from the perspective of individual tasks that AI takes care of.

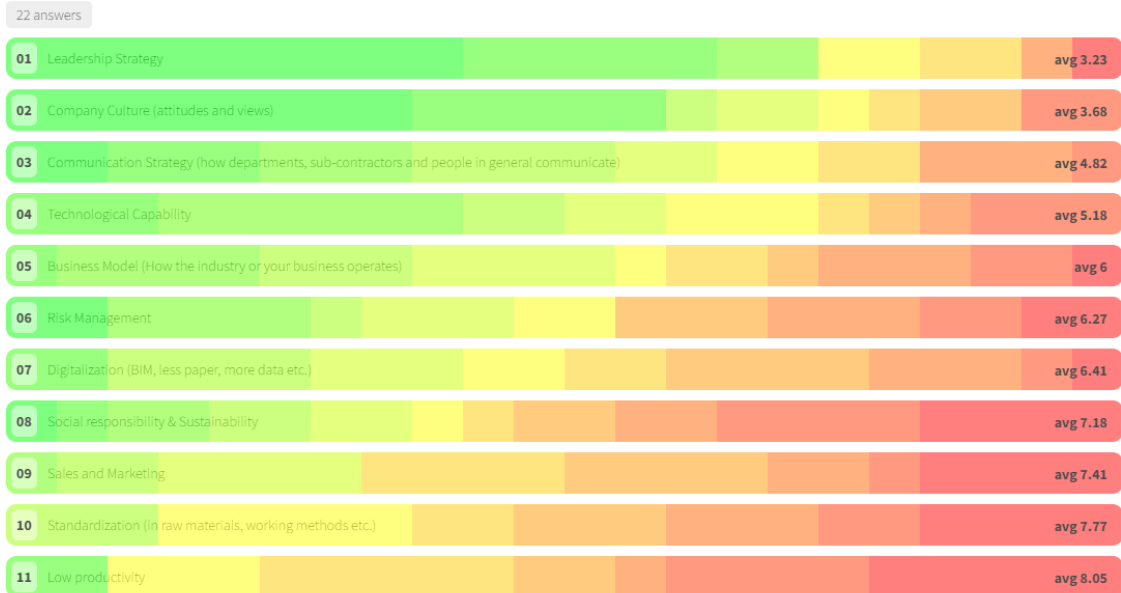


28. Is your company moving closer to AI, or further away from it?

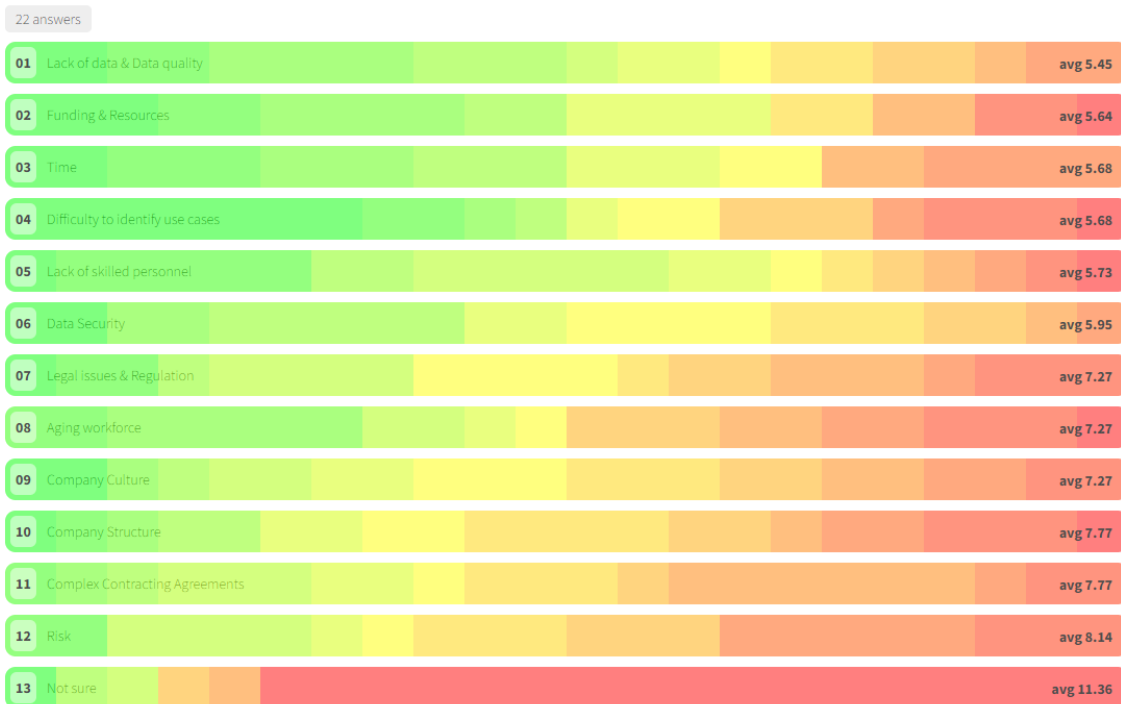


29. Please organize options from most important to least important, in terms of functions to update in building construction industry.

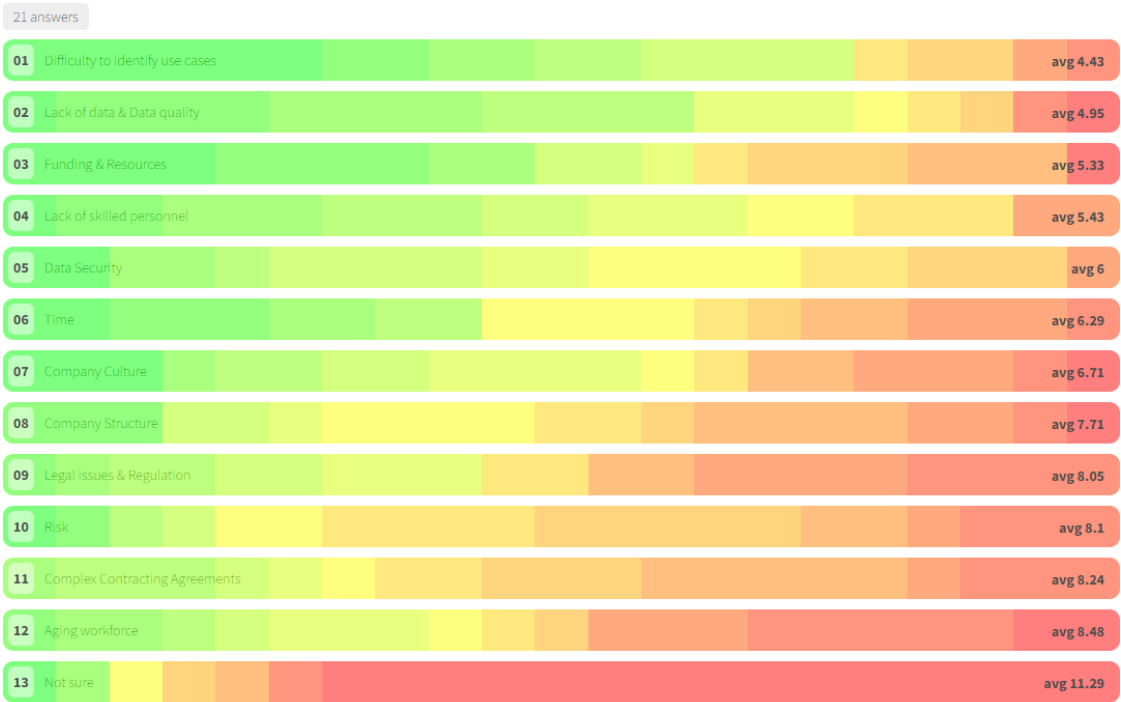
If you had the power to change the industry, what would be your ranking? Use drag-and-drop method to arrange options according to your preferences.



30. Please rank obstacles to AI adoption in building construction industry, from most to least important.



31. Please rank obstacles to AI adoption in your company, from most to least important.



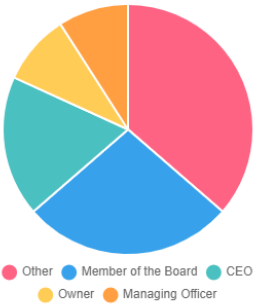
Main Survey: High Performers

LAB-University of Applied Sciences
Master of International Business Management
2022
Otto Kirjalainen

2. What is your current role in your company?

This is a multiple choice question. You can choose more than one option - in most cases. If there isn't a suitable option available, type it yourself by clicking 'Other'.

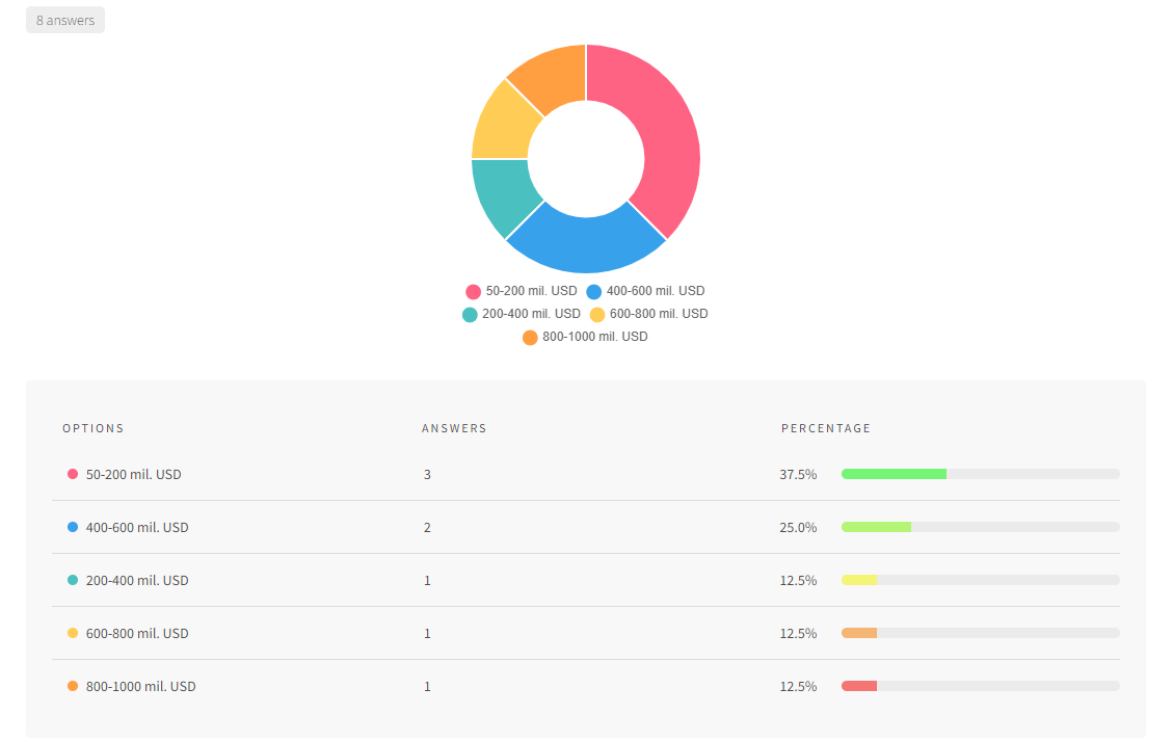
11 answers



OPTIONS	ANSWERS	PERCENTAGE
Other	4	36.4%
Member of the Board	3	27.3%
CEO	2	18.2%
Owner	1	9.1%
Managing Officer	1	9.1%

3. Please select your company size measured in yearly revenues. (USD = US dollars/year)

Indicate your company size by selecting your most recent yearly revenue bracket. We are using GARTNER's definition of mid-sized business; 50 mil. - 1 mrd. USD revenues/annum.



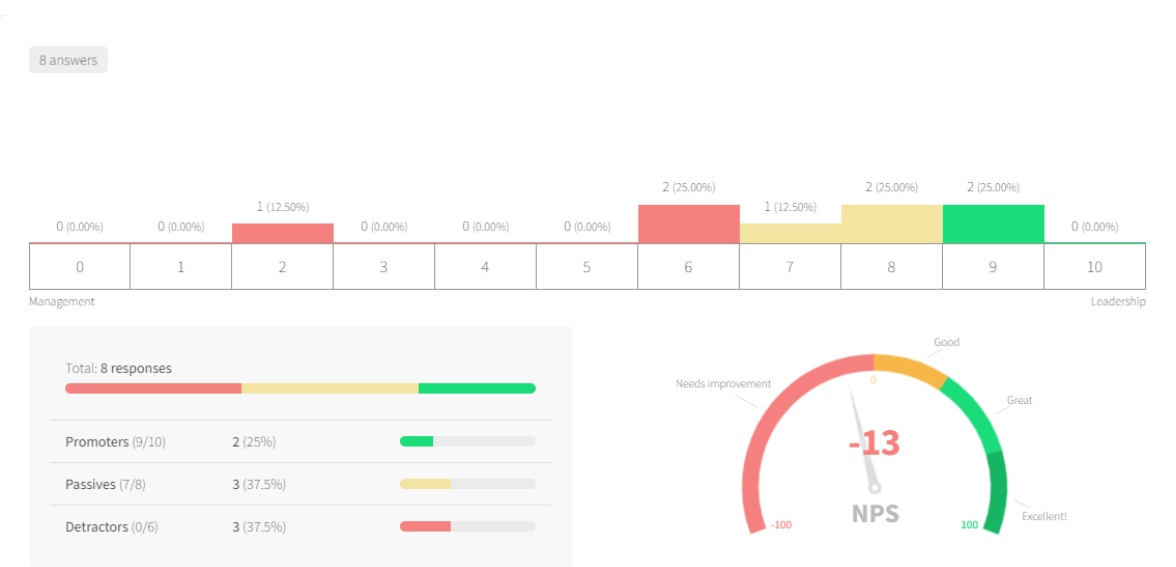
4. Please rate how advanced your company is, in terms of business strategy, leadership practices and technology.

This is a ratings question where you can select a number from the scale as your answer.



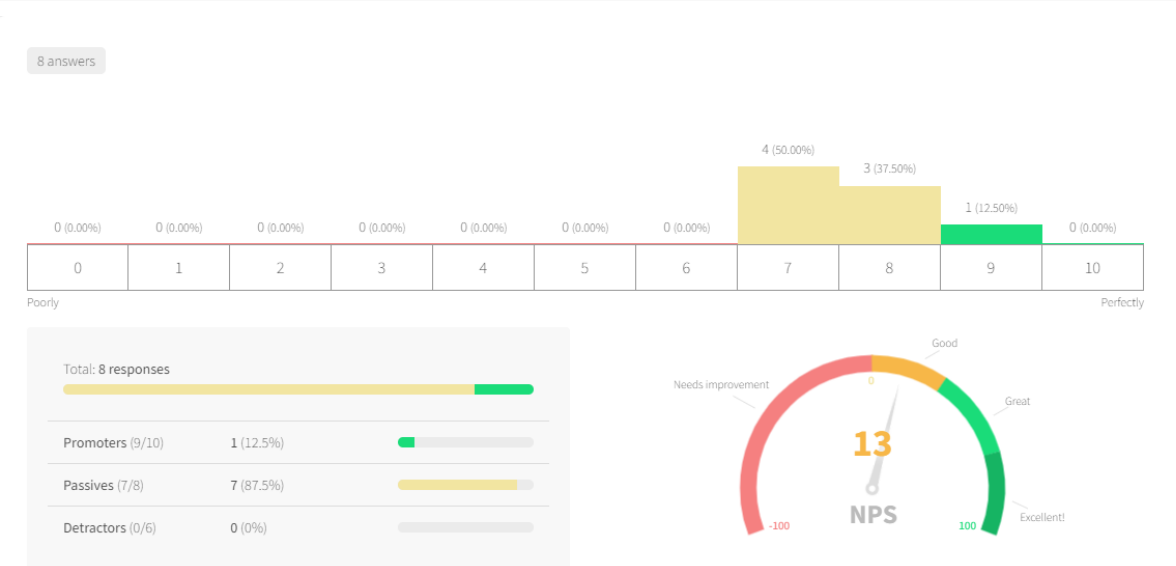
5. Which management method is closer to your personal style?

Please position yourself in the scale.



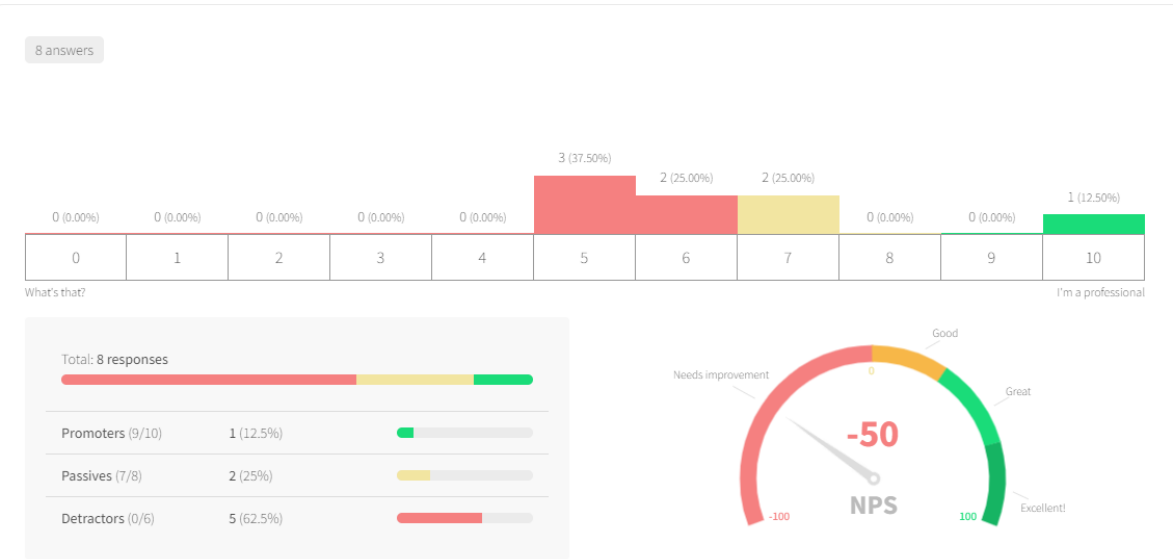
6. How have you managed to carry out your strategy and vision with your subordinates?

Do your workers understand your vision, utilize tools and strategies you offer them? Or do you feel disconnected from them?



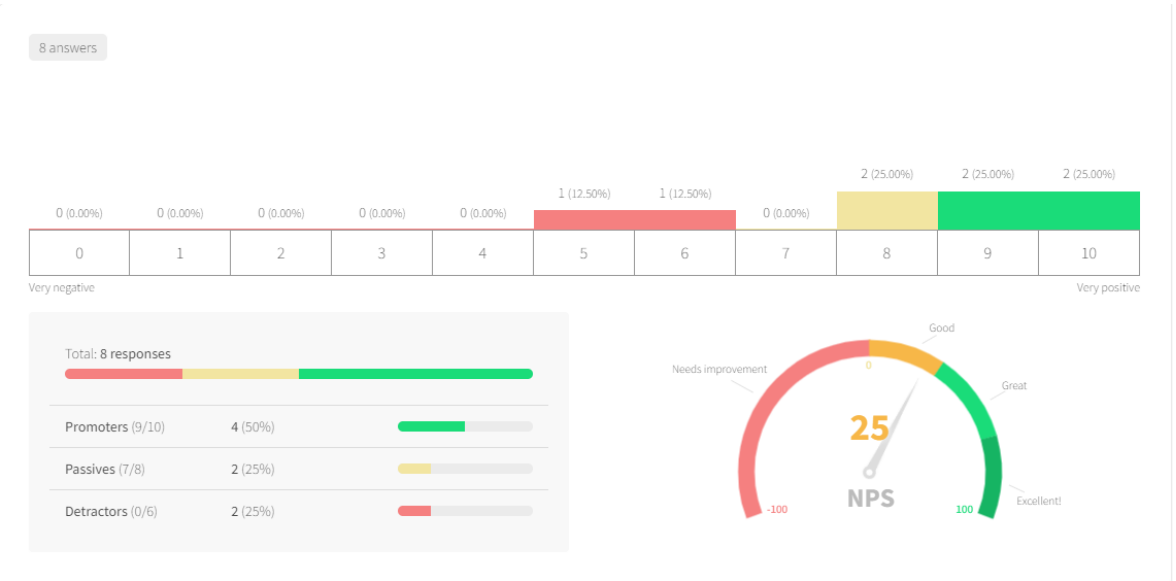
7. How familiar are you with artificial intelligence (AI) solutions?

Select a number signifying your level of knowledge.



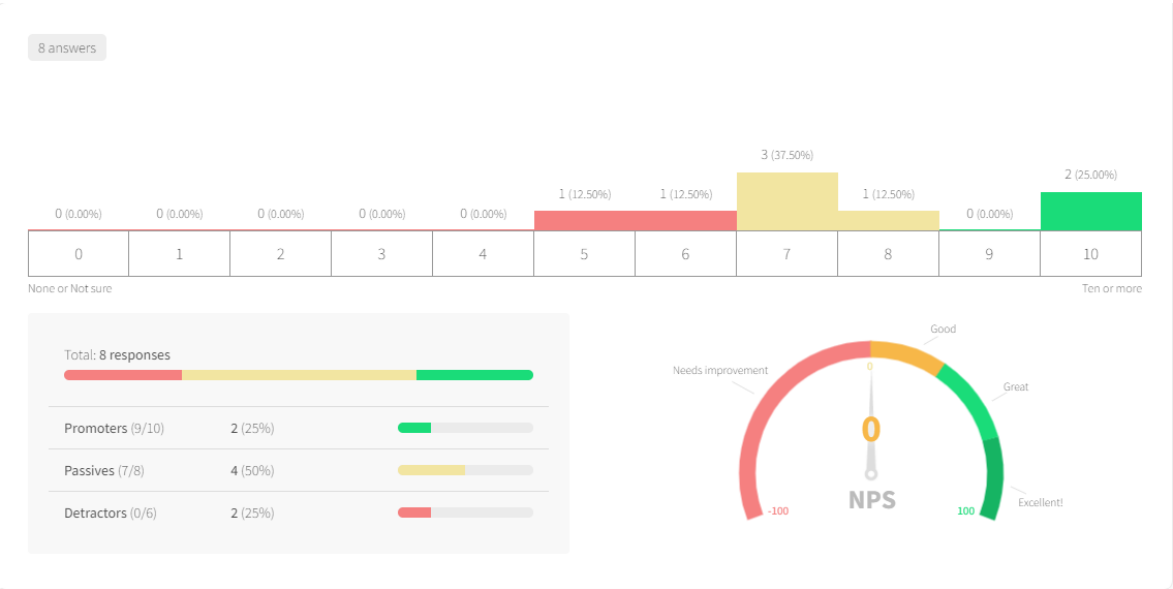
8. Please rate your personal attitude towards AI.

Select an option closest your current mindset.



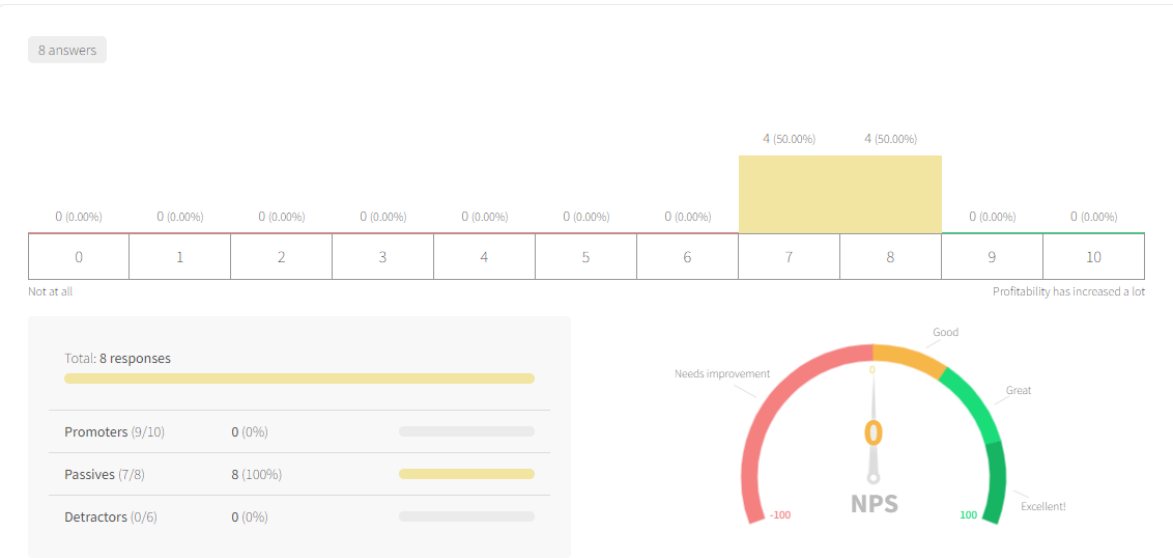
9. How many AI technologies/solutions you have in place in your business?

If you don't know how many you use, just guess.



15. Has your company seen financial benefits from the use of AI?

How much has your profitability increased with the help of AI?



19. Where is AI being used in your business?

Please select as many business categories operating with AI as you are aware of

83 answers



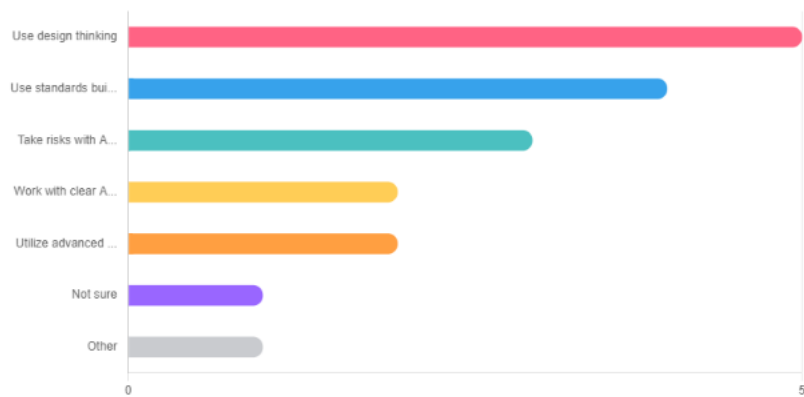
OPTIONS	ANSWERS	PERCENTAGE
Business Strategy	5	06.0%
Human Relations	5	06.0%
Construction Site	5	06.0%
Safety	5	06.0%
IT	5	06.0%
Procuments	4	04.8%
Marketing, Sales & Public Relations	4	04.8%
Communications	4	04.8%
Design & Planning	4	04.8%
Leadership	3	03.6%
Finance & Accounting	3	03.6%
Management	3	03.6%
Operations, Facilities, Fleet Management	3	03.6%
Logistics	3	03.6%
Quality Management	3	03.6%
Risk Management	3	03.6%

Predicting Scenarios	3	03.6%	
Project Department	3	03.6%	
Engineering Department	3	03.6%	
Research & Development	2	02.4%	
Customer Service	2	02.4%	
Manufacturing & Production	2	02.4%	
Corporate Strategy	2	02.4%	
Collaboration between organizations	2	02.4%	
Legal & Regulation	1	01.2%	
Decision Making	1	01.2%	
Not sure	0	00.0%	
Other	0	00.0%	

20. How do you work with AI?

Here are some known work methods with AI.

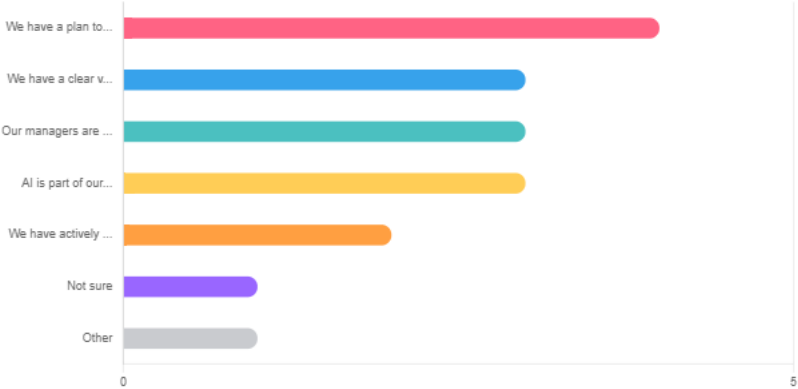
18 answers



OPTIONS	ANSWERS	PERCENTAGE
Use design thinking	5	27.8%
Use standards building AI tools	4	22.2%
Take risks with AI related investment decisions	3	16.7%
Work with clear AI governance framework	2	11.1%
Utilize advanced AI deployment processes	2	11.1%
Not sure	1	05.6%
Other	1	05.6%

21. What strategic variables are you utilizing with AI?

17 answers



OPTIONS	ANSWERS	PERCENTAGE
We have a plan to create value with AI	4	23.5%
We have a clear vision and strategy	3	17.6%
Our managers are devoted to AI strategy	3	17.6%
AI is part of our corporate strategy	3	17.6%
We have actively developed partnerships within AI sphere	2	11.8%
Not sure	1	05.9%
Other	1	05.9%

22. Which of the following method(s) you use in AI adoption?

16 answers



OPTIONS	ANSWERS	PERCENTAGE
● Employ processes of moving AI from pilots to actual use	6	37.5%
● Tracking performance indicators	5	31.3%
● Whole organization searches points to add value to with AI	2	12.5%
● Have change management in place	2	12.5%
● Reserve an option to scale up AI opportunities	1	06.3%
● Not sure	0	00.0%
● Other	0	00.0%

23. In your opinion, which are the highest impact functions for AI?

Where, in your opinion, are the most gains to be achieved?

34 answers

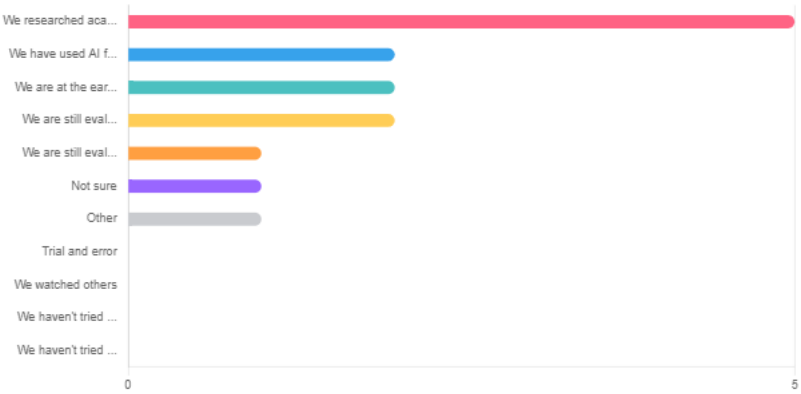


OPTIONS	ANSWERS	PERCENTAGE
Design & Planning	6	17.6%
Human Resources	5	14.7%
Engineering	4	11.8%
Purchasing	3	8.8%
Logistics	3	8.8%
Cost Estimation	3	8.8%
Marketing & Sales	3	8.8%
Projects	3	8.8%
Construction Site	2	5.9%
Finance	2	5.9%
Not sure	0	00.0%
Other	0	00.0%

24. How did you learn to use AI?

Please tell us how have you progressed with AI. If you answered either of the "We haven't tried anything new"-questions, please explain briefly by clicking also option 'Other' and type your reasons.

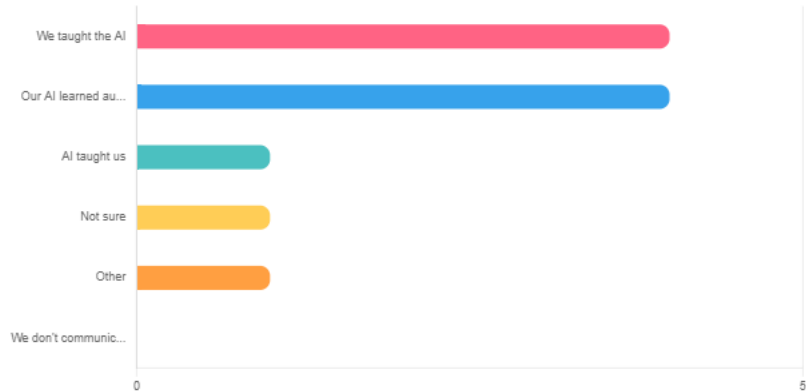
14 answers



Options	Answers	Percentage
We researched academic or other sources	5	35.7%
We have used AI for long without progress in learning	2	14.3%
We are at the early stages of our learning process	2	14.3%
We are still evaluating learning methods	2	14.3%
We are still evaluating AI and the need for it	1	07.1%
Not sure	1	07.1%
Other	1	07.1%
Trial and error	0	00.0%
We watched others	0	00.0%
We haven't tried anything new with AI (because we couldn't, for various reasons)	0	00.0%
We haven't tried anything new with AI (because we didn't need to)	0	00.0%

25. How was your organizational learning process with AI?

11 answers

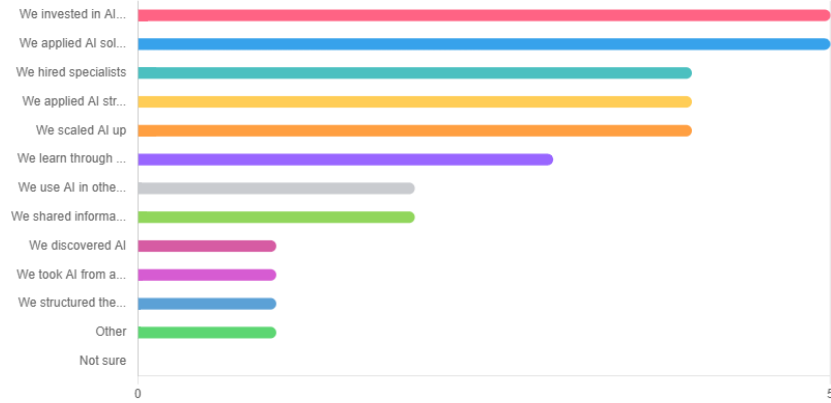


OPTIONS	ANSWERS	PERCENTAGE
We taught the AI	4	36.4%
Our AI learned autonomously	4	36.4%
AI taught us	1	09.1%
Not sure	1	09.1%
Other	1	09.1%
We don't communicate with AI	0	00.0%

26. Please select all options that apply to your business.

This will help us determine at which stage you are with AI.

33 answers



OPTIONS	ANSWERS	PERCENTAGE
We invested in AI infrastructure	5	15.2%
We applied AI solutions effectively	5	15.2%
We hired specialists	4	12.1%
We applied AI strategy	4	12.1%
We scaled AI up	4	12.1%
We learn through collective knowledge and adapt accordingly	3	09.1%
We use AI in other fields beside automation	2	06.1%
We shared information between human and AI	2	06.1%
We discovered AI	1	03.0%
We took AI from an experiment trial to organizational use	1	03.0%
We structured the modes of interaction between humans and AI	1	03.0%
Other	1	03.0%
Not sure	0	00.0%

27. How many modes of interaction does your company use with AI?

Select all that apply to you. Look at this from the perspective of individual tasks that AI takes care of.

11 answers



OPTIONS	ANSWERS	PERCENTAGE
● AI recommends action, human makes final call	4	36.4%
● Human creates, AI evaluates	3	27.3%
● Not sure	2	18.2%
● AI creates insights, human may or may not use them	1	09.1%
● Other	1	09.1%
● AI has all control on decision and execution	0	00.0%
● AI decides, human executes	0	00.0%

Main Survey: Medium Performers

2. What is your current role in your company?

This is a multiple choice question. You can choose more than one option - in most cases. If there isn't a suitable option available, type it yourself by clicking 'Other'.

9 answers

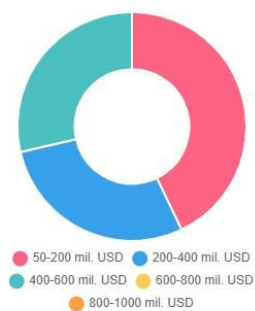


OPTIONS	ANSWERS	PERCENTAGE
CEO	4	44.4%
Owner	3	33.3%
Member of the Board	1	11.1%
Other	1	11.1%
Managing Officer	0	00.0%

3. Please select your company size measured in yearly revenues. (USD = US dollars/year)

Indicate your company size by selecting your most recent yearly revenue bracket. We are using GARTNER's definition of mid-sized business; 50 mil. - 1 mrd. USD revenues/annum.

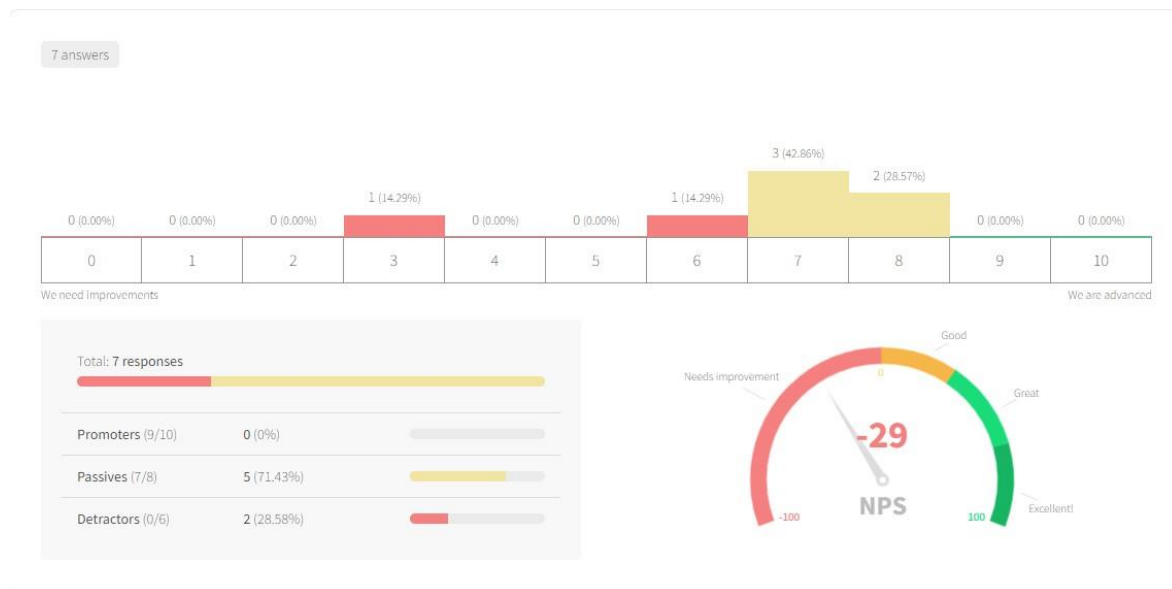
7 answers



OPTIONS	ANSWERS	PERCENTAGE
50-200 mil. USD	3	42.9%
200-400 mil. USD	2	28.6%
400-600 mil. USD	2	28.6%
600-800 mil. USD	0	00.0%
800-1000 mil. USD	0	00.0%

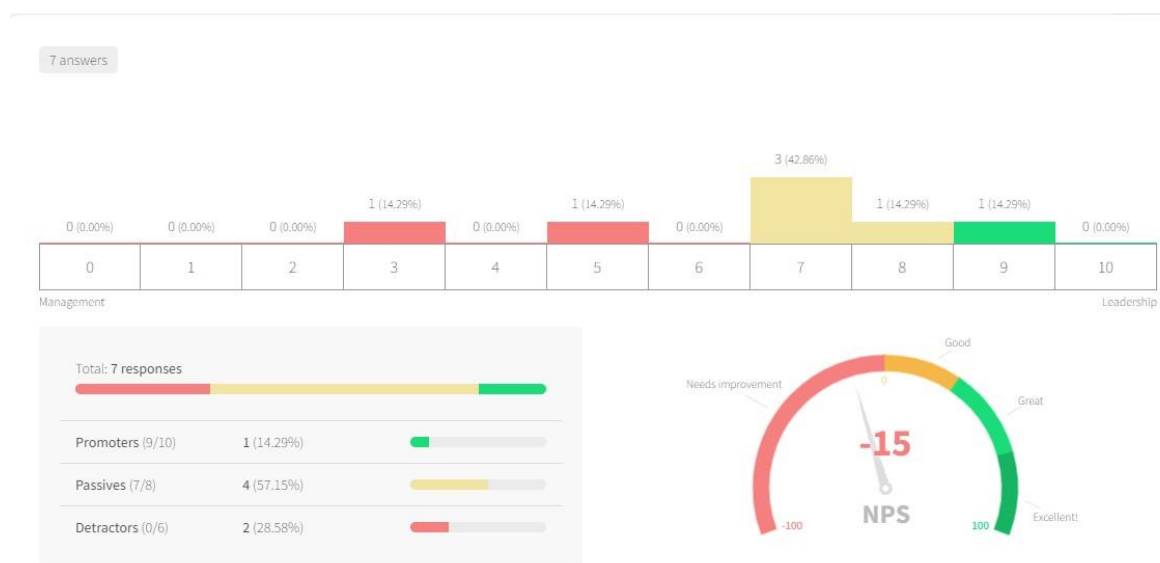
4. Please rate how advanced your company is, in terms of business strategy, leadership practices and technology.

This is a ratings question where you can select a number from the scale as your answer.



5. Which management method is closer to your personal style?

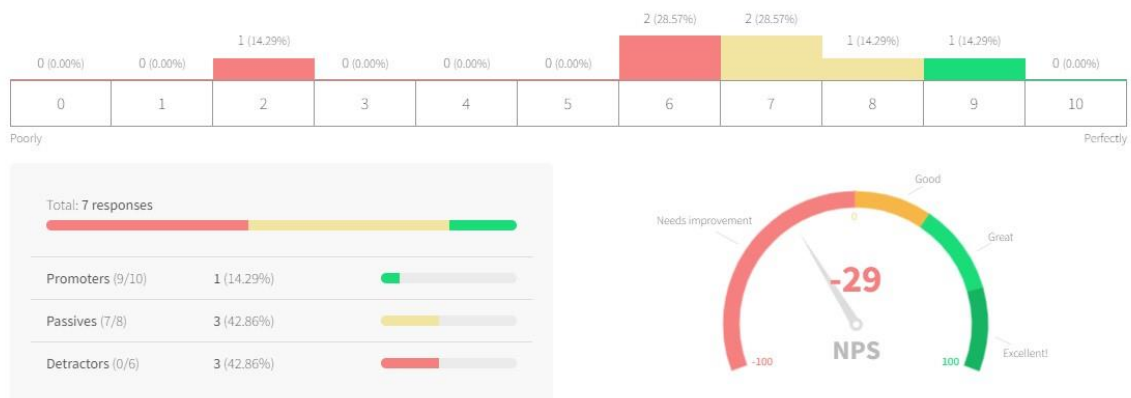
Please position yourself in the scale.



6. How have you managed to carry out your strategy and vision with your subordinates?

Do your workers understand your vision, utilize tools and strategies you offer them? Or do you feel disconnected from them?

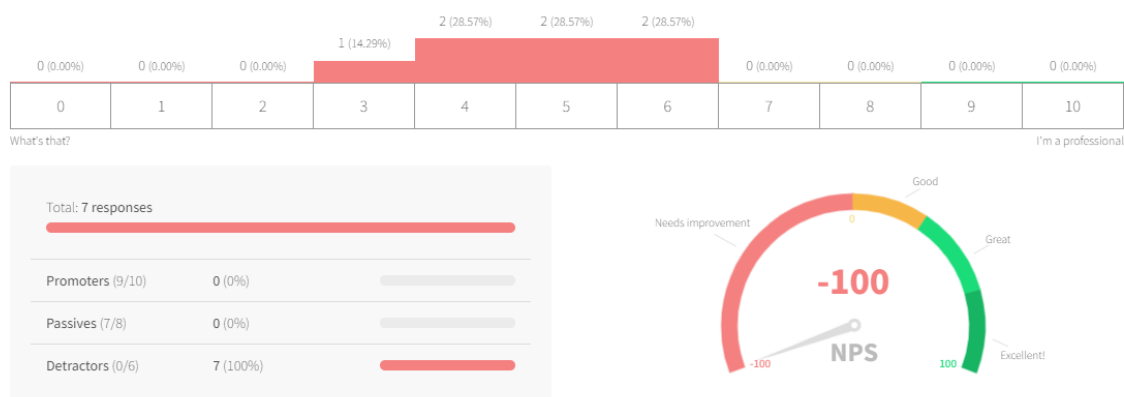
7 answers



7. How familiar are you with artificial intelligence (AI) solutions?

Select a number signifying your level of knowledge.

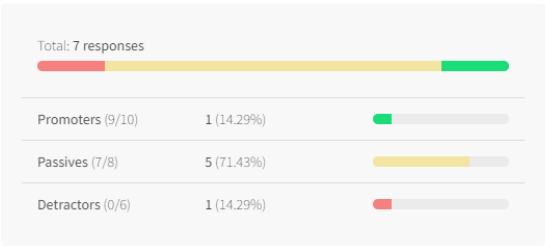
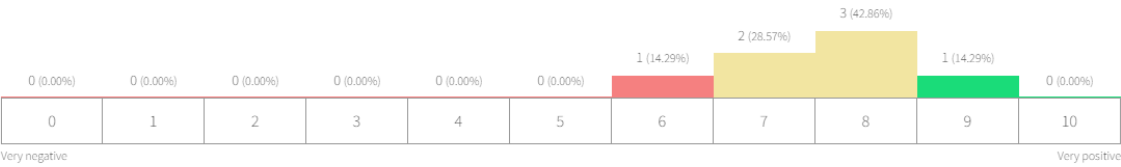
7 answers



8. Please rate your personal attitude towards AI.

Select an option closest your current mindset.

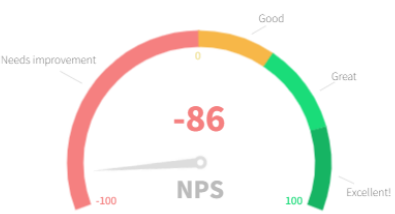
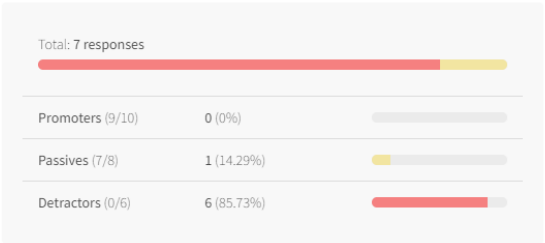
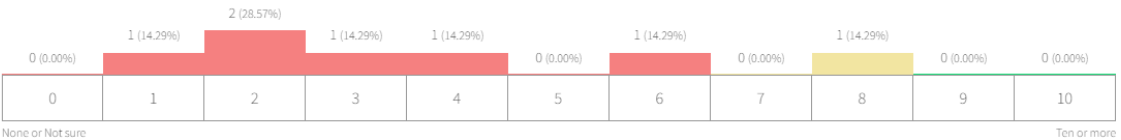
7 answers



9. How many AI technologies/solutions you have in place in your business?

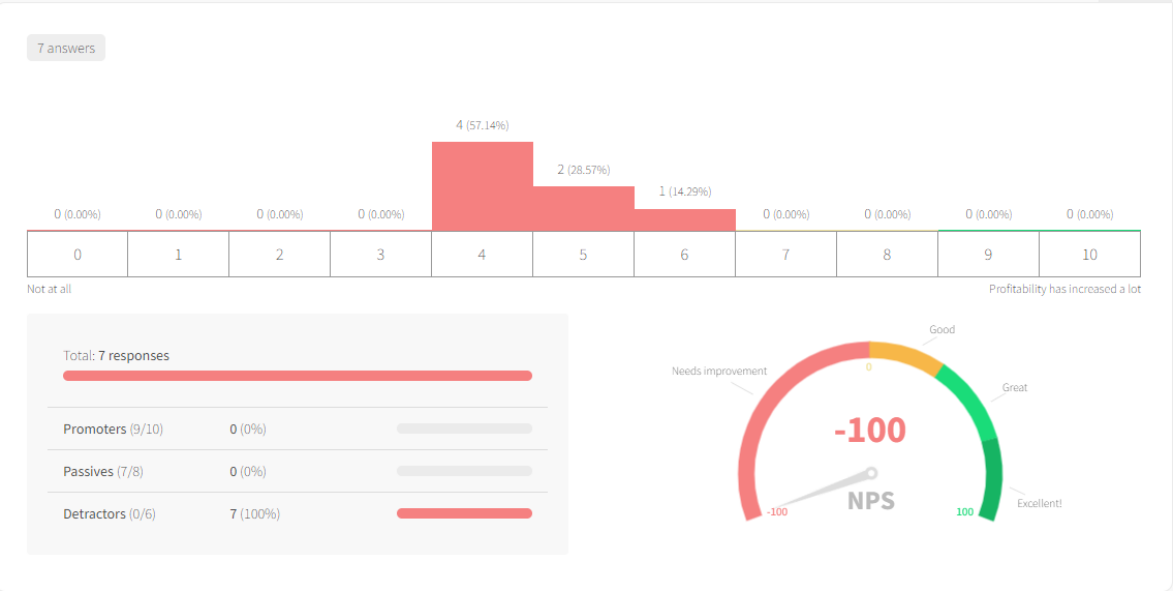
If you don't know how many you use, just guess.

7 answers

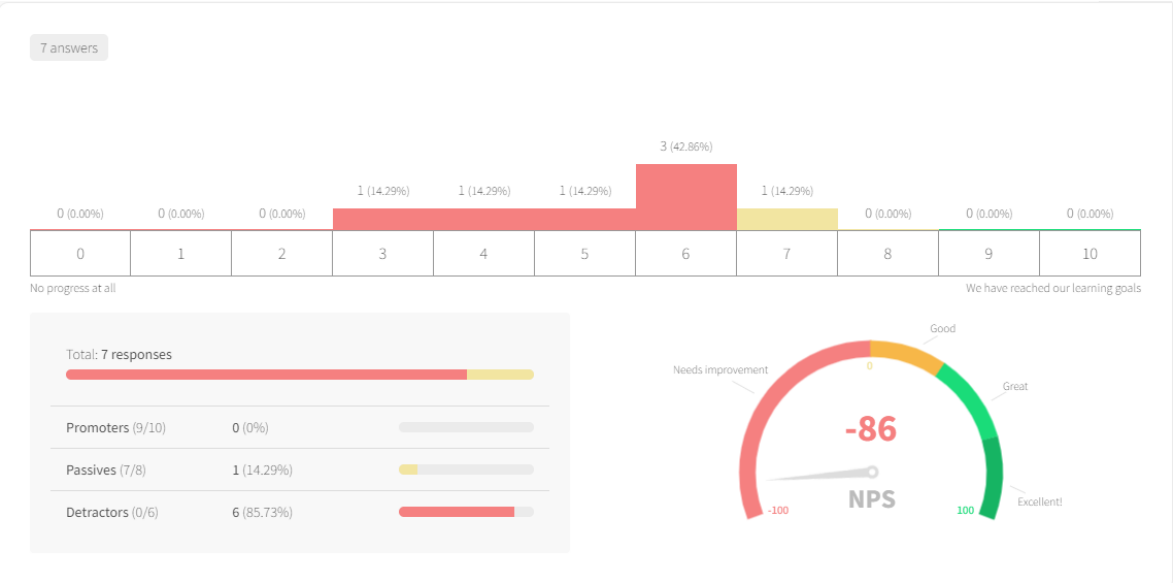


15. Has your company seen financial benefits from the use of AI?

How much has your profitability increased with the help of AI?

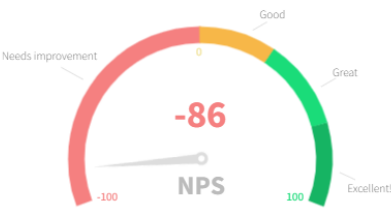
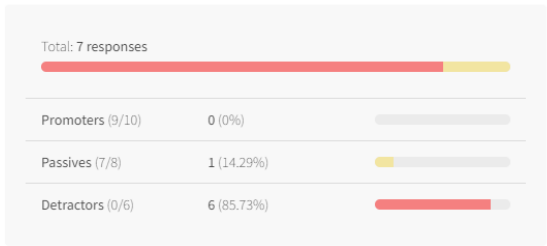
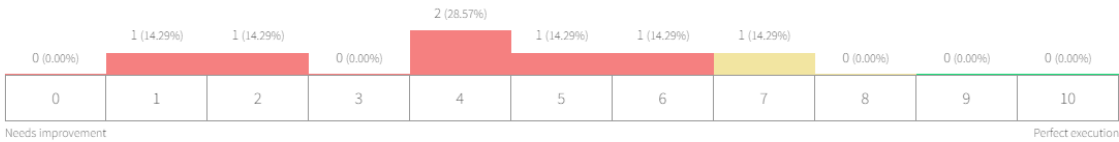


16. How would you rate your company learning progress?



17. How would you rate your working process with AI?

7 answers



18. What are your strategic expectations from AI?

What do you hope to achieve with AI? You can select more than one option.

25 answers

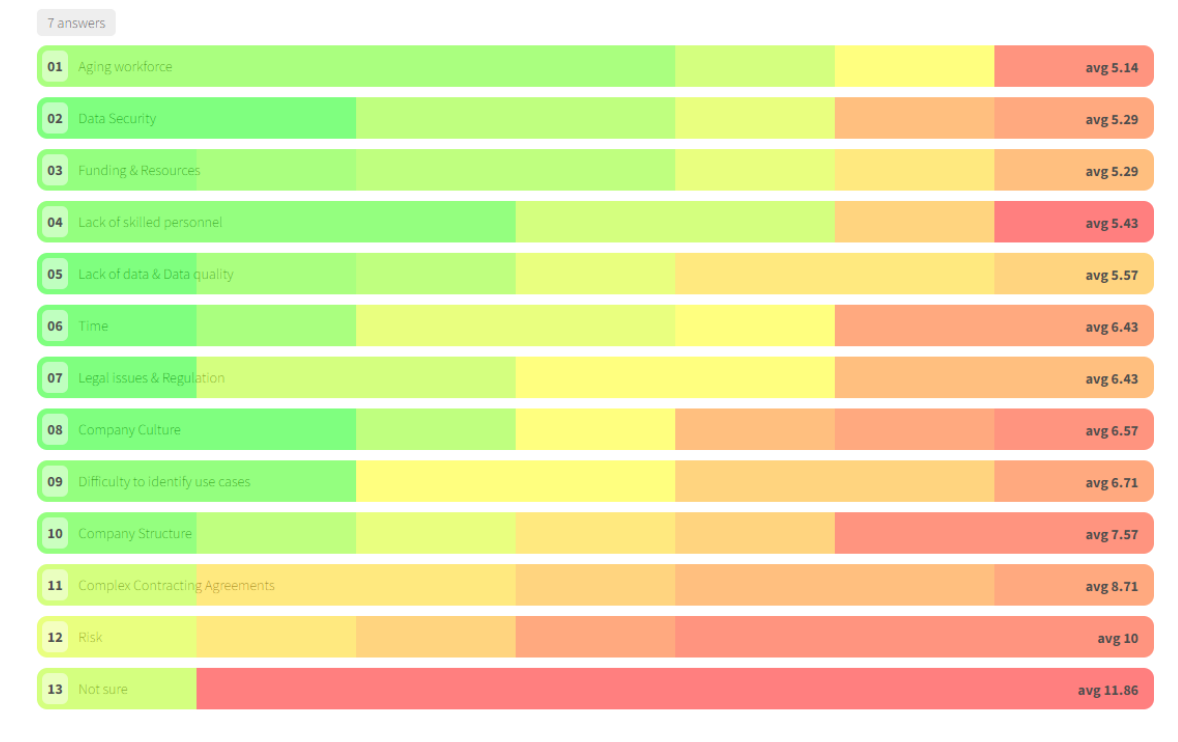


OPTIONS	ANSWERS	PERCENTAGE
● Efficiency	7	26.9%
● Time Saving	4	15.4%
● Growth	3	11.5%
● Cost Savings	3	11.5%
● Improved Risk Management	3	11.5%
● Increased Productivity	3	11.5%
● New Business Strategies	2	07.7%
● Increased Safety	1	03.8%
● Nothing	0	00.0%
● Not sure	0	00.0%
● Other	0	00.0%

28. Is your company moving closer to AI, or further away from it?

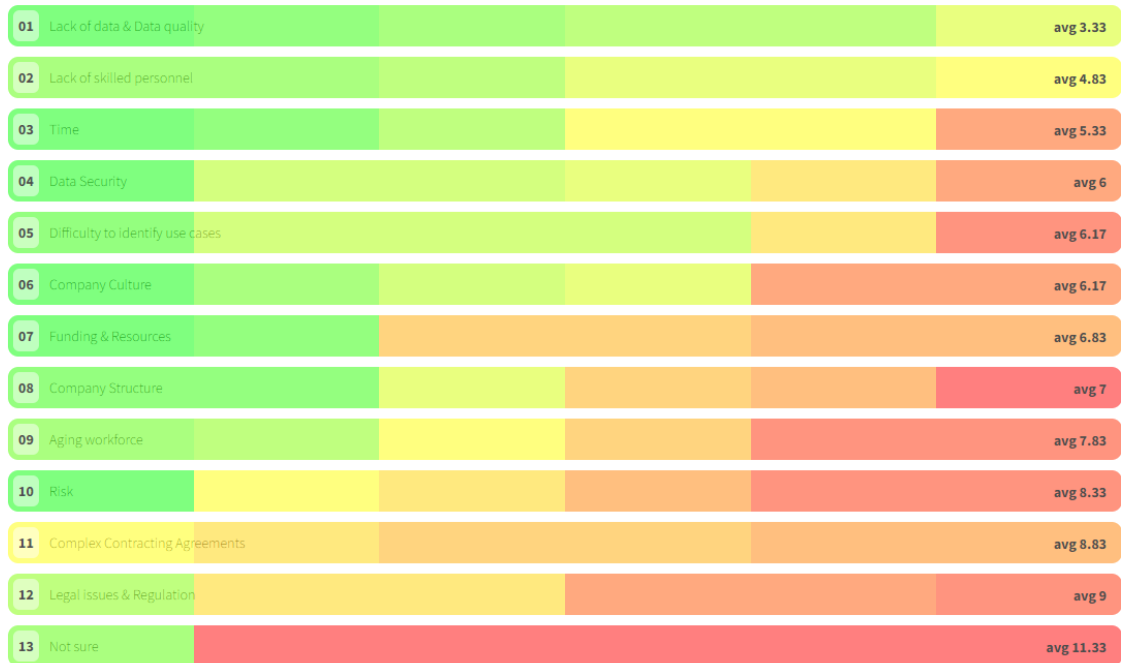


30. Please rank obstacles to AI adoption in building construction industry, from most to least important.



31. Please rank obstacles to AI adoption in your company, from most to least important.

6 answers



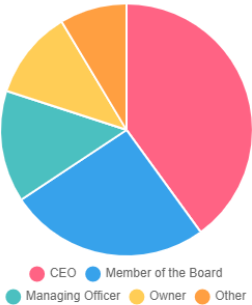
Main Survey: Low Performers

LAB-University of Applied Sciences
Master of International Business Management
2022
Otto Kirjalainen

2. What is your current role in your company?

This is a multiple choice question. You can choose more than one option - in most cases. If there isn't a suitable option available, type it yourself by clicking 'Other'.

35 answers

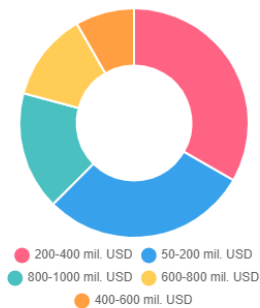


OPTIONS	ANSWERS	PERCENTAGE
CEO	14	40.0%
Member of the Board	9	25.7%
Managing Officer	5	14.3%
Owner	4	11.4%
Other	3	8.6%

3. Please select your company size measured in yearly revenues. (USD = US dollars/year)

Indicate your company size by selecting your most recent yearly revenue bracket. We are using GARTNER's definition of mid-sized business; 50 mil. - 1 mrd. USD revenues/annum.

24 answers

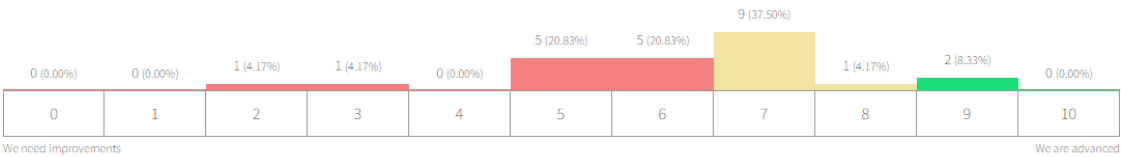


OPTIONS	ANSWERS	PERCENTAGE
200-400 mil. USD	8	33.3%
50-200 mil. USD	7	29.2%
800-1000 mil. USD	4	16.7%
600-800 mil. USD	3	12.5%
400-600 mil. USD	2	08.3%

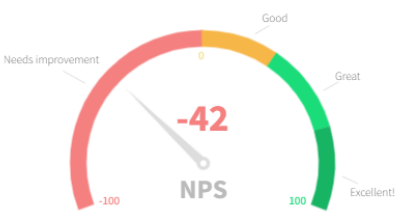
4. Please rate how advanced your company is, in terms of business strategy, leadership practices and technology.

This is a ratings question where you can select a number from the scale as your answer.

24 answers

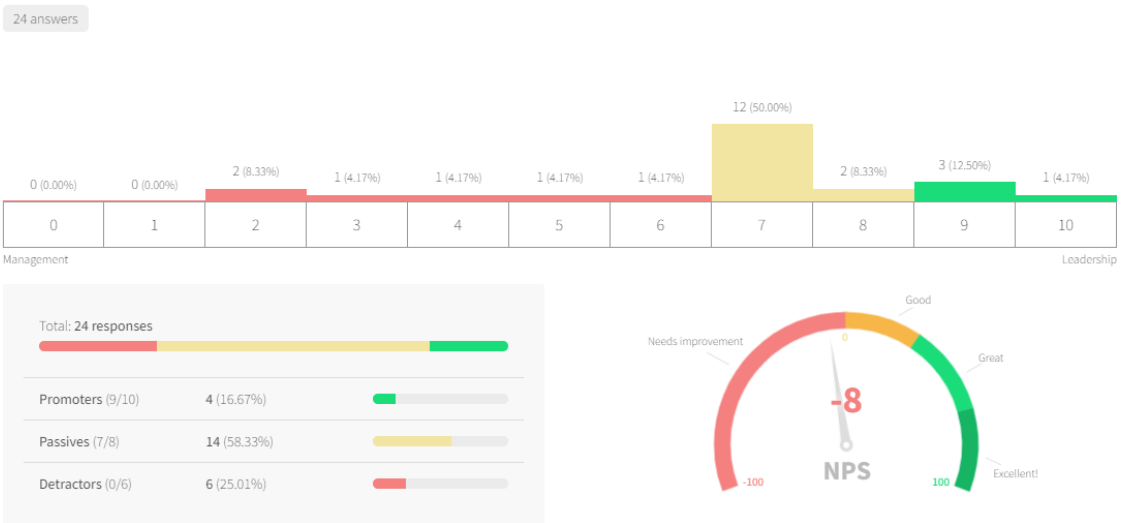


Total: 24 responses		
Promoters (9/10)	2 (8.33%)	
Passives (7/8)	10 (41.67%)	
Detractors (0/6)	12 (50%)	



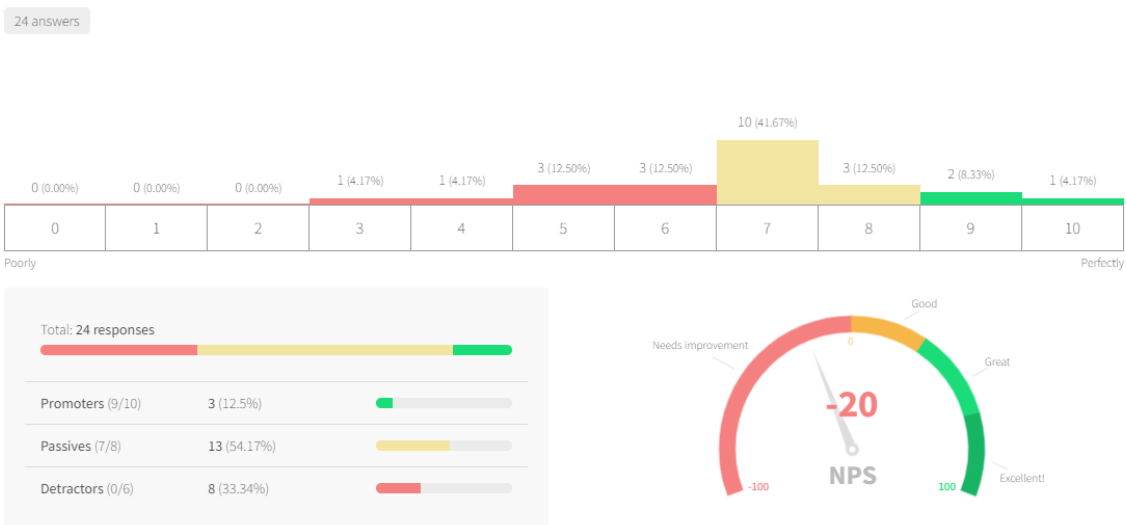
5. Which management method is closer to your personal style?

Please position yourself in the scale.



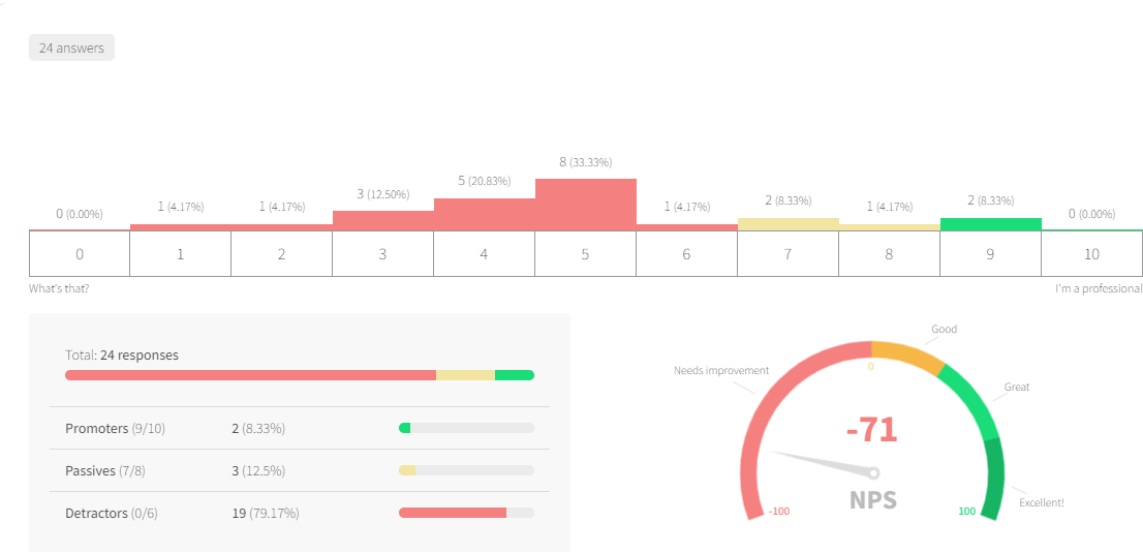
6. How have you managed to carry out your strategy and vision with your subordinates?

Do your workers understand your vision, utilize tools and strategies you offer them? Or do you feel disconnected from them?



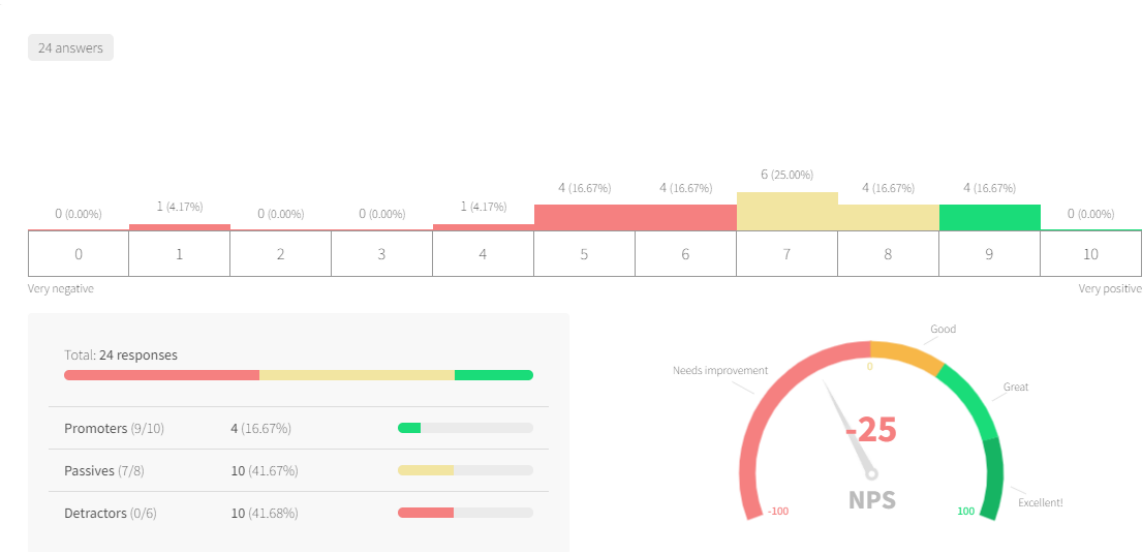
7. How familiar are you with artificial intelligence (AI) solutions?

Select a number signifying your level of knowledge.



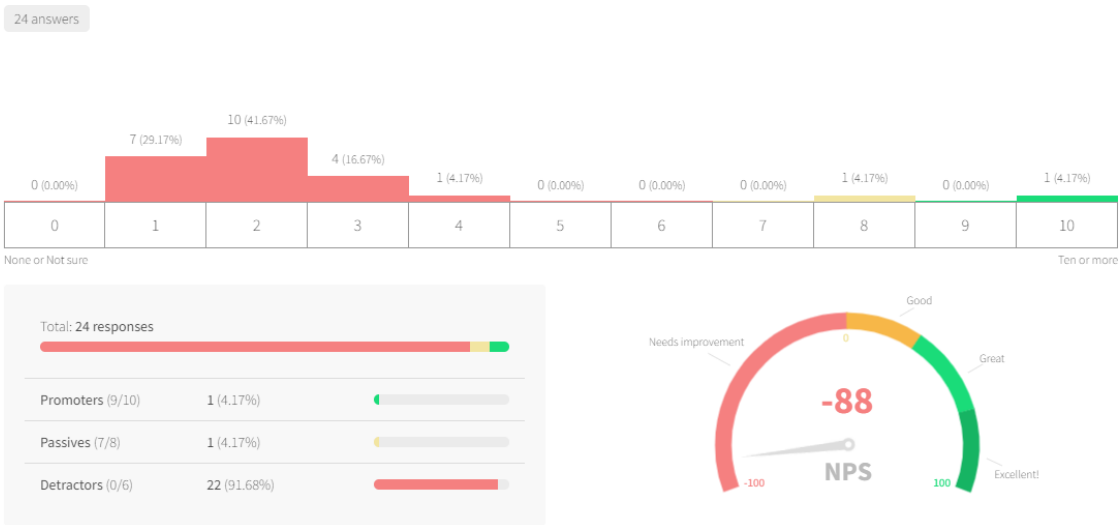
8. Please rate your personal attitude towards AI.

Select an option closest your current mindset.



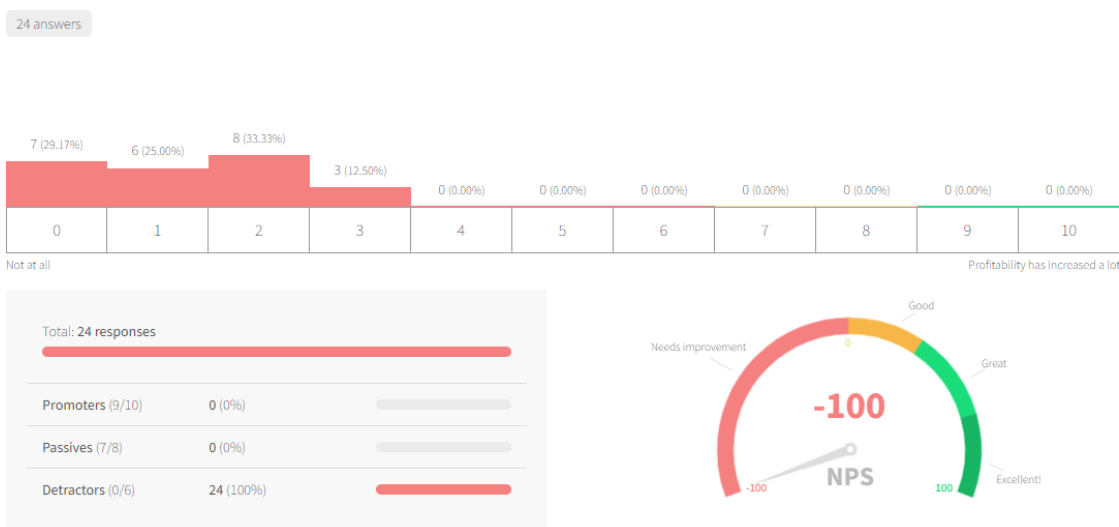
9. How many AI technologies/solutions you have in place in your business?

If you don't know how many you use, just guess.



15. Has your company seen financial benefits from the use of AI?

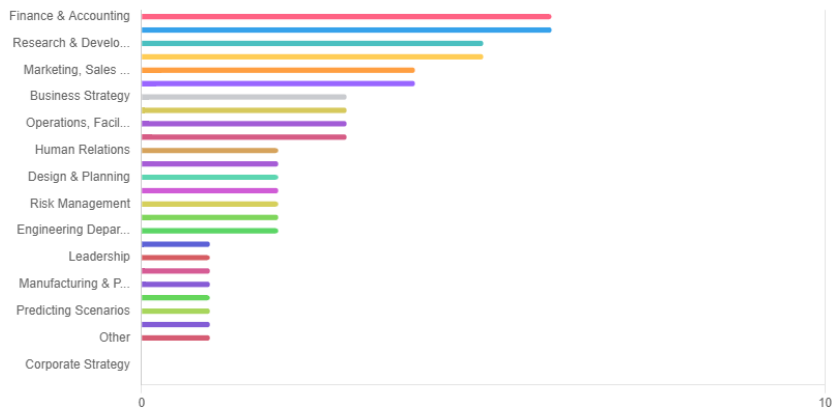
How much has your profitability increased with the help of AI?



19. Where is AI being used in your business?

Please select as many business categories operating with AI as you are aware of.

64 answers



OPTIONS	ANSWERS	PERCENTAGE
● Finance & Accounting	6	09.4%
● IT	6	09.4%
● Research & Development	5	07.8%
● Not sure	5	07.8%
● Marketing, Sales & Public Relations	4	06.3%
● Construction Site	4	06.3%
● Business Strategy	3	04.7%
● Customer Service	3	04.7%
● Operations, Facilities, Fleet Management	3	04.7%
● Safety	3	04.7%
● Human Relations	2	03.1%
● Legal & Regulation	2	03.1%
● Design & Planning	2	03.1%
● Quality Management	2	03.1%

● Risk Management	2	03.1%	
● Decision Making	2	03.1%	
● Engineering Department	2	03.1%	
● Procuments	1	01.6%	
● Leadership	1	01.6%	
● Management	1	01.6%	
● Manufacturing & Production	1	01.6%	
● Communications	1	01.6%	
● Predicting Scenarios	1	01.6%	
● Project Department	1	01.6%	
● Other	1	01.6%	
● Logistics	0	00.0%	
● Corporate Strategy	0	00.0%	
● Collaboration between organizations	0	00.0%	

20. How do you work with AI?

Here are some known work methods with AI.

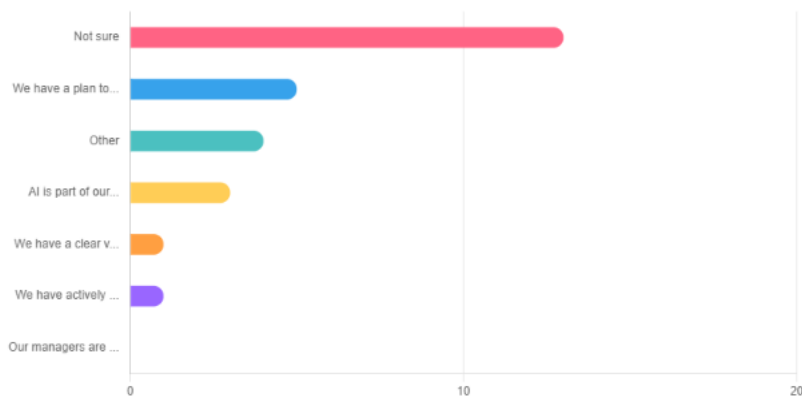
28 answers



OPTIONS	ANSWERS	PERCENTAGE
Not sure	10	35.7%
Use design thinking	5	17.9%
Take risks with AI related investment decisions	4	14.3%
Use standards building AI tools	4	14.3%
Other	4	14.3%
Work with clear AI governance framework	1	03.6%
Utilize advanced AI deployment processes	0	00.0%

21. What strategic variables are you utilizing with AI?

27 answers



OPTIONS

ANSWERS

PERCENTAGE

● Not sure

13

48.1%

● We have a plan to create value with AI

5

18.5%

● Other

4

14.8%

● AI is part of our corporate strategy

3

11.1%

● We have a clear vision and strategy

1

03.7%

● We have actively developed partnerships within AI sphere

1

03.7%

● Our managers are devoted to AI strategy

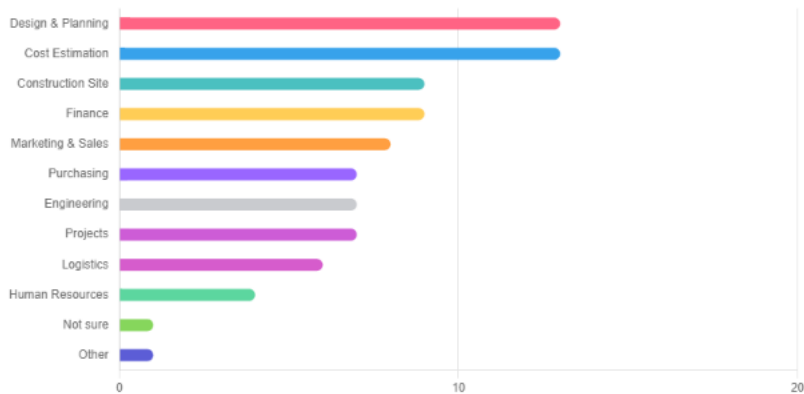
0

00.0%

23. In your opinion, which are the highest impact functions for AI?

Where, in your opinion, are the most gains to be achieved?

85 answers

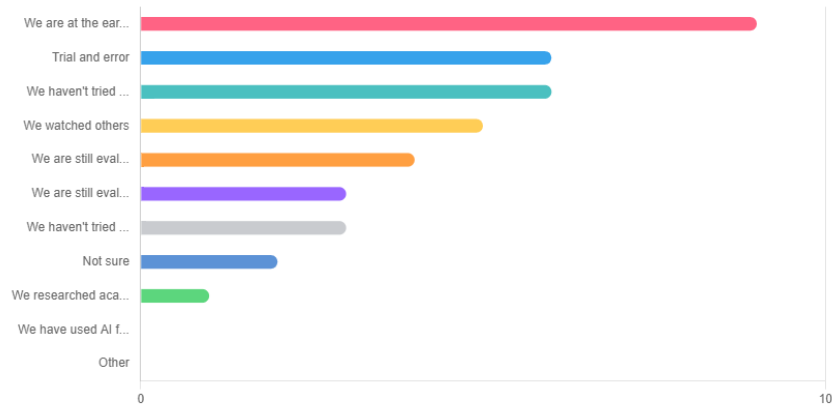


OPTIONS	ANSWERS	PERCENTAGE
Design & Planning	13	15.3%
Cost Estimation	13	15.3%
Construction Site	9	10.6%
Finance	9	10.6%
Marketing & Sales	8	9.4%
Purchasing	7	8.2%
Engineering	7	8.2%
Projects	7	8.2%
Logistics	6	7.1%
Human Resources	4	4.7%
Not sure	1	1.2%
Other	1	1.2%

24. How did you learn to use AI?

Please tell us how have you progressed with AI. If you answered either of the "We haven't tried anything new"-questions, please explain briefly by clicking also option 'Other' and type your reasons.

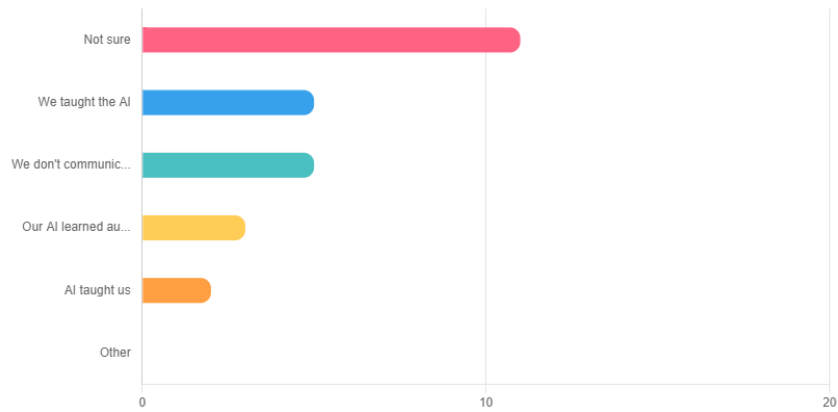
39 answers



OPTIONS	ANSWERS	PERCENTAGE
We are at the early stages of our learning process	9	23.1%
Trial and error	6	15.4%
We haven't tried anything new with AI (because we couldn't, for various reasons)	6	15.4%
We watched others	5	12.8%
We are still evaluating AI and the need for it	4	10.3%
We are still evaluating learning methods	3	07.7%
We haven't tried anything new with AI (because we didn't need to)	3	07.7%
Not sure	2	05.1%
We researched academic or other sources	1	02.6%
We have used AI for long without progress in learning	0	00.0%
Other	0	00.0%

25. How was your organizational learning process with AI?

26 answers

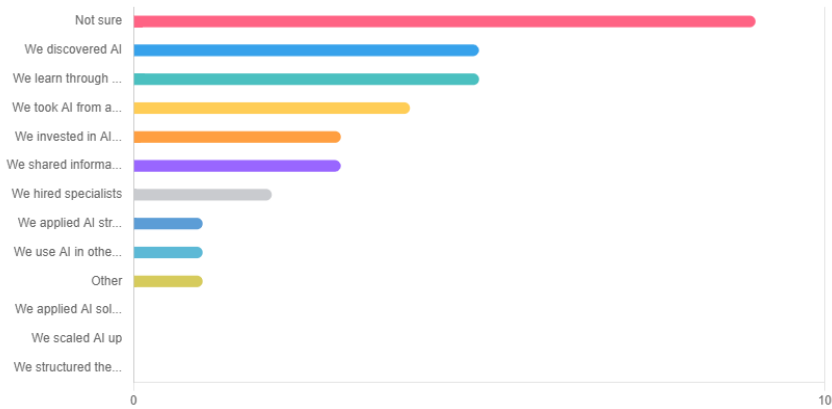


OPTIONS	ANSWERS	PERCENTAGE
● Not sure	11	42.3%
● We taught the AI	5	19.2%
● We don't communicate with AI	5	19.2%
● Our AI learned autonomously	3	11.5%
● AI taught us	2	07.7%
● Other	0	00.0%

26. Please select all options that apply to your business.

This will help us determine at which stage you are with AI.

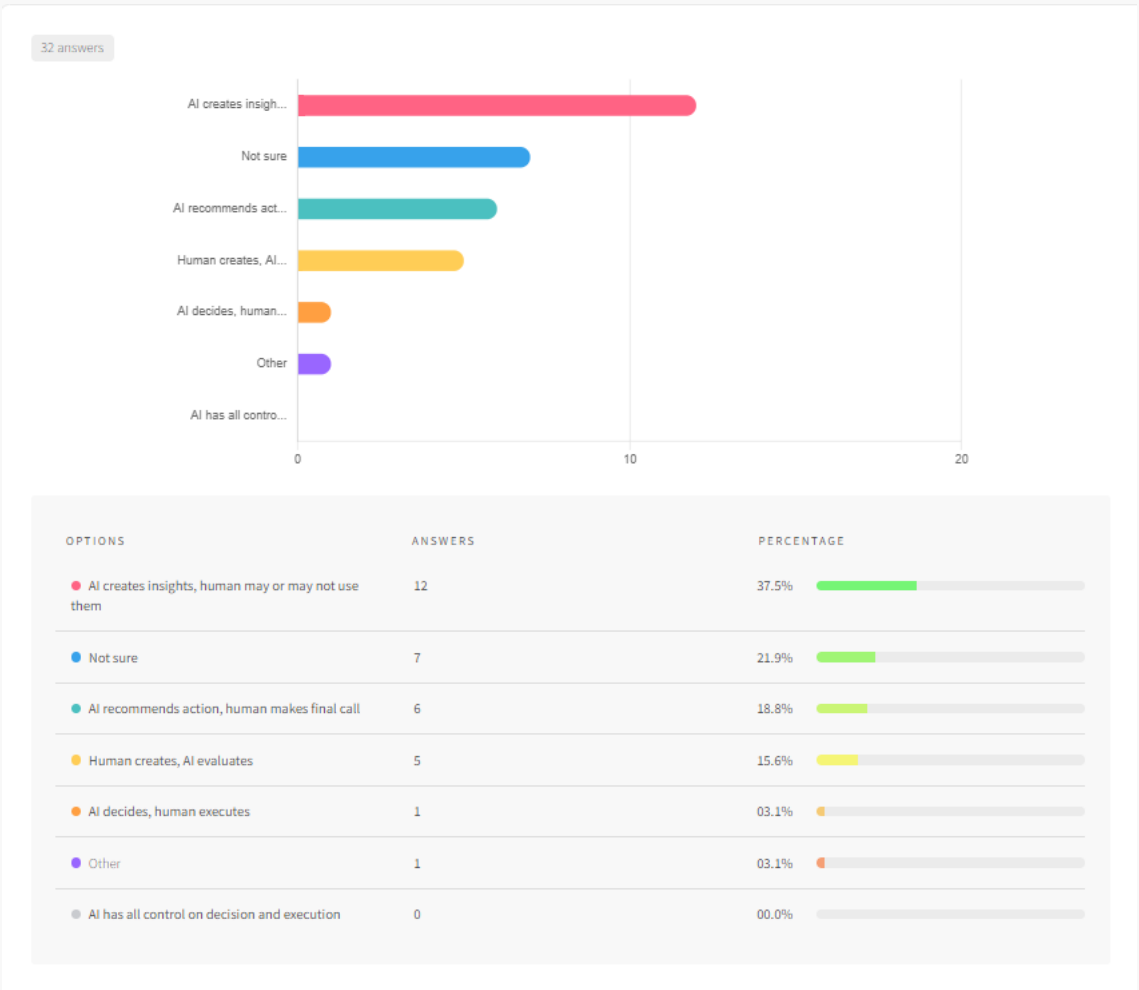
34 answers



OPTIONS	ANSWERS	PERCENTAGE
Not sure	9	26.5%
We discovered AI	5	14.7%
We learn through collective knowledge and adapt accordingly	5	14.7%
We took AI from an experiment trial to organizational use	4	11.8%
We invested in AI infrastructure	3	8.8%
We shared information between human and AI	3	8.8%
We hired specialists	2	5.9%
We applied AI strategy	1	2.9%
We use AI in other fields beside automation	1	2.9%
Other	1	2.9%
We applied AI solutions effectively	0	00.0%
We scaled AI up	0	00.0%
We structured the modes of interaction between humans and AI	0	00.0%

27. How many modes of interaction does your company use with AI?

Select all that apply to you. Look at this from the perspective of individual tasks that AI takes care of.



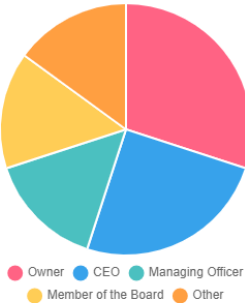
Main Survey: Not using AI

LAB-University of Applied Sciences
Master of International Business Management
2022
Otto Kirjalainen

2. What is your current role in your company?

This is a multiple choice question. You can choose more than one option - in most cases. If there isn't a suitable option available, type it yourself by clicking 'Other'.

20 answers

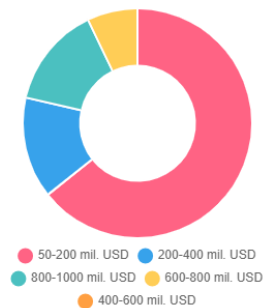


OPTIONS	ANSWERS	PERCENTAGE
Owner	6	30.0%
CEO	5	25.0%
Managing Officer	3	15.0%
Member of the Board	3	15.0%
Other	3	15.0%

3. Please select your company size measured in yearly revenues. (USD = US dollars/year)

Indicate your company size by selecting your most recent yearly revenue bracket. We are using GARTNER's definition of mid-sized business; 50 mil. - 1 mrd. USD revenues/annum.

14 answers

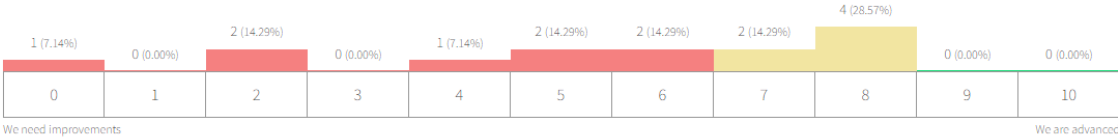


OPTIONS	ANSWERS	PERCENTAGE
50-200 mil. USD	9	64.3%
200-400 mil. USD	2	14.3%
800-1000 mil. USD	2	14.3%
600-800 mil. USD	1	07.1%
400-600 mil. USD	0	00.0%

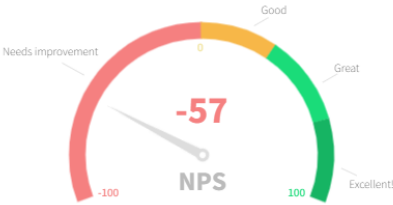
4. Please rate how advanced your company is, in terms of business strategy, leadership practices and technology.

This is a ratings question where you can select a number from the scale as your answer.

14 answers



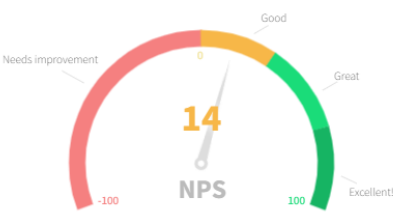
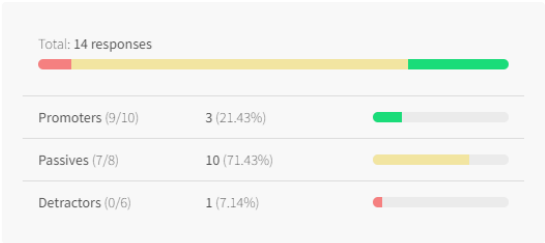
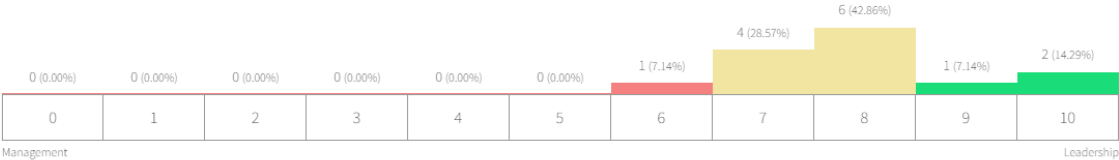
Total: 14 responses		
Promoters (9/10)	0 (0%)	
Passives (7/8)	6 (42.86%)	
Detractors (0/6)	8 (57.15%)	



5. Which management method is closer to your personal style?

Please position yourself in the scale.

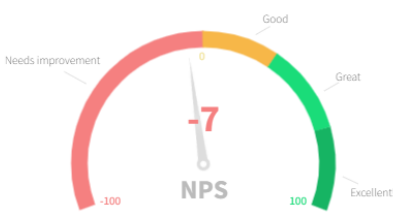
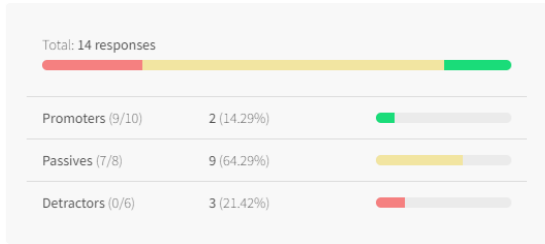
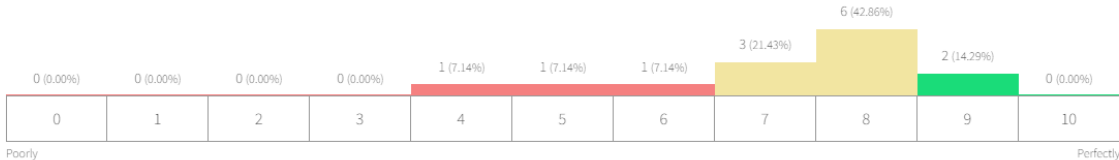
14 answers



6. How have you managed to carry out your strategy and vision with your subordinates?

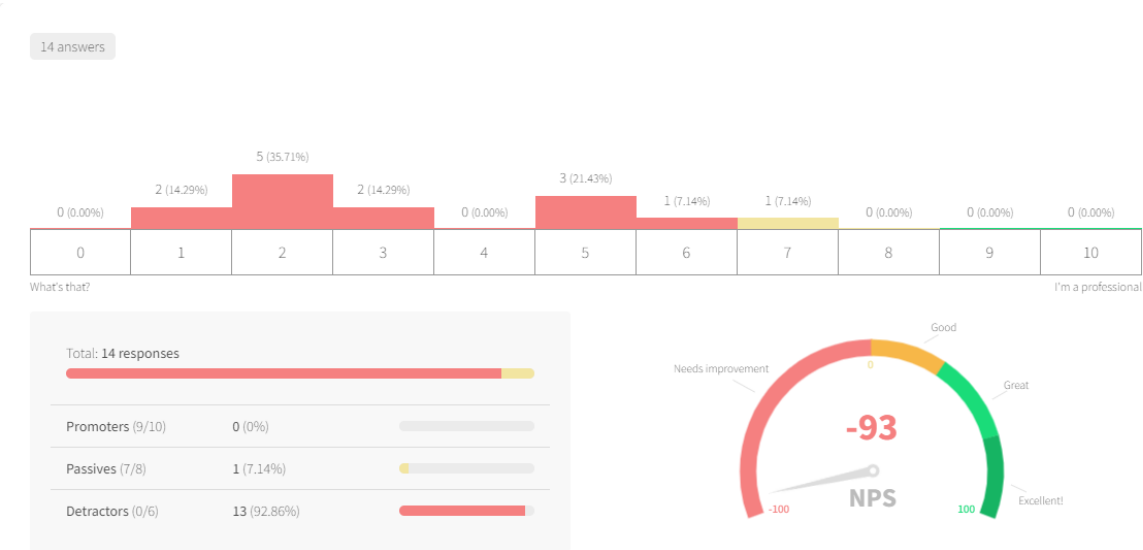
Do your workers understand your vision, utilize tools and strategies you offer them? Or do you feel disconnected from them?

14 answers



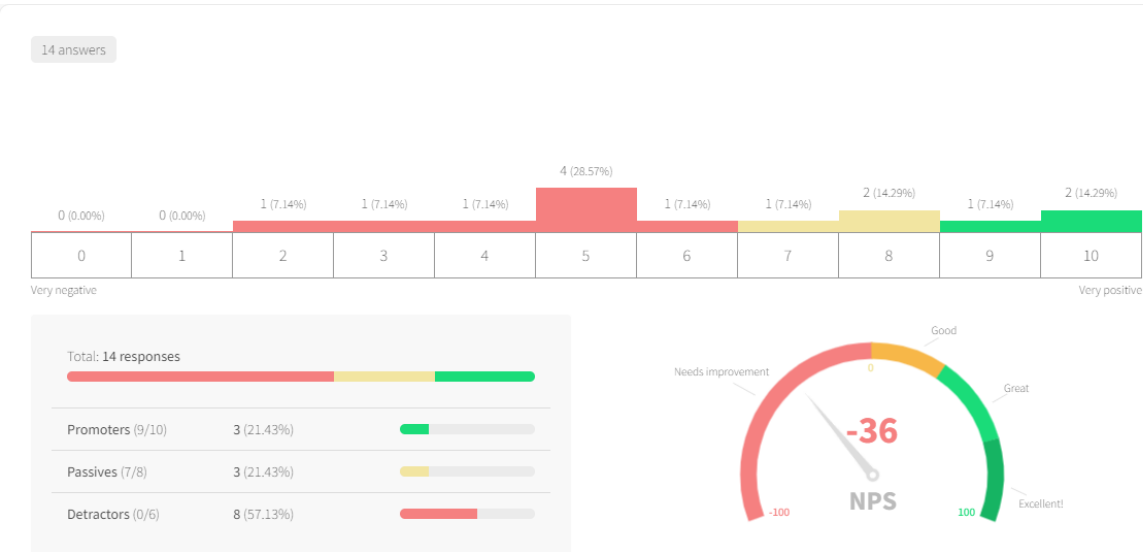
7. How familiar are you with artificial intelligence (AI) solutions?

Select a number signifying your level of knowledge.



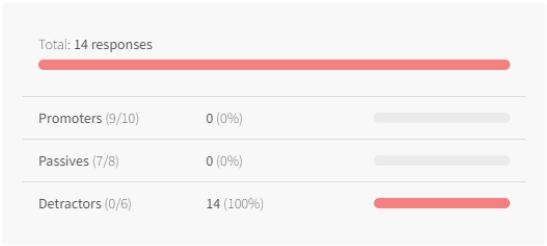
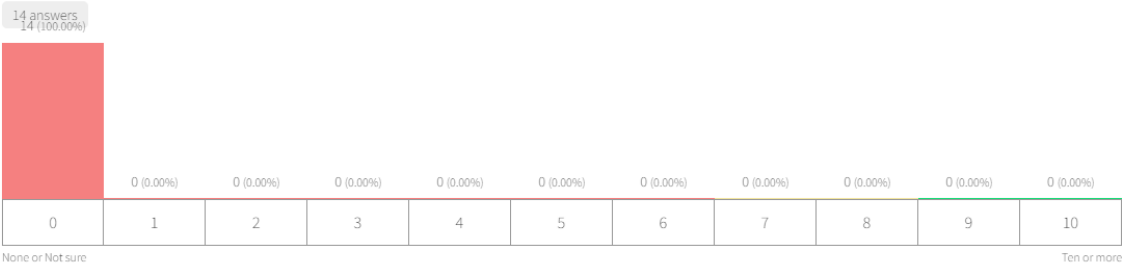
8. Please rate your personal attitude towards AI.

Select an option closest your current mindset.



9. How many AI technologies/solutions you have in place in your business?

If you don't know how many you use, just guess.



10. We would like to know why?

Tell us what are your reasons for not choosing to use AI in your company.

18 answers



OPTIONS	ANSWERS	PERCENTAGE
It has not been tested enough	5	27.8%
We lack the budget and/or time	4	22.2%
We don't need it	3	16.7%
We don't understand it	2	11.1%
Not sure	2	11.1%
Other	2	11.1%
We don't like it	0	00.0%

11. Did your business try using AI before this survey?

14 answers

OPTIONS	ANSWERS	PERCENTAGE
We have not tried or tested AI	11	78.6%
Not sure	2	14.3%
We have tried AI once but failed	1	07.1%
We have tried multiple times, and failed	0	00.0%
We tried AI and succeeded but scrapped it nonetheless	0	00.0%
Other	0	00.0%

12. What were the main reason(s) for aborting AI?

Choose as many as you like.

This question was reserved for those answered previous question: "We have tried AI once but failed".

3 answers

OPTIONS	ANSWERS	PERCENTAGE
☒ Complexity	1	33.3%
☒ Higher expectations	1	33.3%
☒ Not sure	1	33.3%
☐ Absence of results	0	00.0%
☐ High costs	0	00.0%
☐ Time consumption	0	00.0%
☐ Replacement idea	0	00.0%
☐ Other	0	00.0%

13. What about the future?

Will you try again?

3 answers

OPTIONS	ANSWERS	PERCENTAGE
☒ No sure	2	66.7%
☒ We will try it again soon	1	33.3%
☐ Never again	0	00.0%
☐ We will try again after a long period of time	0	00.0%
☐ We will search for other suitable technologies	0	00.0%
☐ Other	0	00.0%

14. Why so?

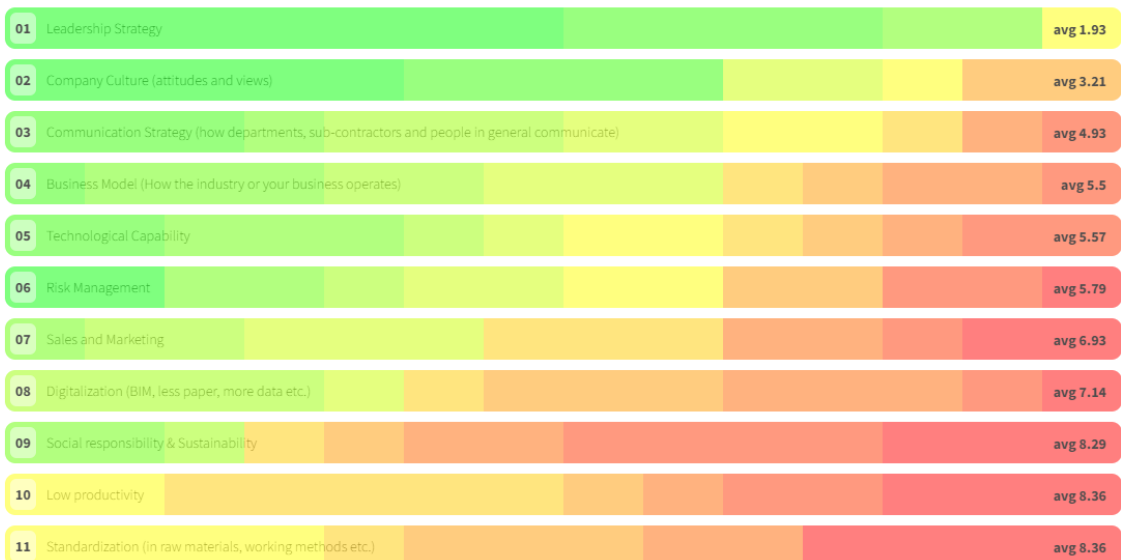
14 answers



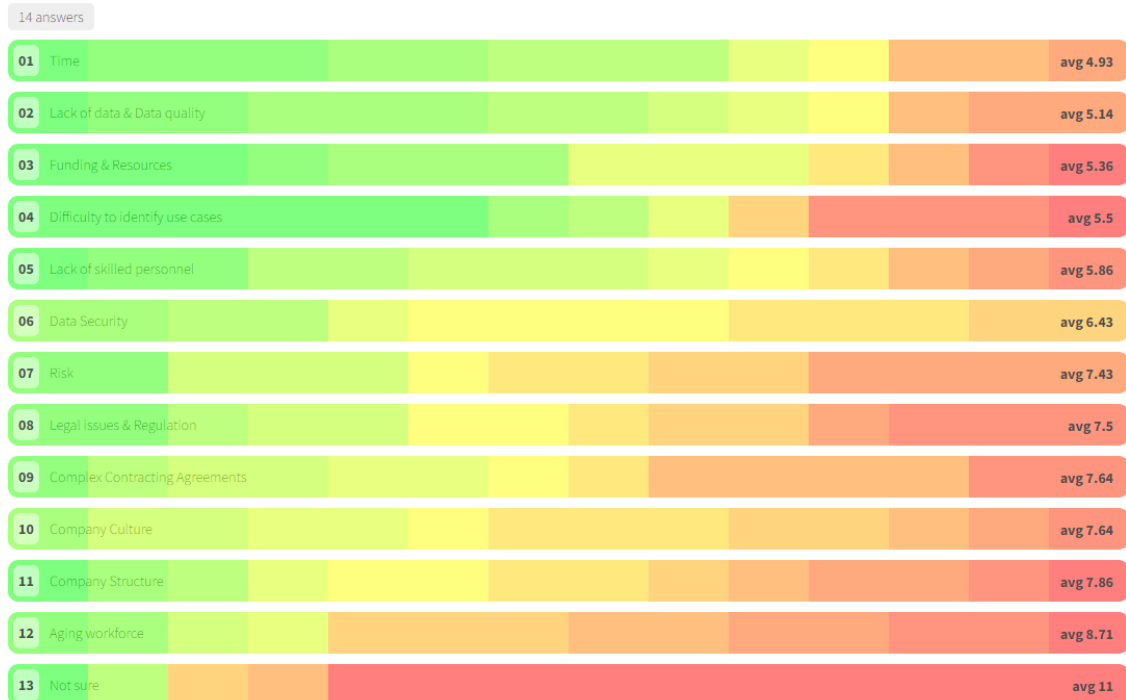
29. Please organize options from most important to least important, in terms of functions to update in building construction industry.

If you had the power to change the industry, what would be your ranking? Use drag-and-drop method to arrange options according to your preferences.

14 answers



30. Please rank obstacles to AI adoption in building construction industry, from most to least important.



31. Please rank obstacles to AI adoption in your company, from most to least important.

