AI meets MAASTRO

UCM THINK TANK

Maastricht University

Maastro

For privacy reasons the names of the students who have created this report are not displayed. If you have any questions or would like to get in contact with its authors, please e-mail f.lysen@maastrichtuniversity.nl

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Executive Summary

This Think Tank served as a task to find models for management and organizational change during technical transitions, more specifically AI and automation, at Maastro, an independent clinic located in Maastricht. The clinic provides clinical patient care using radiotherapy and performs clinical radiotherapy research. Recently, the clinic has been suggesting the possible use of AI in the future of their radiotherapy treatments and asked Think Tank to provide practical considerations regarding implementing this technology in Maastro's work environment. The main question that guides our report is as follows: *"How should the managers at Maastro responsibly guide the current transformation caused by new AI and automation technologies?".* Through the combined efforts of an interdisciplinary student team at the University College Maastricht, recommendations for Maastro were made in this report to develop suitable solutions when integrating artificial intelligence. Essentially, this report focuses on the stakeholders at Maastro affected by changes of AI, such as radiotherapy technologists (RTT). In addition, this Think Tank takes a closer look at the potential needs of individuals. It offers a list of recommendations for Maastro to equip its employees better to deal with these new challenges. The conclusions drawn from this report are based on the active process of literature research and discussions surrounding artificial intelligence in different scenarios. The gathered research takes a closer look at AI's impact in the medical practice and other fields, psychological models of job security, and the need to implement dynamic education to positively integrate this new disruptive technology. The external fields we included in our research were air traffic control, automated driving and the Sepsis Watch app. In addition, three employees at Maastro were interviewed in order to grasp the themes from stakeholders better. By combining both primary and secondary research, we have assembled what we think are the essential elements of those various established models and existing recommendations. The three most important models we have encountered in the literature are the automation acceptance model, horizontal collaborative network, and lean application. However, these were not the only ones we assembled into our conceptual assemblage. This Think Tank's unique contribution is to gather the most suitable and innovative combination of those recommendations based on existing models. Therefore, we have divided our understanding of answering these questions into five parts; management, task restructuring, framing, education and further research.

Managementsamenvatting

Deze Denktank had als taak om modellen voor organisatorische veranderingen te vinden ten tijde van technische overgangen, in het bijzonder kunstmatige intelligentie en automatisering, in Maastro, een onafhankelijke kliniek gevestigd in Maastricht. De kliniek biedt klinische patiëntenzorg met behulp van radiotherapie en verricht klinisch radiotherapeutisch onderzoek. Onlangs heeft de kliniek gesuggereerd kunstmatige intelligentie in de toekomst van hun radiotherapie behandelingen te gaan gebruiken en de Denktank gevraagd om praktische overwegingen te geven over de implementatie van deze technologie in de werkomgeving van Maastro . De belangrijkste vraag die ons in ons rapport gesteld wordt, is als volgt: *"Hoe moeten de managers van Maastro op verantwoorde wijze de huidige transformatie leiden die wordt veroorzaakt door nieuwe kunstmatige intelligentie- en automatiseringstechnologieën?".* Door de gezamenlijke inspanningen van een interdisciplinair studententeam van University College Maastricht zijn in dit rapport aanbevelingen voor Maastro gedaan om passende oplossingen te ontwikkelen bij het integreren van kunstmatige intelligentie. In wezen richt dit rapport zich op de belanghebbenden bij Maastro die worden beïnvloed door veranderingen van kunstmatige intelligentie, zoals radiotherapie technologen (RTT). Daarnaast neemt deze Denktank de potentiële behoeften van individuen onder de loep. Het biedt een lijst met aanbevelingen voor Maastro opdat zijn medewerkers beter met deze nieuwe uitdagingen om te kunnen gaan. De conclusies uit dit rapport zijn gebaseerd op het actieve proces van literatuuronderzoek en discussies rond kunstmatige intelligentie in verschillende scenario's. Het verzamelde onderzoek gaat nader in op de impact van kunstmatige intelligentie in de medische praktijk en andere gebieden, psychologische modellen van baanzekerheid en de noodzaak om dynamisch onderwijs te implementeren om deze nieuwe technologie positief te integreren. De externe velden die we in ons onderzoek hebben opgenomen waren luchtverkeersleiding, automatisch rijden en de Sepsis Watch-app. Daarnaast zijn drie medewerkers van Maastro geïnterviewd om de thema's van belanghebbenden beter te begrijpen. Door zowel primair als secundair onderzoek te combineren, hebben we de volgens ons essentiële elementen van die verschillende gevestigde modellen en bestaande aanbevelingen verzameld. De drie belangrijkste modellen die we in de literatuur zijn tegengekomen zijn het automatiserings acceptatiemodel, het horizontale samenwerkingsnetwerk en de lean applicatie. Dit waren echter niet de enigen die we in onze conceptuele assemblage verzamelden. De unieke bijdrage van deze Denktank is het verzamelen van de meest geschikte en innovatieve combinatie van die aanbevelingen op basis van bestaande modellen. Daarom hebben we de antwoorden van deze vragen in vijf delen verdeeld; management, taakherschikking, framing, educatie en verder onderzoek.

List of Recommendations

The following list of recommendations provides an overview of the Think Tank's recommendations to Maastro. They will be explained and contextualized throughout this report.

Management and organization

1. Create a horizontal collaborative network through interdisciplinary teams.
2. Officially and explicitly communicate about the intended introduction of AI.
3. Make use of a Point of Care (P-O-C) tool to bridge the gap between research and practice and for communication within Maastro.
4. Use (international) web-based communities outside of Maastro and social media to connect to other radiation oncology professionals.

Framing

5. Frame new tasks due to AI's implementation as a challenging and enriching experience that will broaden employees' expert knowledge.
6. Demystify the reliability of AI.

Education

7. Provide theoretical background knowledge on AI technology, the consequences of its use and the impact on workflows.
8. Maastro's Academy Should Include Trust Training in Employees' Curriculum
9. Introduce Adaptive Automation and foster practical experiences through training sessions to prevent employees' deskilling.
10. Ensure that RTTs have the skills to communicate AI findings in an understandable manner to patients and colleagues.
11. Teach RTTs computational thinking to deal with the increasing complexity of remaining manual tasks.
12. Continue applying Lean while personalizing it to the interest of Maastro's employees.
13. Avoid methodological overload of RTTs by distributing or balancing knowledge on different treatment planning methods.

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1. Abbreviations

AA = Adaptive Automation

AI = Artificial Intelligence

ATC = Air Traffic Control

ATCos = Air Traffic Controllers

CORA = Conflict Resolution Assistant

CT = Computer Tomography

M-HAT = Modified Human-Automation Trust scale

OOTL = Out-Of-The-Loop

P-O-C = Point of Care (Tool)

RTT = Radiotherapy Technician

SA = Situation Awareness

SAGAT = Situation Awareness Global Assessment Technique (SAGAT)

SOP`s = Standard Operating Procedures

2. Introduction and Problem Analysis

a. Introduction of Maastro

Maastro is a Maastricht-based radiotherapy clinic specialized in treating cancer patients. The organisation focuses on creating a bridge between education, scientific research and patient care (Maastro, 2021). Hence, it is a pioneer in technological advancements and implementing the latest scientific research with a national and international influence. As automation, driven explicitly by artificial intelligence (AI)-techniques, is currently entering the radiotherapy domain (Hussein, Heijmen, Verellen, & Nisbet, 2018; Nystrom, Jensen, & Nystrom, 2019), Maastro has been incorporating AI to generate treatment plans for cancer patients automatically. The hope is that thereby accuracy, quality and productivity of treatments are enhanced. Yet, the AI implementation seems to result as well in new challenges for the organisation.

b. Problem Defined by Maastro

The Maastro clinic presented the problem to us as the following:

New forms of automation are expected to significantly impact the practice of radiotherapy, particularly on the day-to-day work of radiation technologists. AI-supported applications have already started to automate the generation of radiation treatment plans - a task that currently takes about 50% of the time of radiotherapy technicians (RTTs). In the future, AI may also serve the (partial) automation of the actual irradiation of patients. Such developments raise potentially controversial questions about patient safety, liability, responsibility, 'trust' in technology, etc.

AI and forms of automation are causing changes in the type of work and the variation of jobs for radiation technologists. This also means radiation technologists will need a different set of skills. The professional focus will probably shift from performing computational tasks to checking and controlling the equipment. However, RTTs should still need to understand these tools. New tools will allow for more individualized decision making to optimize the individual patients' treatment. Therefore, medical decision-making is required rather than technical expertise. Yet, currently, awareness of these oncoming changes among the group of radiation technologists is relatively low and does not seem to lead to a sense of urgency or alarm (a reaction that appears to be in line with previous research about responses to automation) (Terminio & Gilabert, 2017).

However, not all employees affected by automation may feel comfortable with these changes: some might not like how their work is changing, and others might not be able (or willing) to adopt the

necessary new skillset. Hence, a vital and urgent question for the Maastro clinic is: how should the managers at Maastro responsibly guide the current transformation caused by new AI and automation technologies?

c. Problem Analysis of the Think Tank

i. Context

To further understand the context of AI in radiotherapy, a brief outline of the subject's noteworthy political and historical development should be given. Looking back at past actions should help to grasp the challenges that the implementation of new technologies holds and helps to situate the current goal of Maastro to use AI in radiotherapy. Overall, the field of radiation in oncology "has seen a rapid transformation from clinic and hypothesis-based medical art to technology and evidence-driven science" (Rattan et al., 2019). The close link to scientific research (e.g. clinical trials) is also an integrated part of today's work at Maastro.

Looking at the history of radiotherapy, the findings of sociologist Cynthia Cockburn provide valuable insights and parallels to recent questions on automation technology implementation. She conducted research in British hospitals in 1983, observing the process of implementing the novel technology of Computed Tomography's (CT) in radiotherapy for cancer diagnosis. Firstly, she reported that doctors acknowledged the innovation but reported tensions and "movement in the relationships between these various groups of professional and technical employees" (Cockburn, 1985, p.116). In our interviews, it evinced that similar developments are also present at Maastro. Such tensions might be due to a change of skills and additional responsibility (Cockburn, 1985, p.124). Further, some employees that Cynthia Cockbrun interviewed criticized a shift towards "push the button job(s)", leading to an increased monotony in their job routines as well as less opportunity to interact with patients (Cockburn, 1985, p.121). Despite these circumstances, it was observable that individuals, independently of their duties, used their ideas and personal skills when confronting this new challenge (Cockburn, 1985, p.117). Therefore, once the handling of the latest technology was learned, it was an advantage on the labour market (Cockburn, 1985, p.122). Double the number of patients could be treated in only a couple of years. In the end, it turned out that most radiographers were "pleased by the arrival of computed tomography" but wouldn't like to work on it full-time (Cockburn, 1985, p.124). This preference was due to the more monotone way of work, but it would "mean gaining an additional skill" just to "lose the ability to practice those they already have" (Cockburn, 1985, p.124).

Similar worries and concerns about changes in job tasks, satisfaction and the work environment are still relevant today when new technologies are introduced, especially when looking

at automating working processes with AI. Despite mentioned challenges, Cockburn's qualitative research emphasises the positive aspects of introducing new technologies. Namely, the CT added to the competence of the staff; it also added new dimensions to (anatomical) knowledge, opened career protects, and overall improved treatments (Cockburn, 1985, p.123). This data is valuable as it points out changes and potential challenges that come along with the implementation of new technologies. Similar observations were found throughout our exchange with the Maastro team and our research about the consequences of implementing AI.

When we look at today's implementation stage of AI in healthcare, it is not as advanced as other fields, such as the driving industry. There is missing "data quality and quantity" in certain fields, while treatment complexity for cancer patients is rising (Kann et al., 2021). However, within oncology, treatment planning is a central promising application point for AI, and it is expected that the use of AI in healthcare will increase exponentially (Kann et al., 2021; Netherton et al., 2020)

However, as showcased in studies like those mentioned above conducted by Cockburn, technological changes in healthcare are accompanied by concerns regarding responsibility and the impact on patients and employees (Rattan et al., 2019). Additionally, due to the comparably relatively unexplored nature, people are concerned about "demographic discrepancies concerning patients, disease and their natural history and reports of manipulation of AI, the ultimate responsibility will rest on the treating" (Rattan et al., 2019). These concerns are understandable, especially regarding peoples experience throughout history where new technologies lead to the extinction of jobs in specific sectors (job insecurity). An extreme example would be the changes clothing workers faced due to the introduction of new technologies (Cockburn, 1985, p.126). However, with change come new opportunities, as seen in the previous example (e.g., better treatment). Therefore, the goal should be to recognize and acknowledge challenges that come with implementing new technology so that solutions can be sound to reasonably introduce and benefit from technological advancements. Thus, Maastro can learn from history and other fields to avoid potential pitfalls and make the AI implementation process as smooth as possible. Regarding this context, we can agree that the argument for a comparative analysis to other fields in which AI is introduced is valuable to answer the questions proposed by Maastro. Therefore, we will use this perspective as a critical component in the development of our report.

ii. Stakeholders Affected by Maastro's AI Implementation

Three significant stakeholders may be concerned with Maastro's AI implementation: Mastro's managers, the employees - especially RTTs, and the clinic's patients. Yet, even within the three groups, differences exist. Especially among the RTTS, individual differences need to be taken into account. Age

is a determinant factor for AI acceptance in the workplace, where younger employees are more willing to incorporate technology (Li, Bonn, & Haobin Yea, 2019). Moreover, some RTTs work full time while others work part-time. An interviewed RTT explained that, on average full-time workers are more committed and engaged in the clinic. This impacts the smooth AI implementation, as higher job engagement facilitates change processes. Another variable is the RTTs' knowledge regarding treatment plans. The RTT **interviewee 2** mentioned that deeper treatment plans knowledge is increasingly needed for complex treatments which AI is currently not able to develop. Overall, this shows that the perception of AI may vary among those who are affected by automation.

Further, the decision to implement AI was taken as a top-down decision by the management. This implies that increased automation was not necessarily chosen by the RTTs (or the patients), but they now have to adjust to it. Identifying the needs and interests of the different stakeholders will be essential to identify potential conflicts, resolve them and come together. Thereby, it became apparent during the two client meetings that the focus for Maastro lies on the AI implications for employees and less on the effects for patients. For the latter, there are currently no significant changes in treatment. Thus, due to the limited scope of this project, the Think Tank follows Masstro's preference and focuses on the consequences for RTTs of the management decision to implement AI.

iii. Mission, Vision and Strategy of Maastro

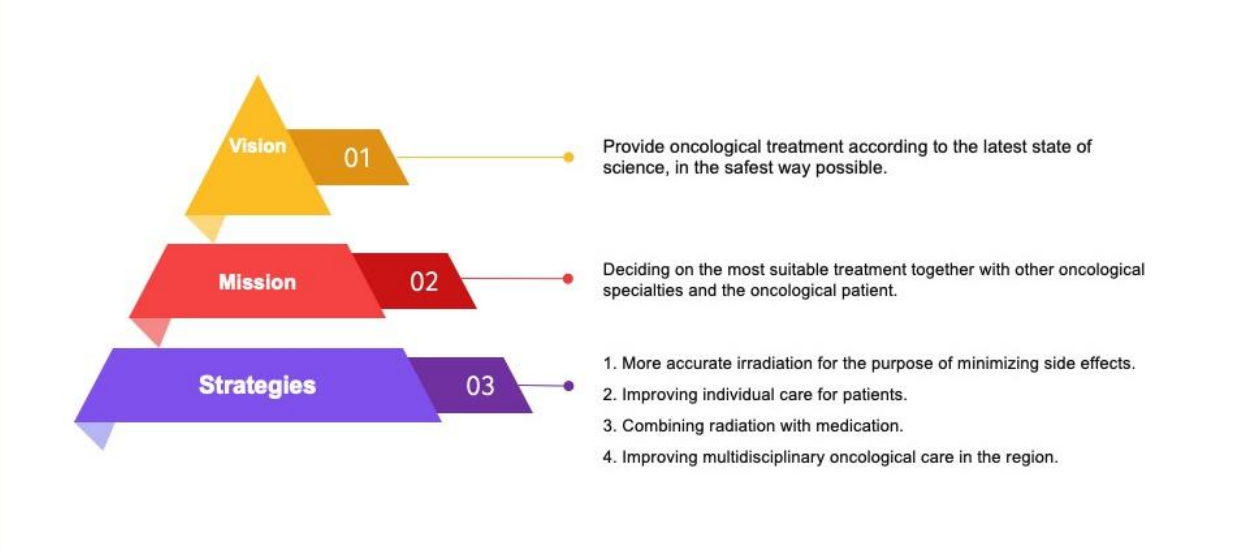

Figure 1: Mission, Vision, Strategies of Maastro

Maastro's overall vision is to provide oncological treatment according to the latest state of science in the safest possible way (see figure 1) (Maastro, 2021). That means to decide on the most suitable treatment with other oncological specialities and their patient with the greatest chance of cure and the least physical and mental side effects (mission). For decision-making, Maastro stresses the

importance of scientific research and educational programmes aiming at improving patient care. Further, Maastro formulated four strategies towards their mission for 2018 to 2022 in a strategic plan. One of them is to enhance individual care for patients. Therefore, the implementation of AI might be crucial to improve treatments. However, in order to benefit from automating specific processes, such as treatment planning, a model needs to be developed on how this can be reasonably done. The simple use of technology does not safely guarantee conduct treatment. Moreover, risk and insecurities can come along with the implementation of AI. Thus, the use of state-of -the-art tools should be congruent with Maastro's vision to provide safe treatment; therefore, successful collaboration among the employees of Maastro is essential. Consequently, Maastro's representatives emphasised the importance of employee satisfaction for their work tasks as well as their education and understanding about AI in order to follow their vision. As Martien van Bussel, manager of patient care stated: "it is not our intention to fire people with the AI implementation"; instead, automation should be in unity with their mission, vision and strategy to provide safe and effective treatment.

iv. Approaching the Problem

As already established, the management decision to implement AI at Maastro encounters several challenges. Specifically, the introduction of the new technology affects collaboration and work culture within the organisation. The tasks of employees are restructured, among which RTTs are primarily affected. Consequently, these changes impact job satisfaction and well-being. Thus, in order to approach the presented problem of successfully implementing AI at Maastro, a threefold conceptual framework is presented in the following (as indicated in Figure 2).

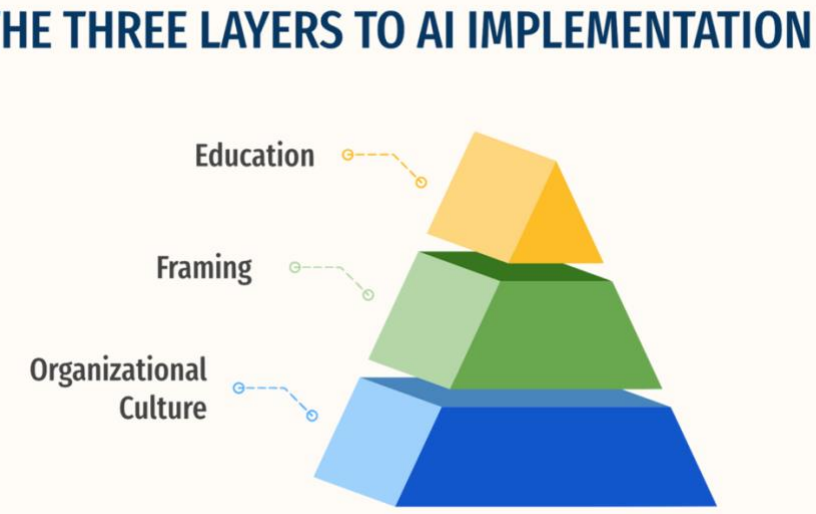

Figure 2: Visual representation of the three essential pillars for a successful implementation of AI at Maastro

First, Maastro's organisational culture and communication with the management arises as the foundation for the change forms. Therefore, it should be considered what fundamental elements are needed to create an atmosphere of trust. Questions are posed such as: How is the communication between the different members of Maastro? How can RTTs and other employees exchange their perspectives on the AI implementation? What is needed to secure their job satisfaction?

The second layer forms the framing of change. On the one hand, this concerns the precise understanding of task restructuring, which also raises questions about job insecurities - both in qualitative as well as quantitative nature. This implies people's fear of being replaced by a machine (quantitative) as well as of no longer being able to exercise some liked manual tasks (qualitative). On the other hand, it might be relevant to consider the idea people have in their minds about AI: benefits and risk. Consequently, it should be considered what conception is needed for a successful AI implementation at Maastro.

Thirdly, the implementation of AI at Maastro raises questions regarding the necessary education. What skills and education about AI are needed to implement the new technology successfully? How do people need to be re-educated? How can overload be avoided? These are some questions that will be answered in the following sections.

In sum, all three layers build on each other. Without supportive management and culture at Maatstro, AI cannot be accepted. Furthermore, AI should be framed as an opportunity and not as a threat, and finally, relevant education is needed for a successful AI implementation. This conceptual framework is the basis of the section of recommendations after the methodological approach.

3. Methodological Approach

In order to provide an answer to Maastro's research questions as well as the questions mentioned above in the previous section, the Think Tank took two different approaches. On the one hand, extensive literature research was conducted, following the client's suggestion. Thereby, our literature review was based on the three above mentioned topics: Management and organisational culture, framing of AI and changing tasks, and needed education. For each of these three sections, sub-topics (e.g., job satisfaction, change management, lean processes etc.) were researched. Additionally, comparative investigations about AI in other fields (air traffic control, automated driving, and healthcare) were undertaken.

Concerning the first topic concerning management and organisational culture, general effects of the AI implementation on the work environment were investigated. Topics such as job well-being, acceptance of change, trust of management decisions and effective communication for digital change

processes were relevant to give suggestions; further, the Think Tank looked at the managerial strategies that can support responsible digital transformation. Found managerial models were incorporated in a personalized manner for Maastro. An important topic which later translated into several recommendations was communication. Overall, findings were translated into suggestions found in the first section, 'Management and Organizational Culture', which specifically aims to create an enjoyable and supportive work environment, the first layer of the conceptual framework (see figure 2).

Secondly, it became apparent that the framing of AI and the changes in tasks due to its implementation significantly affect whether change in an organisation is supported. Thus, it was looked at how AI can be demystified so that negative misconceptions are replaced by recognizing that the technology can result in state-of-the-art treatment (in accordance with Maastro's vision). On the other hand, we looked at other fields, such as Air Traffic Control (ATC), to understand how this new technology has already been framed as a change to further develop the sector.

The third part of the following section focuses on the needed education to reasonably work with AI at Maastro. We were specifically concerned about the changes in competencies as well as what is necessary to ensure trust in AI and quality of care to allow for the responsible implementation of AI. Thus, the Think Tank's research looked at practical aspects of education's set up, concepts and knowledge that the RTTs need to know about the AI, and the changes in employees' skillset or job description.

Moreover, the Think Tank looked at successful examples of AI implementation in comparative fields. The aim was to provide Maastro with a different perspective and suggest innovative approaches that could be applied in the clinic. Deductions and predictions for Maastro were fed into the specific sections of the report. More specifically, the Think Tank looked into the air traffic control system, the automated driving field, and other areas of healthcare.

Air Traffic Control (ATC) seemed to be an excellent comparative case since air traffic controllers' tasks require highly educated people with incredible critical thinking and problem-solving abilities. They are thus a hard-to-replace elite of professionals. Nevertheless, efforts have been made to successfully implement AI in this field to provide air traffic controllers (ATCos) with more accurate information and decision-making aids. The shift towards automation in ATC was complicated but successful since issues such as the controllers' role changing, their AI acceptance, and the need for education were solved using effective plans and strategies. The Think Tank thus took inspiration from this comparative case in suggesting framing and educational strategies to Maastro.

Furthermore, we looked at general experiences within healthcare regarding automation and specifically the implementation of AI. Hereby, not only the radiology field provided insights. We used

different case studies in our analysis, such as AI implementation in hospital protocols. This case highlights the importance of a horizontal approach wherein all stakeholders participate in the change process. Showing the critical role of human labour in practical clinical work validates the sociotechnical view because it shows the systems in practice, its problems, and how to solve them (Elish & Watkins, 2020, p.27). With a sociotechnical approach, they consider the technical and social context of the implementation process, which is precisely what we want to include in our recommendations.

The third field of comparison forms the discussion about AI integration in fully autonomous vehicles. In this field, significant concerns were raised due to the complete takeover of technology; AI has received a lot of hesitation from individuals participating in research studies on this topic. According to a study by Lijarcio et al. (2019), knowledge about such technology creates a feeling of hostility amongst some users, especially due to its disruptive nature. In addition, the field of autonomous driving is a topic that has possible considerable effects of changing the way many people move around. Therefore, research in this field has been extensive and allows this Think Tank to explore essential considerations in the discussion about Maastro's ambitions to integrate artificial intelligence for radiotherapy treatments.

Aside from the extensive literature research, the Think Tank gathered qualitative data to gain additional knowledge for our recommendations. Therefore, people concerned with tasks restructuring, management and organisational culture interviewed two RTTs: **interviewee 1** and **interviewee 2** (transcript of the interview can be requested). This interview aimed to get some insights about the RTTs' perspective about implementing AI and the state of the arts in the clinic according to them. Thus, the two RTTs were asked what their job exactly looks like as of now; what do they know about the AI implementation in Maastro and what they think about the current communication about it within the clinic; what are RTTs' concerns about this change; what are the factors contributing to their motivation and job satisfaction. On the other hand, the education team interviewed **interviewee 3a** Maastro's education policy officer. Through this interview, the Think Tank gained important knowledge about the educational dynamics within the clinic, as well as **interviewee 3**'s perspective on important issues such as changing skills, change of work role, and education policies. Data gathered from the two interviews contributed towards the final recommendations, as important knowledge was gained about Maastro.

4. Research-based Recommendations

a. Management and Organizational Culture

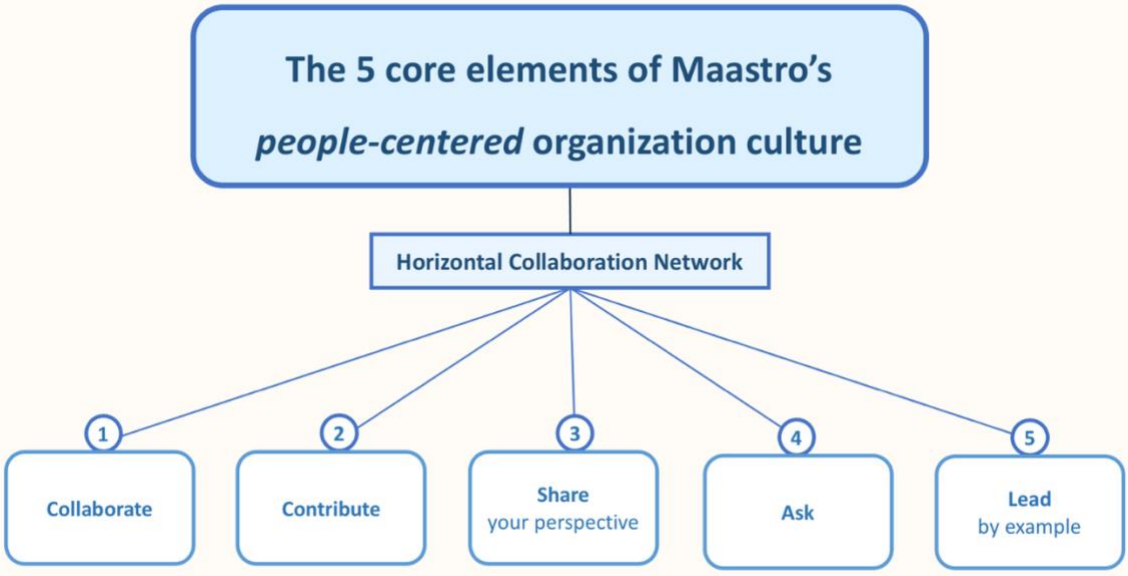

Figure 3: 5 core elements of Maastro's people-centred organisational culture

Our research on how managers have successfully and responsibility dealt with implementing AI, including healthcare, shows that an underlying supportive organisational culture is fundamental (e.g., Bugembe, n.d.; Drysdale, 2019; Fountaine et al., 2019). Specifically, a horizontal collaboration network should be implemented to drive such a digital transformation (Leonardi, 2020; Siebel, 2019; Tobaccowala, 2020). This means that decisions at Maastro should be discussed and implemented bottom-up and not just be announced by the top management. All members of an organisation should *collaborate* ((1), figure 3). Thus, everyone's *contribution* (2) is fundamental to drive the change of implementing AI into the radiation treatment procedure. However, in the existing literature about technological change, it is suggested that most leaders do not know about their employees' situation. Managers are not fully aware about the psychological and practical consequences of their decisions for their employees (e.g. Leonardi, 2019; Oreg, Vakola & Armenakis, 2011). There is often little room for doubts, fears, or insecurities. The focus often lies on strategic planning, while trust-building is sometimes lacking. This also became apparent to some extent during the interviews. Maastro's top management already decided to implement AI, yet, it "didn't [officially] communicate about that until now", as interviewees as **interviewee 1** highlighted. Thus, the communication between the different members of the organisation is insufficient. However, studies about successful AI implementation

emphasize that employees need to be included in the change process. Maastro's members should have the opportunity to *share their (diverse) perspectives* (3) and concerns as well as *ask* (4) questions. Next to creating an atmosphere in which all employees always feel comfortable to share their thoughts in the horizontal network, further insights could be gained through conducting surveys or interviews (see examples of those in appendix A-E). In the end, people should *lead by example* (5), contributing to making others feel comfortable in the organisation. Every employee should know that they are valuable members of Maastro so that their jobs are satisfactory.

These five core elements form the fundament, an environment in which change results is advantageous for all organisational members. However, existing literature highlights that the ideas behind the five core elements and a horizontal collaboration network are even more critical when implementing AI. Thus, it would be congruous if Maastro consolidates such a people-centred organisational culture.

To put this into practice, we propose that Maastro sets up interdisciplinary teams that consist of both AI specialists and representatives from the different work branches within Maastro (e.g., physicians, physicists, dosimetrists, nurses, radiation therapists). This strategy supports communication within the company, reinforces flexibility and strengthens the acceptance of the intended changes. Establishing such a team in an early stage of the change process is beneficial for "long-term robust project planning'' (Kim, 2019). The different expertise and perspectives lead to carefully considered decisions, following the conception of the core elements in figure 3. The setup of this interdisciplinary team could be further facilitated by having a team-building day. Such a day would include activities that strengthen the team spirit with the goal to pursue the shared vision of Mastro. Furthermore, it needs to be added that the adherence to the five core principles of a people-centred organisation is a work in progress. Yet, to avoid greater friction, the importance of the consultation of all the stakeholders in the planning and implementation process needs to be acknowledged.

i. Recommendation II: Officially and Explicitly Communicate about the Intended Introduction of AI

Explicit and open communication among all employees is crucial in ensuring a satisfactory employee experience during and after AI implementation. It is imperative during change processes, as they usually lead to insecurities and fears regarding job positions (Ashford, Lee & Ivacevich, 1989; Bhargava, Bester, & Bolton, 2021; De Witte, 2005). Changes, such as an AI implementation, can result in a subjective perception of powerlessness and unpredictability (De Witte, 2005). Jean Woulters, an RTT from Maastro, expressed such uncertainty regarding the clinic's future and mentioned a lack of communication towards the expected AI implementation. He said:

> "It is difficult to say what we expect from it when we don't know what it is and what it means to you. [...] But most of them [RTTs] really don't know what the future brings them. So there is not really any communication about that".

The Think Tank recommends establishing an official communication from the team managers in which Maastro's AI implementation strategy is expressed. As will be seen in the education recommendations, RTTs need to be re-educated within AI, and in order to do so, open communication and transparency are essential (Bhargava, Bester, & Bolton, 2021). We suggest having a special meeting in person with employees to explain AI implementation, challenges, and opportunities. Explain the AI technology used in Maastro, its possible effects on employees, how jobs might be affected, and what employees can expect from Maastro. Thus, an open and transparent discussion about AI implementation needs to occur. It is also important to facilitate a space for employees to express themselves, ask questions, fears and bring possible improvement ideas (core elements 3 and 4). Moreover, we encourage Maastro's management to use consistent and explicit language to decrease uncertainty among employees regarding the AI implementation. Employees should not rely on speculation, possibly negatively affecting work motivation. As Martien van Bussel expressed in a meeting, it should be clear for all employees at Maastro that the AI is implemented to improve treatment and not to reduce personnel. Thus, the threat of job insecurities should be removed. This official AI communication would enhance employees''s perception of organisational support, benefit their general well-being and satisfaction, and reduce stress levels and turnover intentions (Li & Ye, 2019). Moreover, it would facilitate employees' adaptability in such transitions by creating certainty (De Witte, 2005).

Additionally to the communication meetings, we recommend creating participative round tables: a space in which employees contribute (core element 2 in figure 3) in the decision making process of implementing AI. The round table can be conducted periodically, open to all employees' participation. In such a space, topics regarding AI acceptability and introduction should be touched. By having a mixed group of different employees and managerial professionals, the decision-makers will have first-hand employee's information about employee's experiences and inputs. Thus, it would be a space of collaboration and peer contribution (core elements 1 and 2). For employees to be satisfied, they need to participate and feel heart (Auer & Rüütmann, 2021). Thus, allowing employees to be part of a leading team, the different needs as well as perspectives of the diversity of employees is considered (reference to core elements 3 and 5). By their contribution to the decision-making process, they can ensure that the use of technology benefits all employees and is not just executed

due to a top-down management decision. Moreover, trust in technology and human capital can be strengthened (Bhargava, Bester, & Bolton, 2021).

Next to the quality of communication, the quality of transferred content is another critical aspect. In medicine, it is evident that communication streams such as establishing contact figures for medical staff have helped during the practical implementation of AI technologies. Research by Jankelová, N., and Joniaková, Z. (2021) suggests that medical workers with access to managerial points of contact significantly reduce stress and workload anxiety. Communication through establishing points of reference to leadership figures enables ease of communication between stakeholders in medical employees. This could take the form of an individual at Maastro helping answer stakeholder questions and listen to their needs. Medical facilities with these managerial communication systems have also noticed a significant decrease in employee burnout. Overall in the case of Maastro, new stress is expected to arise from the implementation of AI. By having such leadership figures, the overwhelming feelings can be mitigated, resulting from disruptive changes in the stakeholder's workforce.

Research by He et al. (2019) suggests that communication streams promoting the education of the AI-literate workforce are essential in allowing stakeholders to understand the construction of algorithms, comprehend outputs of datasets, and their limitations. For efficiency purposes, communication curating specific information designed to suit each stakeholder at Maastro could ensure the stable integration of such technologies. Information communicated should be needed for each employee's job and their satisfaction. As an interviewee claimed, '*I don't want to know everything*'. This could take the form of investing some time to curate literature best suited for each stakeholder. Responsibilities for radiotherapy oncologists are different from clinical physicists and radiation technologists. In addition, radiotherapy oncologists will usually focus on specific areas of the human body for their therapy treatment and therefore need well-defined information detailed to such treatment areas. Management at Maastro could therefore be tasked to compile a list of readings and educational material best suited for each stakeholder's responsibilities.

ii. Recommendation III: Point of Care Tool to Bridge the Gap between Research and Practice and for Communication within Maastro

According to Siebel (2019), communication tools, such as open spaces, could facilitate conversations about AI. Creating these communication networks can foster togetherness and unity, which is vital in ensuring successful collaboration, especially when facing a significant change within the organization, as is the case with the AI implementation. Furthermore, these tools could also be used in preventing job insecurity, as suggested by De Witte (2005). Generally, health care strives for evidence-based

practices to make decisions based on the currently available, valid and relevant evidence (Melnyk, Fineout-Overholt, Stillwell, & Williamson, 2010). At work, an evidence-based practice means that Maastro can achieve a more enhanced quality of care and increase practitioner engagement. This is particularly important as the implementation of AI has rendered change in the entire work environment.

However, there is a barrier between the access to and use of research and the daily practice in radiation oncology. The following recommendation aims to bridge the gap between the practice of radiotherapy and the latest research with the support of a Point of Care (P-O-C) Tool: a web-based community. Researchers examining the field of radiation oncology identified three primary factors of why the gap exists between the daily practice of radiation oncology professionals and research (Grose, 2016): Firstly, due to the access to evidence, secondly, due to the research culture, and thirdly, due to the specific needs of the various disciplines. Through the support of a broad network, the radiotherapy professionals can navigate the implementation of AI more confidently and safely since the access to research and evidence will be more readily av-ailable to all practitioners within radiotherapy.

Moreover, the Russian Society for Clinical Oncology (RUSSCO) shows how implementing a web-based open-access resource for contouring contributes to the practice of radiation oncology (Mcclelland et al. 2019). RUSSCO developed workshops, which are mainly held at Russion oncology conferences. They introduced the majority of radiation oncologists to eContour, an open-access and web-based contouring resource that aims to facilitate point-of-care decision support (eContour, 2021). Around 90% of participants reported that the contouring practices in treatment planning changed since starting the program and were deemed helpful. Such open-access and web-based resources can have a meaningful impact on the quality of radiation oncology, as the authors pointed out its potential for worldwide applications (Mcclelland et al., 2019).

Healthcare professionals such as RTTs still need support regarding the latest advances in oncology. We recommend implementing a P-O-C tool, which specifically targets those interested in increasing their knowledge and bridging the gap between actual life practice and academia. This can be done through a website-based research source, which is beneficial as it offers easy access to evidence-based healthcare. One research source is *UpToDate*, a software system that provides trusted references for healthcare professionals when the evidence is unclear (UpToDate, 2021). When comparing P-O-C tools, *UpToDate* offers the content in a more comprehensive and faster way, according to Bowen and Graham (2013). RTTs can use this website to examine the research before making clinical decisions. Lastly, an essential part that Grose (2016) pointed out is that this website has to be customizable according to the departmental needs and how the knowledge is already implemented in current clinical work processes.

iii. Recommendation IV: Make Use of Social Media to Connect to Other Radiation Oncology Professionals

Our interview with the RTTs **interviewee 1** and **interviewee 2** highlighted that the internal communication at Maastro is instead spread out due to the complex work structure. The Maastro clinic is already involved with scientific organizations like the European Society for Radiotherapy and Oncology (ESTRO) and associated with the American Society for Radiation Oncology (ASTRO). These organizations ensure the scientifically sound dissemination of knowledge by offering panels, meetings, courses and workshops (Grose, 2016). Furthermore, institutes such as the Data Science Institute of the American College of Radiology coordinate among key stakeholders and cooperate with global partners to set standards for medical imaging AI, certify algorithms and address the relevant legal and ethical issues that arise. Although these organizations can offer insights on the latest research in radiation oncology and radiotherapy, Grose (2016) suggests implementing a communication tool in order to share the knowledge and discuss clinical experiences on a national and international level. The available research resources are often not designed for the specific discipline needs and cannot address all of the clinical questions. Moreover, the study highlights that radiotherapy practitioners would engage with the resource if it is more prepared and catered towards them, as well as easily accessible. This calls for a collaborative research agenda between academic researchers and practitioners and facilitates involvement in research initiatives (Grose, 2016). Therefore, we propose Maastro to make use of an international web-based community among radiotherapy practitioners.

Within healthcare, Social Media usage can contribute towards education, information sharing and professional connections among peers (Cain, 2011), through platforms such as Facebook and Twitter. Generally, social media is characterized by accessibility, opportunities for participation in the process of decision making, openness, feedback and listening (Lingaraj, Nagaveni, & Girisha, 2013). Health care has been adapting to the growing trend of social media and termed its use as 'Medicine 2.0' or 'Health 2.0' (Cain, 2011). More specifically, mainstream Social Media platforms can build cross-country communities and connect radiotherapy professionals to one another (Ganesh, Manikandan, Mohanti, Munshi, Sarkar, 2019). The authors found that, among peers, the exchange of information is enabled through blogs, which can be utilized for open communication among radiation oncology professionals and researchers (Lingaraj et al., 2013). Besides offering beneficial communication, social networks can encourage the redistribution of influence even beyond formal hierarchies. As a result, social media usage can enhance the bottom-up approach previously emphasized by us.

Especially when considering the future of academia and research, it is anticipated that social media platforms will supplement citations and scientific journals (Ganesh et al., 2019). Healthcare professionals often lack time to visit the library or online scientific websites to gather updates on the

latest advances in oncology (Ganesh et al., 2019). When participating at scientific conferences such as ASTRO and ESTRO, visitors used platforms such as Twitter and Facebook to tweet and comment on their experiences and insights. This kind of interaction is beneficial towards the popularity of the conference and establishes itself as a valuable resource for radiotherapy professionals. Regarding the platform Twitter, tweets have to be curated regularly and similarly to scientific content to contribute sustainably (Ganesh et al., 2019). Therefore, the trouble-free access and utilization of social media can play an essential part in keeping the radiation oncology community and organizations updated and offering more accessible access to research.

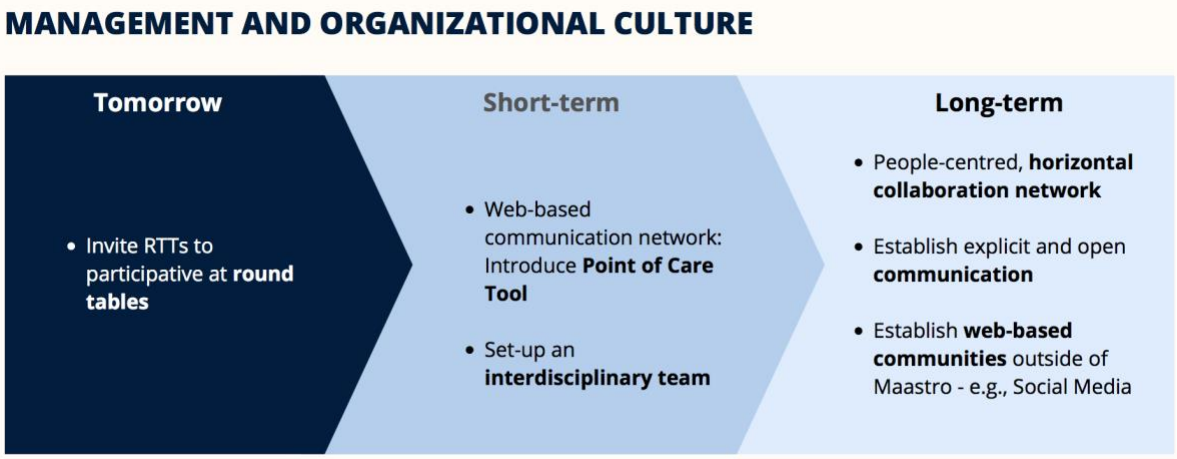

Figure :4 Timeline for recommendations on management and organizational culture

b. New Tasks, New Framing

Based on research in AI and its implementation on jobs, scholars have demonstrated that automation is more likely to occur in activities than in occupations (Chui, Manyika & Miremadi, 2015). As the automation of physical and knowledge work advances, many jobs will be redefined rather than eliminated—at least in the short term (Chui, Manyika & Miremadi, 2015). As mentioned, task restructuring can be termed as a management-initiated change that entails the redefinition of jobs and business processes. As a result, it directly affects employees' performance and productivity, even disrupting the workflow. It is important to note that job restructuring is one of the most frequently occurring types of change in our contemporary knowledge society (Nikolova et al., 2014).

Nowadays, organizations are continuously being challenged to adapt quickly and effectively to dynamic market conditions. The fast changes in the organizational environment driven by global competition and technological advances require companies to be flexible and to adopt change-oriented management approaches and practices in their daily life (Oreg, Vakola, & Armenakis, 2011 in (Nikolova et al., 2014)). From a practical point of view, task restructuring is often conducted

simultaneously with general structural changes in the organization, such as downsizing, which also causes fear of job loss and job insecurity. As already mentioned, researchers have shown that task restructuring is generally negatively related to employee well-being (in terms of emotional exhaustion and vigour). In contrast, workplace learning can mitigate the negative relationship between task restructuring and well-being (Nikolova et al., 2014). Also, this type of change is not always voluntary for the employees and may be experienced as a threat. Self-initiated task changes are by default voluntarily, and thus, would not constitute a threat (Tims, Bakker, & Derks, 2013). Due to this, framing of the tasks and how they are framed has become ever more important in order to open the black box of AI by demystifying the implementation of AI in medicine as well as other fields. In that light, the following are some of the recommendations under new framing, new tasks that will help Maastro restructure the tasks by implementing Framing.

i. Recommendation V: Frame New Tasks Due to AI's Implementation as a Challenging and Enriching Experience That Will Broaden Employees' Expert Knowledge

The automation process will replace many manual tasks (Korreman, Eriksen, & Grau, 2021). AI promises to increase efficiency and reduce the time that is spent on treatment planning in radiotherapy. Besides re-positioning and redefining themselves and being more involved in the entire care path of radiation oncology, RTTs are taking up different responsibilities. There will be new tasks such as the supervision, deployment and maintenance of the AI algorithms in the future (ESR, 2019). AI has the opportunity and benefit to make room for practitioner's cognitive and emotional space for patients and work towards personalized care (Lin, Mahoney, & Sinsky, 2019). The documentation and administrative work can be automated, which makes it more manageable for the radiotherapy practitioner. Otherwise, cognitive information overload can occur due to overlooking patient data, considering evidence-based practice guidelines and compliance monitoring that RTTs must be mindful of. In the following sections, the Think Tank proposes the framing of the newly automated system towards employees' predisposition of AI acceptance and keeping employees motivated and satisfied with their job.

In order to be able to frame the presentation of the new AI to the Maastro staff, Maastro needs to conduct more qualitative research into the factors of employees' job satisfaction and motivation. Examples of the type of research that could be done are surveys or semi-structured interviews with physicians and RTTs before implementing the new automated system (see Appendix A and following, for example, questions). In such qualitative research, employees should be asked

about their job motivation, namely which components of their role are most motivating and important, and the characteristics of an ideal futuristic tool. Such questions were posed to the air traffic controllers when AI was implemented, and answers were used to adjust the process of AI implementation (Beijer et al., 2011; Prevot et al., 2012).

The efficacy of semi-structured interviews can be seen by the example of the work of Madeleine Elish and Anne Watkins, who researched the implementation of the Sepsis Watch App, a device combining AI with new hospital protocols to improve the treatment quality (2020, p.1). They conducted interviews at the early phase of the introduction of the app, which offered many important insights on the success of the implementation, its consequences and especially the impact on the employees and the company's spirit. By following their example, Maastro could use technical, social, and practical results to monitor the implementation process. Additionally, it provides insights into the opinions of the employees about the new technology. In this case, the new roles and responsibilities were perceived as enjoyable, whereas others criticized that their primary duties changed rapidly (Elish & Watkins, 2020, p. 41). Nonetheless, people agreed that it was still an exciting challenge (Elish & Watkins, 2020, p.41).

The researchers framed Sepsis Watch as a sociotechnical system, as they consider the technical and social context of the implementation process. Because innovation is often envisioned as disruptive, as it changes the old ways of work, the consequences of such disruptions of sepsis watch were investigated (Elish & Watkins, 2020, p.25). These disruptions affected existing workflows, relationships and created "gaps, breakdowns and miscommunications that needed to be attended to" (Elish & Watkins, 2020, p 25). Overall, it was observable that, for example, the app forced a reckoning of the different perspectives of different workgroups, and imposed the set of priorities, those of the leadership, which were not aligned with those from other parts of the organization. Hence, the importance of the consultation of all the stakeholders in the planning and implementation process is emphasized from a different perspective. Knowing about such tensions is extremely important for the management, as early detection of these problems leads to compensatory measures before further problems can arise. Therefore, the case of Sepsis is a practical example on the importance of qualitative research, mainly interviews, during the implementation process of new automation technologies.

Overall, by conducting qualitative research, Maastro's managers can gain specific insights into the employees' jobs and ensure an untroubled transition. When we interviewed RTTs as part of our research, we were already able to experience the efficacy of questions regarding job motivation and futuristic AI tools ourselves. As declared by **interviewee 1** (RTT), the part that he appreciates the most about his job is "the contact with the patients, to give them a good feeling, that we are treating them

well, to answer questions and calm them down if they are sad.". This response can be taken into account when designing the official presentation of the new AI to employees. For instance, Maastro's managers could emphasize that one of the advantages of AI is that the employees will have more time to dedicate to patients. On the other hand, **interviewee 2** (RTT) declared:

> *"I like to get to be part of the entire process, I do the treatment planning and treatment delivery so it is the whole package. But also because of the variation, one day I do one thing, the other the treatment planning, so the combination of that is giving me a satisfying feeling, to be part of the bigger Maastro work".*

Given what **interviewee 2** said, AI implementation might raise some issues, as the RTTs will no longer complete all of the tasks in the process. The substantial difference to compensatory rence of the answers and point of view of the two RTTs demonstrate the diversity within the employees in the clinic. Thus, Maastro's managers should interview a larger sample of RTTs through either a questionnaire or semi-structured interviews to gain more information from the employees and predispose them towards acceptance.

Furthermore, to promote AI acceptance, Maastro's managers should present the new automated system in the previously mentioned communication meetings as useful and easy to be used, consequently improving the attitude towards using. Such concepts are explained in the AI implementation Acceptance Model (Figure 5) designed by the Think Tank based on the Automation Acceptance Model by Westin et al. (2015) and the new Technology Acceptance Model by Lo Presti et al. (2021).

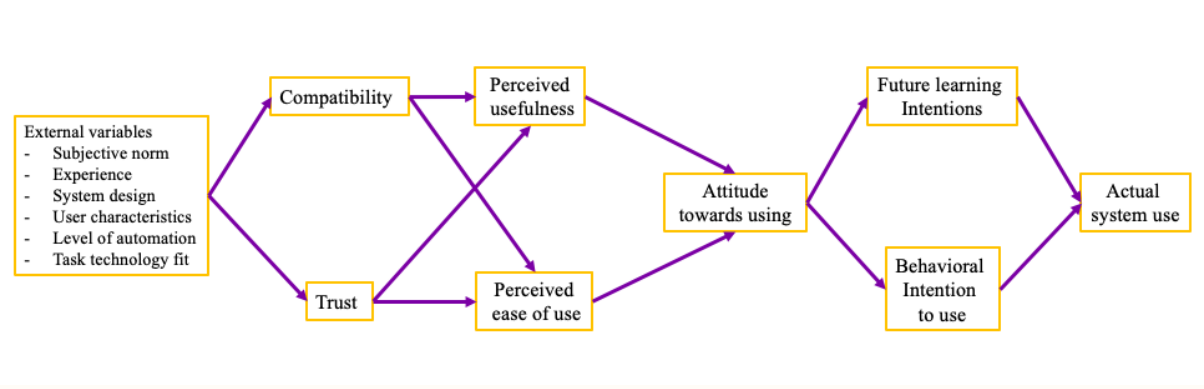

Figure 5: AI Implementation Acceptance Model (adapted from Westin et al., 2015 and Lo Presti et al., 2021)

The AI Implementation Acceptance Model shows how external variables such as subjective norm, experience, system design, user characteristics, level of automation and task-technology fit, influence employees' trust and the compatibility between human and the automated system (Westin et al.,

2015; Lo Presti et al., 2021). These two latter factors subsequently affect the perceived usefulness and the perceived ease of use, determining the employees' attitude towards using (Westin et al., 2015). Based on the attitude, employees will display certain future learning intentions and behavioral intentions to use, resulting in a certain degree and fashion of actual use (Lo Presti et al., 2021). As shown in Figure 5, the experience of the actual system use provides employees with feedback, resulting in an adjustment of all the previously mentioned factors (Westin et al., 2015). Therefore, according to the AI Implementation Acceptance Model, employees must be presented with good arguments as for why the AI is useful (which can be also derived from the research mentioned above), and with an effective explanation of how to use the new technology in a simple manner. Doing so will promote employees' sympathetic attitude towards using the new automated system, and thus towards acceptance.

Lastly, it is essential for Maastro's managers to frame the introduction of AI and the resulting need for education as an essential but enriching experience that will broaden their expert knowledge. This will contribute to employees' acceptance and the maintenance of their motivation and job satisfaction, as shown by the successful implementation of the Conflict Resolution Assistant (CORA) in the Air Traffic Control (ATC) field (Brooker, 2005). According to Brooker (2005), CORA's introduction process was triumphant because it was human-centered and gradual, so as to allow for adequate training, facility differences, and user requirements. Moreover, the operational experience from the initial implementation of CORA was very carefully monitored, enabling adjustments at the organizational and employees' levels (Brooker, 2005). Similarly to RTTs, air traffic controllers (ATCos) have always felt their contribution as crucial to the ATC field and in charge of the entire process, making them perceive their job as vital (Brooker, 2005). CORA's introduction in the ATC field did not demotivate ATCos, since CORA requires expertise in its use and thus ATCos were challenged and able to maintain their master skills level. Moreover, ATCos felt as if they had "moved up a gear" and their expertise in the field had increased (Brooker, 2005). In line with the successful example of CORA, the Think Tank recommends Maastro to frame the presentation of the new AI and the education plan as an enriching experience, which portrays the employees' jobs as more prestigious. By doing so, physicians and RTTs are more motivated, which increases their job satisfaction. Overall, this is favorable, as the implementation of the new technology will be perceived as challenging and expertise-requiring.

ii. Recommendation VI: Demystify the Reliability of AI

Next to an inclusive, people-centred organisational culture, there is a need for an accurate understanding of AI (Zweig et.al., n.d.). The way AI is introduced, as well as how it is conceptualised,

impacts the idea people have in their mind about this technology, as well as its effects. A lack of personal experience and scientific understanding of such technology can create hostile reactions from potential sceptical stakeholders. This was for example noticed in the discussion about the integration of AI in autonomous driving. Participants of Lijarcio et al.'s (2019) study showed signs of hesitation when it came to perceived safety, value attribution, and the intention to use autonomous cars. Thus, AI should be demystified, which means that when officially communicating about AI, the technology should be properly understood. Misconceptions and prejudices should be dismantled. The following factors can be taken into account to demystify AI.

Firstly, it should be clarified that there is no one 'AI' technology or product (Zweig et.al., n.d.). The concept generally refers to "software applications that can learn", however, these different applications are used and designed for different purposes. Thus, an understanding of the underlying AI algorithm that is used at Maastro is important to further understand the capabilities and risk of the technology when designing treatment plans. Further details about the specific knowledge will be provided in the following section on education.

Secondly, AI should be explained in terms of technical functionality, specifically highlighting technical features that facilitate fast and efficient work (Krafft et. al., 2020). For Maastro this specifically could mean to highlight how the AI implementation follows the organisation's vision to provide the safest possible treatment according to the latest state of the art (see as well 'Mission, Vision, Strategy' above). Maastro is a people-centred organisation, prioritizing the needs and well-being of people. Due to the introduction of AI, the well-being of people can improve by offering upgraded treatments according to the newest and most effective treatment methods. Treatment plans can, for example, be more accurate and health professionals have more time for their patients as the automation results in time saving (Topol, 2019). Benefits should be highlighted, while there should always be room for questions (core element of a people-centred organizational culture 4 'ask' and 2 'contribute' - see box 2 in figure 3). Risk and shortcoming should be discussed, while the clinic should give insights into how the new technical features can ameliorate treatment planning, currently for common cancer cases.

Furthermore, it is advisable to emphasize that human and artificial intelligence do not compete (Boston Consulting Group, 2018; Fan et.al., 2019). The use of AI should not result in the fear of being 'replaced' by a machine but instead unique skills and competencies of the employees at Maastro highlighted. It should be clear how the AI *supports* human skills. The RTTs remain in control and make the ultimate judgments. Further, the word 'intelligence' in the term AI does not indicate any degree of intelligence. Scientific education on AI is needed in order to know about the changes and possible risks of AI.

In sum, the concept of AI should be demystified so AI can be understood as an opportunity instead of a threat (Bhargava, Bester, & Bolton, 2021). The importance of proper framing of AI was for example documented in the longitudinal cohort study by Lauritsen et. al. (2021) who evaluated framing for sepsis prediction. There, the authors highlighted that their results most likely apply also to other (medical) areas. Consequently, discussing and establishing an accurate definition of AI within Maastro might be an opportunity to demystify the concept of AI. Further, through collaboration people are brought together and can start to develop trust in the new technology. A feeling of togetherness could also enable stakeholders to feel more in control of AI's operations. Accurate knowledge about AI is therefore needed.

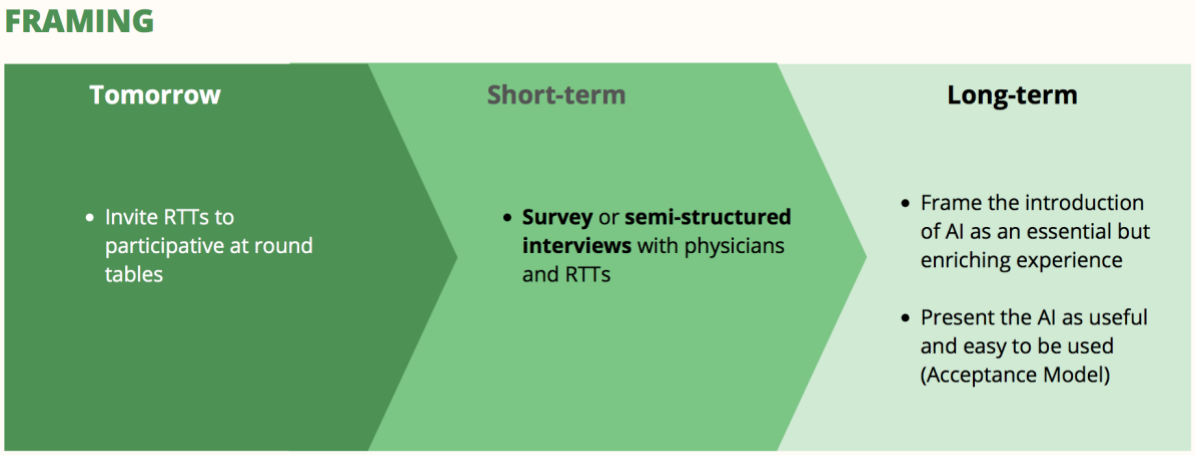

Figure 6: Timeline for the recommendations on framing

c. Education

Upskilling employees' abilities is essential to reduce job insecurity (De Witte, 2005) and facilitate the AI translation in Maastro's clinic. The gain of new employability skills and technological support has been proven to ensure the disappearance of AI negative effects on the health sector because it creates a healthier employment relationship, beneficial to mitigate potential AI threats (Silla, Gracia, Peiró, De Witte & De Cuyper, 2009; De Witte, 2005). The employees interviewed by Bhargava, Bester and Bolton (2021) reported feeling confident with their own skills but believed that 'upgrading their skill sets' might improve their employability and, thus, better job satisfaction. Furthermore, employees usually respond to high levels of organisational support with high levels of organisational commitment and psychological attachment (Li, Bonn, & Haobin Yea, 2019). In the following section four beneficial recommendations for the employees' education will be presented.

i. Recommendation VII: Provide Theoretical Background Knowledge on the Technology of AI, the Consequences of Its Use and the Impact on Workflows

The Think Tank recommends Maastro to enable additional education for their staff. This is necessary for a successful implementation of artificial intelligence at Maastro, supported by the research of Tang et al. (2018) for the Canadian association of radiologists. One of their main recommendations is that radiologists facing AI implementation need additional education (Tang et. al, 2018). They base their recommendations on the findings of an interdisciplinary working group to establish a clear position of the Canadian association of Radiology. This research relates to the RTTs from Maastro, because, similar to the radiologists described in their research, the AI affects their field of work directly. In both cases, this leads to more automated processes in the daily workflow and the use of technology with which the employees are not familiar yet. Thus, similar effects can be expected. Such education is necessary to assure a successful implementation into the workflow and adaptation to the new technology. Making the necessary tools for the understanding and work with AI available, is called *end-user support*, which is identified as "one of the most crucial success factors for the AI implementation" (Kim, 2019, p.4). In this regard, we were able to formulate sub-recommendations which outline the goals for this education.

Firstly, "radiologists need to become familiar with the different AI techniques'' (Tang et. al, 2018, p.122). As obvious as it may be, the Think Tank recommends Maastro's managers to provide the employees involved in the automation transition with sufficient knowledge to use the new systems effectively. More specifically, Maastro "should provide opportunities for trainee enrichment in machine learning techniques and data science and AI tools and evaluation" (Thompson et. al, 2018, p.4). This is especially necessary so that RTTs "can shape the way that the technology influences and impacts their work" (Tang et. al, 2018, p.121). Researchers point out that hereby the role of the AI applications "should be clearly defined according to their role and type within the company" and emphasise the "application in routine clinical workflows'' (Tang et. al, 2018, p.130 Chamunyoga et al. 2020, p.1). Tang et al. (2018) made suggestions about inclusions into the radiation therapy curriculum. Since the people at Maastro are most likely finished with their education, it is important that they need to stay up to date with their knowledge, especially to avoid a knowledge gap between younger and older employees within the company. This is also important to avoid potential frictions in the future. The educational content the researchers mention are the fundamental concepts of AI and machine learning, ethics and legislation, quality and safety, multidisciplinary care and research (Chamunyoga et al. 2020, p.216).

Secondly, radiologists must understand the challenges and opportunities of and through AI (Kim, 2019). This requires transparency and cooperation by the company. A corresponding

understanding by the staff helps to “avoid either excessive hype or fear about the implementation of AI (Tang et al., 2018, p.124). How the company can support this transparency and understanding, is outlined in more detail in the suggestions that refer directly to communication. These two web-based points go hand in hand, because without the technical understanding by the stakeholders of the implementation of AI, especially the *end-users* which are at Maastro the RTTs, such a discourse would not be possible within a company. Therefore, it is important for Maastro “to ensure that their employees are equipped with the knowledge to comfortably engage in AI conversations and be able to apply future technologies in a safe and competent manner” (Chamunyoga et al. 2020, p.217).

Indeed, currently there is a lack of courses, workshops and other scientific events on AI, also within medical physics academics or educational programs (Kortesniemi, 2018). One of Maastro’s most important strengths is that it can provide the necessary knowledge with the help of its Academy (Maastro, 2021). Furthermore, Maastro has made first experiences with web sessions about AI developments provided by the European Society for Radiotherapy and Oncology (ESTRO) (Maastro, 2021). Further education could be enabled by encouraging the employees to attend special training by AI specialists. Attending additional courses next to work should be included in the academies programme and organized in accordance with the workflow. This could also be in the form of webinars, school courses, workshops, conferences or distributed materials. To make this as accessible as possible, this should not be an additional stress factor for the employees. Tying this to our previous recommendations, by utilizing a Point of Care Tool and web-based communities, employees can share insights on research and foster connection between peers in a more accessible way. Maastro can contribute to this process in multiple ways: by reinforcing such engagement of the employees, distributing their information on AI and the implementation plan, as well as through organizing informative events.

Lastly, it is important for Maastro to include the knowledge of AI integration in other fields to understand how humans and artificial intelligence cooperate. From examples shown in previous research, automated driving and artificial intelligence have been proven to contribute knowledge throughout several stages of AI integration. Hereby, Hanckock pointed out that because of AI's disruptive and developing nature, Maastro needs to understand the early stages of such technology. In this scenario, researchers concluded that AI and humans would interact at a specific level before artificial intelligence takes over the entirety of such tasks. He showed that particular behaviour responses of humans would be adopted based on their knowledge of how artificial intelligence works in road driving dynamics (Hancock, 2019). Furthermore, he suggests that it is essential to consider the concept of cohesion when understanding workflow dynamics between AI and humans (Hancock, 2019).

In the early stages of AI at Maastro, such nascent technology might not be equipped with the practical understanding of implicit cues. Such cues could be in responding to emotional behaviour from patients and even stakeholders at the clinic. This was noticed in observing the complexity of the implicit rules of driving. Researchers suggest that AI and autonomous vehicles in the early stages would not be equipped with an understanding of this level. For instance, in India, driving dynamics on the road engage in implicitly choreographed dances which can be difficult for AI to interpret. AI's current rational approach to undertake tasks could struggle in such an environment. In addition, AI in countries where road infrastructure isn't as refined could struggle from a lack of visual, implicit cues that would only be understood by the human mind.

When applying the considerations and knowledge about how artificial intelligence is being discussed for autonomous vehicles, it is crucial to conclude the limitations of artificial intelligence as of not replicating real-world scenarios. In the case of Maastro, when dealing with individuals who have cancer, artificial intelligence might lack emotional responses that can be beneficial in these cases. In addition to this, AI at Maastro might struggle when facing unusual cancer cases that could only be tackled by the human mind. Therefore, these differences and uncertainties should still require the supervision of stakeholders equipped with the knowledge to understand AI's conception realm. Although individuals being treated might not respond negatively to this, a radiotherapist supervising AI might feel unsure about the treatment process during radiotherapy treatment. Education can therefore equip stakeholders at Maastro with specific knowledge relevant to their concerns and feelings of untrust. Understanding the interaction between humans and AI is vital in establishing the correct educational goals and equip stakeholders with the proper knowledge to resolve dissonance in the radiotherapy teams.

ii. Recommendation VIII: Maastro's Academy Should Include Trust Training in Employees' Curriculum

Regarding the content of the education plan, the Think Tank would like to also recommend Maastro's managers include trust training. In the interview conducted by the Think Tank, **interviewee 2** (RTT) said: "*We also need to gain some trust in the system. In the beginning, you think: it is really the best one can do? We also have to gain trust that it is doing proper work. It takes time for us to do it.*" As declared by one of the RTTs, trust is something that needs to be there and that has to be developed over time to obtain a smooth workflow. Employees' trust levels in AI can be correctly calibrated by making them acquainted with the new automated system. Thus, Maastro should plan several educational sessions in which the main features of the new technology (its reliability, false alarm rate and miss rate) are taught, and employees get to experience the AI in a safe environment (i.e. there is

no risk to harm the patient). In order to assess whether the trust levels are calibrated, the Modified Human-Automation Trust scale (M-HAT) (see Appendix E), an empirically based tool that measuring human trust in automated systems, could be used at different stages of the education plan (i.e. beginning, halfway, and end). The M-HAT scale is a questionnaire containing statements concerning the employee's trust in the AI, to which the respondent has to indicate his or her level of agreement on a Likert scale (Mirchi et al., 2015). This tool can be very useful, as shown by its usage in the air traffic control field, and could also be used in future scenarios, for instance, for keeping track of the trust levels two or five years from the implementation, to make sure that the over-trust or distrust won't occur.

It is essential for the responsible AI implementation that employees develop calibrated levels of trust in AI. In fact, as explained by the Automation Acceptance Model (Figure 5), trust is one of the essential factors leading to AI acceptance, and consequently to a successful AI implementation. Moreover, as observed in the ATC field, if employees' trust levels are not calibrated, over-trust or distrust might occur (Mirchi et al., 2015). Over-trust is present when human trust exceeds the actual AI's abilities, resulting in loss of situation awareness (SA) and out-of-the-loop (OOTL) phenomena. Over-trust derives from the psychological phenomenon called automation bias, which leads people to over-rely on automation systems (Sand, Durán & Jongsma, 2021). On the other hand, distrust is defined by the operators' underestimation of the reliability of the automation, preventing it from realizing its full benefits (Mirchi et al., 2015). Distrust is instead caused by the uniqueness neglection bias, which refers to the common misconception that AI is less able than humans to account for unique patient's characteristics and circumstances, thereby, that automated systems treat every case the same (Longoni, Bonezzi, & Morewedge, 2019). In order to avoid these phenomena resulting in disuse, an educational plan was designed and applied in the Automated Traffic Control (ATC) field. Thereby, ATCos were taught, through exposition, about the way automation worked, the principles behind its design, and the conditions determining its effectiveness (Mirchi et al., 2015). Trust levels were then measured according to the M-HAT scale. Results showed that the training was followed by calibrated trust levels, allowing for the responsible use of AI (Mirchi et al., 2015). Such results were supported by Miramontes et al.'s (2015) study, in which ATCos were trained in a NextGen environment for a semester. The results confirmed that as experiences with automation were made, ATCos developed better trust in automation (Miramontes et al., 2015).

iii. Recommendation IX: Introduce Adaptive Automation and Foster Practical Experiences Through Training Sessions to Prevent Employees' Deskilling

As established before, the new tasks due to the AI implementation will require new skills and knowledge for RTTs. During the second client meeting, Maastro mentioned tacit knowledge as part of an RTTs skillset. When Maastro introduces AI, there is a possible shift from mostly tacit knowledge to more theoretical knowledge. Tacit knowledge refers to unexplicit knowledge that one gains from experience rather than a textbook. Interpreting imagery to generate treatment plans is part of this tacit knowledge and the AI takes this over from the RTT. What the RTT is left to do with, is analysing the data of the AI and assessing whether the treatment plan fits the patient. Therefore, RTTs may lose their tacit knowledge in the future due to AI, which may lead to deskilling and loss of situational awareness (Gillan et al., 2018; Walker, 2017). While interviewing **interviewee 2** (RTT), it became apparent that RTTs are aware of potential deskilling and loss of SA; still, she holds a realistic view regarding their future work:

> "*It (the new AI system) cannot take 100% of our work, we still have to do so, thinking ourselves, that I think that is a good thing to keep our mind trained*".

The field of automated traffic control can offer valuable examples Maastro can use to combat the loss of tacit knowledge and situational awareness (SA). In this field, changes due to AI implementation generated the out-of-the-loop (OOTL) phenomenon, which is defined as losing SA, decreased vigilance, and deskilling (Di Flumeri et al., 2019). Air traffic controllers (ATCos) observed and reported this phenomenon in Schiphol airport when implementing the new automated aid system called SARA (Merwe et al., 2012). Nevertheless, SA increased as familiarity with SARA increased, underlying again the importance of training and education (Merwe et al., 2012). In other cases of the ATC field "adaptive automation" (AA) was employed as a countermeasure to OOTL phenomena (Di Flumeri et al., 2019). Adaptive automation (AA) is a system that dynamically allocates tasks to the machine or the ATCos based on their level of engagement in the task to be performed.[1]

Considering the studies conducted in the ATC field, we suggest Maastro's managers investigate whether new automation would decrease employees' engagement in task and situation

[1] The dynamic allocation made by the adaptive automation is based on the estimation of the air traffic controllers' (ATCos) behavioral performance in real-time and on the psychophysiological measures assessing the real-time ATCo's mental state (Di Flumeri et al., 2019). The AA thus uses electroencephalogram (EEG) and eye-tracking (ET) analysis techniques. According to the analyses' results, the AA allocates the task to the automated system or to the controller, assuring ATCos' engagement in the job (Di Flumeri et al., 2019).

awareness. To do so, two widely used methods can be applied: the Situation Awareness Global Assessment Technique (SAGAT), which uses probes and queries during task suspension to ascertain levels of situation awareness, and the Situational Awareness Rating Techniques (see Appendix D), which produces a general score of employees' perceived level of situation awareness (Cooper, Porter, & Peach, 2013). If results show decreased employees' situation awareness and task engagement, Maastro's managers should foster experiences with AI in training sessions for employees. Moreover, Maastro could employ an AA system to keep track of the employees' mental state. This way, if the monitoring task causes them OOTL phenomena, active tasks can be assigned to them to increase their SA and engagement. It is crucial that Maastro prevents, or at least minimizes, the effects of OOTL phenomena among its employees through the suggested strategies, allowing for a responsible and successful AI implementation.

iv. Recommendation X: Ensure that RTTs Have the Skills to Communicate AI Findings in a Comprehensible Manner to Patients and Colleagues

The last changing skill the Think Tank considers is the change in the communication skills of an RTT. Communication with others within the organisation as well as patients becomes an area of focus for the RTTs as the decrease in time and the adaptive treatment require RTTs to communicate their treatment plan more often. This requires RTTs to communicate their AI findings and treatment plan to others who do not necessarily have expertise on AI and an RTTs job. As they also need to relay information to colleagues, coordination between the different actors of a patient is especially important as the organisation works as a collective (Gillan et al., 2019). In our interview with **interviewee 3**, she mentioned that there is a standardised way to communicate among employees, but also with patients. This is the HiX journaling system, which is an eHealth system that allows for standardised communication within and among departments. (ChipSoft, 2021). Communication through an eHealth system such as HiX has different aspects that RTTs should keep in mind. The goal of communication is to influence health decisions and ensure patients feel safe and comfortable. Patients may sometimes feel intimidated by messages on eHealth platforms and health care providers want to avoid this feeling. Ways to avoid such feelings is to ensure the readers are engaged; mirror their emotions; provide messages that are easy to understand; provide opportunities for readers to give feedback; and demonstrate empathy in the relayed messages (Kreps & Neuhauser, 2013). The Think Tank recommends Maastro to ensure that RTTs have the skills to communicate findings from the AI in the manner mentioned.

v. Recommendation XI: Teach RTTs Computational Thinking To Deal With The Increasing Complexity of Remaining Manual Tasks

Besides minding deskilling and loss of SA, the remaining manual treatment plans may need computational thinking to write them. In an interview **interviewee 3** mentioned how the AI takes over the simple treatment plans but that RTTs still have to generate the more complex treatment plans. To ensure RTTs have the ability to deal with such complexity, researchers in the field of radiology (Nystrom, Jensen, & Nystrom 2020) proposed that such remaining manual tasks should involve computational thinking. This way of thinking regards problem-solving and analysing according to the field of computer science. In computer science, they ensure the computer can solve problems or questions by reprogramming or rewriting algorithms and. Wing (2006) put it as follows: "We must consider the machine's instruction set, its resource constraints, and its operating environment" (p. 33). While this goes for computer problems, this is also a way of looking at problems people have to solve. Within treatment planning, when an RTT is posed with a complex task, they should do as the computer scientist and reanalyse and rewrite their task into one they can operate on. We recommend including this way of analysing a problem within future education plans. A method to teach computational thinking is through computer science. Novices to the idea of computational thinking learn it through trying to write algorithms and programming. Therefore, through experiencing this an RTT can use the knowledge gained on computational thinking within the complex treatment plans (Atmatzidou, & Demetriadis, 2016; Buitrago Flórez et al., 2017).

vi. Recommendation XII: Continue Applying Lean While Personalizing It to the Interest of Maastro's Employees

> *"I think there's the anxiety that they are going to be standardized but that's not the main goal."*
>
> - **Interviewee 3**

The adoption of lean dynamics promises to enable RTTs to identify and to prevent them from accepting inefficiency and risks as if it were normal. Only if the latter happens, AI technologies can be implemented in a successful way for Maastro's patients, management and employees as negative side effects can be detected and tackled. Staats and Upton (2011) argue that not only car assemblies but also knowledge jobs can be made lean if organizations draw on six principles:

1. Continually rooting out waste should be an integral part of every knowledge worker's job.

2. Strive to make tacit knowledge explicit.
3. Specify how employees should communicate with another.
4. Assess problems quickly and directly.
5. Codify the lessons learned.
6. Leaders must blaze the trail.

The lean implementation at Maastro might be more challenging. One the one hand, lean is not new to Maastro as they aim to re-educate their employees in lean (Maastro, 2021). On the other hand, lean requires standardization through standard operating procedures (SOPs). The interview with **interviewee 1** revealed that RTTs are reluctant to work with this increasing standardization. Thus, they are not in favour of implementing lean:

"The lean philosophy is challenging, it's challenging to transfer lean and lean business to healthcare because employees don't like to think that way […] Because standardization in the car industry and in the airplane industry is okay. But with a patient it's different. Every patient is different, and every treatment is different in their eyes. So why it's challenging for them to comprehend the lean in the healthcare there […] I think there's the anxiety that they are going to be standardized but that's not the main goal."

Indeed, van Assen (2018) suggests that lean dynamics in itself are paradoxical in nature as they incorporate technical aspects like fact-based management, analysis and adhering to SOPs for sake of efficiency while at the same time also incorporating social, follower-related aspects. Therefore, simply "re-educating" RTTs in lean might not be enough to solve this conflict. To make lean truly work for Maastro we suggest the management to:

1. Clearly envision and communicate the meaning of lean
2. Set goals and active steering on improvement performance metrics
3. Encourage continuous improvement

Again, great emphasis is on the organizational culture which needs to be receptive to lean thinking. Most importantly for Maastro, the lean method is also about framing. That is, Maastro's management must lead the change in a visible and vocal way, being a good example of enhancing a lean culture. A survey of 178 Dutch organizations indeed suggests that such management actions have a positive effect on lean (van Assen, 2018). Thus, the most important recommendation here is that Maastro needs to be aware of the consequences of lean and not accept it as a simple on-size-fits-all solution.

vii. Recommendation XIII: Avoid Methodological Overload of RTTs By Distributing or Balancing Knowledge on Different Treatment Planning Methods

When talking about new technology implementation it is often stated that education is needed to teach additional skills necessary for this implementation. In many parts, this report is doing the same. Additional education seems to be the solution to improve the treatment with AI, for employees to accept AI or to avoid deskilling. However, simply adding skills RTTs have to master is no solution either. It has been found in robotic surgery, where this approach in education has been taken, that as a result, the people did not master any method completely, neither robotic or open surgery (Lo Presti et al., 2021). This problem has also been found as university professors began working with online education while still being expected to continue giving traditional lectures (Lo Presti et al., 2021). It was found that "the only people who handled both old and new methods well were those who were already technically sophisticated and had significant organizational resources" (Lo Presti et al., 2021). Only adding new competencies to the work of RTTs would therefore risk overwhelming employees, if a methodological overload is not avoided.

The possibility of a methodological overload of RTTs at Maastro can be derived from the interview with **interviewee 3**. **Interviewee 3** mentioned two main concerns about the implementation of AI. One of them was that elderly employees might want to continue checking even standard plans, while the other was that young RTTs might not learn the tacit knowledge that elderly employees gained through experience with making treatment plans themselves. About the first concern, that **interviewee 3** thought of as the more important one, she said "It's useless to keep on checking in the standard. And I think it's hard for people to let that go". This can also explain the resistance that Maastro mentioned in previous meetings, that they already experienced and fear for the future implementation. For the AI implementation acceptance model, the perceived ease of use would be lower, when RTTs are convinced that they have to check on each plan made by AI. Furthermore, the perceived usefulness would also decrease, if making the plan does not become faster and to use several plans over time for a treatment would not be possible. According to the AI implementation acceptance model, this leads to a less positive attitude towards using AI and therefore also to decreasing intentions to continue learning and using it. In this situation, the RTTs would be an expert on the old methods but not be an expert on working with AI. Working on trust in the work of AI could be a solution to some extent, but as explained in recommendation 8, this involves education about AI and the use of it would mean a decrease of skills connected to old methods, which can be seen negatively by RTTs. **Interviewee 2** explained also in our interview:

> *"If you have to do it (the treatment plan) by hand, I don't think everyone will keep up with that because you wouldn't do it that often and I think the information will go and then you will have a lack of information and experience in a couple of years*.".

This relates to the second concern, that was mentioned by **interviewee 1**. The transfer of tacit knowledge about the creation of treatment plans to younger students, when AI is frequently taking over the work. She said:

> *"… for the difficult patients, they have to be able to manage to do the job and a highly skilled, highly complex plans. And then if they cannot, I think they do not know how to do it, then yeah, then you lose quality*."

Elderly employees might feel it is their responsibility to do this and keep their skills in the previous methods to ensure a high-quality treatment. To some degree, young students could represent a deskilled RTT that decided to work with AI. They are experts on new methods but not that skilled in old methods. However, as **interviewee 1** explained, young students will have less opportunities to learn the old methods because more experienced employees will take that responsibility. Therefore, **interviewee 1** feared that they will not acquire the tacit knowledge that is needed to reach perfect planning using AI, if the plan becomes more complex. Maastro is currently creating more and more e-learnings, which might help with this. However, Maastro noticed that it is crucial, "that they know what they're doing" but the tacit knowledge is like a black box so the content cannot easily be teached.

So, while elderly employees might focus too much on previous methods and become less efficient, young employees might have too little tacit knowledge to keep the quality up. Considering the methodological overload, there has to be either an acceptance of a distribution of knowledge between the different methods that ensures the best possible treatment, or the knowledge has to be distributed between different people. **Interviewee 1** said about this, that specialisation, which means the knowledge would be distributed between different people, also makes the work process more complex as each employee with the specific knowledge has to be present to do the work.

As transfering the tacit knowledge has been difficult without enough experience though, it might be worth trying to specialise some employees on different methods. Maastro could create teams of young students with knowledge on AI methods and elderly employees with knowledge about the previous methods to ensure high quality and efficient use of time. Together, they can discuss the best possible treatment considering both methods and still learn the most essential parts of the other

method from each other. Furthermore, considering that interviewee 1 said “I think there's a time in a few years that the computer is better than us.” focusing on the skills for making treatment plans without AI for some RTTs makes sense. However, as over the time the need for this knowledge can decrease and it could be enough if only 20% of the RTTs are experts on this and the ones who are still doing the work, do not have the problem of deskilling and maybe in the far future, this skill can even be completely neglected, if AI is also better at doing complicated plans. A similar but different collaboration between young and older employees and people with different expertises has been done in robotic surgery. Students who worked with robots in urology for example, would collaborate with fields that are less advanced with this new technology and thereby also teach them about this new method (Lo Presti et al., 2021).

Another way to avoid a methodological overload, that focuses more on keeping the tacit knowledge of making treatment plans is still a more careful evaluation of the need of education of both areas and creating a balance that can be standardised for all RTTs. This way, they would know how much training on old methods and how much tacit knowledge they are expected to have. This could decrease the felt responsibility, elderly RTTs have to continue to check on every treatment plan made by AI. Furthermore, the horizontal collaboration network that has been mentioned before, can also contribute to deal with a possible methodological overload when the knowledge is not distributed between different employees. RTTs should be informed about the problem of methodological overload, encouraged to share their perspective, if they encounter this problem and contribute and ask questions if they see that because of the limitation in expertise using this approach, important knowledge in one of the methods is lost. To keep the employees however, methodological overload should be avoided.

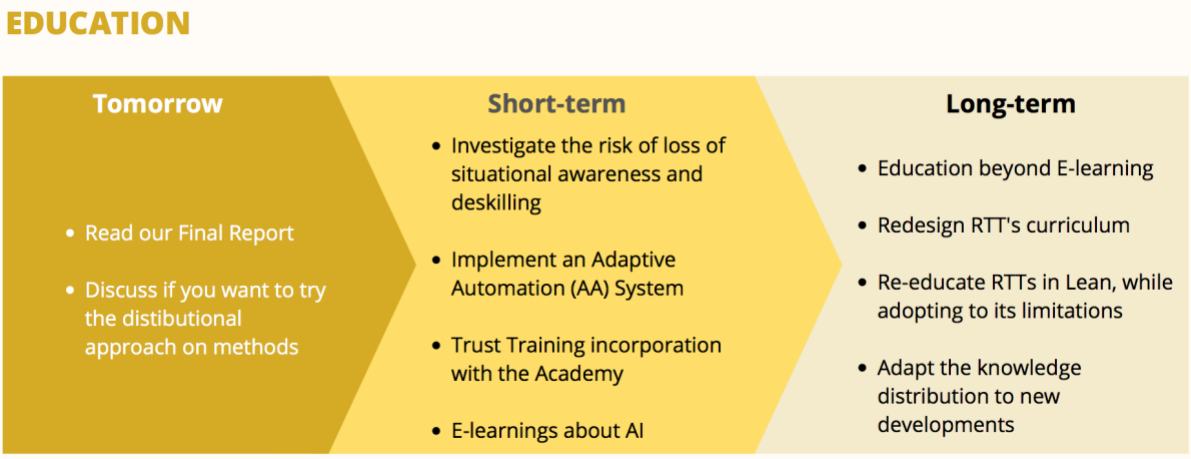

Figure 7: Timeline for the recommendations on education

d. Connections between recommendations

As mentioned in the methodology, we broke down the presented problem and the recommendations in three sections: management, organisational culture (blue), framing (green) and education (yellow). Yet, all sections are connected and influenced by each other. Figure 8 provides an overview of the major recommendations that are connected. The connection should be kept in mind for possible further challenges. As presented, AI can be successfully implemented at Maastro if the connections among people, their attitude towards change and their (educational) backgrounds are recognized.

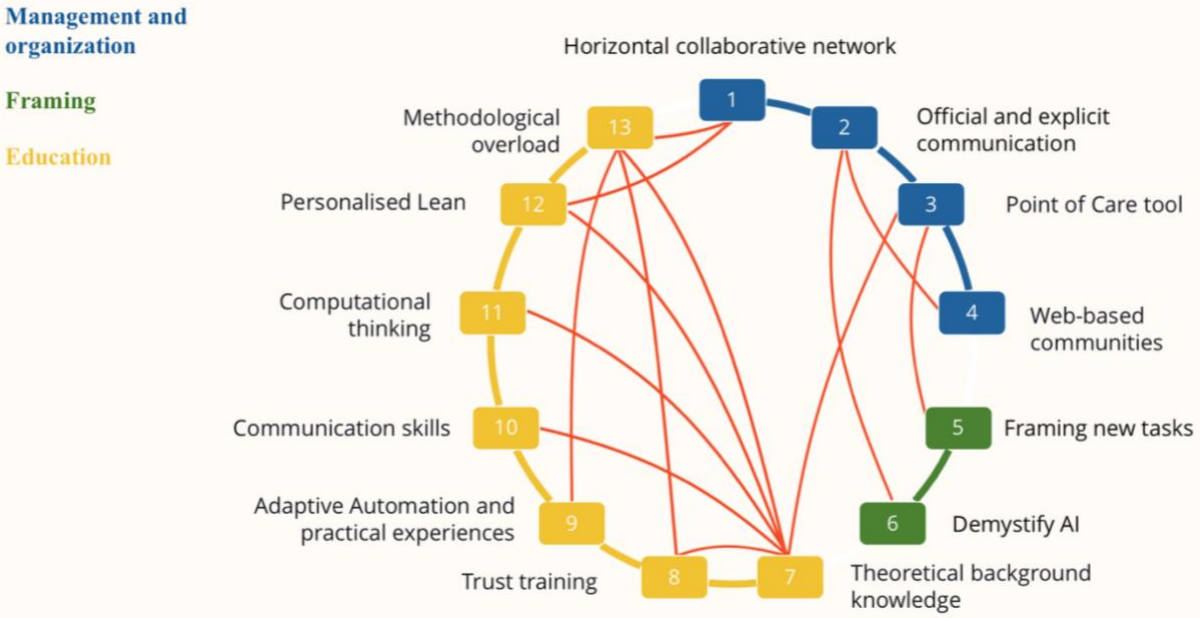

Figure 8: Connection between recommendations

5. Limitations

This Think Tank made recommendations on implementing AI within the radiotherapy clinic Maastro. There are, however, some limitations to the recommendations given by the Think Tank. Firstly, Maastro wanted us to primarily focus on RTTs, but there are multiple aspects to implementing AI that our recommendations may not touch upon. Secondly, the interview sample we used was quite small because of time and logistical reasons. Therefore, the answers given by the participants may not reflect the opinions of other people with the same job and answers may diverge when the sample size is bigger. Lastly, Maastro is a pioneer in the field of radiotherapy and AI, which makes it hard to predict how these recommendations develop practically. We used comparative studies and many of the recommendations are based on other fields as well. This means that, as Maastro is one of the first to use AI in treatment planning, the recommendations may not always carry out as suggested in this

report. Generally, this report mentioned many recommendations, but limitations indicate that further research needs to be conducted.

6. Further Research

Throughout this report, the Think Tank already provided suggestions about further research that could be conducted by Maastro. The main methodology that has been suggested is qualitative research, as it enables the involved stakeholders to elaborate on the reasoning behind their answers, and the affective component of what they are experiencing. This would provide the managers with deeper insights into the employees' needs. Methods to measure job satisfaction usually take the form of personal interviews and questionnaires of self-administration (Gholami Fesharaki, Talebiyan, Aghamiri & Mohammadia, 2012). Semi-structured interviews were suggested by the Think Tank to investigate employees' job satisfaction factors and most motivating parts of RTTs' job (see Appendix C). This could be done by internal employees or an external agent such as a parthernish with UCM in the form of internship -MaRBle project-. A semi-structured interview will help managers to frame the AI implementation so that employees will be more predisposed to accept the new automated system.

However, interviews with employees are time consuming because it is slower to generate and evaluate than quantitative data and are not feasible in large samples (Gholami Fesharaki, Talebiyan, Aghamiri & Mohammadia, 2012). Even though Maastro has a size in which semi-structured interviews are feasible, we also suggest conducting self-administration surveys. The general recommendation for different kinds of surveys to gather employee's information have been mentioned throughout our report quite often. For example, because it allows employees to share their opinions, concerns, and can provide grounds for open communication on which managerial resolutions can be based on. This knowledge is important for the technical part of the implementation as well as for the human part which strongly affects job satisfaction, attitudes towards the changes and therefore motivation.

Regarding job satisfaction, there is a lack of standardised survey or job satisfaction measurement methods. However, Think Tank suggests using the Job Satisfaction Survey (JSS) (Appendix C) as it has the exact number of questions within the 9 diverse aspects of job satisfaction. Gholami Fesharaki et.al, (2012) researched its validity within the healthcare personnel finding out satisfactory value of reliability indiceAt the same time, surveys and more quantitative-like research were also suggested. For instance, surveys were proposed to assess the risk of loss of situational awareness through the Situation Awareness Global Assessment Technique (SAGAT), and the Situational Awareness Rating Techniques (see Appendix D). Moreover, the Modified Human-Automation Trust scale, a questionnaire containing statements about trust and a likert scale rating,

was recommended as a means of measuring employees' trust in the automation (see Appendix E). Surveys and questionnaires can be extremely helpful to Maastro, since they provide easy-to-analyze data and allow for the overview of data from a larger sample.

Furthermore, Maastro could conduct ethnographic research, investigating employees' culture and social organization. Ethnography can be extremely useful in predicting employees' reaction and behavioral patterns to the AI implementation based on observations and considerations about their environment. The efficacy of such a research when introducing AI in a work field is provided by several studies. Hartmann, Fischer, & Haymaker (2009) conducted a cross-cultural study with an ethnographic approach to investigate the different behavioral reactions of restaurant's waiters when implementing service robots within the staff. The results of the research highlighted important managerial implications for the responsible implementation of service robots and the subsequent change of roles of waiters. Moreover, ethnography and applied social science methods can be used for understanding the synergies between users and AI solutions. Usability evaluation entails ensuring users can identify, comprehend, and use system features. Usability measures such as simulation studies or scenario-based testing that require hypothetical clinical situations and ask the study participants to execute distinct tasks can be applied to identify cognitive overload or overtrust concerns (Park, 2020). Equally important is identifying potential uncertainties, such as workflow disruption, patient safety concerns, or model outputs that oppose clinician insights. Evaluation should also judge the extent to which mechanisms exist for detecting and rectifying errors, including inadequate model fit, numerical uncertainty, software fault, hardware failure, or human error (Park, 2020).

Lastly, Maastro could team up with other healthcare or radiology institutions that deal with the implementation of AI. Together, qualitative or quantitative research could be conducted and the research results shared. Thus, more data could be conducted and the efficacy of strategies compared. Such partners could be hospitals with radiology, or radiotherapy departments, universities and other companies that have similar practices like maastro. Maastro could consider partners from the more than 18 radiotherapy centres only within the Netherlands such as, for example, the Netherlands cancer institute, the UMC Utrecht, the KVI centre of advanced radiation technology.

Concluding, the question remains who will conduct this research? One possibility would be to set up a dedicated team in the Maestro Academy to work closely with the implementation team we proposed in recommendation 1. Since the employees at Maastro are certainly busy with their original tasks, one could consider hiring students, similar to us as a think tank, as interns or temporary staff for this purpose. It might also be possible for someone to do their capstone research on Maastro and the introduction of AI, and in the course of this collect data.

7. Conclusion

The problem analysis introduced the overall research question: how should the managers at Maastro responsibly guide the current transformation caused by new AI and automation technologies? Throughout the past four weeks, the Think Tank has investigated this question by an extensive literature review, qualitative research methods, and by looking at comparative industries where AI has already been implemented.

This report conceptualized the essential pillars of a successful AI implementation at Maastro which are management and organizational culture, framing and education. All three pillars represented in the conceptual framework aim at maintaining or potentially increasing the job satisfaction of RTTs at Maastro. By streamlining and contextualizing several recommendations and linking them to these pillars, this report promises to help establish a guideline and potential starting point for future research. At the same time, practical action plans were developed suggesting possible actions for the short and long run but also for tomorrow.

In the realm of AI implementation in the medical field, ongoing research will be needed by Maastro to develop new AI algorithms. Medical applications, as well as collaboration, will only be improved through the continual use of such technologies at Maastro. Programmers developing better algorithms will allow better correspondence with the goals of stakeholders at Maastro providing patient care. Ensuring that research and development at Maastro is possible can be emphasized through the continual communication and collaboration between physicians and healthcare providers, data scientists, computer scientists, and engineers. It is also important to note that although these technologies are possibly promising for increasing treatment efficiency, they are still nascent to the point where such technology still needs to be supervised to some extent. It is necessary to evaluate and implement them with a critical eye, keeping in mind their limitations and educating Maastro's stakeholders to do the same.

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9. Appendix

A. Questions for Survey / Semi-structured Interview to Employees

Adapted from Beijer et al. (2011) and Prevot et al. (2012).

- What do you like most about your job as a [job name] (RTT / physician)?
- Which automated tools are you currently using? Which aspects of those do you most appreciate?
- If you were to imagine an ideal futuristic AI tool, what features would it have? Which tasks do you think will change?
- What are some areas where you wish AI can support you?

B. Questions for Survey about Employee Attitudes towards the Implementation of AI

Adapted from (Abdullah & Fakieh, 2019); Measurement is a ranking from 1 to 4

Table 3. Perceptions of AI (N=250).

Rank	Question	Mean (SD)	*n*	Approximate agree rate	Level
4	I have good knowledge of AI[a]	2.95 (1.14)	185	74%	Moderate
2	AI abilities are superior to human experience	3.01 (1.17)	187	75%	Moderate
1	AI could replace me in my job	3.11 (1.13)	195	78%	Moderate
3	I have high hopes about AI applications in the health care sector	2.96 (1.11)	185	74%	Moderate
N/A[b]	Overall perception of AI	3.01 (1.13)	187	75%	Moderate

[a]AI: artificial intelligence.
[b]N/A: not applicable.

Figure 9.Questions about “the perceptions of AI” (Abdullah & Fakieh, 2019, p.10)

Table 4. The advantages of using AI (N=250).

Rank	Question	Mean (SD)	*n*	Approximate agree rate	Level
1	AI can speed up the process in health care	3.50 (1.23)	175	70%	High
3	AI can help reduce the number of medical errors	3.36 (1.08)	167	67%	Moderate
5	AI can deliver clinically relevant, vast amounts of high-quality data in real time	3.24 (1.17)	162	65%	Moderate
2	AI has no space-time constraint	3.45 (1.17)	172	69%	High
4	AI has no emotional exhaustion or physical limitation	3.27 (1.16)	162	65%	Moderate
[a]N/A	The advantages of using AI overall perception	3.36 (1.16)	167	67%	Moderate

[a]N/A: not applicable.

Figure 10. Questions about “the advantages using AI” (Abdullah & Fakieh, 2019, p.11)

Table 5. The application of AI in health care (N=250).

Rank	Question	Mean (SD)	*n*	Approximate agree rate	Level
5	AI cannot be used to provide opinions in unexpected situations	3.20 (1.14)	160	64%	Moderate
4	AI is not flexible enough to be applied to every patient	3.28 (1.19)	165	66%	Moderate
1	AI is difficult to apply to controversial subjects	3.62 (1.17)	180	72%	High
3	AI has low ability to sympathize and consider the emotional well-being of the patient	3.34 (1.15)	167	67%	Moderate
2	AI was developed by a specialist with little clinical experience in medical practice	3.41 (1.17)	170	68%	High
[a]N/A	Problems regarding the application of AI in health care, overall perception	3.37 (1.16)	167	67%	Moderate

[a]N/A: not applicable.

Figure 11. Questions about “the application of AI in healthcare” (Abdullah & Fakieh, 2019, p.11)

The data was evaluated through a statistical analysis according to Gender, Age, Job Type and Educational Level (Abdullah & Fakieh, 2019, p.6). Similarly, van Hoek and colleagues conducted qualitative research on “the future of radiology among radiologists, medical students and surgeons” (van Hoek et al., 2019).

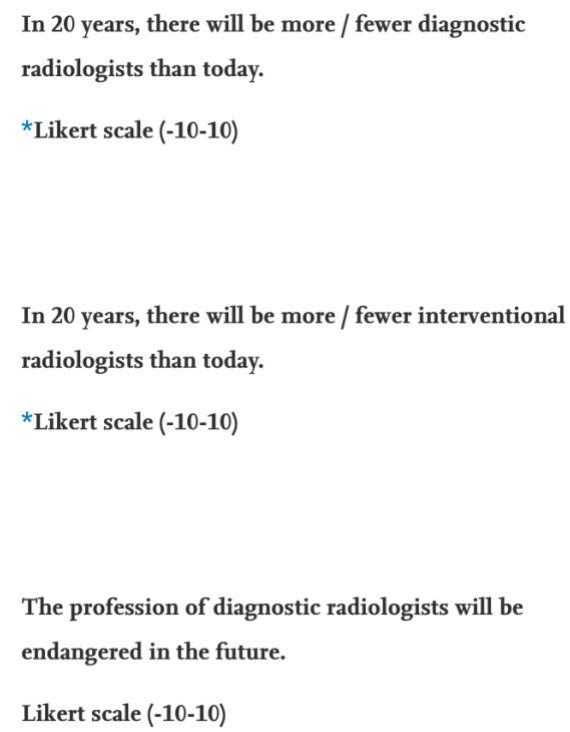


Figure 12. Extract from survey on the perception of the future of Radiologists (van Hoek et al., 2019, p.3)

In today's situation, would you again opt for radiology as a specialization?

Yes (91%) – No (9%)

When answered Yes: Would your interest in future technological developments in radiology (such as artificial intelligence) be one reason for you to re-elect radiology as a specialty?

Yes (79%) – No (21%)

You are afraid to become unemployed due to technological developments.

Likert scale (0-10)

You expect a significant acceleration of your work from new technologies (AI / Artificial Intelligence).

Likert scale (0-10)

Could you imagine doing a great deal of you work from home, using teleradiological software?

Likert scale (0-10)

Figure 13. Extract from survey on the perception of the future of Radiologists (van Hoek et al., 2019, p.4)

C. Job Satisfaction Survey (JSS)

	JOB SATISFACTION SURVEY Paul E. Spector Department of Psychology	

	University of South Florida 	
	PLEASE CIRCLE THE ONE NUMBER FOR EACH QUESTION THAT COMES CLOSEST TO REFLECTING YOUR OPINION ABOUT IT.	Disagree very much Disagree moderately Disagree slightly Agree slightly Agree moderately Agree very much
1	I feel I am being paid a fair amount for the work I do.	1 2 3 4 5 6
2	There is really too little chance for promotion on my job.	1 2 3 4 5 6
3	My supervisor is quite competent in doing his/her job.	1 2 3 4 5 6
4	I am not satisfied with the benefits I receive.	1 2 3 4 5 6
5	When I do a good job, I receive the recognition for it that I should receive.	1 2 3 4 5 6
6	Many of our rules and procedures make doing a good job difficult.	1 2 3 4 5 6
7	I like the people I work with.	1 2 3 4 5 6
8	I sometimes feel my job is meaningless.	1 2 3 4 5 6
9	Communications seem good within this organization.	1 2 3 4 5 6

10	Raises are too few and far between.	1 2 3 4 5 6
11	Those who do well on the job stand a fair chance of being promoted.	1 2 3 4 5 6
12	My supervisor is unfair to me.	1 2 3 4 5 6
13	The benefits we receive are as good as most other organizations offer.	1 2 3 4 5 6
14	I do not feel that the work I do is appreciated.	1 2 3 4 5 6
15	My efforts to do a good job are seldom blocked by red tape.	1 2 3 4 5 6
16	I find I have to work harder at my job because of the incompetence of people I work with.	1 2 3 4 5 6
17	I like doing the things I do at work.	1 2 3 4 5 6
18	The goals of this organization are not clear to me.	1 2 3 4 5 6

19	I feel unappreciated by the organization when I think about what they pay me.	1 2 3 4 5 6
20	People get ahead as fast here as they do in other places.	1 2 3 4 5 6
21	My supervisor shows too little interest in the feelings of subordinates.	1 2 3 4 5 6
22	The benefit package we have is equitable.	1 2 3 4 5 6
23	There are few rewards for those who work here.	1 2 3 4 5 6

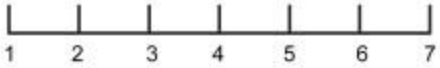
24	I have too much to do at work.	1 2 3 4 5 6
25	I enjoy my coworkers.	1 2 3 4 5 6
26	I often feel that I do not know what is going on with the organization.	1 2 3 4 5 6
27	I feel a sense of pride in doing my job.	1 2 3 4 5 6
28	I feel satisfied with my chances for salary increases.	1 2 3 4 5 6
29	There are benefits we do not have which we should have.	1 2 3 4 5 6
30	I like my supervisor.	1 2 3 4 5 6
31	I have too much paperwork.	1 2 3 4 5 6
32	I don't feel my efforts are rewarded the way they should be.	1 2 3 4 5 6
33	I am satisfied with my chances for promotion.	1 2 3 4 5 6
34	There is too much bickering and fighting at work.	1 2 3 4 5 6
35	My job is enjoyable.	1 2 3 4 5 6
36	Work assignments are not fully explained.	1 2 3 4 5 6

Figure 14. Job Satisfaction Survey, Paul Spector (2021)

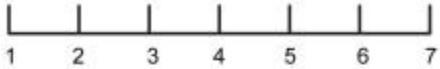
D. Situational Awareness Rating Techniques

SITUATION AWARENESS RATING TECHNIQUE (SART; Taylor, 1990)

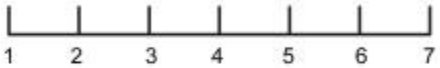
Instability of Situation
How changeable is the situation? Is the situation highly unstable and likely to change suddenly (High) or is it very stable and straightforward (Low)?



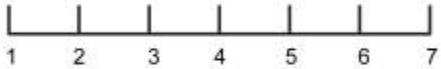
Complexity of Situation
How complicated is the situation? Is it complex with many interrelated components (High) or is it simple and straightforward (Low)?



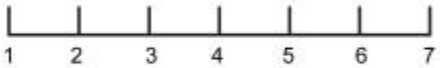
Variability of Situation
How many variables are changing within the situation? Are there a large number of factors varying (High) or are there very few variables changing (Low)?



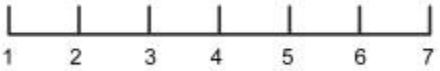
Arousal
How aroused are you in the situation? Are you alert and ready for activity (High) or do you have a low degree of alertness (Low)?



Concentration of Attention
How much are you concentrating on the situation? Are you concentrating on many aspects of the situation (High) or focussed on only one (Low)?

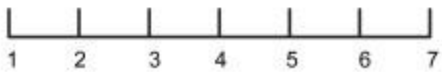


Division of Attention
How much is your attention divided in the situation? Are you concentrating on many aspects of the situation (High) or focussed on only one (Low)?

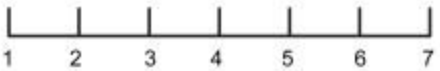


Spare Mental Capacity
How much mental capacity do you have to spare in the situation? Do you have sufficient to attend to many variables (High) or nothing to spare at all (Low)?

Information Quantity
How much information have you gained about the situation? Have you received and understood a great deal of knowledge (High) or very little (Low)?



Familiarity with Situation
How familiar are you with the situation? Do you have a great deal of relevant experience (High) or is it a new situation (Low)?



e. Figure X. Situational Awareness Rating Techniques (Cooper et. al, 2013)

E. Survey for Trust Levels - Modified Human-Automation Trust Scale

1	The system is deceptive	1 2 3 4 5 6 7
2	The system behaves in an underhanded manner	1 2 3 4 5 6 7
3	I am suspicious of the system's intent, action, or outputs	1 2 3 4 5 6 7
4	I am wary of the system	1 2 3 4 5 6 7
5	The system's actions will have a harmful or injurious outcome	1 2 3 4 5 6 7
6	I am confident in the system	1 2 3 4 5 6 7
7	The system provides security	1 2 3 4 5 6 7

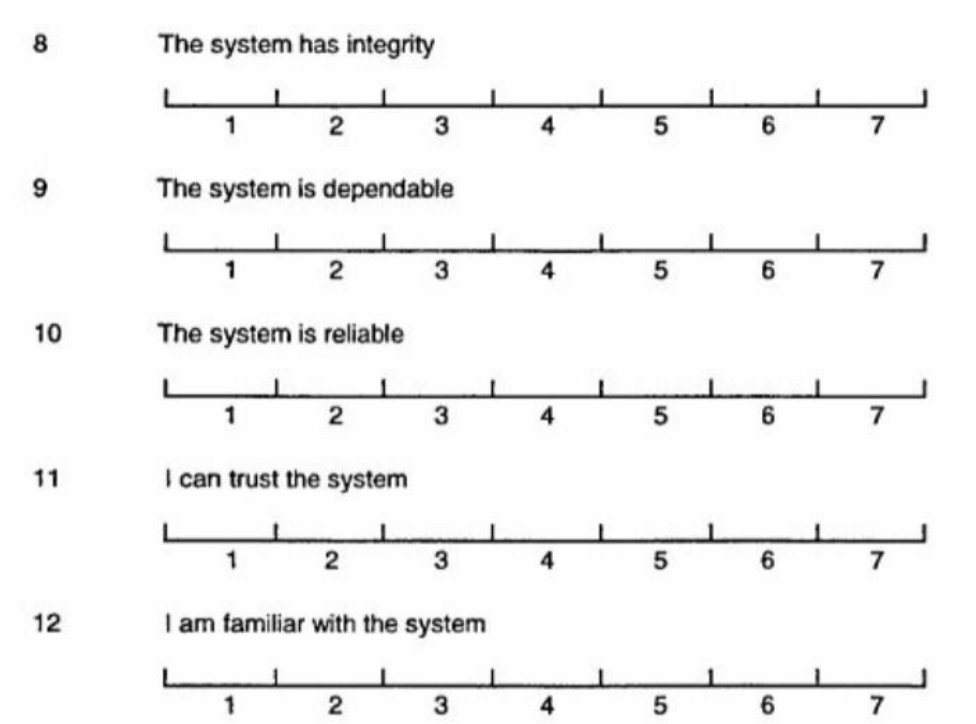


Figure X. Survey for Trust levels (Mirchi et al., 2015)