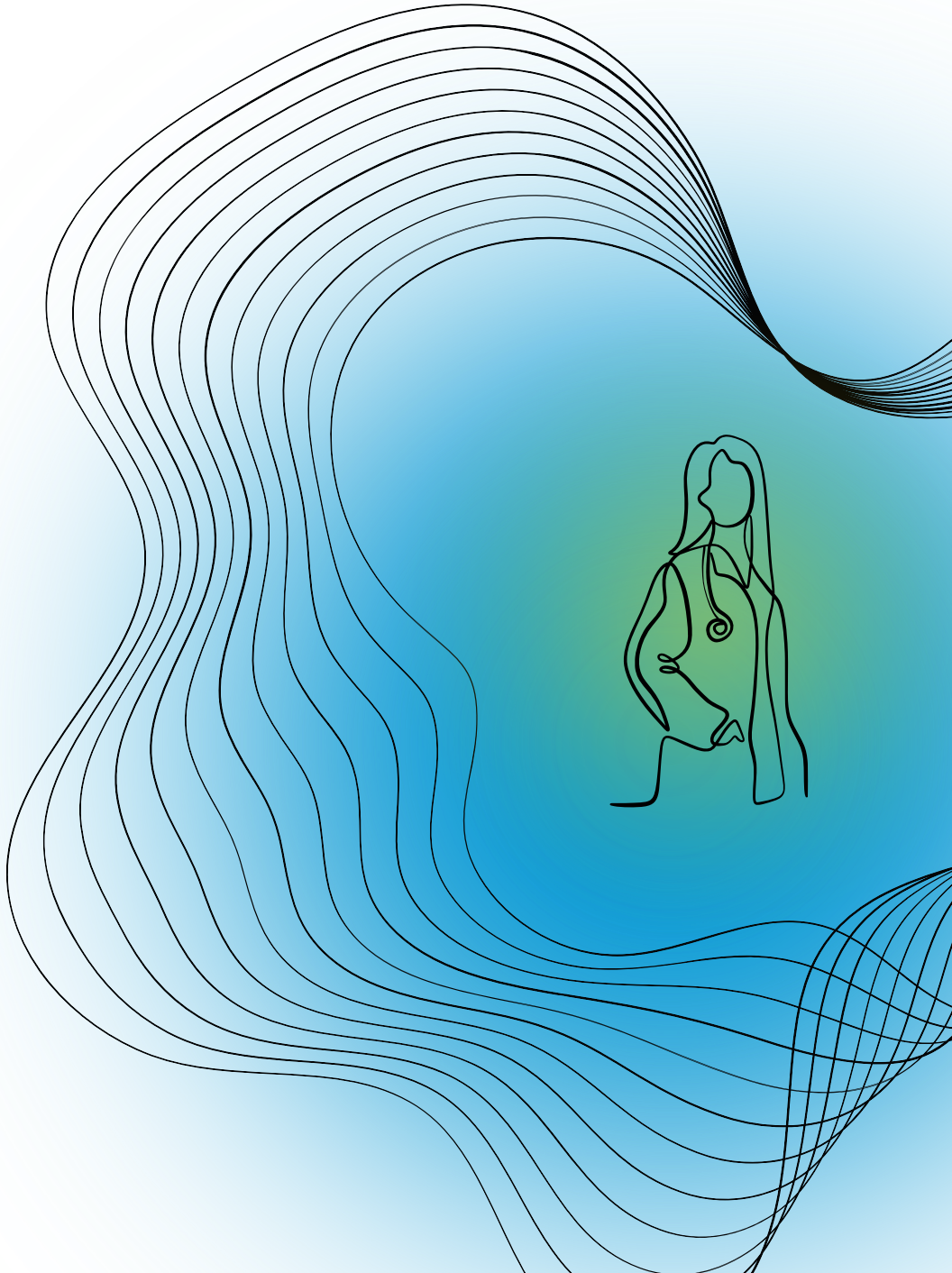
IMPROVING THE WORKFLOW OF RADIATION ONCOLOGISTS

Facilitating Data-Enabled Pre-treatment Process Optimization in Radiation Therapy



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INTRODUCTION

Radiation therapy is a local treatment using ionizing radiation to treat cancer and some benign diseases. Its goal is to kill cancer cells while sparing normal tissue, preserving function, and achieving better cosmetic results. In the Netherlands, radiotherapy is a key part of treatment for about one-third of the 100,000 cancer patients diagnosed annually . Erasmus MC Radiotherapy, one of the 21 radiotherapeutic centers in the country, performs radiation therapy for both curative and palliative purposes. The treatment process involves multiple steps and takes approximately 10 hours per patient, with an average lead time of 14 days (reference). Extended lead times result from various factors such as variations in working methods, staff shortages, inefficient staff utilization, and errors due to overworked staff (ref). A shortage of laboratory technicians is a significant bottleneck. Additionally, numerous quality checks contribute to the overall processing time. It is crucial to consider the unique needs of each patient, including emotional, psychological, physical, social, and financial burdens, during treatment planning. Prolonged waiting times can worsen the patient's condition and emotional distress. Optimizing staffing and workload, streamlining scheduling processes, and maintaining communication and quality across departments can lead to reduced lead times, decreased staff workload, improved efficiency, and enhanced patient experience (Washington, Leaver, & Trad, 2020) (https://www.nki.nl/, n.d.) (https://iknl.nl/nkr , n.d.)

As a DFI master's student, my thesis project, titled "Improving the Workflow of Radiation Oncologists and Facilitating Data-Enabled Approach to Pre-Treatment Optimization," filled me with motivation and enthusiasm. This project was a gateway to learning and provided an opportunity to contribute to digital product design. It involved critically evaluating the current digital landscape of the radiotherapy system, focusing on functionality and usability, and participating in the digital and data transformation of healthcare.

What excited me most was the prospect of collaborating with a hospital to address a real issue in Radiotherapy, a field known for continuous innovation and its potential to enhance the lives of cancer patients. My goals for this project included using context mapping and various design research methods, such as system, stakeholder, and journey mapping, to address the quadruple aim through innovative solutions. I was also committed to applying experience and usability design, along with testing methods, to improve the patient care experience. While the data-enabled approach was optional, I was genuinely eager to explore its potential to enhance the project's impact.

This project embodies my spirit of innovation, collaboration, and a firm dedication to improving the lives of those in need.

Approach

To address this project, a combination of a few design methods are implemented during the four major stages of the project: Discover, define, develop, and Deliver.

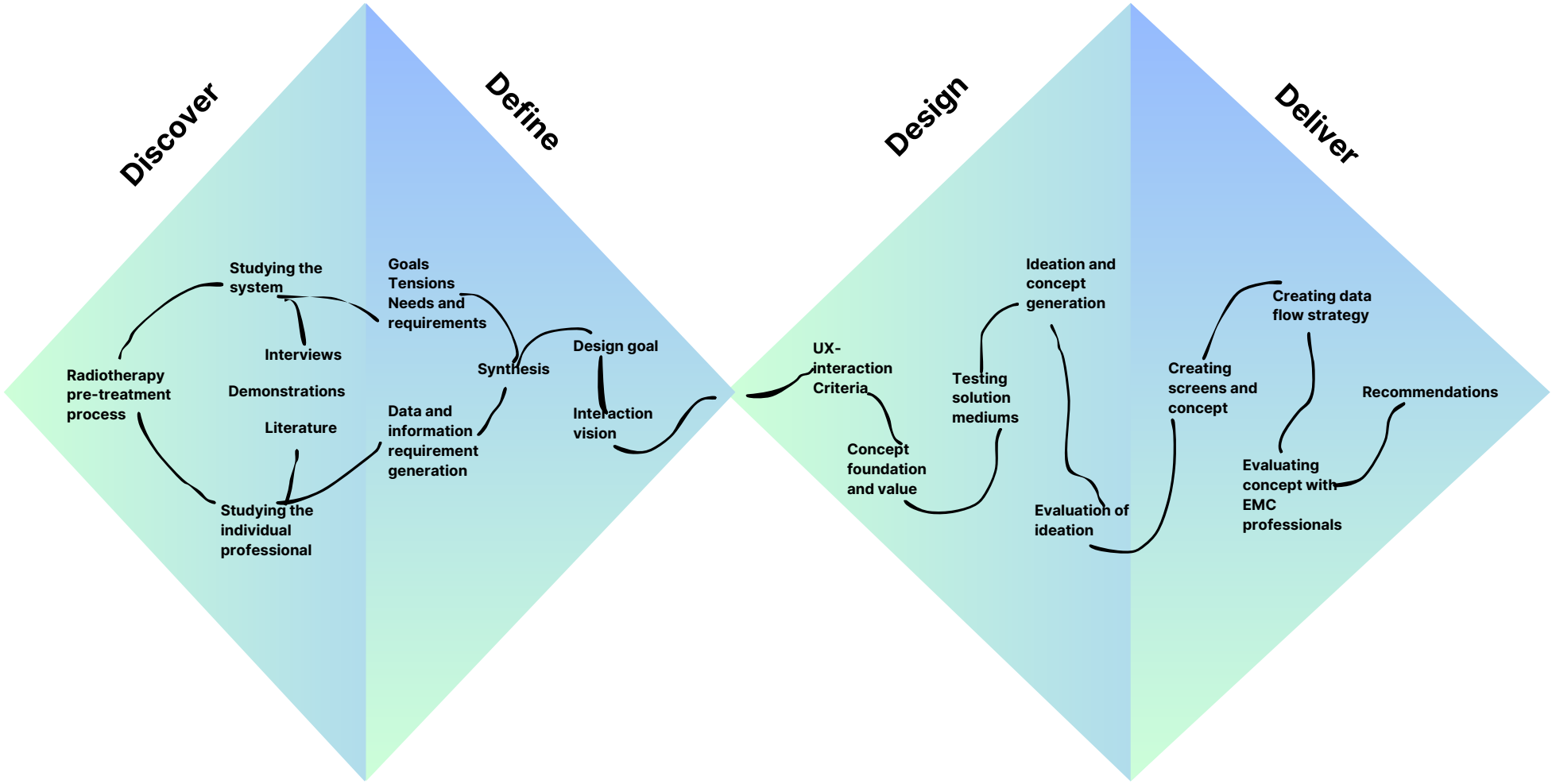


fig 1:Design process

Understanding Radiotherapy

As a precursor to this project, it is crucial to understand what a patient goes through stage - by -stage for their radiotherapy treatment. The patient being the end-reciever of the treatment it is importnat to first see it through their perspective before we go into the intricacies of the backend professional work that goes into the radiotherapy treatment planning and implementing.

What

Radiation therapy is a form of localized treatment that is either used alone or alongside other treatment modalities. It utilizes ionizing radiation to address cancer and certain non-cancerous conditions. But because of its limitation to a local area, patients with tumors diffused throughout the body are not candidates for radiation therapy.

Why

The benefit of utilizing radiation therapy includes preserving function and better cosmetic results.

fig 2: mouldroom

How

External beam x-rays, electrons, protons, or gamma rays can be directed towards the tumor using various methods. Linear accelerators have the ability to generate x-rays with precise energy levels tailored to the treatment requirements.

Steps

To achieve this objective, the radiation pre-treatment process includes multiple steps of setup, planning, adjusting, and rechecking that lead up to the start of the radiation of the patient. From the perspective that the patient sees it, the following stages occur:

1. Consultation: The patient will meet with a radiation oncologist. The radiation oncologist will check the patient's test results, assess their fitness for treatment, and explain the process and expected results, as well as discuss possible side effects and risks. The patient will be asked to agree (consent) to have the treatment.

2. Planning: The patient will meet with a radiation therapist. The radiation therapist will determine the optimal positioning of the patient's body during External Beam Radiation Therapy (EBRT) or decide the appropriate placement of applicators for Brachytherapy. The patient will get a CT scan done and possible mold to immobilize the specific part of the body during the treatment. (fig 2).

3. Treatment plan: Based on the planning session and the treatment guidelines for the specific type of cancer, the radiation oncologist, radiation therapist, and medical physicist will collaborate to determine the radiation dose, identify the treatment area, and devise the appropriate method for delivering the precise radiation dosage.

Understanding Radiotherapy

4. Treatment Sessions: The radiation therapists will administer the prescribed course of radiation therapy as outlined in the treatment plan. The duration of each treatment session will vary depending on the type of radiation therapy being used (fig 3).

5. Review and follow-up: The patient will undergo regular reviews throughout the treatment to monitor and address any side effects that may arise. Following the completion of radiation therapy, they will have an appointment with the radiation oncologist to assess the treatment's effectiveness and determine the response of the cancer to the therapy.
(Steps in radiation therapy, 2020) (Radiation therapy process, n.d.) (UC Davis Health & Department of Radiation Oncology, n.d.) (What to expect when having radiation therapy, 2013) (https://www.imaginis.com/radiotherapy/who-are-the professionals-in-radiation-therapy n.d.) (Your radiotherapy team, n.d.)

fig 3:Cyberknife radiation machine

PROBLEM DEFINITION

Every year in the Netherlands, approximately 100,000 patients are diagnosed with cancer (https://www.nki.nl/ , n.d.) . With these numbers on the rise, and a shortage of staffing, there is an increased workload on the existing professionals to work fast, despite the complexity and meticulous nature of radiotherapy planning. There are multiple obstacles that may cause a buildup and inability for a smooth flow of a patient through the system, sometimes causing oncologists to lose track of the patients' situation in the care pathway. This further builds onto the pyschological stress owing to their sense of responsibility towards the patient in the process, and to their need to preserve their control over the patient's treatment process.

With increasing demand to work with complex systems and technology, there is also an increasing reliance on the smooth operations and uniform working methods of other professionals and colleagues for the radio oncologist's smooth workflow. But there are currently some unaddressed operational and working issues faced by the Erasmus radiotherapy department that attribute to inefficiencies, delays, and loss of patient status in the pre-treatment process. Hence there is a strong motivation to explore this space through the project, where there is currently a lack of solutions towards optimising and supporting the professionals in this stage of the process.

The nature of this problem also gives rise to certain design challenges. For example, to tackle this problem, one must take into account the learning curve for healthcare professionals when introducing a new (possibly tech-based) solution, which may, in turn, temporarily increase the lead time. It is also important to strike a balance between patient and professional needs (considering the example of scheduling), technology, and human contact (determining where automation is required and where it is essential for the patient to experience a human interface instead of a machine), as well as quality and efficiency (ensuring that reducing the time of certain processes does not jeopardize the quality of the output). This problem statement also provides the opportunity to examine the problem from both a system perspective and an interaction perspective. The challenge lies in ensuring that any interaction-level intervention can be smoothly implemented into the current radiotherapy system and process without adversely affecting other parts of the process. The nuanced and complex nature of this problem makes it all the more interesting to address this brief from these two levels.

The preliminary design goal was formulated as follows:
How can a service be designed to help alleviate the problems with workflow disruption and keep track of delays in the process?

fig 4: linear accelerator(left), professional in control room (right)

Research questions

The thesis hence aims to answer the following research question:

What are the factors causing delays in the pre-treatment process of radiotherapy, and how is the workflow of an oncologist affecting and being affected by the same?

Research Questions Based on Quadruple Aim

In embarking on this research endeavor, a comprehensive exploration of the quadruple aim was undertaken, taking into account the specific context and initial brief. The quadruple aim is a principle that pushes innovators to tackle healthcare problems sustainably, strategically, and meaningfully. The 4 "aims" are: To improve patient experience, better population health outcomes, reducing cost of care, and improving staff experience.
The quadruple aim has its origins in the Triple aim that provides a framework for Healthcare systems and transition to population health. It helps focus on improving the health of populations while lowering healthcare costs. The fourth aim “improving staff experience” that concerns workforce engagement and workforce safety was added later on to account for the healthcare providers in the equation, since there is great benefit and value in keeping the workers of healthcare systems happy, safe and physically and mentally healthy. (Privitera, 2018) (Bodenheimer & Sinsky, 2014)
Quantifiable metrics for the same come in the form of surveys, documenting both satisfaction and burnout.
For this project the quadruple aim provides a great starting point to probe deeper into the context of the Hospital to tackle the issue from the different perspectives. This model urges its user to think about the different stakeholders in this context.

As a result, the following sub-questions were formulated to shed light on various dimensions of the radiotherapy process (fig 5):

1. What are the different tasks being performed by the professionals during the pre-radiation process?
2. What are the factors affecting lead time in Radiotherapy?
3. What are the patient's experiences in the radiotherapy process?
4. What are the healthcare professional's experience in the Radiotherapy process?
5. What are the different types of tasks of the radiation oncologist towards patient treatment planning?
6. What are the interdependencies that directly impact their workflow?
7. What are aspects of the bigger radiotherapy system that indirectly impact their workflow?

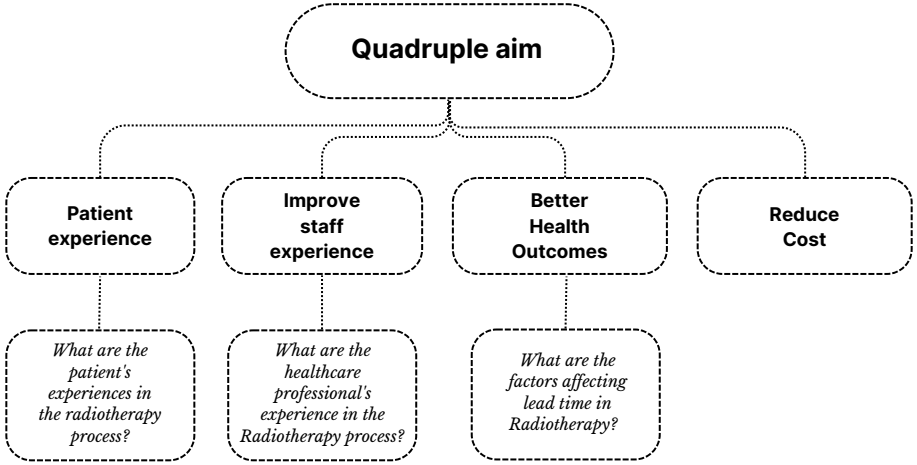


fig 5 : Research questions based on quadruple aim

THEME EXLORATION

Prior to field research, this section provides literature insights into key themes that this thesis addresses. The themes explored along with their significance for this study is listed below:

- **SEIPS 2.0- Human factors configuration model (fig 6) -** Understanding the model and its application in the healthcare context. Further understanding its significance in the project.

RQ: What are the different types of tasks of the radiation oncologist towards patient treatment planning?
RQ: What are the interdependencies that directly impact their workflow?
RQ: What are aspects of the bigger radiotherapy system that indirectly impact their workflow?

- **Delays in the pre-treatment process (causes, effect, and mitigation) -** the overarching problem that the thesis is based on, and hence understanding in detail the key contributing factors and effects of delays in the process on the patient are looked into. The focus on the pre-treatment phase of radiotherapy is the scope of this project arising from the client's needs.

RQ: What are the factors affecting lead time in Radiotherapy?

- **Optimization- Needs and methods** : Optimization is the organization of the treatment process in a way that maximizes quality of the treatment plan while taking as less time a spossible. This is the defining concept of radiotherapy treatment planning and is at the crux of achieving desirable health outcomes. Hence this section goes into understanding the needs and methods of optimization in the current radiotherapy context.

RQ: What are the factors affecting lead time in radiotherapy?

- **Professional Job Satisfaction- Factors and Correlations –** As established earlier, addressing workforce satisfaction and engagement is a key factor in advancing and sustaining healthcare strategies. This section looks into what this means for radiotherapy professionals and what contributes to workforce retention.

RQ: What are the healthcare professional's experience in the Radiotherapy process?

- **Patient Experience**- In accordance with patient-centered design, understanding the patient's needs, emotions, experiences with the radiation therapy treatment process.

What are the patient's experiences in the radiotherapy process?

SEIPS 2.0

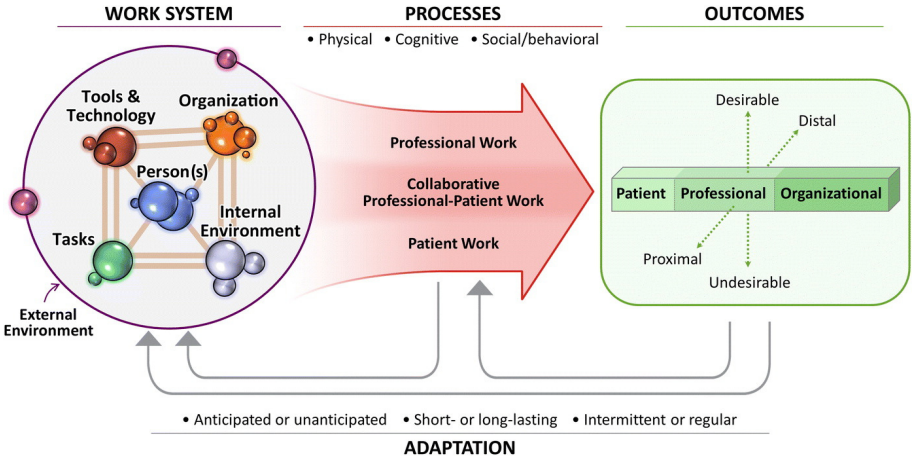


fig 6 : SEIPS 2.0

It is beneficial to use the SEIPS 2.0 model to effectively map the system in the current/possible future radiotherapy process. SEIPS 2.0 model is a human factors/ergonomics framework for studying and improving health and healthcare. It describes how sociotechnical systems shape health-related work done by professionals and non-professionals, independently and collaboratively. This framework was an appropriate choice to fit results into from the discussions and demonstrations from the various professionals so that there was a comprehensive and meaningful visualization of the work system of the radiation oncologists in the department. From background study and understanding of the client's problems, it was clear that the delays and inefficiencies occurred for a multitude of reasons, some more obvious while some being more hidden and causing damage in the background. This framework can help map out the interactions, and interdependencies and help pinpoint the factors affecting the workflow of the radiation oncologist. Hence the focus of the results is on the first section of the model, I.e., the "work System". Subsequently, the SEIPS 2.0 configuration model which is an offset framework from the work system aspect of the model is used to define the results in a meaningful manner, which will be elaborated on further in this chapter. (Holden et al., 2013)

Delays in the pre-treatment process - causes

Delays in the pre-treatment process can occur from a large variety of reasons. A primary cause for delays is the insufficient availability of medical staff (Chen, King, Pearcey, Kerba, & Mackillop, 2008)(Probst, Holmes, & Dodwell, 2003) (Saure, Patrick, Tyldesley, & Puterman, 2012). However, the problems can arise owing to a combination of factors, including an imbalance between capacity and demand, as well as inefficiencies in patient scheduling. Three key factors contribute to the complexity of scheduling radiation therapy treatments:
1. The categorization of radiotherapy into various types
2. Distribution of the treatments over an extended period
3. Variation of the duration of the radiation therapy sessions.

All of these factors add to the challenge of scheduling radiation therapy and result in delays between the referral and the commencement of treatment (Dodwell & Crellin, 2006). Inefficient resource utilization in healthcare not only wastes money but also misses opportunities to save lives and alleviate suffering. This is especially critical in cancer care and radiotherapy, which is a complex process involving various interconnected activities (Santos & Amado, 2012a).

A study with UK radiotherapy services departments showed professionals carrying managerial, political, and clinical responsibilities overseeing the process face the most significant challenges with capacity management. They need to navigate the difficult task of balancing competing clinical priorities while facing pressures from various stakeholder groups. This is especially challenging within an environment that places a huge emphasis on fair and prompt access while also respecting patient preferences. Unfortunately, there is no clear national guidance or precedent to guide them in making these difficult decisions. (Santos & Amado, 2012a)

Considering how timely radiotherapy improves cancer care outcomes; it is important to investigate poor performance through local practices, staffing levels, and equipment downtime, and which facilities can influence improvement (Santos & Amado, 2012a). Key inputs for staff include clinical oncologists, radiographers, and physicists, but other equipment factors also impact facility performance.

Delays in the pre-treatment process- effects

Literature findings indicate that extended waiting periods in healthcare settings have negative impacts on clinical outcomes, including an elevated risk of local recurrence, tumor progression, and prolonged psychological distress. Additionally, delays during the diagnostic phase have been linked to the advancement of tumors to higher stages, often due to medical misjudgment and repeated referrals leading to deferred diagnoses. (B¨utof & Baumann, 2013) (Vieira, Demirtas, B van de Kamer, Hans, & Van Harten, 2019) (Mackillop, Bates, O'Sullivan, & Withers, 1996). In a study at a particular facility, it was noted that unfortunately, a significant number of patients were no longer eligible for curative strategies due to delays prior to commencing treatment.(Conforti, Guerriero, & Guido, 2008) For individuals diagnosed with incurable cancer, a delay in receiving palliative radiotherapy leads to prolonged symptoms and distress but is unlikely to negatively impact their overall survival. In cases of radical radiotherapy, where the treatment aims for long-term disease control or a cure, delays can significantly affect cancer control, preservation of affected organs, and mortality rates. (Dodwell & Crellin, 2006). Unplanned treatment gaps indicate inefficient resource use and can negatively affect treatment outcomes. (Santos & Amado, 2012a).

Furthermore, incidents within healthcare often result from designs that overlook crucial human factors. When developing technologies and systems, it is essential to consider human abilities, cognitive processes, and limitations(Bolderston, 2016). Usability plays a critical role in determining how easily users can learn and adapt to new technologies introduced during the treatment process, such as AI. Factors like the learnability of AI and its impact on the time required for pre-treatment processes should be carefully taken into account to ensure the efficient and effective delivery of healthcare.(Chan et al., 2012).

Delays in the pre-treatment process- mitigation

Ideal cancer care in radiotherapy should ensure timely access, clinical effectiveness, minimal patient disruption, equipment and staff efficiency, and ample resources. These themes align with performance assessment frameworks in healthcare. (Santos & Amado, 2012a). Current strategies employed to mitigate the consequences of limited treatment capacity encompass reducing the frequency of treatment sessions, transferring patients to other facilities, or implementing some form of rationing (Santos & Amado, 2012a). By incorporating human factors and usability principles into the design of healthcare technologies, we can improve overall patient care and reduce the occurrence of adverse events. Preventing gaps in unplanned treatment enhances tumor control and reduces long-term healthcare costs. (Santos & Amado, 2012a) (insert image- optimum radiotherapy facility).
To tackle this issue, it is crucial to implement appropriate measures that prioritize optimizing workflow, ensuring an adequate number of staff members, and providing the necessary technical resources to prevent waiting lists. The Dutch Society for Radiation Oncology has established maximum waiting time targets, requiring acute patients to be treated within 1 day, subacute patients within 10 calendar days, and regular patients within 28 days.(Vieira et al., 2019).

Optimization - Needs and Methods

Radiotherapy presents a multi-faceted challenge as it requires balancing the radiation dosage between the tumor and various healthy organs, all while aiming to maximize the patient's quality of life. This intricate process involves considering 10-30 highly correlated criteria, with each patient having a unique anatomical composition that demands an individualized approach. (Conforti et al., 2008).

In the pre-treatment stage, all patients require CT scans, contouring, and treatment planning. Some patients may have more steps, and all of these together make up the workflow for the various professionals. Hence the primary objective of using optimization techniques to the workflow is to optimize the utilization of medical resources and ensure timely delivery of the appropriate treatment to each patient. The literature describes pull and push strategies influenced by logistics and supply chain management principles. (Conforti et al., 2008). (Breedveld, Craft, Van Haveren, & Heijmen, 2019). While pull strategies involve pre -planning the first radiation and hence already scheduling CT and outpatient appointments, push strategies employ a continuously flowing system, where each stage leads into the next without specific due dates for any of them (Vieira et al., 2019).

When comparing pull and push strategies, there are advantages and disadvantages to consider. Pull strategies offer improved predictability in meeting waiting time targets, but they may result in slightly longer average waiting times compared to push strategies. However, they can enhance control over work in progress, leading to fewer patients exceeding waiting time targets. On the other hand, push strategies in radiotherapy provide flexibility in performing pretreatment activities and consequently reduce the need for rescheduling first linac appointments. In the literature, it is suggested that a hybrid constant work-in-progress workflow has the potential to increase the number of irradiation sessions per day by 32 percent (Vieira et al., 2019).

Literature described newer AI planning systems such as Automatic Treatment Planning (ATP).Automatic treatment planners have proven effective in reducing the time required for generating treatment plans, particularly by minimizing human interactions, which often involve repetitive tasks, with Treatment Planning Systems (TPSs). But it was also stressed that it still required essential human tuning, and ultimately AI's goal is to augment treatment plan quality (Wang, Zhu, Hong, & Zheng, 2019) (Hutton et al., 2014) (Conforti et al., 2008) (Breedveld et al., 2019) (Siddique & Chow, 2020) (Uyar, Ozcan, & Urquhart, 2013).

In conclusion, implementing appropriate workflow management systems, such as scheduling routines, and designing efficient resource planning schemes are crucial to meet the desired waiting time targets while prioritizing patient-centered care and ensuring labor quality. Staffing being a common issue, it is interesting to look into how this problem can be compensated through automation and intelligent support of tasks and functions.

Professional Job Satisfaction - Factors and Correlations

Literature describes that the clinical radiotherapy workforce is drawn to their vocational roles, deriving a lot of satisfaction from caring for patients and delivering quality service.
Job satisfaction is a complex concept influenced by individual factors, the work context, and the overall environment (Hutton et al.,2014). There is a well-established link between job satisfaction, performance, and retention. Despite this, there is a surprising lack of data investigating the workforce in the field of radiotherapy. While physician burnout is increasingly recognized, little is known about medical oncologist job satisfaction and the factors associated with low satisfaction (Hutton et al., 2014) (Sehlen et al., 2009).

It is important to recognize that job satisfaction and burnout are distinct concepts. While multiple recent studies have demonstrated alarming rates of burnout among medical oncologists, there is less information available on job satisfaction (Raphael et al., 2019).

The radiotherapy profession can also face a stressful work environment that may feel threatening and unsafe, leading to the risk of compassion fatigue and burnout among professionals Sehlen et al. (2009)(Vieira et al., 2019).

At Erasmus MC there is the need for radio oncologists to find the balance between adequately spending time with patients and the expectations to work quickly, owing to the highly time-sensitive and already delay-prone workflow. Workload and job satisfaction must be carefully addressed to mitigate these effects.

High stress and low job satisfaction among staff pose risks to treatment quality and safety. Including indicators like staff publications and satisfaction with the work environment can provide valuable insights. Overall, efficient resource utilization is crucial in cancer care, especially in radiotherapy, to enhance patient outcomes and well-being (Santos & Amado, 2012a). Identification and removal of the above-mentioned critical points requires various changes which should lead to the reduction of stress. In a study conducted, Radiographers rated the following items as the most stressing (from highest to lowest): "against the conviction, patients were kept alive by all means", "stress due to patient's disease progression", "high physical workload" and "patients suffering of my therapy". Physicists expressed as sources of stress "time pressure" , "underpayment" , "ill-defined responsibilities" and "reduction of private life through high workload" (Swafford & Legg, 2009).

With regards to the patient and healthcare provider relationship, the literature describes the importance and prevalence of Shared Decision Making as a practice. An attempt to measure and teach Shared decision-making (SDM) over decades revealed that in medical encounters it is found to be limited, occurring only about 10 percent of the time (Godolphin, 2009). Certain groups, such as those with fewer resources, less education, older individuals, and the seriously ill, may have less involvement in the decision-making process.

Patient Experience

Literature substantiates how in any clinical setting, and also specifically in radiotherapy decisions should be guided by patient preferences, needs, and values. This is the crux of providing an exceptional patient experience. There are a few crucial aspects being discussed in the context of patient experience.

The emphasis on technology also tends to dominate the culture of these departments, which was also accepted by patients as the focus of the RTs (Merchant, O'Connor, & Halkett, 2017). Hence striking a balance between technology and human factors is important, as it should not compromise the patient's connection, comfort, and relationship with healthcare professionals (HCPs) (Bolderston, 2016). Introducing new interventions in the pre-treatment process must hence take into account the stages where patient interactions cannot be compromised.

Regarding patient engagement, literature describes how patients value communication, individualized care, access to information, the professional competence of HCPs, proper follow-up, and positive attitudes from their healthcare providers (Tomlinson, Samuels, Murphy, James, & Beardmore, 2014).
For the patients, the idea of experiencing the 'unknown' is a strong feeling of anxiety going into the treatment, and this becomes especially crucial in the aspect of taking the time and communication from the professionals' side to alleviate these fears (Merchant et al., 2017). In the context of radiotherapy, this also means giving sufficient time to a patient with concerns and fears, and helping a patient understand the procedures and the

side effects of the treatment. This task is usually carried out by radio oncologists and radiotherapists, including assessing the response to treatment (Bolderston, 2016).

A possible tension towards effective communication is, that patients can be at the receiving end of the perceived time pressure and stressful environment that the professionals are subjected to (Gamble, 1998). They can notice the fast-paced environment focused on efficiency, which can sometimes hamper communication with patients. In an observational study, the radiation therapists confirmed this situation that the "workload took away from the emphasis on patient support and care" Merchant et al., 2017).

Takeaways

Collaborative Approach: Surgeons, radiation oncologists, medical oncologists, radiologists, pathologists, and other professionals collaborate to create treatment plans that prioritize both tumor management and the patient's quality of life. This emphasizes interdisciplinary teamwork in creating successful cancer treatment strategies.

Impact of Delays on Clinical Outcomes: Delays in radiotherapy treatment can occur due to multiple reasons, including a disproportionate ratio of demand to resource availability/allotment, scheduling, and inefficient process management. Delays can lead to negative clinical outcomes, including elevated risks of local recurrence, tumor progression, and psychological distress for the patient.

Importance of Human Factors and Usability: Designing healthcare technologies with consideration for human abilities, cognitive processes, and usability is essential. The SEIPS 2.0 model is an effective way to map a work system with the human factor at the core and their interactions with functional, technical, and organizational aspects of the system.

Job Satisfaction on Radiotherapy Workforce: Job satisfaction is influenced by individual factors, work context, and the overall environment. Operating procedures, co-workers, nature of work, and communication are crucial aspects that can significantly impact performance and workflow efficiency.

Challenges in Radiotherapy Profession: The radiotherapy profession can face a stressful work environment, potentially leading to compassion fatigue and burnout. Balancing patient time with quick work expectations is particularly challenging due to the time-sensitive nature of the workflow.

Patient-Centric Approach: A patient-centric approach is crucial, balancing technology and human touch for strong patient connections and comfort in healthcare. New interventions should preserve quality patient interactions. Patient engagement values communication, access to information, HCP competence, follow-up, and positive attitudes.

Conclusion

The literature indicates that radiation oncologists play a significant role in bridging the gap between the back-end treatment planning professionals, meeting personalized patient needs, and being a key point of contact for patients. Additionally, they face high workloads and fatigue due to various factors, leading to process inefficiencies. Therefore, it is essential to better understand the work and interactions of radiation oncologists within Erasmus MC's radiotherapy department.

CONTEXT DEEP DIVE

RQ: *What are the different types of tasks of the radiation oncologist towards patient treatment planning?*
RQ: What are the interdependencies that directly impact their workflow?
RQ: What are aspects of the bigger radiotherapy system that indirectly impact their workflow?

This project is for the Erasmus MC Radiotherapy department and focuses on the problems experienced specifically by the radiation oncologists, and the specific issues that come together to create the bottlenecks in their process. Hence, a context-deep dive was necessary to step into the shoes of a professional employed at the radiotherapy department and understand what their day-to-day work looked like. Since the pre-treatment process is a multi-stage process with numerous professionals, the discussions and interviews were not limited to the radiation oncologists but also to other professionals to understand the different tasks that go into creating a highly personalized and accurate treatment plan. Hence, generating a holistic understanding of the context involved garnering insights of the process at both a micro level as well as a macro level.

Aim

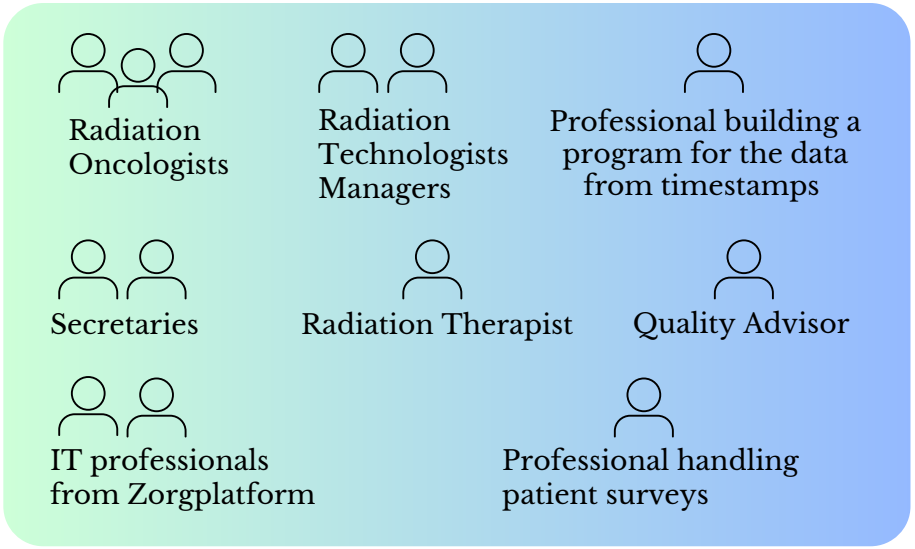
The aim of the research was to dive deeper into the context of the problem, by understanding it from a few different perspectives: The Oncologist, the managers, and the system level.
Hence the following aspects were investigated more closely:

- The pre-treatment steps that occur from the start of the patient's referral to the first fraction
- The makeup of the internal work system (as per SEIPS model, discussed below)
- To understand tasks, interactions, and delays from the perspective of the radiation oncologist as well as the managers.
- To understand the workflow of the oncologists in the radiotherapy pre-treatment phase.
To understand what issues are experienced by the managers in identifying and capturing delays.

Through the interviews and discussions, the idea was to probe deeper into the tasks of specific professionals (oncologists, secretaries) at every pre-treatment stage, their mode/medium of operation, tools used as well as the patient touchpoints during these different steps. The end goal was to be able to map these aspects parallel to each other, and also to map current stakeholder interactions with the intent to identify strained and limited interactions.

Method

The method employed was a combination of one-on-one interviews along with demonstrations of tasks performed (fig 7).
The professionals involved were:



Apart from this, there were discussions outside of the Erasmus MC with:

- Sales Director of a Digital Medical Technology company- to discuss software adaptability and learnability for radio imaging, and how well it is integrated with the current healthcare information system.

- A radiation oncologist in charge of setting up a radiation therapy and oncology department in Mauritius- discussions were related to understanding the criteria for setting up a radiotherapy department, and what factors affect the time that it takes to start radiating a patient.

The questions for the professionals were based on understanding the work system as per SEIPS 2.0 model. The SEIPS 2.0 model is a human factors/ergonomics framework for studying and improving health and healthcare. It describes how sociotechnical systems shape health-related work done by professionals and non-professionals, independently and collaboratively. This was believed to be fitting in the context of the radiotherapy process and the aim of the project, to dive deeper into the pre-treatment process to identify synergistic aspects of the tools and technology, organization, tasks, and internal environments of the current work system surrounding the oncologist's workflow (Holden et al., 2013). Fig x
For interview guide, please refer to appendix. The questions involved:

- Communication,
- Tasks performed and responsibilities,
- Tools used,
- Proficiency with tools,
- Skills that can be automated,
- Skills that are hard to automate and
- Their perception of the workload.

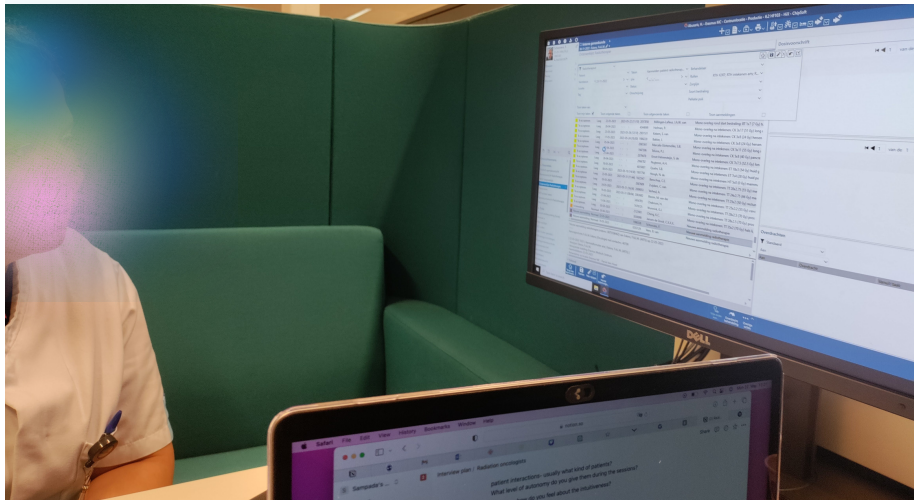


fig 7 :demonstration activity with radiation oncologist

The method of conducting the interview was derived from ethnography (Savage, 2006), as well as the Path of Expression model which describes the ideal method to explore the present, past, and future experience of the target use (Sanders, Stappers, 2020) (fig 8).

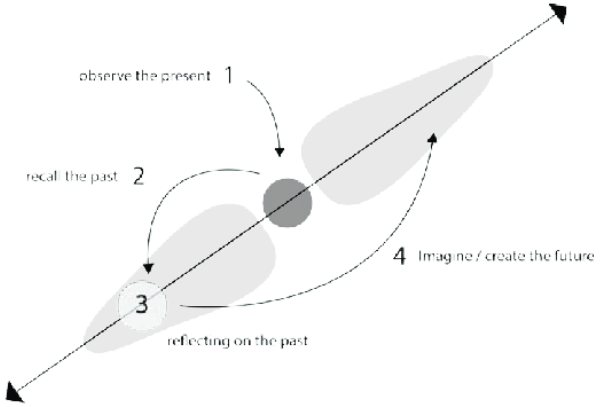


fig 8 : path of expression

RESULTS

The results were categorized into two levels: **system level** and **Radiation oncologist as a persona**.

System level:

- Pre-treatment Process Mapping - a broad overview of the steps taken by professionals toward creating a treatment plan at Erasmus MC, along with a view of the touchpoints with patients they currently have.
- SEIPS 2.0 Configuration model - The "Person(s)" are at the center of the work system, and are individually linked to and interact with the surrounding aspects of the work system. As per our context, these person(s) in focus are the Radiation Oncologists. Tools and technology, organization, internal and external environment.

Radiation oncologist persona level:

- Tasks
- Goals
- Guiding principles and values
- Tensions
- Effects and emotions
- Needs and requirements

The order of the discussed results involves a broad overview of the pre-treatment process mapping, and then an introduction first to the radiation oncologist tasks and goals. This sensitization helps to further empathize with the factors affecting the oncologist's workflow while discussing the SEIPS 2.0 configuration model. Then the results continue into the persona level insights of the radiation oncologist.

It must be noted that the description of tasks and problems faced during tasks are limited to the above professionals and additional comments are made based on background information of the other professionals involved in the process.

Pre-treatment Process Mapping

As discussed briefly during the theme exploration, the pre-treatment phase is a multi-step process that requires multiple professionals within and outside of the radiotherapy department to curate a unqiue and highly specialized radiation treatment plan for the patient. This section discusses the results of the study regarding the pre-treatment process followed in Erasmus MC, based on discussions and provided background information. The aim of mapping the pre-treatment workflow was to: understand the step-by-step procedures and juxtapose existing information on the "happy flow" (the ideal workflow) and understand the various tasks conducted by the healthcare professionals at each stage. Each stage with the Professionals involved, the Tasks, the tools used, patient touchpoints as well as the issues faced (briefly described) were indicated in the map (see fig 9).

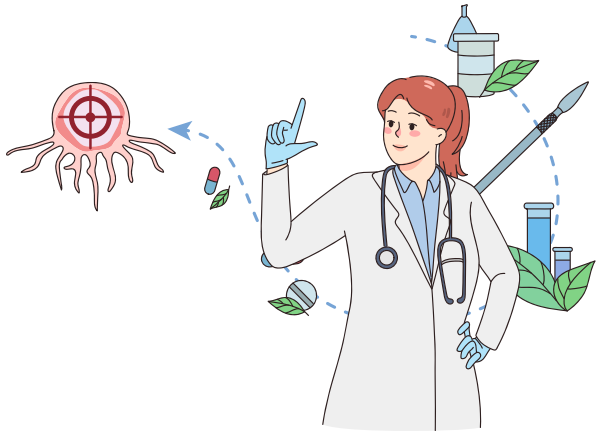
	Referral stage	Logistic preparation	Out patient clinic	Image acquisition and image processing	Dose Planning	Treatment Verification
Happy flow		day 1 **Poli Planning** 30 min	day 4 **Poli** 30 min	day 4 **CT** 30 min **Delineating target** 15 min **Critical organs** 15 min **Mono** 5 min	day 6 **Schedule** 60 min **Dose plan** 120 min **Placo** 15 min	day 8 **Plan room** 60 min **Start RT** 16 min
Professionals and tasks	**Medical specialist** Share patient referral with Erasmus, share necessary documents by uploading on Zorgdomain OR by sharing via email	**Triage Secretaries** Share patient referral with Erasmus, share necessary documents by uploading on Zorgdomain OR by sharing via email **Radiation oncologist** • What kind of tumor and treatment. If they need MRI, CT. • Checking all the documents • Radiation plan **PPR** • Plan first appointment with doctor • MRI, chemo	**Radiation oncologist, Radiotherapist** • Seeing patient at outpatient clinic • What exactly to do, onboarding patient, • Preparation on computer • 3 outpatients- new patients, patients currently undergoing radiation, flow up	**Radiation oncologist** • Contour target • Mono, • Drawing tumor, OAR • Check the plan and say if it's alright • See patients at CT **Radiotherapists** • Make plan • check amongst eachother • Sign the plan **CT Lab technicians** **X-ray technicians** • Quality Assurance • Multidisciplinary meeting-if target and prescription is correct • Protocols- norm that the plan must conform to before they send it to oncologist. **Physiotherapists**	**Technicians** • How much dose by specific beam • How radiation is coming through the patient **Physicists** • Automatic quality assurance **PPR** • Booking CT appointment • Booking first fraction and treatments according to number of times the patients come back • Extra appointments for dieticians	**Radiation Physicists** **Radiation Therapist** **Lab technicians** • Specific details like patient lying down etc • Manual check of data and process atm
Tools	HiX	HiX zorgdomain - filling in patient info Info in Hix. Triage list for Radio onco patient comes into checklist as new patient start putting in a plan	HiX Radiotherapist's patient screen	HiX, MiMs HiX, MiMs, CT machine and imaging software mono- 2/3 times a week- look at 0-5 plans 2 screens note down changes in hix	HiX MiMS • HiX, MiMs	• Linear accelerator, • Cyberknife
Patient touchpoints		Discussion with triage secretary on preference for scheduling first appointment, medication. Taking messages	First appointment with radiotherapist	Mould room (head and neck), with mould room technician CT machine- with technician	Information of appointment	Patient in the plan room with lab technicians
Issues causing delays per stage	Sometime they don't have the radiation- information isn't good enough- they call the referred doc- not clear, missing info If we look at triage- every radiation Onco puts comments- three other doctors in my name, but the patient is coming at my poli	MRIs are very hard to get within a short time.	Scattered outpatients disrupts workflow for radiooncologists Unevenly distributed outpatient clinics	i"f we look at when patients are CT scanned and I have an hour to do contouring. If I get the ct in the afternoon and the poli is in the afternon, then that time is no longer available. Instead it would be nice to see it and do it all the same day. I lose continuity, it's not only one patient. cuz I get new patients, there's a pile up of patients ! missing data on delays" most ideal is-" if I finish contouring now and they check it immediately it's nice" "good triage- doesn't take too much time, but otherwise may need to go back and forth" "if plan looks doesn't look good they usually walk by"	! missing data on delays	! missing data on delays

fig 9 : pre-treatment process map at Erasmus MC

Radiation Oncologist Persona

Tasks

The process begins with reviewing the outpatient clinic schedule to identify new patients requiring radiation treatment. Radiation plans are then prepared, involving tasks such as drawing, contouring, and considering organs at risk. Collaboration within the oncology groups is emphasized to streamline the workflow from the clinic to the initiation of radiation treatment, aiming for efficiency. Multidisciplinary meetings (MONO) are conducted twice a week, where treatment plans and radiation decisions are discussed. The goal is to achieve agreement on the target area, and if further contouring is required, revisions are made. However, individual checks may be necessary in between tasks, potentially leading to some waiting time. After triage, appointments are made, and the treatment planning process begins, including scheduling a CT scan. The radiation oncologist contours the target area, presents the plan during the MONO meeting, and collaborates with radiotherapists for plan checking and adjustments. The final plan is then sent to the physicist for implementation on the radiation machine.



Goals

Through discussions and better understanding the radiation oncologists' roles, the following goals were identified:

- **Creating the best radiation treatment plan that is personalized for the patient**
- **Alleviating patient fears and taking into account the patient needs and preferences while making the plan**
- **Helping patients achieve maximum quantity and/ or quality of life through the treatment.**
- **Ensure patients can start the radiation treatment as soon as possible**
- **Care at the right moment/time for the right patient so that the greatest likelihood of the best health outcomes can be achieved.**

> *Some patients after referral start within 4 weeks- for patient with tumor inside that's a lot*

> *Everything should be fluid for patients and for us, everyone does their work*

Factors Affecting Workflow of the Radiation Oncologist

The SEIPS 2.0 configuration model is useful for identifying the relevant aspects of the work system based on the strength of influence of the interactions on work process performance. Hence, the configuration model on the following page is a depiction of the major factors affecting the Radiation Oncologist's workflow and the interactions between said factors in the work system. (Holden et al., 2013)
Each Factor is depicted as an alphanumeric corresponding to the type of factor and its description. The size of the bubbles is indicative of the importance of the given factor in the current system with regard to its influence on the radiation oncologist's workflow.(fig 10)

Below, each factor is discussed further in detail:

Persons

P1: availability of oncologists for peer review

Collaboration within the oncology groups is emphasized to streamline the workflow from the clinic to the initiation of radiation treatment, aiming for efficiency. Peer review meetings (MONO) are conducted twice a week, where treatment plans and radiation decisions are discussed. The goal is to achieve agreement on the target area, and if further contouring is required, revisions are made. CT scan. The radiation oncologist contours the target area, presents the plan during the MONO meeting, and collaborates with radiotherapists for plan checking and adjustments. The final plan is then sent to the physicist for implementation on the radiation machine. However, individual checks may be necessary in between tasks, potentially leading to some waiting time.

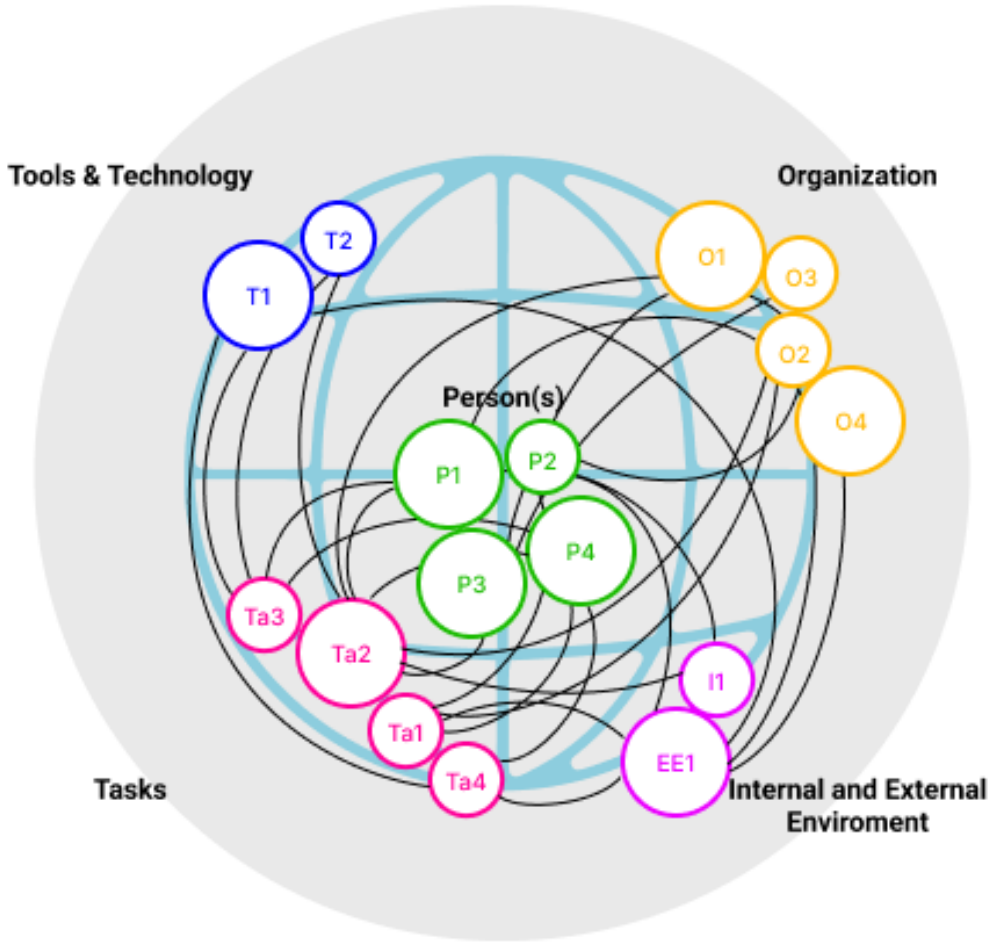
P2: Triage secretaries sharing patient cases with the right specialty

Triage Secretaries Sharing Patient Cases with the Right Specialty: The role of triage secretaries in appropriately directing patient cases to the relevant specialty significantly impacts the workflow of radiation oncologists. Triage serves as a critical initial step, guiding patients to medical groups like palliative, irradiation, stereotactic, and gynecological departments based on their needs. However, incomplete or unclear patient information can challenge accurate assessment by triage secretaries. When essential radiation-related details are absent, the triage process stalls, requiring additional communication with referring doctors for clarification. This leads to delays, inefficiencies, and potential duplication of efforts among multiple doctors during patient visits.

Radiation oncologists often find themselves addressing issues stemming from the triage process, diverting their attention from core patient care and treatment planning responsibilities. Administrative concerns, delayed appointments, and coordination challenges further burden their workflow. Conversely, an efficient and accurate triage process directs patients to the appropriate specialty, streamlining radiation oncologists' tasks and enabling them to prioritize patient care.

P3:Availability of staff for CTs

According to a statement made by Remi Nout (Professor of Radiotherapy, Erasmus MC), the Netherlands possesses cutting-edge radiotherapy services and advanced equipment, including CT- or MRI-guided radiotherapy and proton therapy. However, it has been emphasized that there is a need to limit the rise in healthcare expenses and the workforce, as per the Integral Care Agreement. Despite this, there is a strong commitment to



Person(s) Factors
P1: Availabilty of Oncologists for peer review
P2: Triage secretaries sharing patient case to the right specialty
P3: Availability of staff for CTs
P4: Complexity and tumor group of patient

Tasks
Ta1: Time available to plan outpatient
Ta2: Time available to do the drawing, contouring, OAR
Ta3: Necessity and frequency of re-checks of plans
Ta4: Frequency and recurrence of administrative tasks

Tools & Technology Factors
T1: Uniformity in usage of the Healthcare information system
T2: Comfort and level of expertise with technological tools and softwares

Organization Factors
O1: Scheduling of CTs and MRIs
O2: Time and task allotment of HCPs based on the larger work system and tumor groups
O3: Staffing of technicians and physicans
O4: Working protocols

Internal and External Environment
I1: Proximity to oncologists and surgeons
EE1: Recieving the right and complete referral from the previous hospital

Current workflow of the Erasmus MC oncologist during the treatment planning is shaped most strongly by a combination of:

Active agents: Oncologists, patient, secretaries

fig 10 : SEIPS 2.0 Configuration model

maintaining the quality and accessibility of healthcare services while ensuring their sustainability. The future is expected to present significant challenges in this regard.

CT scan capacity and workload have a significant impact on the radiation oncologist's workload since their treatment plan creation tasks start with the receipt of the imaging for each patient in order to dive into a patient's case before creating a treatment plan (fig 11). The radiation oncologists expressed concerns about the repercussions of current CT scan allotments on their workflow, if the CT scan is not conducted on the same day, they are forced to reexamine it after three days, leading to a delay in the planning process. This delay results in a loss of continuity in patient care, impacting not only one patient but causing a pile-up of cases. The availability of CT scans depends on various factors like whether it is open and if there is sufficient personnel. Consequently, the radiation oncologist finds themselves in discussions with the manager to address these issues and improve the workflow for smoother and more efficient patient care.

P4: Complexity and tumor group of patient

The complexity and tumor group of a patient play a significant role in shaping the radiation oncologist's workflow. For gynecological cases, the oncologist typically schedules weekly treatments for a whole week, as they are closely connected to the oncology group. However, for palliation cases, treatments occur once every two weeks in a larger group, with the oncologist being available for frequent telephone consultations. The importance of precise planning becomes evident, ensuring the tumor is well-covered, and adhering to specific dosage rules (e.g., 59 percent dosage around the Planning Target Volume - PTV) without creating wider hotspots or damaging nearby organs at risk (OAR). To streamline the process, strict protocols and formatting guidelines are followed, with variations depending on the tumor type and location.

At the palliation poli, the formatting requirements may be more relaxed compared to the gynae cases, where they utilize a clear format and input data into the physical system. If any deviations from the norm are made, the oncologists must be able to provide justifications for their choices. For cases where tumors extend beyond the skin, specialized procedures in the mould room may be necessary to determine the best patient positioning and treatment approach.

Patient interaction varies depending on the complexity of the case. For instances like brain metastasis, detailed explanations might not be as necessary, whereas for cervical cancer, it is crucial to conduct physical exams, inquire about their well-being, and thoroughly explain procedures such as brachytherapy. However, the oncologist faces time constraints, with some treatments, such as placing markers, requiring efficient time management within a tight 40-minute window. Overall, understanding the complexity of the tumor and adapting the workflow accordingly ensures effective treatment and patient satisfaction.

fig 11 : patient going through CT scan

Tasks

Ta1: Time available to plan outpatient

The time available to plan outpatient treatments significantly affects the workflow of radiation oncologists. This factor is highly correlated to the schedule of the oncologist as well as the distribution of the out patient clinics of the oncologists. The oncologists would ideally be able to plan the outpatient and the CT scans on the same day for patients, but sometimes they do not have time to plan sufficiently in advance. Efficiently planning treatment regimens for outpatient cases demands careful consideration of individual patient requirements, dosimetry calculations, and treatment delivery logistics.

Ta2: Time available to do the drawing, contouring, OAR

Accurate contouring is essential for precise treatment planning, but the intricate nature of these tasks demands careful attention and expertise (fig 12). The availability of sufficient time directly affects the quality of contouring and, consequently, treatment accuracy. The tension lies in balancing the need for meticulous contouring with the broader workflow demands, often leaving radiation oncologists to prioritize efficient time management without compromising the accuracy of these critical tasks.

Ta3: Necessity and frequency of re-checks of plans

The necessity and frequency of re-checking treatment plans are crucial factors influencing radiation oncologists' workflow. Ensuring treatment plan accuracy through thorough reviews and re-checks is essential to prevent errors and optimize patient outcomes. However, frequent re-checks can extend the time required for plan approval and delivery, potentially delaying treatment initiation. Striking a balance between comprehensive plan validation and timely treatment is challenging. Radiation oncologists must manage this tension by adopting efficient review processes without sacrificing plan accuracy.

Ta4: Frequency and recurrence of administrative tasks

Administrative tasks, though not directly related to clinical care, significantly impact the workflow of radiation oncologists. These tasks encompass patient documentation, scheduling, reporting, and coordination with other departments. The radiation oncologists mentioned the heavy workload of paperwork and administrative tasks, including managing numerous emails. The recurrence and frequency of these administrative responsibilities can divert valuable time and attention away from patient care and treatment planning. The challenge lies in managing administrative duties effectively to ensure smooth operations while still dedicating ample time to clinical tasks. Efficient administrative support and streamlined processes can alleviate this tension by minimizing administrative burdens on radiation oncologists.

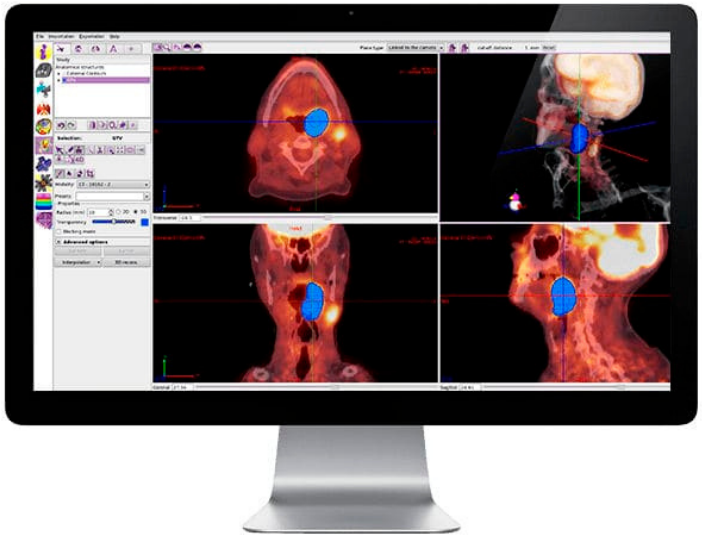


fig 12 : contouring software example

Tools and Technology

T1: Uniformity in the usage of the Healthcare information system

One major concern is the lack of trust in the system.(fig 13). For instance, when a patient with skin cancer undergoes surgery and needs time to heal before starting treatment, the information is entered into HiX with a note to pay attention to it. However, there is no way to ensure that the wound has closed, causing frustration and impatience. Additionally, there is a lack of safety measures to keep patients secure within the system. For example, if a patient has been previously treated by a specific radiation oncologist, they should be able to come directly to the oncologist without going through HiX, which can involve unnecessary delays and interactions with multiple healthcare providers. HiX also encounters difficulties when patients need to be changed, such as when a new treatment plan or CT scan is required. The complexity of the system is often cited, with users expressing that they are not IT specialists and may struggle with navigating HiX efficiently. Furthermore, once an action is performed in HiX, there is uncertainty about the patient's status and whether they will return to the appropriate provider. The excessive number of administrative clicks required on HiX adds to the frustration and inefficiency experienced by radiation oncologists and their teams.

T2: Comfort and level of expertise with technological tools and software

The radiotherapy field increasingly relies on advanced software for treatment planning, data analysis, and patient management. Radiation oncologists with a high degree of expertise can efficiently navigate these tools, streamlining treatment planning processes and data interpretation. On the contrary, limited familiarity with complex software can lead to inefficiencies, delays, and errors in treatment planning.

Moreover, the comfort level with technology impacts communication and collaboration within multidisciplinary teams. Proficient use of electronic health records (EHRs) and communication platforms ensures seamless information sharing among healthcare professionals. When radiation oncologists lack confidence in utilizing these tools, miscommunications and missed opportunities for collaboration can arise.
Striking a balance between technological proficiency and core clinical responsibilities is vital. Radiation oncologists must allocate time to enhance their familiarity with software and tools, ensuring they can maximize their benefits without compromising patient care. Training and support mechanisms that address individual needs can assist radiation oncologists in overcoming these challenges and leveraging technology to streamline their workflow effectively.

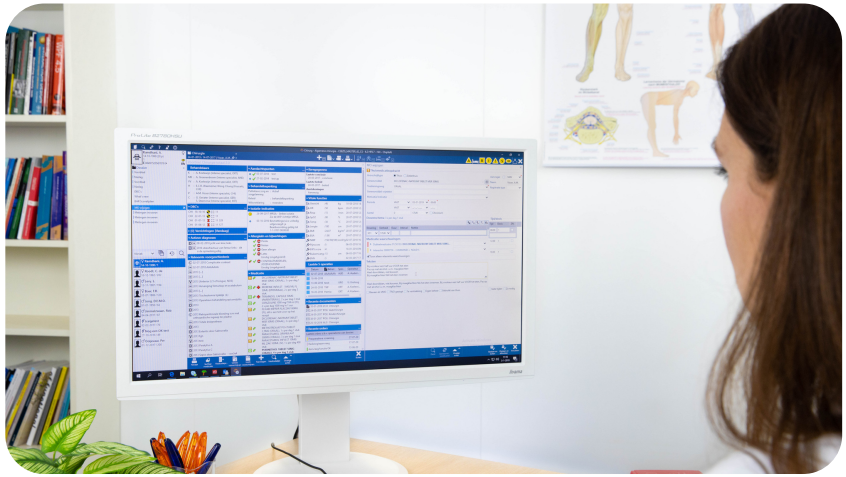


fig 13 : HiX system in use

Internal Environment and External Environment

I1: Proximity to oncologists and surgeons

Other interactions also take place with colleagues, including gynecologists, lung doctors, and neurologists, although not on a daily basis. These interactions occur when these doctors refer patients for radiation treatment. The mode of communication for these interactions varies, with most of the coordination happening through the hospital information exchange system (hix). However, there are instances where communication takes place via phone or email. Sometimes, these interactions occur informally as colleagues walk by and discuss cases.

EE1: Receiving the right and complete referral from the previous hospital

Efficiently receiving accurate and comprehensive referrals from previous hospitals plays a pivotal role in the workflow of radiation oncologists. The utilization of platforms like Zorgplatform aids in referral management and communication between healthcare professionals involved in the pre-treatment phase (fig 14). Zorgplatform streamlines the exchange of referrals, enabling seamless communication between hospitals, which can occur through various channels such as email, fax, or phone. However, challenges associated with the platform have been identified, including limitations in sending images and the necessity for cross-referencing referrals from different platforms.

During discussions with "Zorgplatform," it was revealed that the platform's functionality involves tasks such as receiving referrals, performing triage, scheduling appointments, changing specializations, and document uploads, primarily managed by nurses or secretaries. Despite its benefits, some limitations exist. Users do not receive automated notifications upon referral reception, leading to manual checks for new referrals. Information gaps and the absence of a message feature for referral cancellations contribute to the need for direct communication with hospitals to fill missing details. Moreover, the platform's compatibility with the HIX system poses challenges for hospitals not using this system.

Organization

O1 Scheduling CTs and MRIs

Scheduling of CT and MRI scans- Radiation oncologists expressed several challenges and time-consuming aspects of their work. They questioned why CT scans couldn't be scheduled immediately after a patient's appointment, as obtaining MRIs within a short timeframe proved difficult. The timing of CT scans and outpatient clinic appointments also posed challenges, especially when they occurred in the afternoon, leaving little time for contouring. The lack of continuity caused by delays in obtaining CT scans and planning resulted in a pile-up of patients, affecting overall efficiency. Furthermore, the availability and scheduling of CT scans were dependent on factors such as open slots and personnel, requiring discussions with managers.

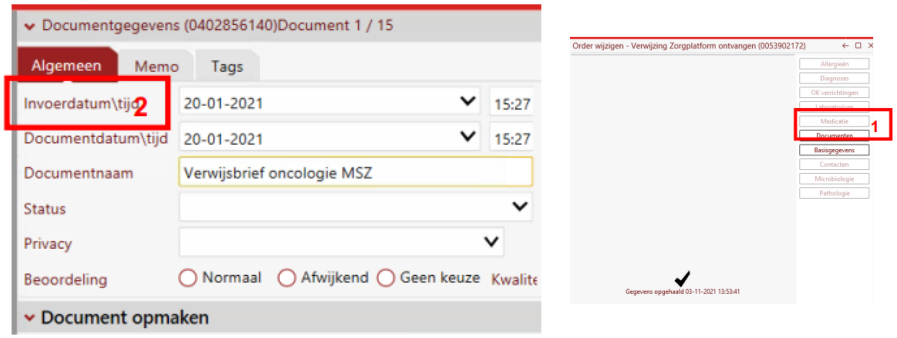


fig 14: zorgplatform snapshot for uploading patient referrals

O2: Time and task allotment of HCPs based on the larger work system and tumor groups

Additionally, scheduling challenges arise from having 18 secretaries, as it can be difficult to ensure continuity and availability to handle patient inquiries and administrative tasks. Furthermore, the limited number of spaces available, where one Poli is shared among three secretaries, poses a constraint on their workflow.

O3:Staffing of technicians and physicians

Adequate staffing is essential to ensure the smooth execution of various stages in the treatment process. A shortage of technicians can lead to delays in patient setup and treatment delivery, affecting the overall treatment schedule. Similarly, a shortage of physicians can result in a bottleneck for treatment planning, consultations, and follow-up appointments. This can lead to extended waiting times for patients, reduced quality of care, and an increased workload for the remaining medical staff.
With an adequate number of physicians, there is ample time for thorough treatment planning, consultations, and regular patient follow-ups, leading to improved patient outcomes and satisfaction. The right staffing levels also allow radiation oncologists to focus on critical tasks like complex treatment planning and engaging in meaningful patient interactions, ultimately contributing to a more streamlined and effective workflow in the radiation oncology department.(Drexhage, 2023)

O4: Working protocols

The presence or absence of working protocols significantly shapes the workflow of radiation oncologists. Established protocols provide a structured framework that guides decision-making, standardizes procedures, and enhances efficiency. With clear protocols in place, radiation oncologists can navigate patient care stages smoothly, ensuring consistent, high-quality treatment. These protocols streamline tasks, reduce errors, and facilitate effective communication among team members, ultimately leading to improved patient outcomes and satisfaction.
On the other hand, the absence of working protocols can disrupt the workflow. Without predefined guidelines, radiation oncologists might struggle with task prioritization, coordination, and decision-making. This lack of structure can result in delays, miscommunication, and increased stress for both medical staff and patients. Therefore, the implementation of robust protocols remains crucial for maintaining an organized and efficient workflow that supports optimal patient care in the radiation oncology department.

Discussion of configuration model as results

The configuration model served as a comprehensive overview of the system level results, with the perspective of the radiation oncologist at the center of the system. The aim of using the configuration model was fulfilled through the mapped interactions and identified key factors affecting the pre-treatment workflow of the radiation oncologist. These results are hence used further as:

- Important considerations during the requirement generation phase
- Assess the role of the design intervention and its fitment and effect on the current EMC RT work system.
- To use as a foundation to build the radiation oncologist's persona from an interaction design perspective.
- The cumulative results from the configuration system are seen in the next section as per the last point mentioned above; discussed under Guiding principles and values, tensions, effects and emotions, needs and requirements.

Radiation Oncologist Persona

Guiding Principles and Values

The following were identified to be the guiding principles and values of the Radiation oncologists

- **Responsibility** - towards patient's well-being and cancer treatment
- **Sense of Duty** - caring is at the heart of their profession
- Accountability - towards ensuring each patient's plan and radiation treatment progresses smoothly and without delay.
- **Fulfillment** - towards helping patients become cancer free, improving their lives and reducing their pain and suffering
- **Thoroughness** - curating each treatment plan with great precision, quality, and personalization for effective tumor targeting and organ saving.

These guiding principles and values are the foundation of what drives the Erasmus MC radiation oncologists in their daily work and tasks. Understanding these core values further help determine the tensions that prevent the oncologists from achieving their goals and following through on their principles. An important aspect of job satisfaction is understanding the origins of satisfaction in the workplace, and what can be compromising this aspect. The tensions discovered during the deep dive are listed below.

Tensions

1. Complexity and Meticulous Nature of Radiotherapy: The complexity and meticulous nature of radiotherapy create a tension for radiation oncologists in achieving a smooth workflow. Radiotherapy treatment planning involves intricate considerations to balance radiation dosage for tumors and healthy tissues. Precision is paramount, requiring detailed contouring and planning, which can consume substantial time. This complexity often contrasts with the demand for efficiency, potentially causing a trade-off between accuracy and timely treatment delivery. Striking the right balance becomes challenging as radiation oncologists navigate the intricacies of treatment planning and execution while managing time constraints.

2. Internal and External Environment Dependencies: The workflow of a radiation oncologist is heavily dependent on both internal and external factors. Internally, coordination among various team members, including therapists, physicists, and dosimetrists, is essential. Externally, factors such as patient compliance, availability of diagnostic reports, and coordination with external facilities impact workflow. This dual dependence introduces potential bottlenecks, making it challenging to maintain a seamless and streamlined process. Balancing these dependencies while ensuring optimal patient care requires careful orchestration and effective communication.

Guiding Principles

- **Responsibility**
- **Sense of duty**
- **Fulfillment**
- **Thoroughness**

Radiation Oncologist Persona

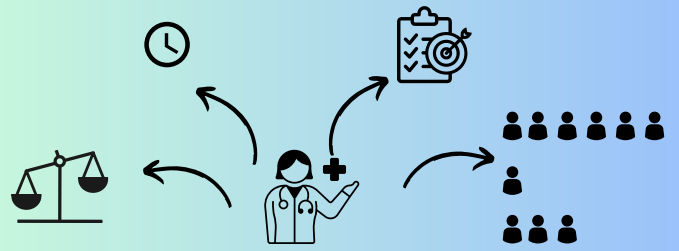
3. Staffing Shortage: The shortage of qualified medical staff, such as radiation oncologists, therapists, and dosimetrists, creates a significant tension in achieving a smooth workflow. The demand for radiotherapy services often exceeds the available workforce, leading to increased workload for existing staff. This shortage can lead to burnout, stress, and compromised patient care. Balancing patient volume, treatment quality, and the well-being of staff members becomes a delicate task, requiring strategies to optimize resource allocation and alleviate staffing-related challenges.

4. Protocols - Rigidness or Lack Thereof: The implementation of treatment protocols presents a tension between rigidness and flexibility in the workflow. While standardized protocols ensure consistent and evidence-based treatment, they can sometimes hinder adaptation to unique patient needs. Striking the right balance between adhering to established protocols and tailoring treatments to individual cases is crucial. The challenge lies in avoiding protocol-driven rigidity while maintaining a structured approach that optimizes patient outcomes.

5. Limitations of HiX- The limitations of the HiX platform introduce complexities in the workflow of radiation oncologists. HiX may not always provide seamless integration, leading to manual data entry, time-consuming adjustments, and potential errors. The tension arises from the desire for a technologically advanced and efficient system contrasted with the practical challenges presented by the limitations of HiX. Radiation oncologists must navigate these limitations while ensuring accurate data transfer, treatment planning, and overall patient management within the HiX environment.

Tensions

- **Complexity and Meticulous nature of Rsdiotherapy**
- **Internal and External Environment Dependencies**
- **Staffing Shortage**
- **Protocols- Rigidness/Lack thereof**
- **Limitations of HiX**

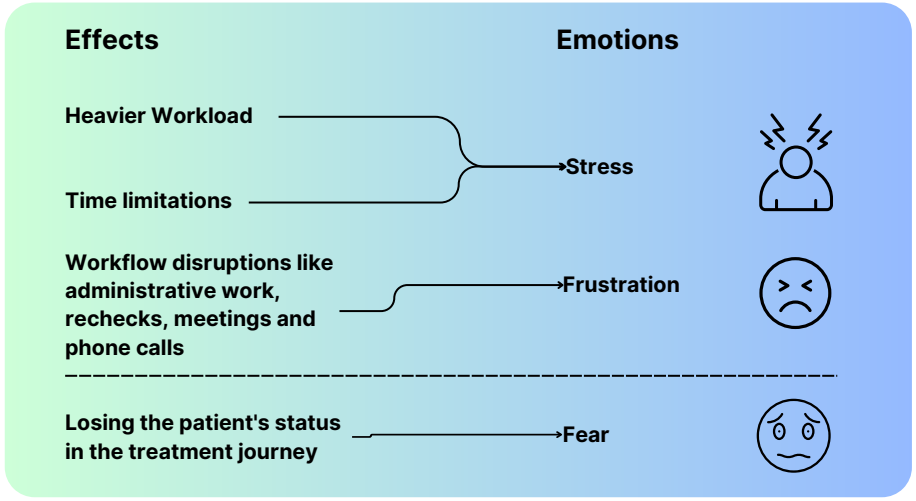


If we look at when patients are CT scanned and I have an hour to do contouring. If I get the ct in the afternoon and the poli is in the afternon, then that time is no longer available

The identified tensions, as discussed are a sure cause of compromise in the workflow. While the consolidated factors in the configuration system detail the technicality of the context these tensions tie back to the core values of the radiation oncologists that leads us to better frame the emotions and the experiences that arise from these tensions. The effects and emotions are listed below.

Effects and emotions

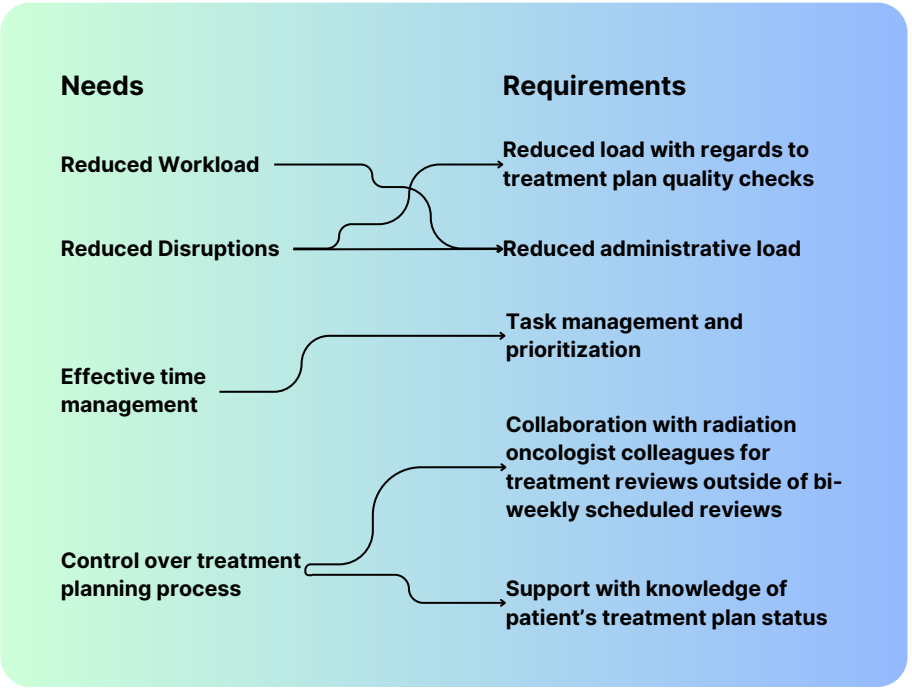
- A heavier workload and time limitations can cause stress to work faster.
- Workflow disruptions like administrative work, rechecks, meetings and phone calls- leads to frustration since they lose their ability to focus on the task.
- The end result of the above effects and emotions leads to losing the patient's status in the treatment journey, which causes fear in the oncologists for losing control over the process.
- Starting at the system entity the research insights have trickled down to the individual entity of the Radiation Oncologist with a clear understanding of the mutual effects down to the emotional level. Transforming these emotions experienced by the oncologists into more positive/neutral ones with the intention of turning undesirable outcome into desirable ones, the next step was to map the needs of the oncologists into their subsequent requirements.



Needs and requirements

The needs and requirements were identified by understanding what can potentially eliminate the tensions and emotional effects.

The final requirements came down to supporting oncologists through 5 ways: Reducing load with treatment plan quality checks, administrative load, task management and prioritization, peer review facilitation and knowledge of the treatment plan. Taking these into account to build a design goal to be able to use as a starting point towards the Design phase.



DESIGN GOAL

The design should support oncologists in the treatment planning phase by providing real-time patient status, assistance, and prioritization of tasks and administrative work in order to minimize disruptions and gain control over their workflow, such that oncologists can uphold their sense of accountability towards their patients, themselves, and the organizational expectations and alleviate their fear of losing the patient to the system.

The design goal focuses on defining the primary user that has to be benefitted, the specific context in which it will function, the functional requirements it needs to fulfill and the outcomes it aims to achieve through the design.

Oncologists being the primary target audience In this project.

Focusing on the pre-treatment phase where delays build up towards an overall prolonged start of the radiation.

A list of requirements to be fullfilled by the design as determined in the need translation step prior to this

Desirable outcomes:
Professional- Minimize disruptions,
-Gain control over workflow

Individual- Uphold sense of accountability towards patient, themselves, and organizational expectations
- Alleviate fear of losing patient to the system.

Moving forward within the defining phase are a few stepping-stone methods applied towards a successful UX based concept, which draw from the identified oncologist needs, tensions and emotions to turn them into desirable experiences. These methods are described below.

SECONDARY GOAL

To support managers with data to document causes for inefficiencies in delays in order to and gain useful insights for optimizing the pre-treatment process

At the systemic level, managers need support in identifying delays at each stage of the process and improving the scheduling of professionals' time. Similar to oncologists, they also lack a comprehensive view of the current patient status. Addressing these issues is of utmost importance as we proceed with the ideation process.

INTERACTION VISION

An interaction vision is a crucial tool in envisioning the concept's user experience, bridging the gap between abstract design goals and relatable scenarios. In this context, an interaction vision draws inspiration from a scenario akin to a head chef in a Michelin-star restaurant working alongside a sous chef to alleviate bottlenecks and disruptions, similar to how a radiation oncologist balances intricacies in treatment planning, fostering focus and meticulous planning (fig 15).

> *"A head chef working with a talented sous chef on an intricate recipe in a Michelin-star Restaurant"*

Good grasp of the recipe creation process from start to end
The radiation oncologist should have a clear overview of the steps and confidence of knowledge of patient status

The Sous chef can help with secondary tasks to assist the chef to do the primary cooking and creating.
The design intervention can help deal with secondary tasks and scheduling in a way that facilitates focused work and reduced load for the oncologist

Having a clear idea of how long each dish should take, and can identify when this is exceeded.
The radiation oncologist should have a clear indication of the timeline of the plan for each patient, and also when it is exceeded so they can stay on top of the process.

Can collaborate with other chefs to perfect the dish.
Facilitating peer reviews and collaboration in the process of treatment planning

fig 15: Interaction Vision

Qualities

The interaction qualities help define the characteristics of the interaction vision, such that they can be translated into the design.

- **Sense of control** – The oncologists need to feel in control of the process and have the authority to make/break protocol based on what is essential for creating the treatment plan and delivering it at the appropriate time.
- **Undisrupted flow** – A major factor affecting the timeline of the treatment plan, is the distractions and loss of flow in the radiation oncologists' flow while exercising their tasks such as the contouring, identifiying organs at risk, etc.
- **Confidence** - Radiation oncologists feel much more confident carrying out their tasks and not having to worry about their patients in the back of their minds.
- **Supported and assisted**- Radiation oncologists need to feel like they have enough support from the system to carry out their work uninterrupted and without doubts.

DATA AND INFORMATION REQUIREMENT GENERATION

From understanding the context and the issues causing the delays, the next important step was understanding what information and data is required per stage to help the oncologists feel in control of the patient's treatment plan and be able to take informed decisions at key moments.

Participants

3 radiation oncologists

Method

The professionals were first shown the insights leading up to the need for understanding their informational and data requirements. Then the activity commenced, where the top row listed the pre-treatment steps, and the first row had cards of their tasks during each of the steps. The space below corresponding steps was populated with sticky notes triggered by prompts like "what information do you miss in this stage?", ”what can help you in your workflow better” (fig 16)

Result:

The fig 17 shows the culmination of the various generated requirements for the radiation oncologists at each stage of the treatment planning process.

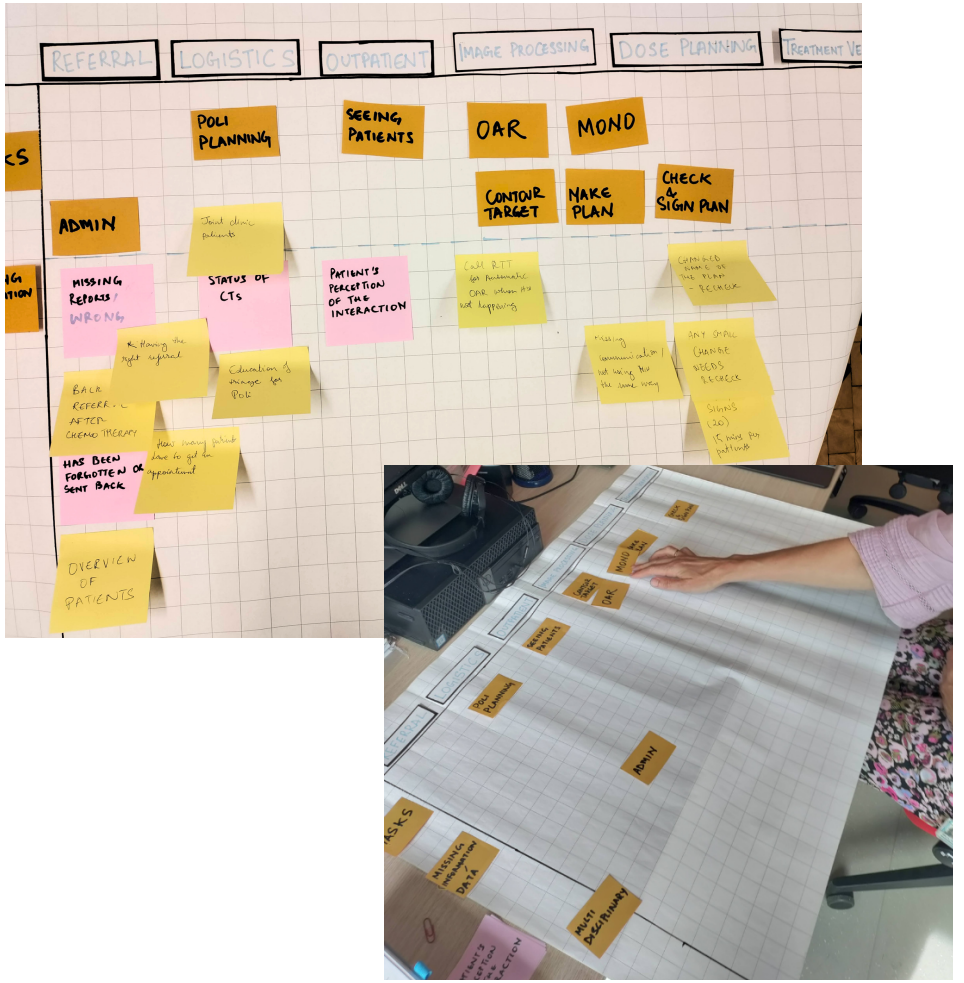


fig 16 : Session with Radiation Oncologists

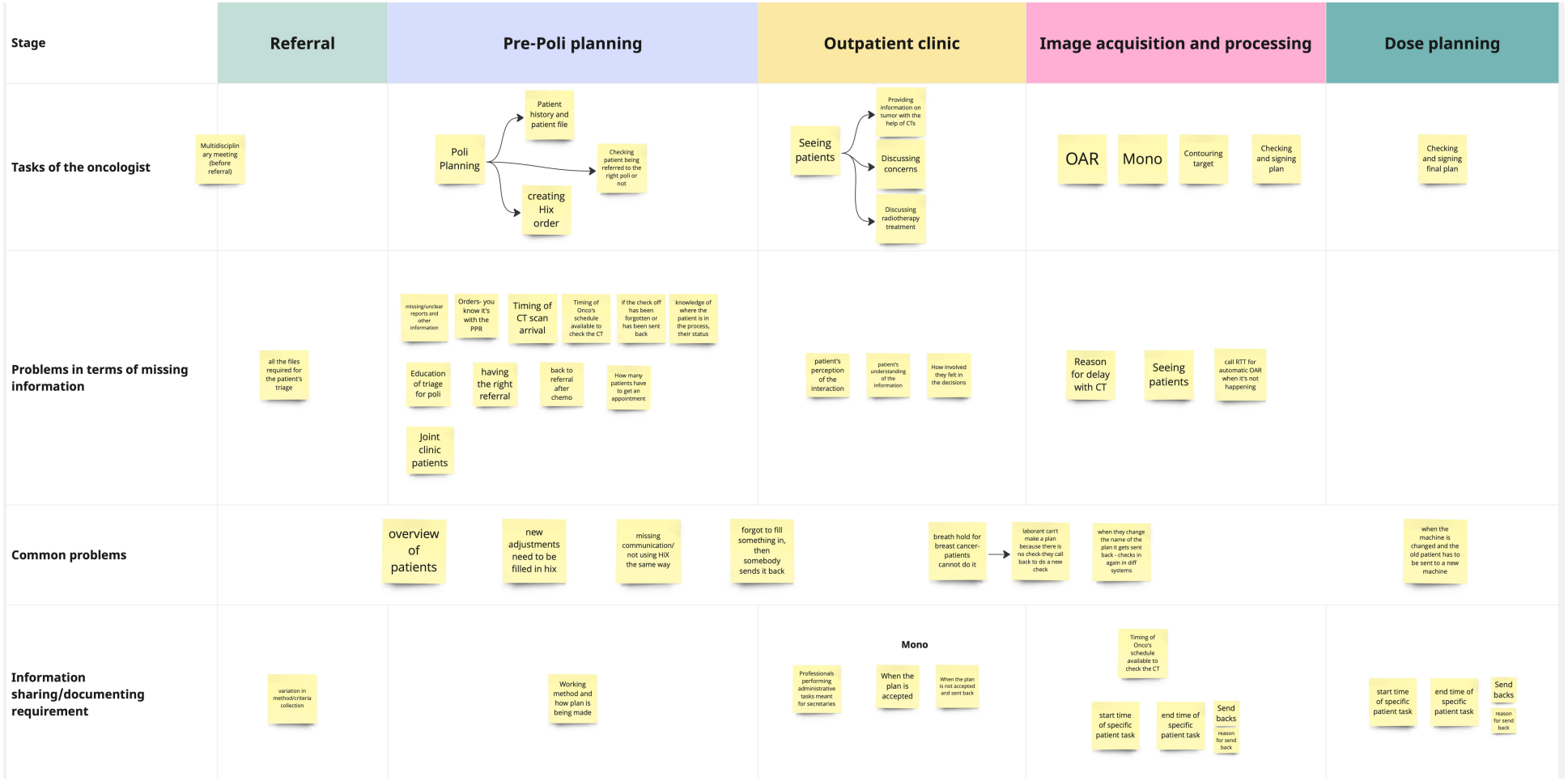


fig 17: Data table- Generated requirements from activity

Referral and pre-poli planning:

At the referral stage a crucial informational requirement is the complete patient file, that can sometimes be missed during the triage stage. This is also important going into the poli planning phase, and ROs further believe the importance of the triage knowing the right files to be collected, and the right classification of the patient at this stage.
Going further into the planning stage before the poli, the professionals need information about the CT scheduled for the patient (since each patient needs to get CT scan, which is required as a first step towards identifying the tumor), since they can plan their time accordingly. And vice-versa, they also feel it is necessary to have their schedules matched well with the arrival of the CT for their patients to be able to plan their days well.
An important factor is having the knowledge of patients who get sent back to the referral after it is deemed necessary for the patient to go through chemotherapy. If they lose such patients and they are not added back into the system, they can lose track of when they need to progress with their radiation treatment plans.

Outpatient clinic:

The outpatient clinic is a moment of interaction for the oncologists with the patients. In this section, the cards "patient's perception of the interaction", "patient's understanding of the information", and "how involved they felt in the decisions" were added by the author beforehand, and were agreed upon by the radiation oncologists. But they did not feel too strongly about collecting this information since they felt each patient case is different, and are quite confident and self-assured about the way they communicate and interact with the patients. The "joint clinic patients" card was brought up as a specific case of patients who require to be at the joint clinic (e.g. gynecology +oncology), and may be unattended at the poli.

Image acquisition and processing phase:

Considering that acquiring the CT scan is crucial to perform tasks of contouring and delineation, it is important for the radiation oncologists to know when the CT scan is completed, and if there is a delay why the delay is occurring. There are specific cases where a CT can be reused and the contouring is available, but automatic Organs-at-risk does not happen and the radiation oncologists have to call the RTTs. It is interesting to note the specific scenarios that can cause disruptions to their workflow on a day-to-day basis.

Common problems:

A number of the issues faced and the lack of information were found to be generalizable across the stages. These were primarily related to lack of uniformity with regards to usage of their Health information system (HiX), and extra work when plans get sent back to the radiation oncologists to be checked again with minute changes made such as name changes, machine changes etc.

A major recurring problem was that they lacked an overview of their patients and their status. In the current scenario, once the patient has finished a particular stage, it disappears from their list. Additionally, connecting back to their information requirement related to chemotherapy patients, they miss out on the status of specific patients who go for alternative treatments or need a planned gap before the treatment starts. This gives them considerable stress and a sense of lost control, which will be addressed further in this report.

The last row discusses the informational needs of the managers whose goal is to identify possible delays and causes for obstructions in smooth treatment planning. Their current common problems include identifying variations in working

methods and how the plan is made, that occurs across different professionals to be able to streamline the same towards a more efficient plan creation system. An important data requirement is the start and end timestamps of each task.

Since a plan "travels" from professional- to- professional before it reaches its state of completeness (with dosage, fractions, tumor target and contouring, schedule etc. being determined by different professionals), a manager currently misses data regarding the time taken at each individual step. Their goal with this information is to identify delays at a specific stage rather than at an overall level, and understanding the reasons why these delays are occurring can further help them address the same. At specific moments plans can get sent back to the previous step and the managers want to know why this happens to identify possible patterns.

Synthesis

The synthesis of the data table was done using the DIKW method. The 4 levels in this method from low to high level correspond to Data, Information, Knowledge, and Wisdom respectively. It was deemed appropriate to use this method to be able to generate high-level insights from the gathered data requirement (Sanders & Stappers, 2020).

The fig 18 shows five major clusters with three different categories- yellow for data/information, orange for knowledge, and pink depicting wisdom. The data and information categories were clubbed since responses were collected that spanned across both. Each cluster was created from the data/information grouped in a meaningful way together, and knowledge was generated based on common points and an overlying understanding of the data points. The knowledge was further clustered into wisdom by the author as a higher-level insight from the clustered data. Five major clusters emerged, namely:

Patient Overview,
There is a need to support the doctors with knowledge of the patient's treatment plan status.

Synchronized Workflows,
There is reliance and interdependencies for the oncologists on other professionals for smooth operations

Admin and re-checks handling,
There is a need for the professionals to be able to filter out and handle re-checks on a need basis.

Triage and referral completeness,
Oncologists need the referrals to be handled right at the triage to be able to handle the patient's case immediately.

Hix Protocols and Rigidity
Rigid Protocols/lack of protocols regarding using HiX causes bottlenecks in the Oncologist's workflow.

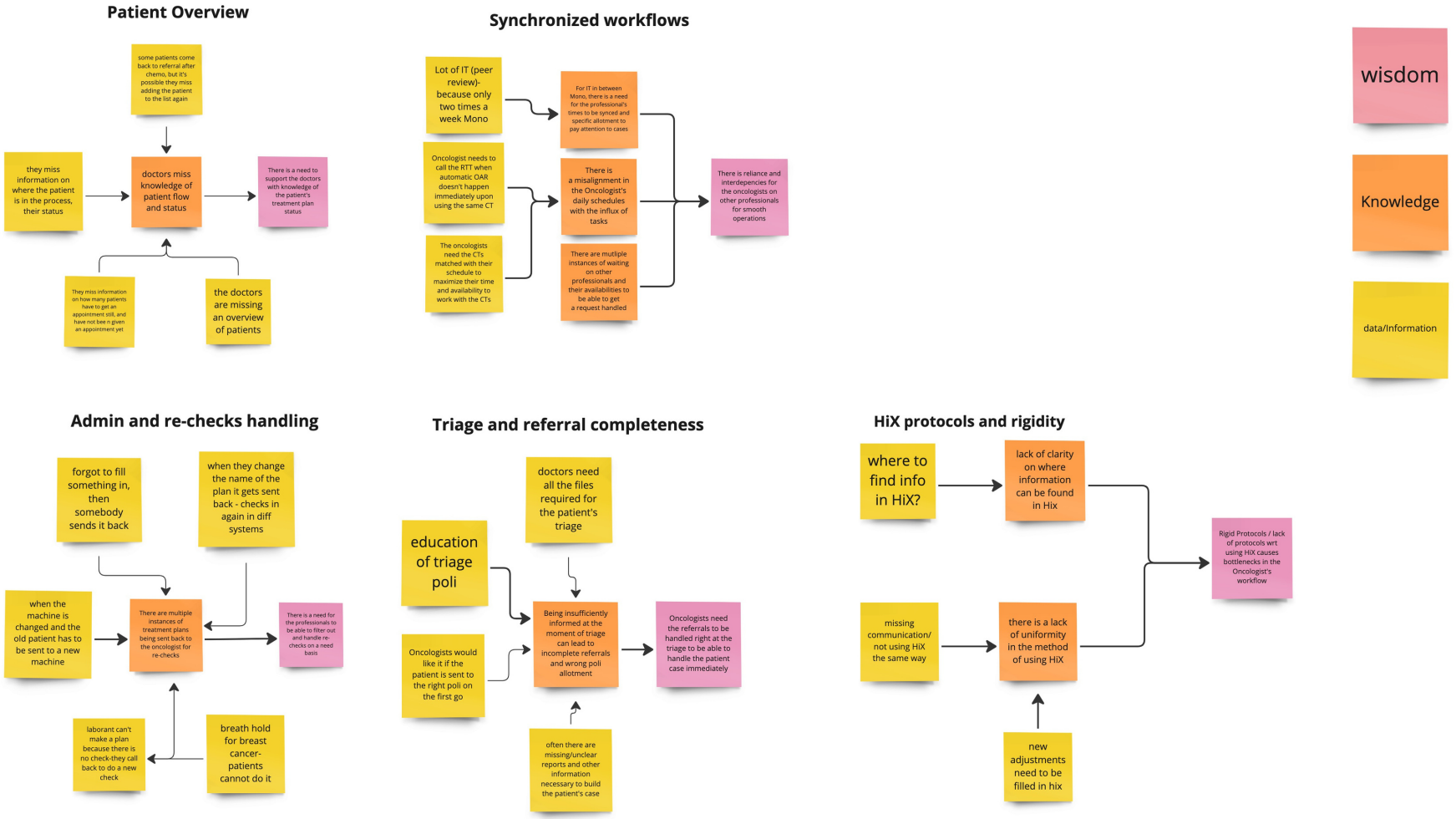


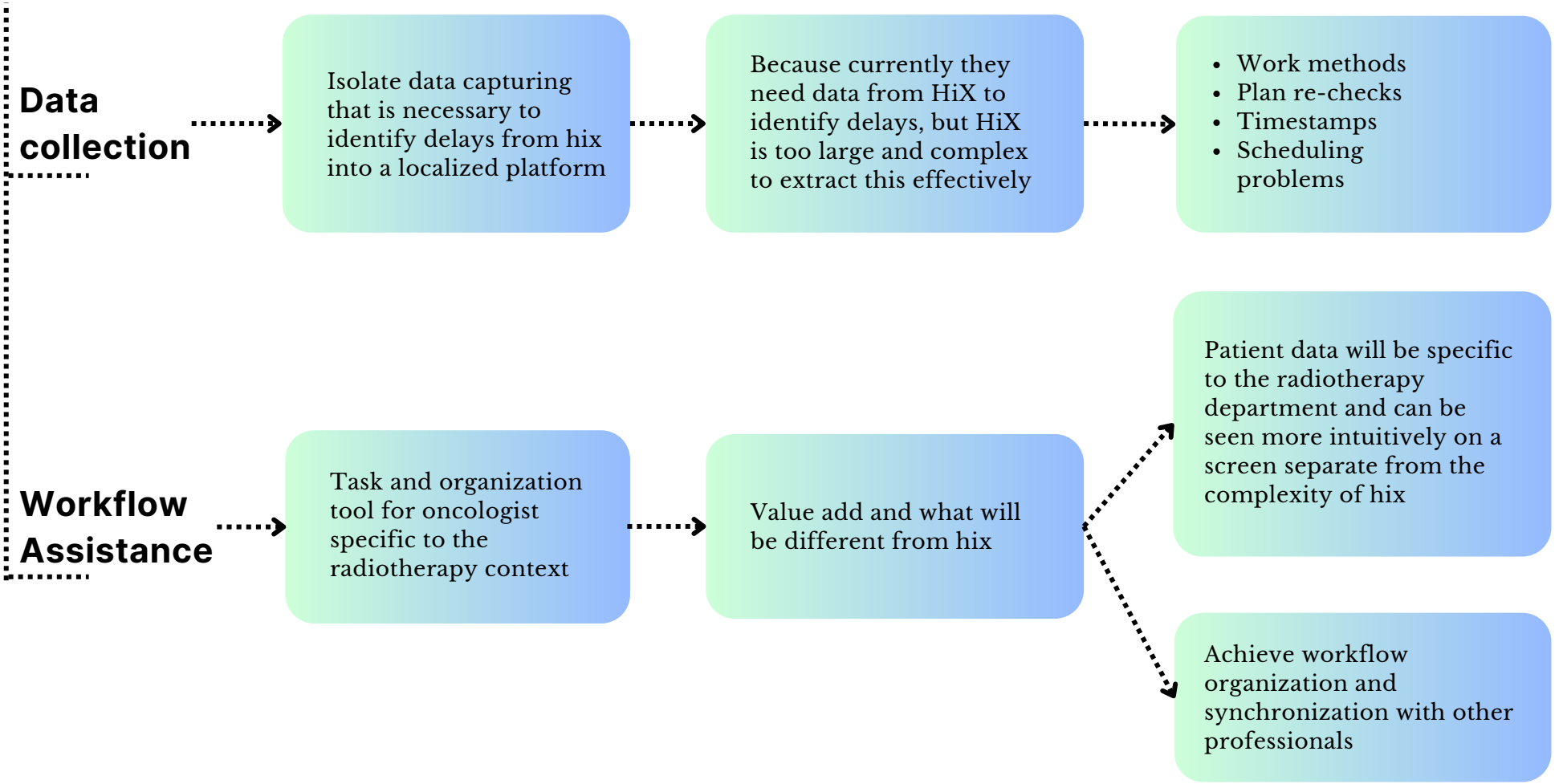
fig 18: Synthesised data

UX- INTERACTION-CRITERIA

The UX- interaction -criteria is a methodology to document the transition between the identified interaction vision and the creation of the user experience with the new solution (reference). The table presented hence details the experiences that need to be evoked from the solution, what specific interactions can allow for the same, and what criteria it needs to fulfill. The criteria emerge from the interaction qualities that accompany the interaction vision. The table details specific tangible interactions that the solution should realize in order to help the oncologist in their workflow. For example, In order to help the oncologist feel more focused, the solution should support their daily routines with a well-planned workflow, and help streamline their attention to their major tasks while keeping administrative tasks hidden. These were taken forward toward building the concept and using that as a starting point for ideation.

User Experience	Interaction	Criteria
Feel informed	• Overview of necessary and missing information for the referral to follow up on	• Informative
Feel in Control	• Facilitate communication and ITs without losing time and flow • Overview of and notifications about patient cases based on severity and time spent in the system	• Enable Communication • Assistive
Feel supported	• Classification of administrative tasks and Intelligent assistance wherever necessary • Intelligent handling of schedules and availability in sync with other professionals' schedules • Support on handling patients based on priority, linked to pt 2 under "control"	• Supportive • Augmentative • Intelligent
Feel focused	• "show" and "hide" administrative tasks based on level of focus required for ongoing task and urgency of administrative task • support their daily routines with a well planned workflow, (e.g. ensuring block hours allotted for certain tasks) • sync with colleagues agendas to plan ITs for max benefit • streamline communication relating to plan changes and modifications; assist prioritisation and attention diversion	• Personalized • Support Productivity
Feel trust	• Support patient overview with information on progression of the patient's treatment plan	• Trustworthy

CONCEPT FOUNDATION AND VALUE



Based on the criteria and requirements generated, the fundamental aspects of what the concept should achieve came down to two things: Data and workflow assistance.

Data-
the concept should help isolate data capturing that is necessary to identify delays into a more localized platform. The main reason for this being that they currently rely on data from HiX to be able to identify delays, but HiX is too large and complex to extract this effectively. The kind of data and information that the new concept should help capture is in the form of:

Work methods-
to be able to identify possible differences in work methods of the various professionals so that it would be possible to make it more uniform.

Plan re-checks-
to be able to identify when and why certain plans get sent back for re-checking to the previous step, and be able to identify possible patterns and over-checks.

Timestamps-
An important part of the concept's purpose is to help extract timestamps for each step, specifically the moment a step has begun as well as the moment it ends. This can help with capturing the lead time of each step and identifying the outliers per tumor group (Lopetegui, Yen, Lai, Embi, & Payne, 2012).

Scheduling problems-
Radiation oncologists tend to have different schedules depending on various factors like their outpatient clinic distribution, tumor groups and individual meetings. Other work throughout the day like referral checking, administrative work, and contouring tends to happen at their own pace and times throughout the day. While it is reasonable that the professionals take certain tasks with the flow of the day, scheduling certain tasks at specific points can help with synchronizing their workflow with that of other professionals like radiation oncologist colleagues for peer reviews and referral handling,

Workflow Assistance-
The concept should serve as a task and organizational tool for the oncologist but more specifically to their radiotherapy workflow. The value it will add over and above using HIX is the ability to have an overview of their individual patient flows, and the ability to achieve organization and communication with other professionals.

CLUSTERED REQUIREMENTS FOR IDEATION

The generated requirements were categorized as shown in fig x towards ideation. Three main directions emerged, namely: Task logging, Patient overview, Task and administrative work.

Task Logging	Patient Overview	Task and administrative assistance
• Logging Task start time • Logging Task end time	• Knowledge of treatment plan status of their patients • Information of Dates of CTs planned for patients	• Taking care of work deemed "unnecessary" and "secondary" • All the information beforehand from the patient's referral to conduct the necessary preparation • Task allotment assistance on day-to-day basis • Communication and collaboration for peer reviewing in between Mono sessions • Assistance with plan re-checks

IDEA AND CONCEPT GENERATION

Task logging (fig 19)

1. One potential approach considered is to log data solely into the iPad, which can then be integrated into the current platform HiX, making it convenient for professionals to extract the log data while seamlessly fitting into their existing workflow.

2. Alternatively, the second option entails inputting data exclusively into HiX, and then having it fed into the iPad to serve as an overview and part of the task management process for professionals. This idea shares the same disadvantage as the first one, pertaining to the challenge of obtaining data from HiX.

3. Using an NFC "task card" attached to the ID badge, particularly useful for professionals working on the move with CT and radiation machines. They can scan the task card into a device, which displays ongoing patient IDs and tasks, allowing them to mark tasks as completed or send them back. The automated task-checking process offers easy interaction.

4. A small handheld device is proposed for logging patient tasks, equipped with its own display showing the patient number, along with two buttons to mark tasks as complete or send them back for rechecking. The downside to this idea is the introduction of a new device with additional steps.

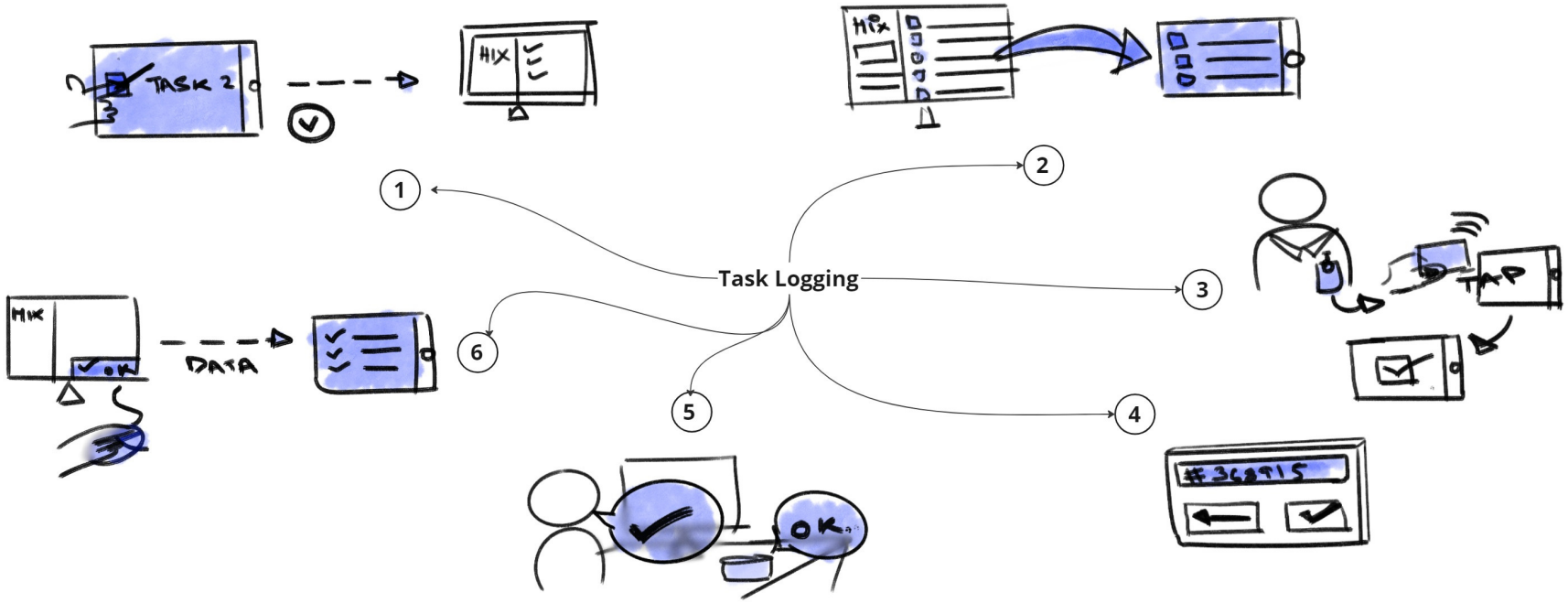


fig 19: Ideation for Task Logging

5. Voice-over to mark task
6.Using HIx checks to mark tasks as complete

Patient Overview (fig 20)

The ideation of a patient overview for a radiation oncologist's workflow was envisioned to be presented through a digital display, either on an iPad or a big screen like a monitor. The main elements that should be contained in the patient overview are the patient number, steps completed, the date the steps were completed, and the severity of the case. Furthermore, notifications will be given when the time spent by a patient in a system is high.

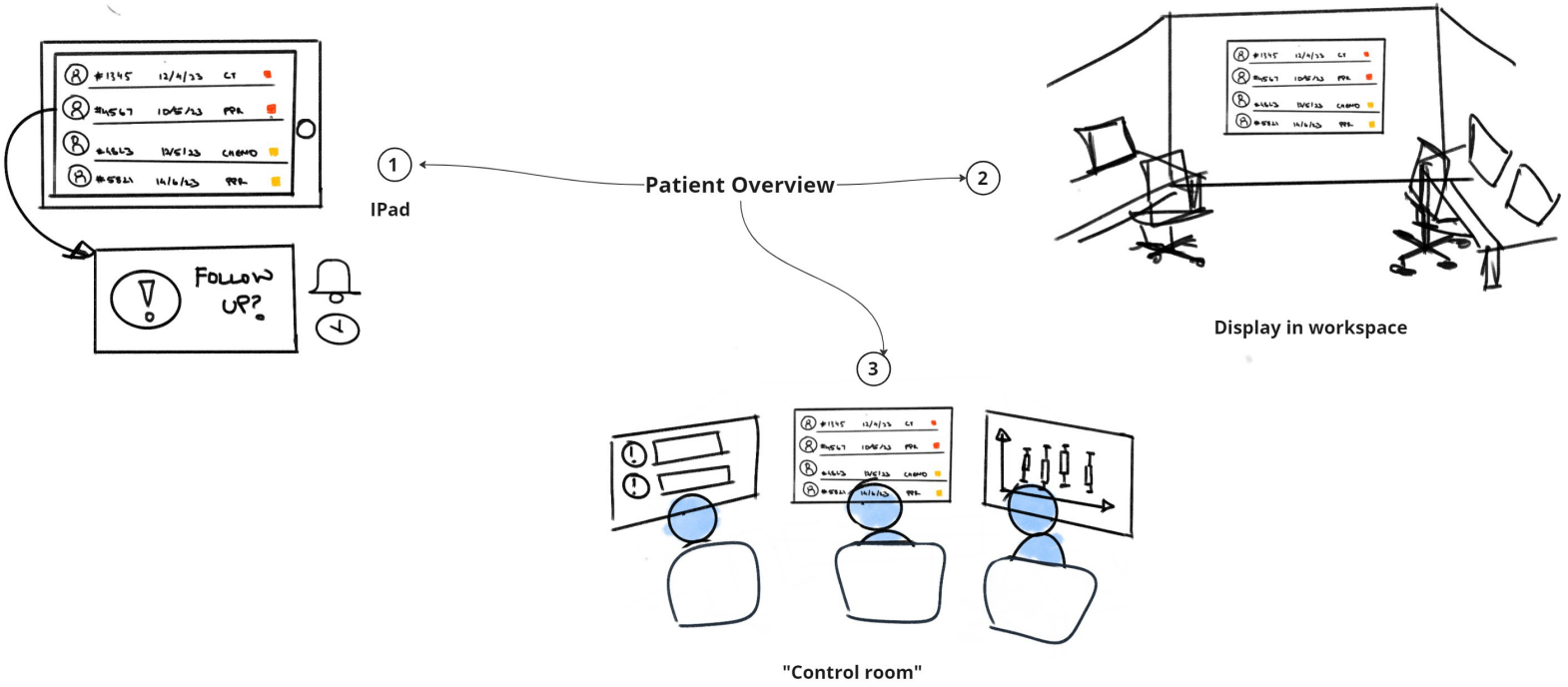


fig 20: Ideation for Patient Overview

Task Organization + Administrative Help (fig 21)

The ideation of task organization and administrative help were combined to create a digital matrix of tasks. Each task is represented as a card categorized under "Plan," "Administrative," or "Personal Task," further divided into "Done," "Ongoing," or "To Do" categories. This setup allows for easy monitoring of status of the tasks both for the oncologist as well as the managers and also helps keep track of the recheck count, enabling the evaluation of plans that undergo multiple rechecks. Plans crossing the recheck threshold, based on established protocols, can be re-evaluated accordingly. Moreover, the system provides assistance with scheduling Peer reviews (ITs).

Alternatively, there is a proposal to use an overlay/extension for HiX that offers several functionalities. Firstly, it assists in highlighting cases based on severity and helps prioritize them, streamlining the workflow. Additionally, the system can identify tasks that undergo multiple re-checks and aids in classifying these re-checks for better organization. The concept of a "digital secretary" is introduced, which can handle rechecks and schedule peer reviews based on professionals' availabilities and case severity, drawing attention to urgent cases. Lastly, the system efficiently tracks patients who have spent an extended period within the system, ensuring timely management of their care.

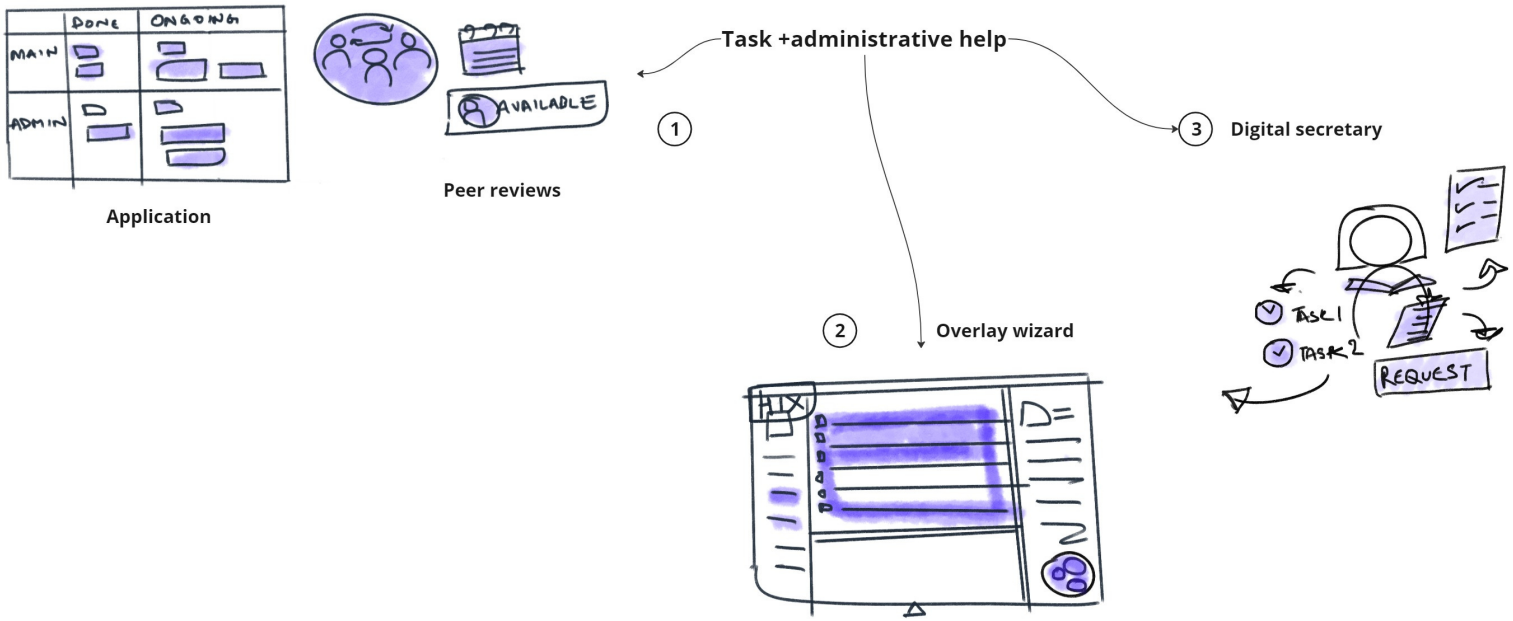


fig 21: Ideation for Task +Administrative help

Testing solution mediums

As part of an initial feedback test, the participating Radiation oncologists were shown three mock-up mediums for the potential solution. The goal was to:
Identify what type of solution they would be most receptive to and why,
Level of comfort with using different mediums,
What is the easiest to integrate into their current workflow.
The three mediums tested(as shown in fig 22), were:
1. A smartwatch-based solution
2. An iPad-based solution
3. A voice-based assistant

The participants were given scenarios and use cases (orally) asking them how they would feel interacting with such a product. They were required to assume the functionality of these mediums was for tracking tasks, receiving important notifications, and patient status. For the voice-based assistant, the scenario was to help the oncologists with transcribing outpatient sessions so as to improve face-to-face time with patient during the session as well as analyse the patient situation to generate the requirement list/order.

The feedback received for the testing activity provided valuable insights. The potential use of incorporating an iPad-like solution was highlighted, suggesting that such a platform could offer enhanced usability and engagement. Additionally, participants expressed varying levels of enthusiasm for the introduction of a new interaction system, emphasizing the importance of motivating users to learn and embrace novel approaches. The viability of a smartwatch interface was found to hinge on the user's comfort level with the device, underscoring the significance of user preferences. In contrast, the idea of implementing a voice-based assistant for the Poli function was met with reservations, as it was deemed potentially excessive for the intended purpose. This feedback collectively illuminates the diverse perspectives on interaction modes and offers valuable guidance for refining the solution's approach to maximize user satisfaction and effectiveness
.

Evaluating the ideation

Based on the ideation exploration for the 3 crucial verticals of the solution, the evaluation (as seen in fig 23, 24, 25) led to the narrowing down of the ideation into one cohesive concept. The intention is to maintain the 3 primary requirements in the concept, while narrowing it down to the most meaningful ways to achieve the requirements.

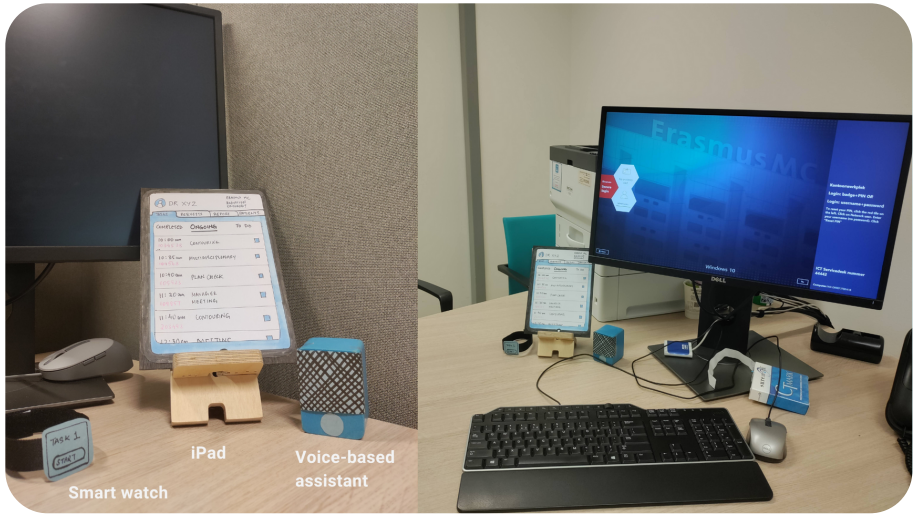


fig 22: Testing mediums of the solution

Evaluation - Task Logging

Concept	Fitment with IV	Feasibility	Integration into workflow	Comment
1.Ipad to Hix	++	+	++	Good to extract task stat and stop time
2. Hix to Ipad	++	++	++	Task starting timestamp is not logged
3. NFC ID tap to log task	++	+	+	Can motivate users to use a new system across different professionals
4. Handheld device for logging tasks	-	+	-	Does not satisfy all aspects of IV
5. Voice based task logging	++	-	+	Tricky to have individual voice assistants for a shared space
6. Extracting data from HiX	-	-	+	Task starting timestamp is not logged

fig 23: Evaluating task logging

Evaluation - Patient Overview

Concept	Fitment with IV	Feasibility	Integration into workflow	Comment
1. Ipad application for displaying overview	++	++	++	Capable of achieving most criteria
2. Communal display for Radiation Oncologists' workspace	+	++	++	Limits individual interaction and benefit
3. Control room for managers	++	+	+	

fig 24: Evaluating patient overview

Evaluation - Task + Admin help

Concept	Fitment with IV	Feasibility	Integration into workflow	Comment
1. 1. a) Task application with to-do, completed, admin and patient tasks b) Peer review feature	++	++	++	
2. Overlay wizard on HiX	++	+	++	
3. Digital "Secretary"	++	+	++	Overlaps with Wizard concept in functionality

The evaluation of the three ideation directions showed a few strengths and weaknesses of the different concepts. Keeping in mind the positives of the various solutions, the following section discusses a combinatory intermediate concept that further tests these solutions with oncologists and managers.

fig 25: Evaluating Task+Admin Help

Creating and Testing Intermediary Concept

Based on evaluation and medium testing, the following ideas were taken forward for detailing and testing:

- A screen-based solution,
- An overlay-based solution

Considering the most important requirements of the solution that needed to be executed in the most pragmatic and useful way, these two directions were fitting as a starting point and anchor for the solution to take shape and further build upon.

Information Architecture

The important basis for building the concept was the information architecture that showcases the required information flow and structuring in the solution. This takes into account the important functionalities to achieve the interaction vision, as well as one step further into the utility of intelligent assistance in the necessary aspects of the solution. The 4 major clusters seen in the information architecture are as follows (fig 26):

-The patient overview showcases the view of the radiation oncologist's ongoing patients with fundamental information about the patient along with the much-needed view of the status of the treatment plan.

-The tasks view helps them distinguish patient and administrative tasks(especially with rechecks of the plans), this being important for task prioritization as well as the ability to automate tasks that can be handled without the (active) involvement of the Radiation oncologist. Additionally, the reflection aspect is useful for Oncologists to document satisfaction levels as well as specific problems that can be brought to the manager's notice. At a micro level, it can benefit as crucial information regarding reasons for the occurrence of delays at intermediate moments.

- Communication: this aspect of the solution helps with managing the peer reviews of the radiation oncologists with their colleagues. These sessions which tend to happen organically as compared to scheduled mono meetings, may leave professionals waiting on each other to receive their feedback on the plans. Hence there is an added benefit to creating a way to align availabilities for reviews in between or facilitate asynchronous reviewing.

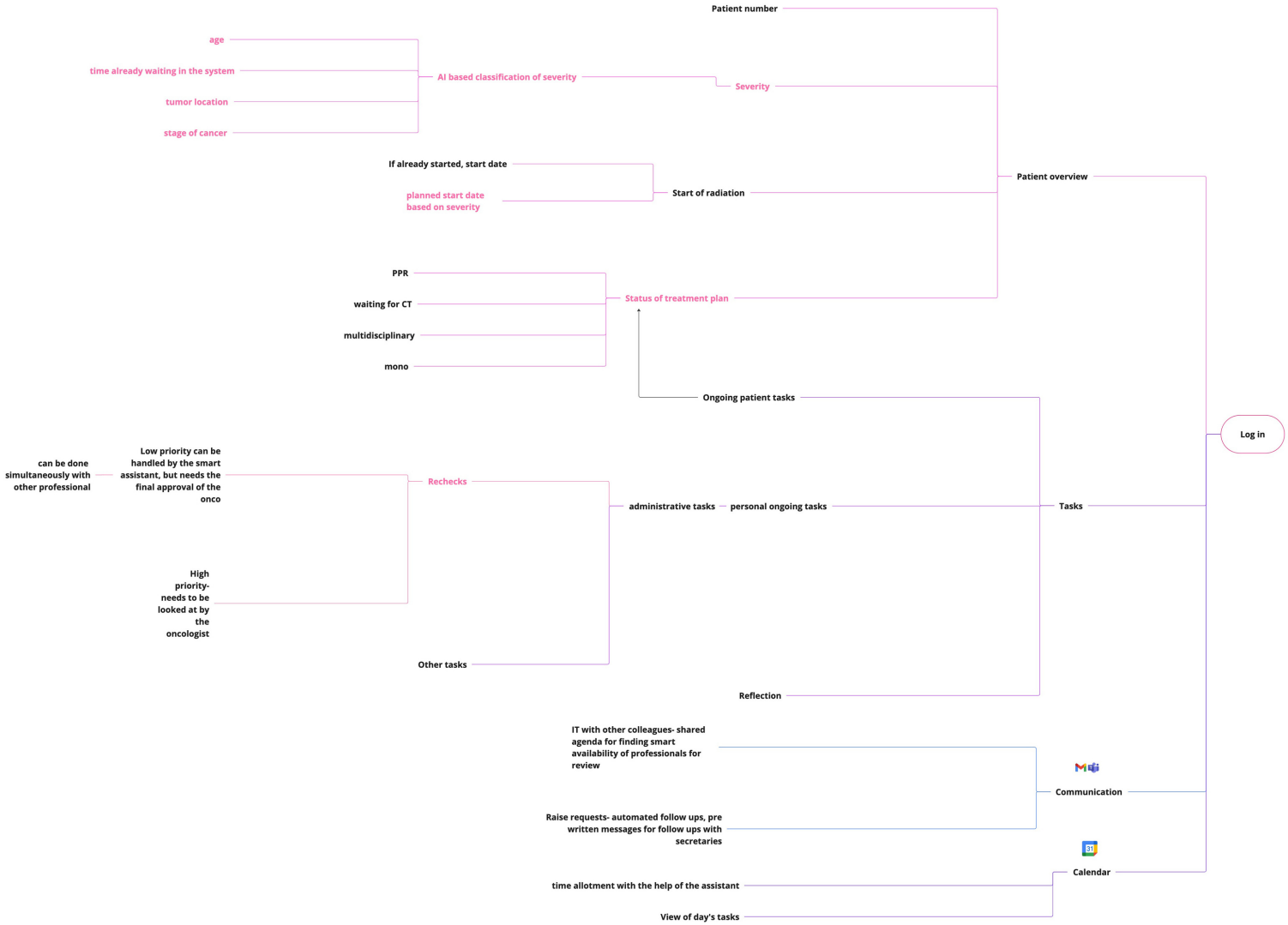


fig 26:information architecture

Designing the Screens

Concept Part 1- app screens

Screen 1: Patient overview

The patient overview screens showcase a list view of the oncologist's patients. The patient is identifiable and searchable by their name, patient number, and age. Each patient row shows the start date of radiation depending on whether it has already started, or will showcase the expected start of radiation as determined at the triage moment. The next item in the row shows the status of the patient's treatment plan, so the oncologist knows with which department the patient is, or whether they have been sent for chemotherapy and how many days. The final item in the row is the severity so the oncologists can act on the patient cases based on priority.

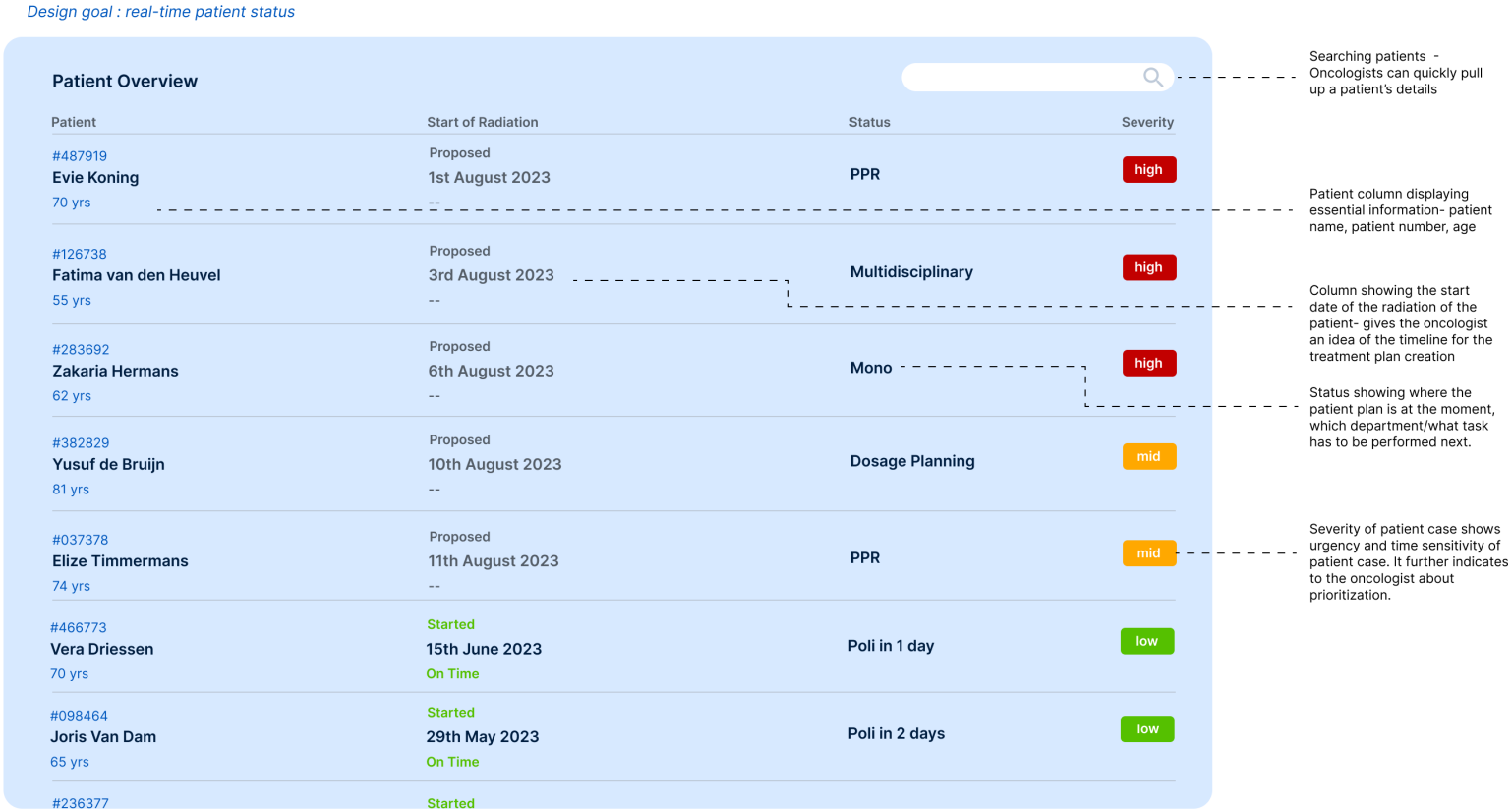


fig 27: Patient overview

Screen 2: Patient overview expanded
The expanded view of the patient goes on to show an amazon-style view of the patient's treatment plan. Here the oncologist can see the completed steps, as well as the current step that the plan is in. There is a prompt to take action if a patient plan is taking too long at a certain stage, so that it can be escalated accordingly.

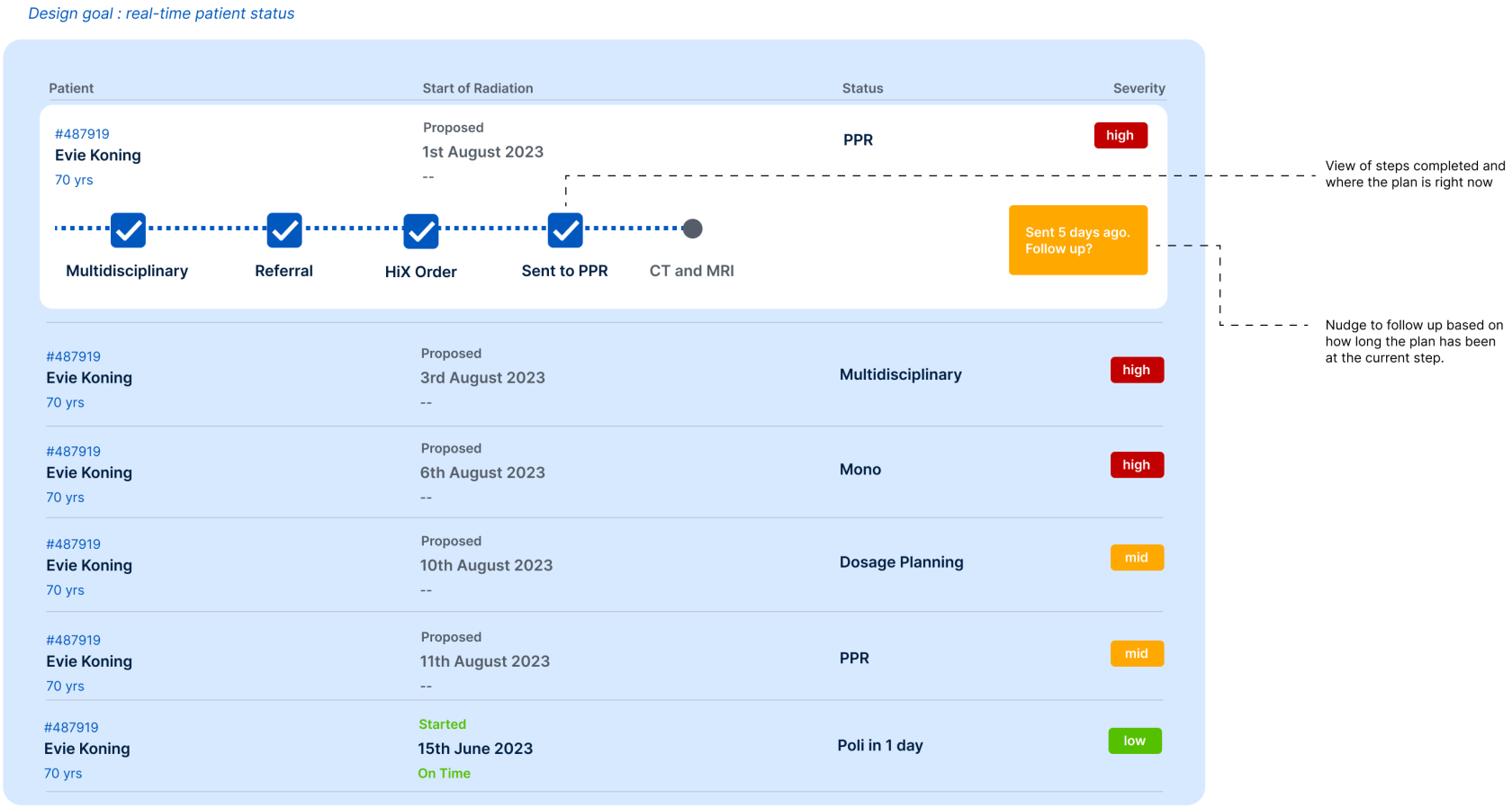


fig 28: Patient overview expanded

Screen 3: Tasks
This screen is an adaptation of the familiar view of a task list, but lists the key treatment plan tasks separated from the administrative tasks. These tasks are primarily identified by the patient number, and actionable in terms of marking the task as complete once done.
The administrative tasks have the additional "wizard" assistance which is the intelligent aspect of the system that can review plans that require trivial checking. These are marked with a graphical icon indicative of the presence of intelligence to assist with the tasks.

Design goal : Task prioritisation and administrative work

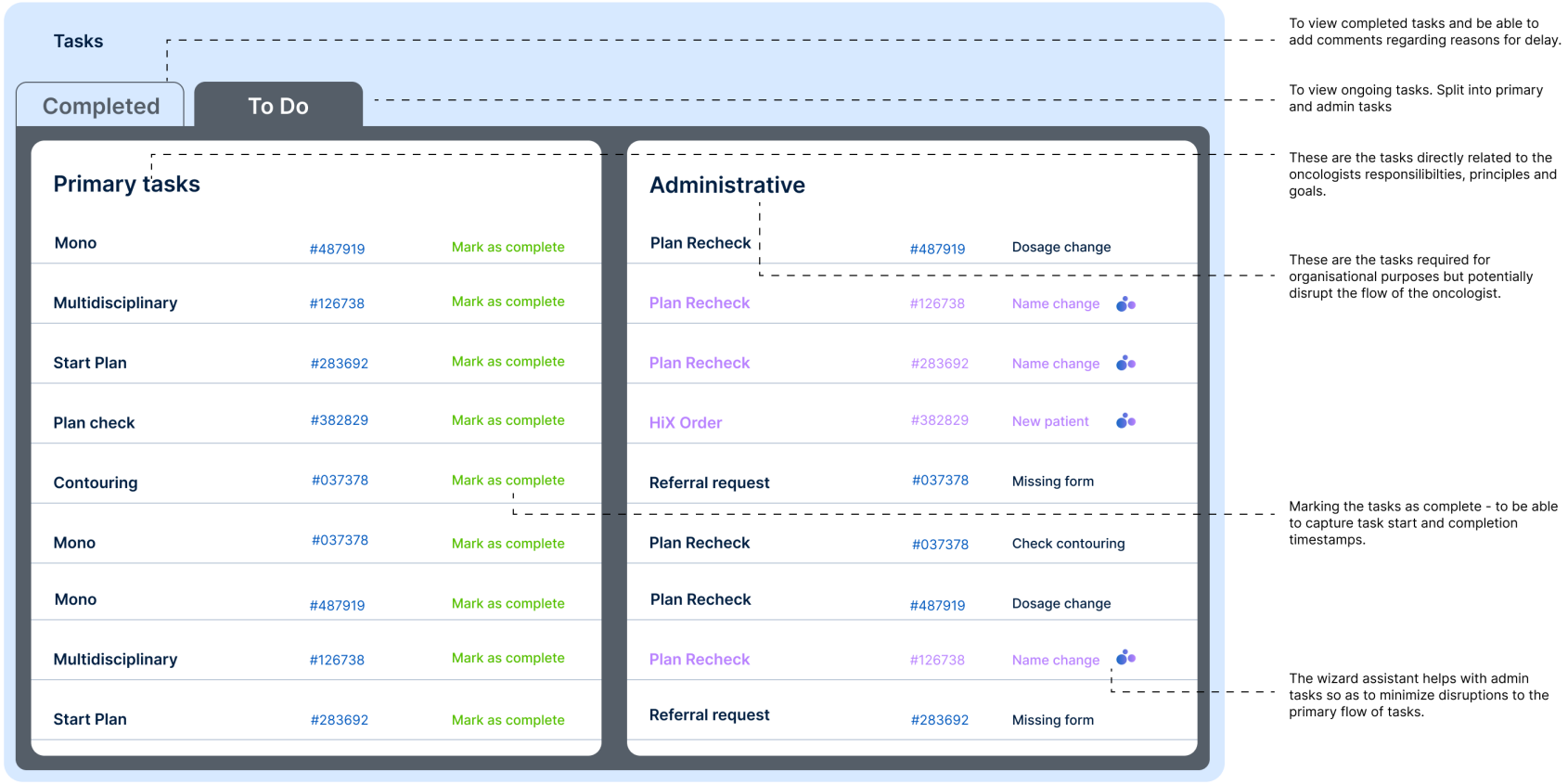


fig 29: Tasks

Screen 4: Reflection
This screen is meant to be a moment of simple reflection for the oncologist to note down moments of satisfaction as well as frustration. This is meant to benefit both the oncologist as well as the managers in an effort to make oncologists reflect and feel heard, and at the same time allow managers to collect qualitative feedback.

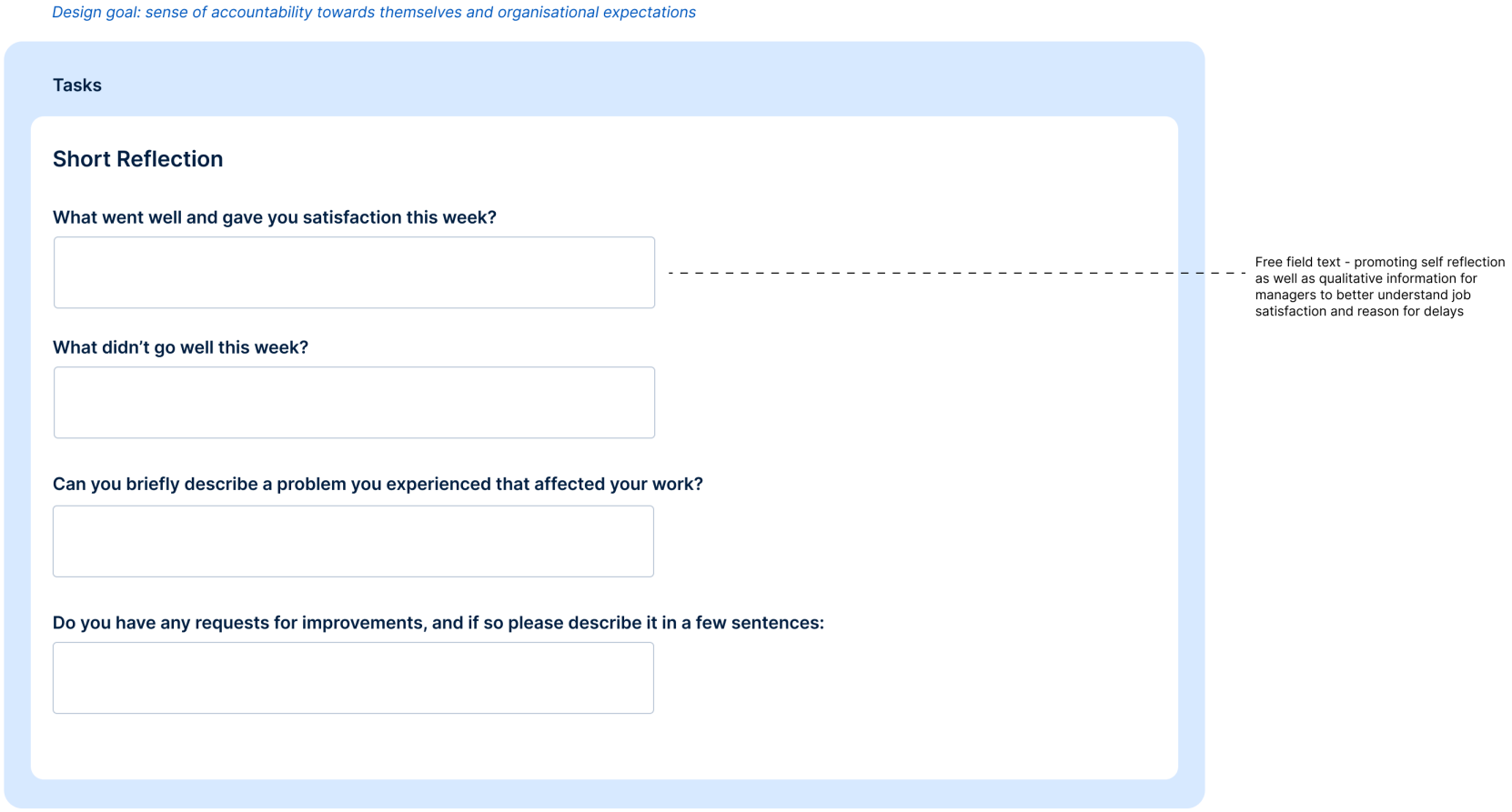


fig 30: Reflection

Screen 5: Peer review requests
This screen facilitates radiation oncologists to schedule and request for peer reviews with their colleagues based on availability. It can be distinguished based on the requests made for them as well as the requests made by them. Since the professionals are quite comfortable utilizing teams for their communications, this screen shows the integration of teams to ease peer review exchanges further.

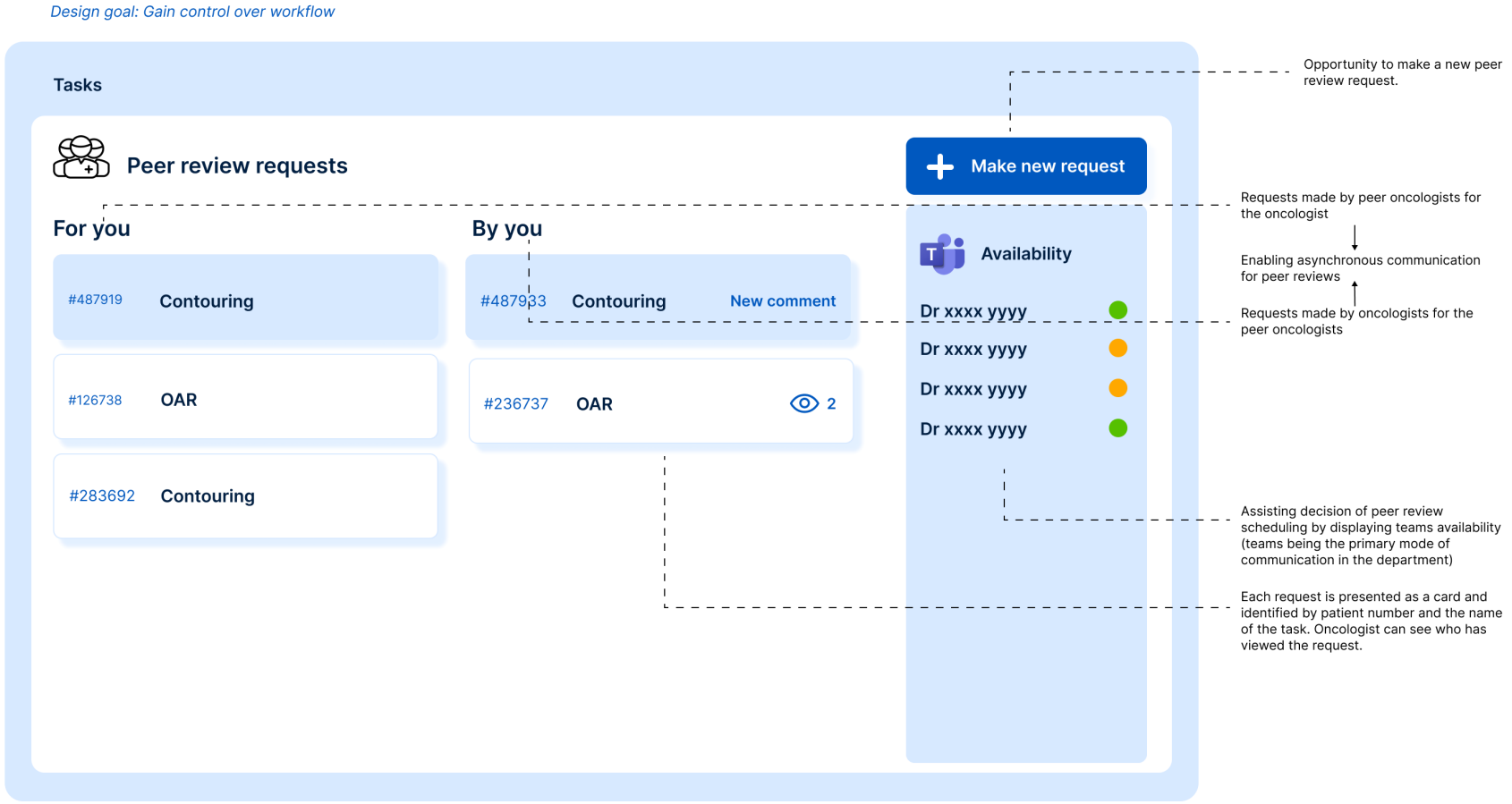


fig 31: Peer review requests

Concept Part 2- HiX Overlay screens

The overlay concepts are meant to serve an assistive role, with the assistant being present as a "wizard". This wizard can perform a few roles at different moments of the oncologist's tasks with HiX.

Screen 1: Autofill -

This function helps professionals with repetitive filling-in tasks that can autofill fields that tend to have the same selections each time. The Oncologist then has the opportunity to review the filled-in information before accepting it.

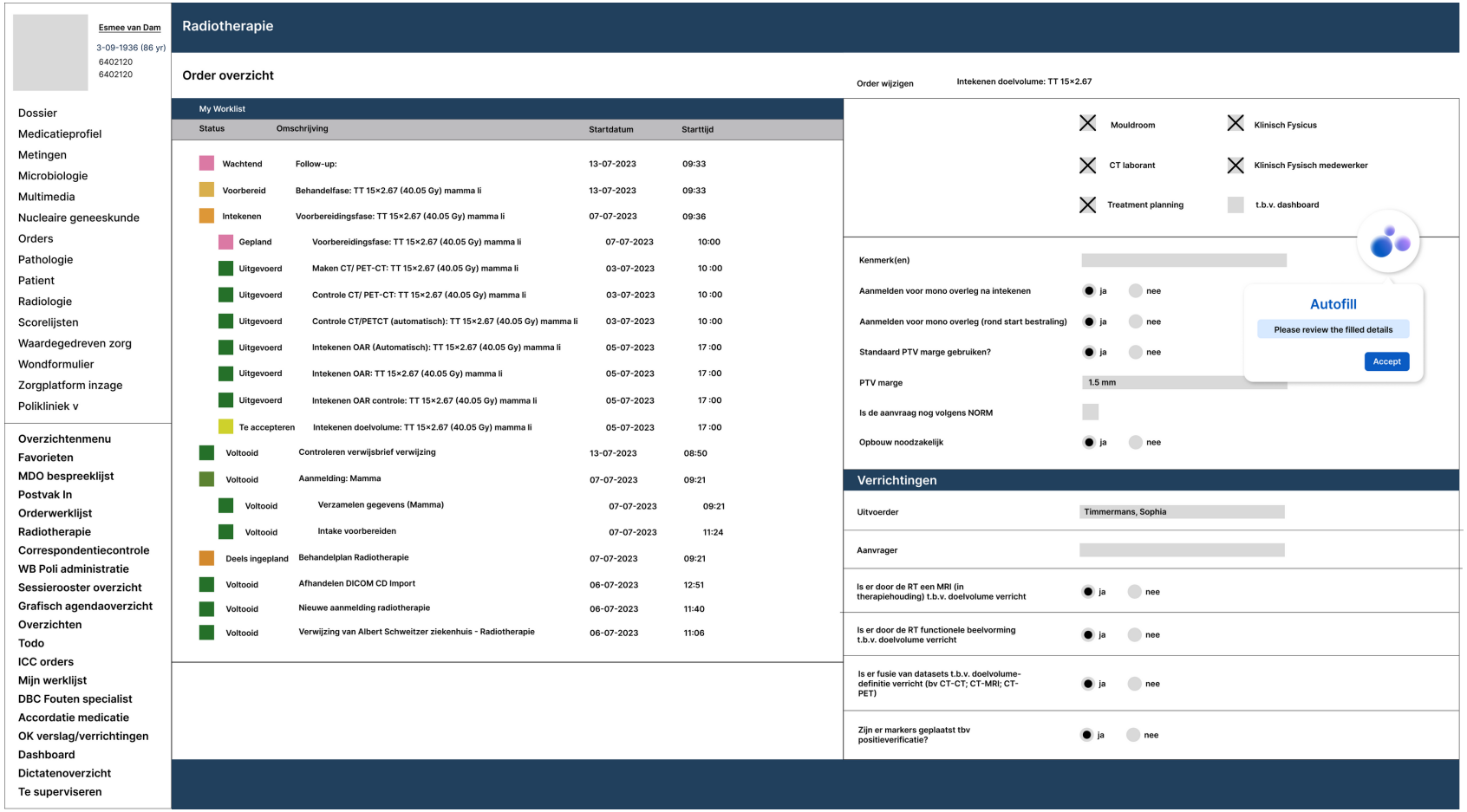


fig 32: Autofill

Screen 2: Autocheck referral -

This function is meant to help radiation oncologists with the checking of the completeness of the referral received from the secretaries. The missing documents can be identified and requests can be made by the system to the triage department/ referring doctor to share the files at the earliest.

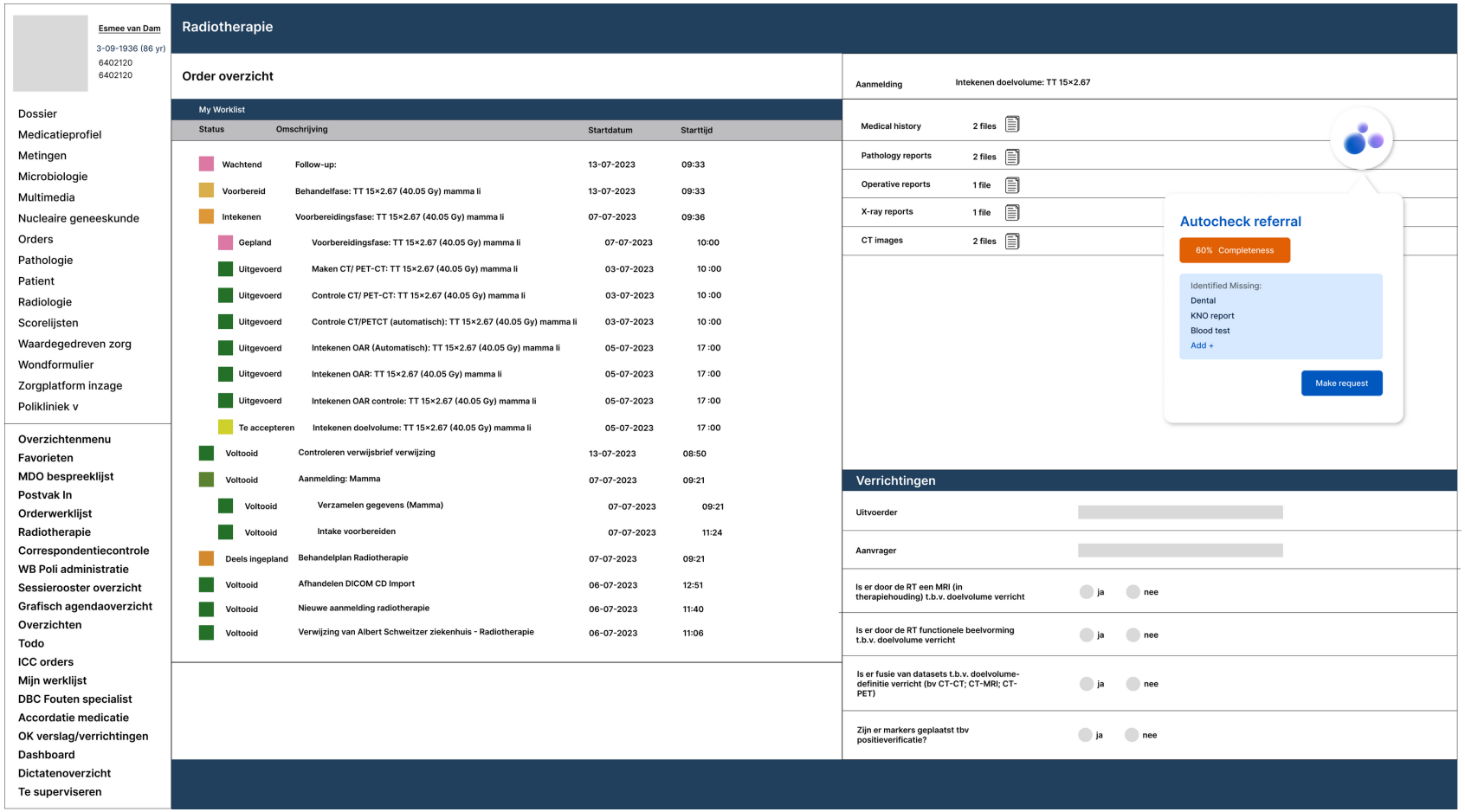


fig 33: Autocheck referral

Screen 3: Peer review-

This function is the overlay version of the peer review screen in the app, which instead of a separate screen, pops up on the HIX page where the radiation oncologist needs to communicate about the treatment plan reviews with their colleagues.

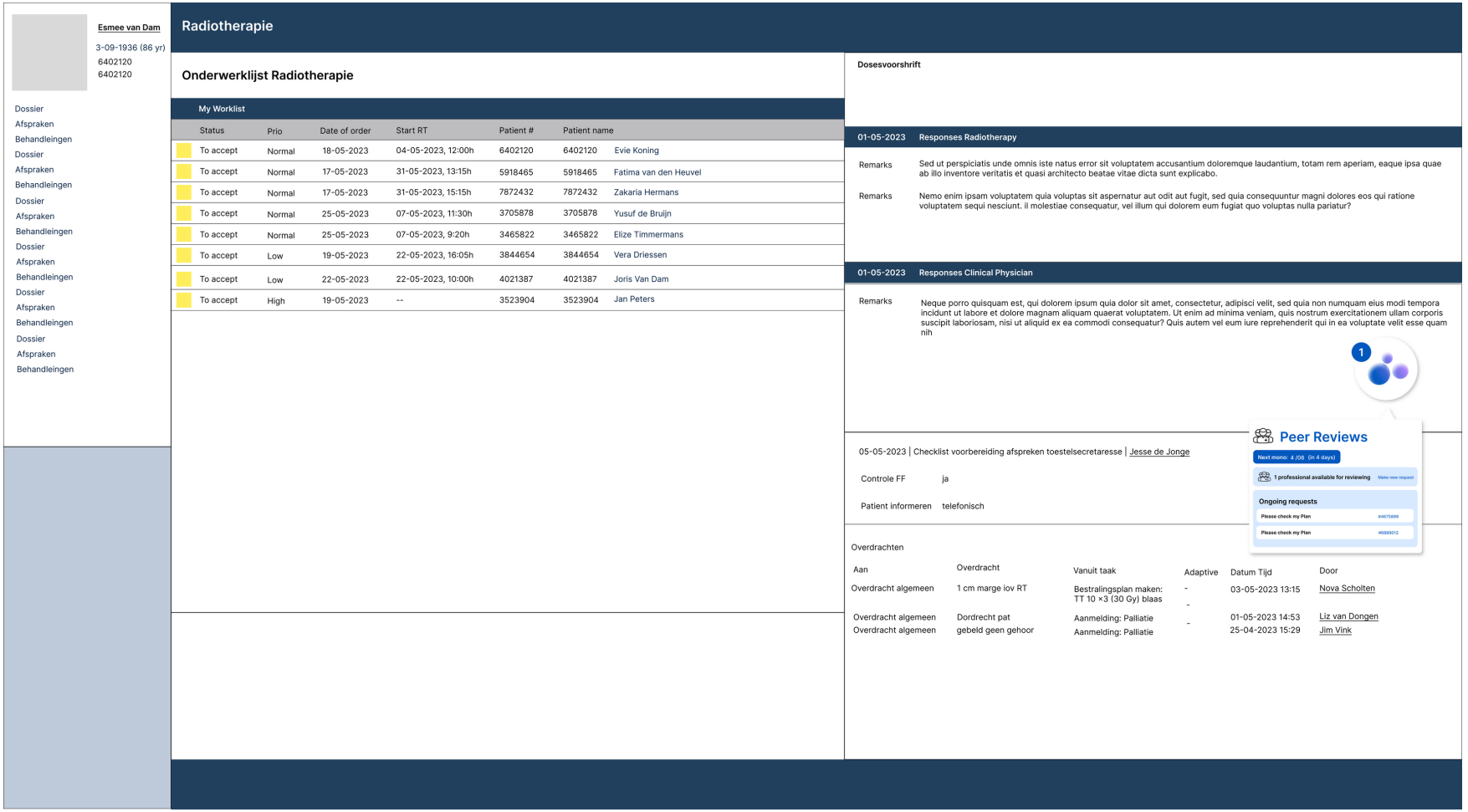


fig 34: Peer review

Evaluation

The aim of the evaluation test was to assess the digital application and the overlay concept for four main new features, which are believed to have the potential to enhance the workflow. At the initial testing level, aspects of accuracy, relevance, and information usefulness on the screen, along with functional significance, will be tested. The objective is to determine the preference between the application and the extension for each of the features, as well as the underlying reasons for these preferences. Please see appendix for evaluation framework.

Results of evaluation

Patient Overview
The following were requested to be included in the patient overview:

- timestamps both before and after each task.,
- tumors' locations and the types of plans involved, such as the number of fractions.
- Incorporate vacation schedules
- CT date and time intervals
- Elapsed time before mono and dose plan
- Timeline between PPR creation and first appointment pivotal.

Task logging solution using badges

- Has to be for everything or nothing at all, professionals work across different systems already. But can save time in their workflow.

Validation of features/functions

- Validated the usefulness of Autofill, peer review synchronization
- Qualitative data from Reflection-interest in integrating it into their dashboard.
- Auto-checking referrals at the triage stage proved useful. Importance is given to involve knowledge from oncologists at the triage referral stage.

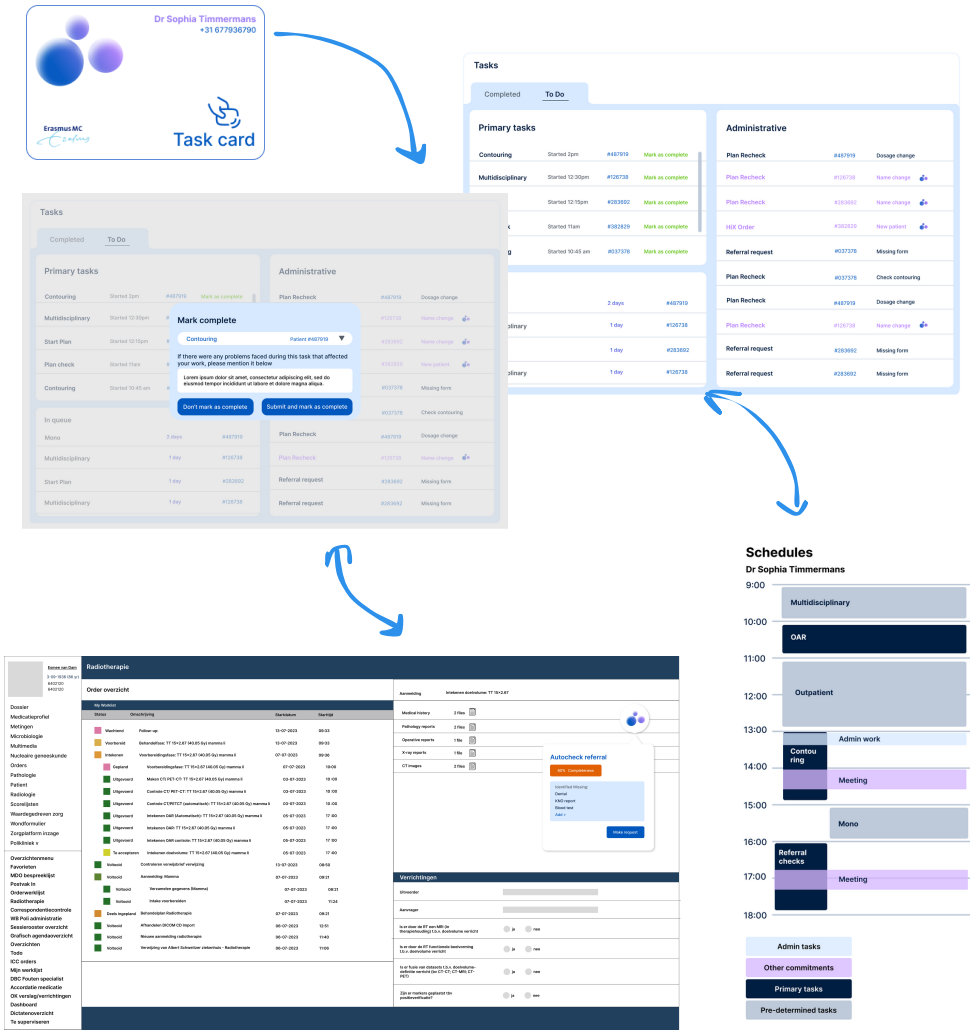
Nice- to - have
Overview of Patient Referrals to Holland Proton Therapy Center (PTC)

FINAL DESIGN

WizWork-
Omnichannel solution

Current hospital information systems typically store a lot of data in one central place. To improve how hospitals work and provide care, it's becoming more important to connect this central system with smaller, decentralized systems. These smaller systems ensure that data and services are easily available where they are needed most in the healthcare process. This helps hospitals run better and provide better care. (Musa, Yusuf, & Meckel, 2012)

Hence the final design functions as an omnichannel solution, with functionalities that extends across different mediums within the radiotherapy department. It can function as a stand-alone product as well as an extension for HiX, and both of these work in conjunction with each other to provide the professionals with a connected and cohesive solution. The task logging function is the third medium of this solution that works with a tangible product i.e the NFC task card. The technology works to automate the task-logging process in the ipad version of the solution. The screens and functions are explained further in the following section of the report.



New Screens

As shown, the new screens were made based on feedback from the previous round.
Fig 35 - Additional features were added to the patient overview home screen such as tumor type, number of fractions, and holiday schedule of the patient. An additional layer of presenting the oncologist and the manager with the AI-recommended ideal flow to juxtapose over the current flow such that there is a clear visual of a possible delay/ lagging behind in the treatment case.

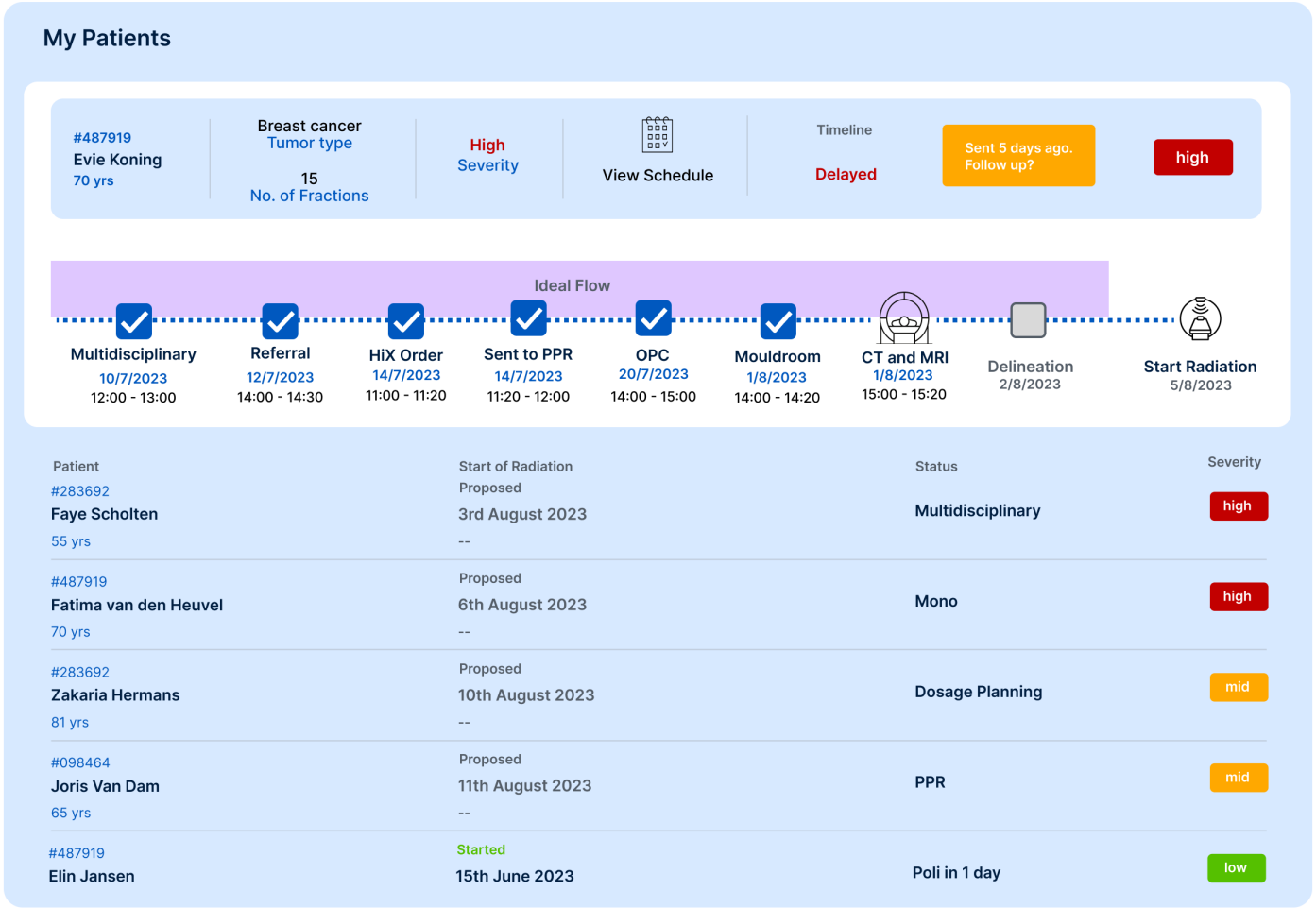


fig 35: New patient overview

New Screens

The task screens were improved to make them more visually coherent with the rest of the concept. Additionally, an "in queue" section was added to help the radiation oncologists see their task list in terms of upcoming work that they have to do apart from ongoing tasks.

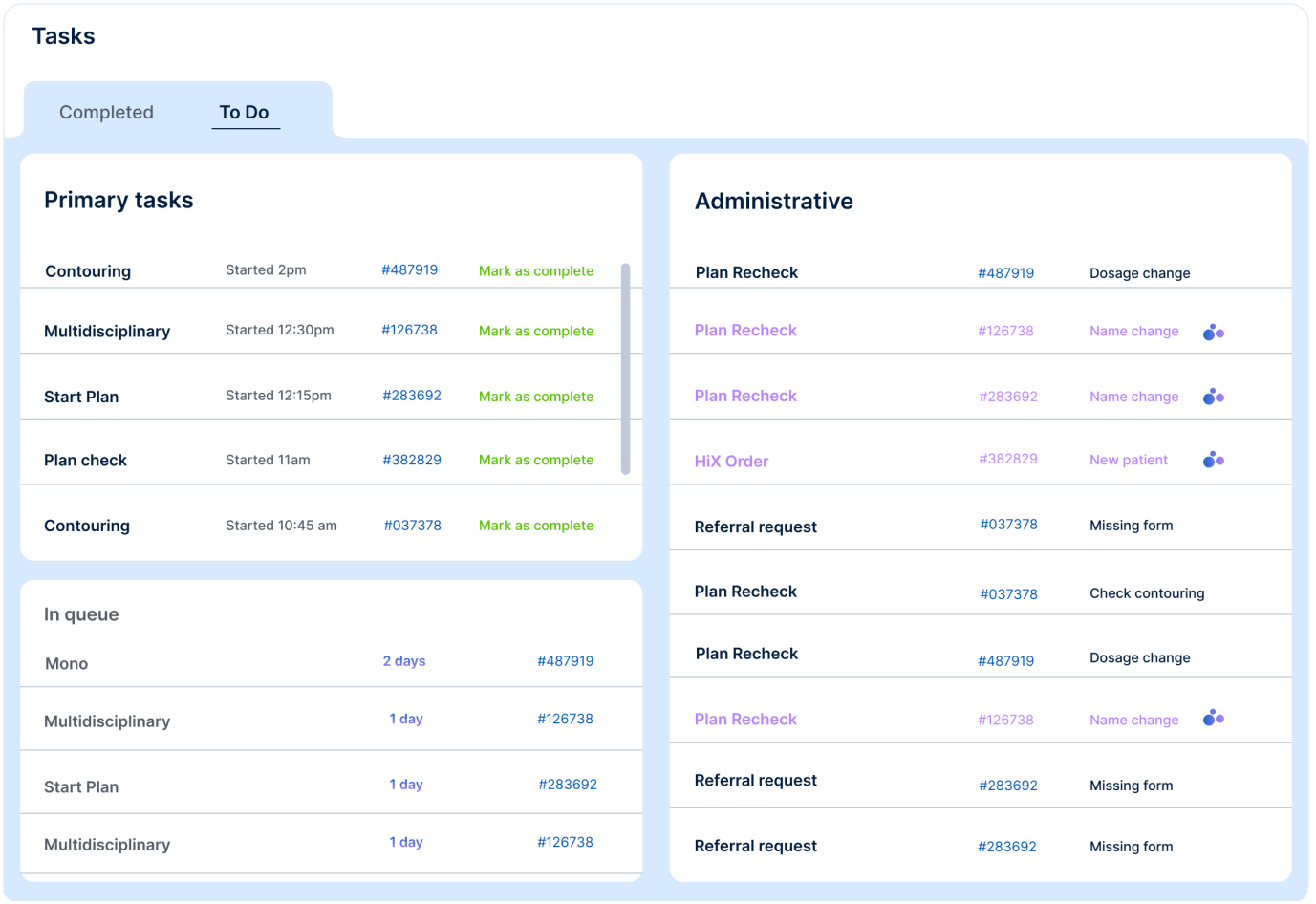


fig 36: New tasks screen

New Screens

NFC Tapping

This new design was created to visualize the previously described NFC task-tapping concept. Upon tapping the task card, a pop-up screen will pull up as seen in Fig x with the choice to mark a specific task as complete. Additionally, taking into account the manager's requirement to be able to understand reasons for delays, the open text field helps the oncologists to quickly fill in any possible reasons they may have experienced for the delay.

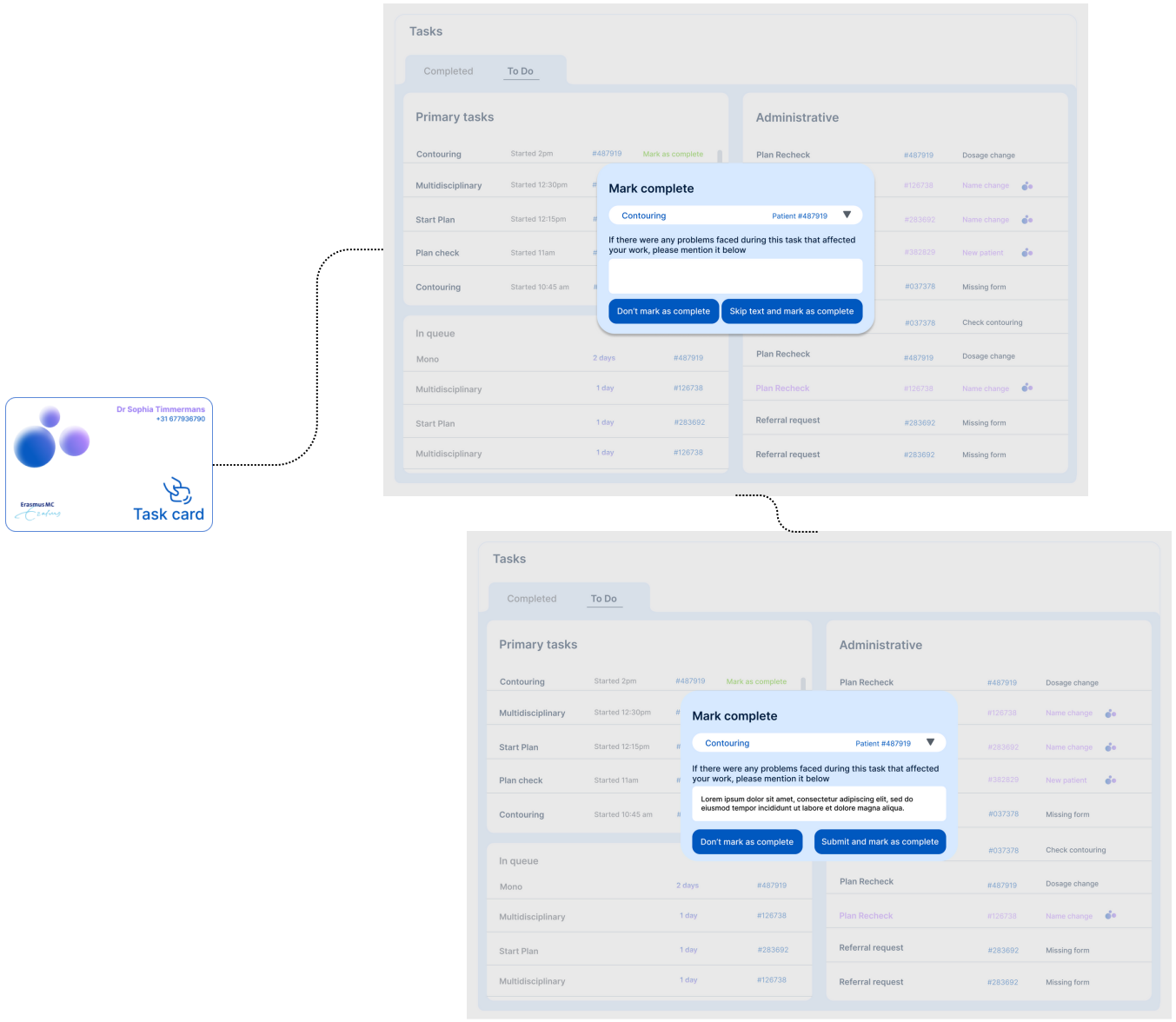
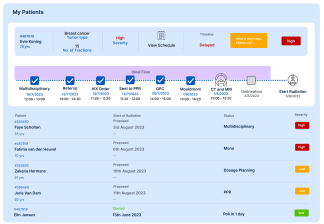


fig 37: New task logging interaction

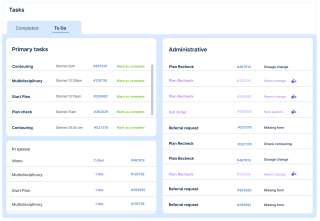
All Screens

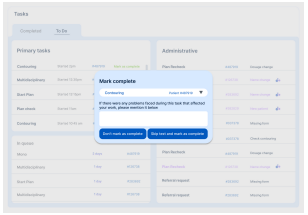
The other screens remain the same, The overview of screens can be seen below:

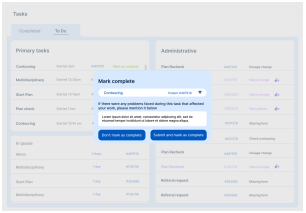
IPad screens



Patient overview

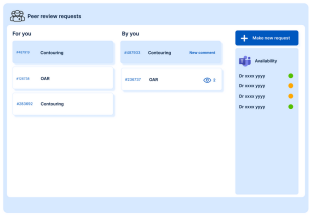






Task logging

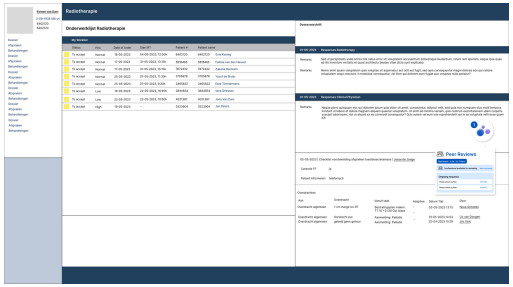
Reflection



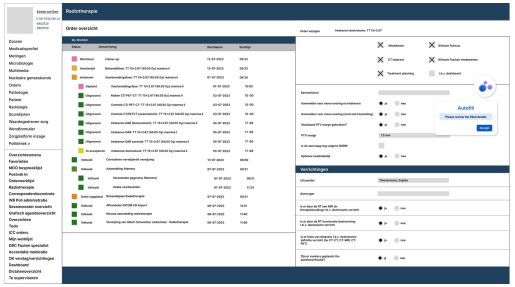
Peer review

Scheduling

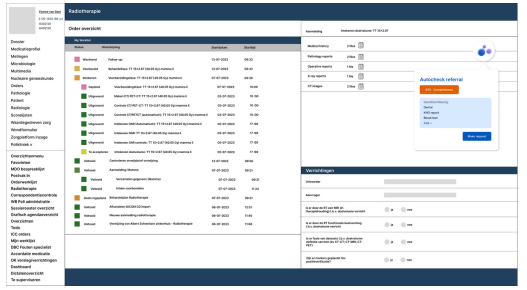
HiX screens



Peer review



Autofill



Autocheck

Data Flow Strategy

The image shows the final concept's fitment in the workflow of the radiation Oncologist. The main aspects of the digital solution comes in the form of the wizard and the ipad solution. The diagram hence shows the various moments in the oncologist's workflow that the solution intervenes to support the RO's task. The Data Flow section shows the exchange of data happening between the solution and the existing Hix platform. The arrows are indicative of where the solution borrows from Hix, and where it's contributing data to the system. (Jung, 2023)

The data flow strategy was created to clearly visualize the various moments in the workflow of the oncologist (as well as the general pre-treatment workflow) that data and information flow takes place and provide a zoomed out view of the concept.
This will be further discussed going forward in the evaluation to get feedback from the managers of the value-add and feasibility of the data exchanges occuring,

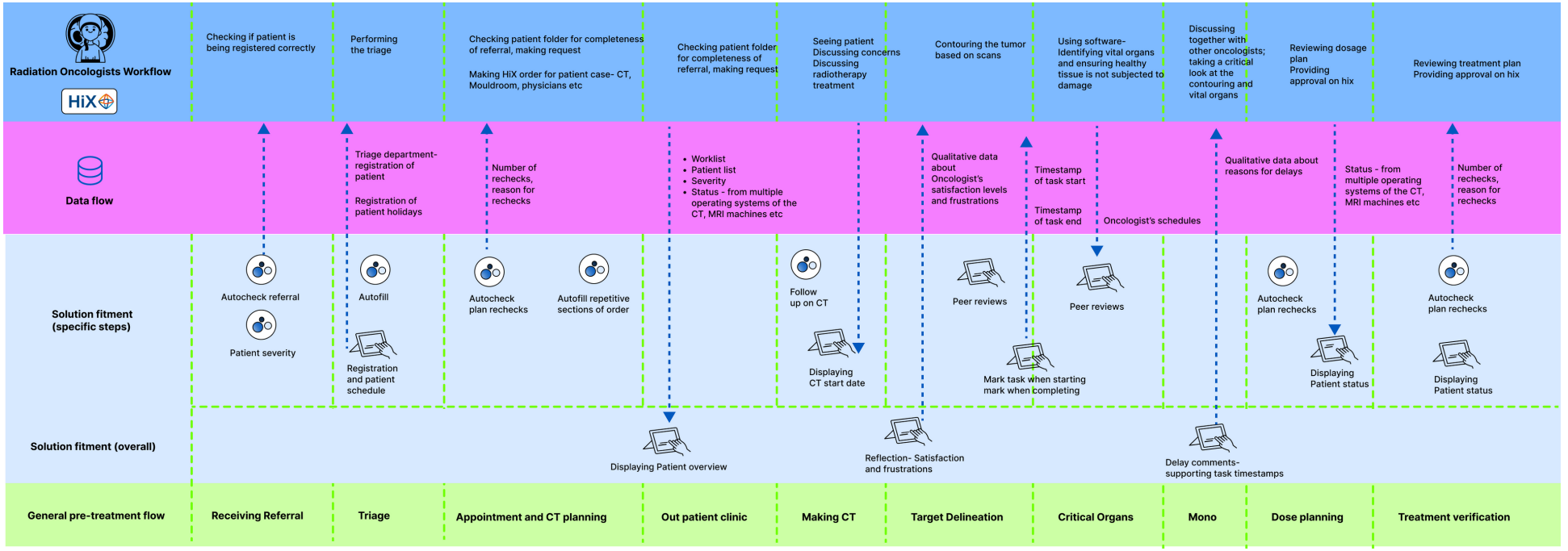


fig 38: Data Flow Strategy

Evaluation

The final evaluation took place with two managers and one oncologist. The set up involved:

- the final screens on an ipad as they would be seen,
- a dummy NFC tap card
- a display of the HiX overlay screens and
- the data flow strategy.

The aim of the evaluation was to test the new concept in terms of the proposed features as well as understand the usefulness of the data being captured with the help of a rating system as well as verbal feedback.
The professionals were taken through the final concept and were asked to rate specific aspects of the concept (refer appendix). It must be noted that the ratings were only asked for the managers. The final comments on the design were taken into the Recommendations section of this report.

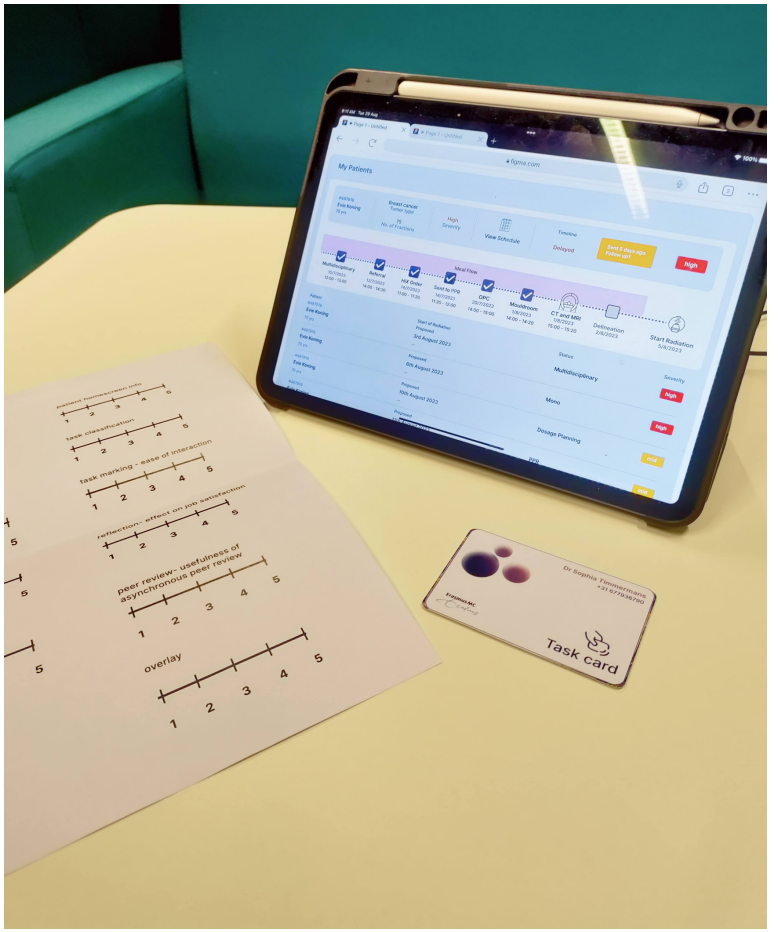


fig 39: Evaluation set up

DISCUSSIONS

Design recommendations

The managers felt like the scheduling concept worked well if they could be scheduled beforehand. That part can be very interesting to forecast per oncologist what the workload can be. Currently, their workloads are invisible to the managers.
They feel such a system looks promising if it can connect to HiX and work according to all systems. Works well if they would still support HiX and this would support and give much better information on the progress of the patient and workload per day, where to start, and prioritize.
When it comes to time stamps, considering HiX is progressing towards extracting the same this could change the purpose and extent of application of this concept.

Manager 1 Feedback:

Number of rechecks - 4/5
It's valuable to have this. But on a sidenote, it shouldn't take much extra time from anyone, if it can keep track of the number and keep feedback as short as possible it was deemed useful.

Qualitative feedback through reflection - bi weekly then 3/5, monthly then 3.5/5
They believe it is valuable to know but shouldn't take too much time.

Reason for delay - If automatic/ requires minimal input, then 3.5 or 4/5
It is really important to learn the reason for the delay. Planned delays are not used optimally in HiX right now. If it can pop up in a meaningful moment it can be very helpful.

Calendar- 3.5/5
Current calendar view is retrospective which is also still useful, really interesting, and valuable data. They rate it over 4 if it can predict and plan the oncologist's calendar view.

Patient view-4/5,
They felt it was very good to have recommendations on what patient to start with.
Because ROs multitask, they feel they should work with blocks in their agenda. It's great if all doctors can work with their agendas since they currently do not. It's also good to add in their free time

Manager 2 Feedback
Timestamps 4/5- considered very helpful
Reason for delays -3.
Transforming voice into text would be beneficial due to delays, currently rated at 3 but with checkboxes for selecting reasons, it's rated 4.
A dashboard tool for identifying significant delays is desired, like a management tool.
Calendar view -5 Calendar view is highly valued, rated 5 for both functionality and visual appeal. AI-based recommendations for the calendar view receive a 4, as it may not suit everyone's needs.
Patient overview- 5.
A patient overview with reminders is deemed excellent, receiving a 5 rating.

Radiation Oncologists Feedback
Oncologists' needs vary when dealing with different tumor types and their workloads, depending on secretary support. The usefulness of the system varies among oncologists for rechecks and triage communication. It should seamlessly integrate with their health information exchange (HIX), and autofill is appreciated. One oncologist doesn't handle triage communication but likes automated emails. Peer reviews are fine if connected to teams with out-of-office statuses. They want assurance that tasks inputted will be addressed. Having a patient status overview is useful, but they may not dig deeper as they're not managers. The in-queue function isn't helpful, and they prefer HIX to pop up seamlessly.

System level recommendations

Introducing a medical technologist - acts as a bridge between medical professionals and the technological aspects of the process. This can ease the burden on the oncologists when it comes to understanding complex software, debugging, etc.

Having a manager keep track of the patient flow- assigning a manager to keep track of the patient's status, including patients being sent to Holland PTC, or patients that require chemotherapy etc. They will specialize in managing the patient flows through various departments and communicating with the oncologists. dosimetrists etc with regard to timelines.

Having an intelligent secretary -cum-nurse practitioner assigned per tumor group- Having the different secretary groups in the current department came up as a possible cause for inefficiencies considering the splitting up of tasks and an additional layer of communication required for scheduling. Hence alleviating some tasks through assistive intelligence can help with aligning the work of the 3 groups better.

Involving the oncologists in the triage of the patient - Since there is the general issue of having to send back the patient from one oncologist to a different oncologist based on misclassification of tumor group and acute/sub-acute registration, it can be useful to involve the role of a medical oncologist early on who is in charge of assisting the triage secretaries with the right patient classification.

Having intelligent assistance in accurate report collection- there is a knowledge gap between the triage and the oncologists in terms of required documents to make a CT scan, or progress in an informed manner towards the treatment plan. Since this can cause loops between the oncologists and secretaries, assistance at the forefront of the process can help prevent delays arising from lack of completeness of the referral.

Protocols- There is a necessity to incorporate protocols to ensure uniformity in operations. These protocols can be: HiX usage, in terms of how to share patient files, how to input rechecks and send backs. Administrative work being handled by Oncologist, vs being handled by the secretary. This is to ensure there is the right work distribution and allow for a more uninterrupted workflow of the radiation oncologist's treatment planning tasks.

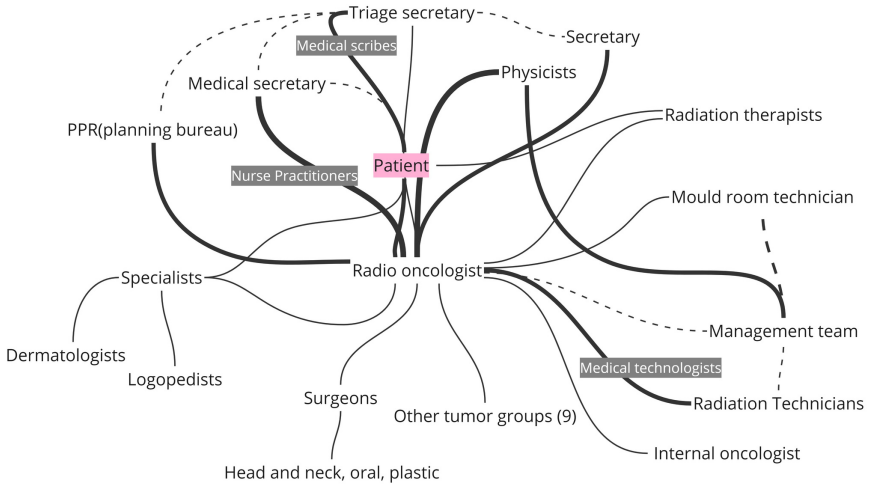


fig 40: A view of the current interrelations between the different professionals.
Thick lines indicate strong connections, dotted lines indicates limited/strained connections.
Grey indicate possible new professionals that can be introduced.

Implementation and future

Implementing this design on a technological level involves two major aspects:

1. Streamlining of software systems across the radiotherapy department is an important factor for such a concept to work. Extracting timestamps from CT machines, MRI machines, linear accelerators etc allows for timestamps across professionals and treatment stages to be collected into WizWork towards a cohesive platform.
2. Bidirectional information flow between HiX and WizWork is a necessity in order to exchange data shown in the data flow strategy towards both receiving and sharing information across the platforms. Wizwork utilizes specific data to display the patient overview, including the worklist and patient severity.

The exploration of the NFC automated task tapping was proposed as a solution for all professionals as a unified way of marking task completion. Hence the future of this concept involves testing this functionality with all professionals as opposed to just radiation oncologists do understand specifics about what works well/does not work for the professionals.

The success of this solution especially considering the omnichannel approach depends on the idea of an Integration platform as a Service (IPaaS) being feasible with HiX in that it can support an overlay system and add on services that enhance professional workflow.
Limitations of the current study include the restricted testing of the concept with radiation oncologists. As a next step it is important to test the scalability of this solution with other professionals.

The timeline of a system-level change to be effective as proposed by this solution may run into years , considering the centralization of the various software is necessary as discussed above , and professionals have to adapt to using WizWork instead of HiX for specific functions. From an optimistic stand point in the span of a few years HiX itself may be able to implement some of the features discussed in this report which may then be no longer necessary to have in the current solution.

Patient information and involvement

Patient needs during the pre-treatment process were briefly touched upon in this report and require further research in order to define and validate the functionalities for the same. But literature and background information provided by Erasmus MC touches up the importance of keeping patients informed of their diagnosis, treatment process, prognostic outlook, hope, side effects etc are all very important for the patient to know(Gamble, 1998).
Apart from this, patient involvement in healthcare can provide valuable data about the patient's perception of the experience with the process, and their inputs can help strengthen the pre-treatment process flow. (Miller & Reihlen, 2023)

Reflection and conclusion

The contribution of this project lies in a few different aspects:

- The configuration system giving a comprehensive understanding of the Radiation oncologist's workflow from a systemic standpoint and the interplay of various factors at the Erasmus MC department that affect their workflow.
- A deeper understanding of the radiation oncologist's professional and emotional needs
- A list of conceptual requirements for an effective workflow management tool.
- A potential digital intervention that adds value to the oncologist's workflow and enriches the data pool for identifying step-by - step delays and issues.

It is also a consideration that in an ideal situation, some of the new features suggested for new digital solution may in fact be introduced in HiX, making the professional's workflow cohesive and reducing software overload. There are multiple considerations in this manner for the development of HiX towards certain improvements and adaptations that can either facilitate such an add-on solution or iterate on the existing software taking into account the pressing needs of the professionals.

It is important to emphasize that the NFC automation feature was intentionally designed to facilitate efficient task logging for professionals. Its purpose is not to capture every moment of an individual's day. Rather, it serves as a comprehensive analytical tool intended to assist managers in gaining insights into step-by-step lead time. It is not meant for scrutinizing oncologists, questioning their efficiency, or pinpointing distractions; rather, it offers a broader perspective for managerial assessment.

Discussions were held with a radiation oncologist running the radiation oncology department in a different country to understand their priorities. This shed light on the scale of the operation at Erasmus MC which further affects the efficiency and outcomes of such a system, proving the cultural and contextual specificity of the project. But literature also proved such waiting times were prominent in other countries such as the UK, and it is up for further study to understand the extent of applicability of such a solution in other contexts. The commonalities with scheduling problems and the universally accepted low understanding of the job satisfaction of the radiotherapy workforce further strengthen the necessity of this project's study and its relevance in the wider scope of the matter.

Reflecting back on the project, the author believes there was a successful attempt at using the SEIPS 2.0 system-level model towards mapping the Erasmus MC's Radiotherapy department in a fresh light while extracting the core needs of the professionals as an "outsider looking in". It also amalgamates Interaction design methods to propose a pragmatic human-centered project that can extend towards multiple touchpoints of the process and benefit multiple stakeholders. The evaluation showed promise in terms of a solution that can truly help managers and oncologists deal with the emotional and professional repercussions of the workload and the complexity better. But there is also the awareness that the concept in its nascent form has much scope for improvement and further rounds of development towards a successful implementation. All in all, it is a step in the right direction toward unraveling the intricacies of a larger radiotherapy system and a point of reference for meaningful design interventions in this space going forward.

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APPENDIX

1. Radiation oncologist interview guide

Steps: informed consent

Explanation of the project briefly:

consent to record

1. can you walk me through the tasks you carry out every day?
2. who are the different professionals you interact with?
3. what are the different tools you use?
4. where do you feel that the process is much slower?
5. which of the tasks listed do you feel has the most reliance on your skill set?
6. which tasks listed have the least reliance on your skill set?
7. which task takes the most time, and which takes the least time?
8. Specific problems: talk about plan creation, triage, mono

Task-interactions during task- how task is carried out- what tools and mediums are used to carry out the task

demonstration of certain tasks

do you have specific concerns?

SEIPS- tools and technology, organization, persons, internal environment, tasks

For automation and augmentation

1. which tasks do you feel like you could use some assistance?
2. what do you feel about the workload?
3. patient interactions
4. do you feel like you get enough time with the patients?
5. patient interactions- usually what kind of patients?
6. What level of autonomy do you give them during the sessions?
7. software- how do you feel about the intuitiveness?
8. heuristics- consistency, visibility, ….

Future-

1. what could be better?
2. When you think of artificial intelligence what comes to mind?
3.

2. Radiation Therapy Technologists Managers interview guide

Questions:

1. What is your role and responsibilities?
2. How do they currently optimize with the different criteria at EMC?
3. What do they follow in Erasmus MC- push vs pull strategy?
4. How do you design efficient resource planning schemes while ensuring patient-centeredness?
5. How do they implement new techniques/technologies in EMC? How does this affect time allotment?
6. What tools do you use right now?
7. What is the level of AI it has?
8. What is the cause for the shortage?
9. How do you determine CT scanning appointments? What is the role of the secretary?
10. Who do you interact with?
11. How do you feel the burden on the professionals can be alleviated?
12. If there are new personnel required within the team, who would be a valuable addition? medical technologists, nurse practitioners
13. What are the barriers to a smooth workflow?
14. What are the biggest problems
15. If you have to implement new technologies, what would be the criteria?

Follow-up

1. Timestamps
2. Importance of being data driven. Can you tell me the main ways data will be helfpul to you?
3. What kind of data will be useful for you from each of these steps to help you make decisions
4. Syncing schedules
5. Do the PPRs plan the first appointment already?
6. Dashboard
7. Qualitative data

3 Secretaries Interview Guide

1. can you take me step by step through the appointment making process?
2. how does Communication between Outpatient and treatment planning department work?
3. how do you determine the priority level of the patient- tumor stage, severity of complaints etc- does the system do it for you?
4. how do you plan the first CT appointment? What factors determine when a patient gets the first CT appointment?
5. What are the patients needs when it comes to scheduling the appointments?
6. who is in your team of planning?
7. what's your connection to the triage?
8. what problems do you have with the current system of scheduling?
9. what happens before this stage? what comes after the stage?
10. Who do you interact with and how?
11. Do you prefer using hix
12. do you feel like you're doing some tasks that are not meant for you?
13. if you need assistance, where and for what do you feel like you would need it?

Follow-up

1. What is the work of the PPR, and wha is the work of triage?
2. what are the different steps in the triage?
3. what are some of the errors that happen during the triage?
4. do you feel like there is good workload distribution?
5. right now what kind of data do you collect
6. what kind of data do you put in the system

4. Patient Perspective guide

Patient perspective guideline
Aim: To understand patient experiences during their touchpoints with the Radiotherapy professionals during the pre-treatment stage.
To understand how and at what moments they gather patient feedback
To identify the level of satisfaction of patients with their (pre) treatment interactions.
To assess to what extent patient needs and values are met during the pre-treatment phase.

Pre-treatment phases to be considered:

1. Logistic Preparation
2. Out patient clinic
3. CT, MRIs
4. Plan room
5. Patient needs and values during the pre-treatment:
6. Empowerment through information- right information given at timely intervals, giving them sense of control over the cancer. Managing the load of the information, and ensuring patient's family members are involved in the right capacity.
7. Managing expectations- duration of treatment, side effects etc.
8. Providing adequate resources for the patients to manage stress, logistics and other concerns prior to treatment.

9. Communication and individual care, information provision, accessibility, professional competence, good follow-up, and the attitudes of the HCPs who care for them

General questions for professional:

1. How often do you collect feedback from patients?
2. At what stages of the process do you collect feedback? (also specifically which parts of the pre-treatment stage)
3. How do you currently know the effect of the delays on the patients?
4. What do you do with the surveys?
5. How do patients report side effects?
6. How do you collect insights from the data, and how does it benefit you?
7. What do you miss now from the patient's perspective to improve the workflow?
8. What are the modes of communication with the patient?
9. Is the website sufficient and does it have the necessary engagement?
10. What current data is captured, what new data types need to be captured?

5. Patient Perspective guide (contd)

- Analysing the survey- does it cover the following:

1. With focus on the answers relevant to pre-treatment phase
2. Specificity to radiotherapy? - not specific
3. Does it cover the pre-treatment phase and distinguish experiences per stage?- just covers the poli
4. Shared decision making and patient empowerment- Whether they are sufficiently informed about the status of their treatment, and sufficiently in control of their disease- yes
5. Relationship with HCPs-how the patients perceive the communication, engagement, level of contact with oncologists, therapists and other professionals? - yes but only during the poli
6. After consultation with doctor, do they feel: reassured, with more knowledge than before, with all your questions answered, with some additional comfort?
7. Information- perception of amount of information provided during poli, phone calls, through website, emails
8. Feeling sufficiently informed throughout the process
9. Awareness of available resources for information and help How do you feel about the information given to you at the poli?
10. Satisfaction of the assistance and resources provided by the hospitals
11. Satisfaction with mode of contact for questions, information, appointments, and prescriptions
12. How often do they find themselves having to ask again/have doubts after the first appointment?

I6. Interview guide with professional creating patient dashboard

1. What kind of data are you trying to retrieve?
2. How do you retrieve it? What problems are you facing right now?
3. how is the data entered right now?
4. how do you determine a delay?
5. patient moving through the system
6. vs staff members
7. what does each professional have to do to provide the necessary data into the system? How do they document the data?
8. do you adopt any other data collection systems?
9. what is your role as medical physicist?
10. which parts are a black box right now?

7. Interview guide with professional creating patient dashboard

1. What kind of data are you trying to retrieve?
2. How do you retrieve it? What problems are you facing right now?
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8. do you adopt any other data collection systems?
9. what is your role as medical physicist?
10. which parts are a black box right now?

8. Interview guide with coordinators of Zorgplatform

1. What are the functionalities of Zorgplatform?
2. Who are the different professionals using zorgplatform?
3. What are the different tasks the professionals perform?
4. How do you collect and implement feedback about the experience using the platform?
5. What are the common complaints that you get? How do you plan to implement the changes?
6. What are you looking to do in future versions?
7. What are the stages of radiotherapy during which the platform is useful?

9. Interview guide with sales manager at Medical software company

1. (about radio oncology software) Can you tell me more about this feature where patient files can be retrieved easily?
2. who is it meant for? radiologists, secretaries?
3. Can you help me understand how it fits into an existing system that a hospital would have
4. Does it also work with scheduling?

10. Interview guide with sales manager at Medical software company

1. (about radio oncology software) Can you tell me more about this feature where patient files can be retrieved easily?
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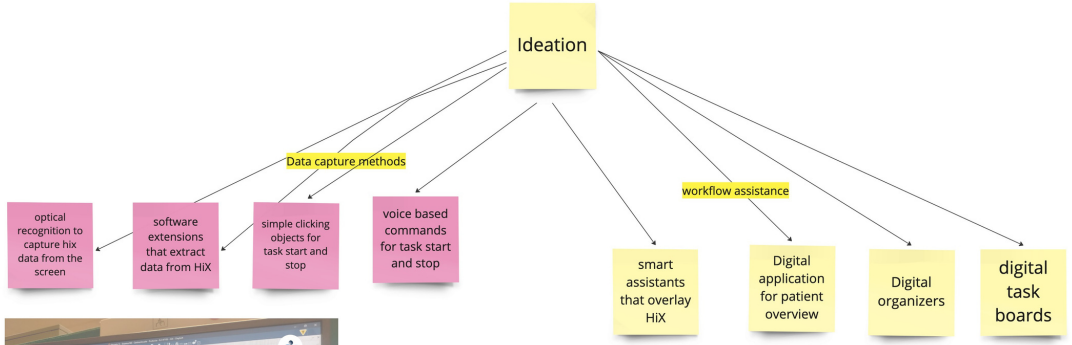
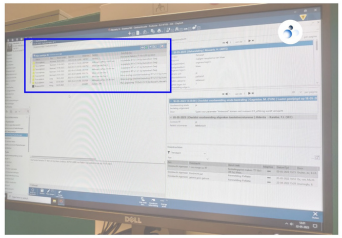
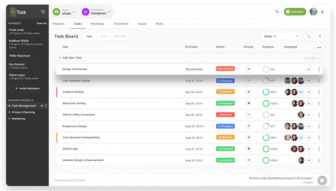
3. Can you help me understand how it fits into an existing system that a hospital would have
4. Does it also work with scheduling?

11. Initial Ideation







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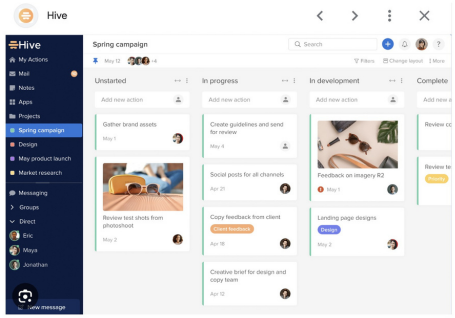
Integration platform as a service



12. Evaluation guide 1

Evaluation

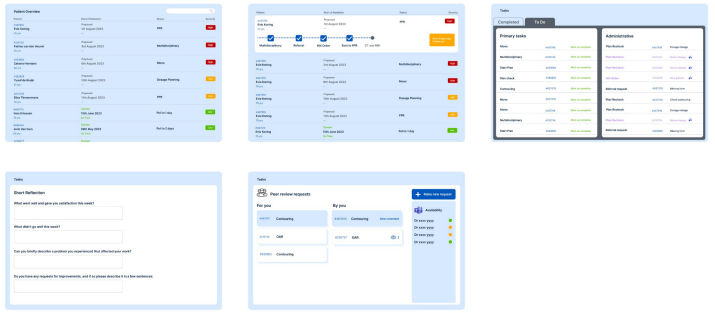
Aim:

1. To Test the digital application and the overlay concept for 4 main new features that I believe can improve their workflow. As a first level test, I want to test simple aspects of accuracy, relevance and usefulness of the information on the screen and functional significance.
2. To understand which of the two (app vs extension) will be preferred for which of the features, and why

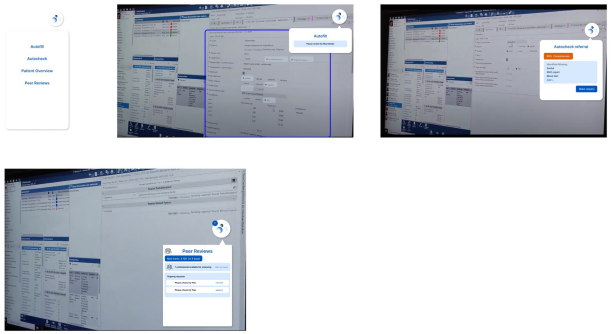
Features to be tested

Patient overview	Tasks	Reflection	Peer review requests	Auto check (extension feature)	Autofill (extension feature)
accuracy of Information displayed	Usefulness of administrative help feature	motivation to fill this on a Weekly basis	Usefulness of having it as an additional feature	Usefulness of having it as an additional feature	Usefulness of having it as an additional feature
usefulness of Information displayed (scale 1-7)	Usefulness of completed and to do distinction	receptiveness to written format vs conversational format	What can be different	What can be different	What contexts will this be useful?
What can be different	What can be different	What can be different			What can be different

App screens



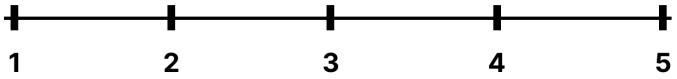
Extension screens



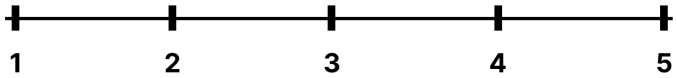
14. Evaluation guide 2 - Managers

Value towards identifying delays and managing workflow

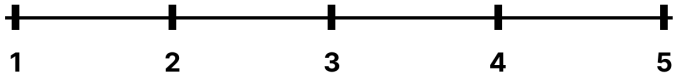
patient homescreen info



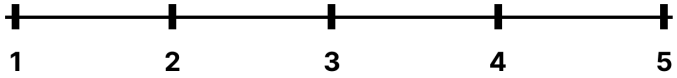
task classification



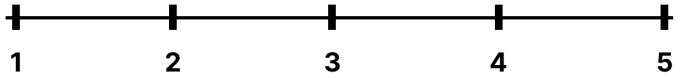
Qualitative data about Oncologist's satisfaction levels and frustrations



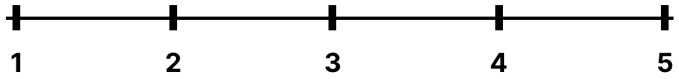
Qualitative data- reasons for delays



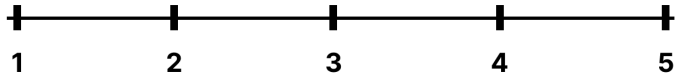
Oncologists schedule management



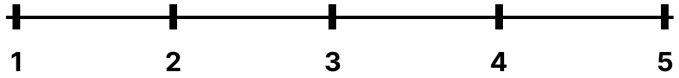
Oncologists schedule management- calendar view Desirability



Oncologists schedule management- calendar view usefulness of AI based recommendations

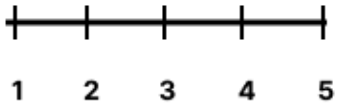


dashboard- usefulness of info

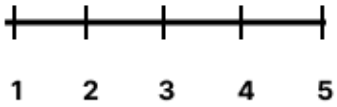


15. Evaluation guide 3 -radiation Oncologist

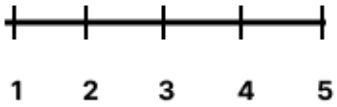
feel informed



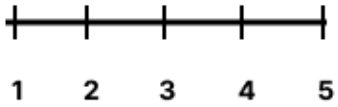
feel in control



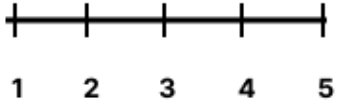
feel supported



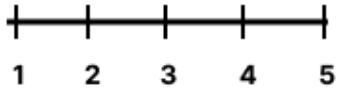
feel focused



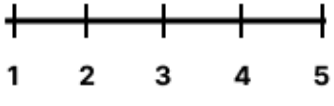
feel trust



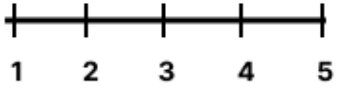
patient homescreen info



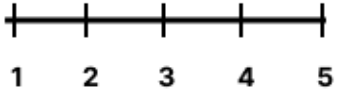
task classification



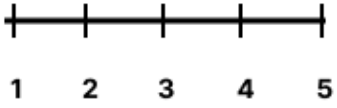
task marking - ease of interaction



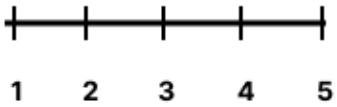
reflection- effect on job satisfaction



peer review- usefulness of asynchronous peer review



overlay



16. Informed consent form

Informed Consent Form – Improving the Process and Experience of Erasmus MC Radiotherapy Department

STUDY INFORMATION

15th May 2023

You are being invited to participate in a research study titled "Improving The Process and Experience of Erasmus MC Radiotherapy Department". This study is being done by Professor Marijke Melles (Responsible researcher) and Sampada Jayaram (corresponding researcher) from the TU Delft in collaboration with Erasmus MC Radiotherapy department.

The purpose of this research study is to analyse the tasks performed by Radiotherapy professionals during the pre-treatment phase, and will take: average 5-6 hours (in the case where researcher will be observing your day's work, with occasional direct interactions), or 1 hour (in the case of an interview/idea generation/concept evaluation). The data will be used for the purpose of the master thesis towards enriching the understanding of the current Radiotherapy process and various interactions, with the end goal of identifying areas of intervention in the form of a design solution. We will be asking you to demonstrate and answer questions relating to: day-to-day tasks, activities, communications, and technological tools related to your professional role. At a future stage of the research, there is the possibility of a call back for a session/s for idea generation and/or discuss and evaluate possible concepts for the identified problem.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by anonymizing your response and all captured data (including any photos, which will either only have non-personal information or will not reveal the personal identity of the subject).

Your participation in this study is entirely voluntary and you can withdraw at any time. You can refrain from answering any questions that you are uncomfortable answering.

In case of questions please contact the Responsible Researcher or the Corresponding Researcher as below:

Responsible Researcher: (Professor and chair of the thesis project)
Corresponding Researcher: (student and author of thesis project)

Thank you for your participation!

16. Informed consent form

Explicit Consent points

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated *15/05/2023*, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves demonstrations, interviews, and guided sessions relating to the tasks and Radiotherapy work process, that may be captured through audio, transcripts, text, and pictures (all of which will be anonymized)	☐	☐
4. I understand that the study will end by August 31st (or upon completion of the masters thesis)		
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
5. I understand that taking part in the study involves the following risks: possible mental discomfort while describing/ recollecting experiences. I understand that these will be mitigated by having the freedom of not answering some questions and also stopping participation at any given time without providing reason.	☐	☐
6. I understand that taking part in the study also involves collecting specific personally identifiable information (PII) [name] and associated personally identifiable research data (PIRD) [profession, designation, role and tasks, technological tools] with the potential risk of my identity being revealed.	☐	☐
7. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach – anonymization, secure storage, blurring.	☐	☐
8. I understand that personal information collected about me that can identify me, such as name, profession, designation will not be shared beyond the study team.	☐	☐
9. I understand that the (identifiable) personal data I provide will be destroyed before publication.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
10. I understand that after the research study the de-identified information I provide will be used for the purpose of the Master thesis of the corresponding researcher, to support their study of the radiotherapy process. This will be later published as a report in the university' repository at the end of the study, containing anonymized data and images of the participants.	☐	☐
11. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
12. I give permission for the de-identified responses and images that I provide to be archived in TU Delft Education repository so it can be used for future research and learning.	☐	☐
13. I understand that access to this repository is open, but as described above, all data will be anonymised and gathered data will be excluded from commercial use.	☐	☐

Signatures

Name of participant [printed]	Signature	Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Name of Researcher	Signature	Date

Study contact details for further information:

TU Delft, faculty of Industrial Design Engineering

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