‘Smart’ Outpatient Department

Exploring which potential optimisations of the outpatient department could improve patient experience, medical specialist’s workflow and utilisation of space

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Exploring which potential optimisations of the outpatient department improve patient experience, medical specialist’s workflow and utilisation of space

Master thesis by
Sebastiaan Willem Jaap Wouters

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Details

Student number	4646940
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Graduation committee

1st mentor	Prof.dr.ir. A. (Alexandra) Den Heijer, Full professor Public Real Estate, TU Delft
2nd mentor	Dr.ir. A. (Alexander) Koutamanis, Associate professor, TU Delft
3rd mentor	Ir. B. (Bart) Valks, PhD researcher Smart campus tools, TU Delft
Delegate examiner	Dr. J.S.C.M. (Joris) Hoekstra Associate professor, TU Delft
Company supervisor	Ing. R. (Ron) Gerritsen, Consultant , Cure + Care Consultancy

Preface

For the fulfilment of the Master of Science in Management in the Built Environment (MBE) at the Faculty Architecture and the Built Environment at the Delft University of Technology, Delft, The Netherlands, I made this final research report. The research focuses on the potential optimisation of the outpatient department to improve the patient experience, medical specialist's workflow and utilisation of space. This topic fits within the department of (smart) real estate management. In total twelve months have been spent on this research, starting in September 2018 and ending now in September 2019.

During this research period of a year, I was able to get support from several supervisors and would like to take this opportunity to thank them. Starting with Bart Valks, his research on smart campus tools inspired me to dive into the world of smart tools. He was always available for questions and was able to give constructive and concrete feedback, this helped me to push my research into certain directions. Moreover, the articles send by Bart were really useful and helped me a lot. The second one I would like to thank is Alexandra den Heijer, who always wanted the best for me regardless of what I had thought up for another subject. She also helped me to regain fun and motivation at diffcult moments during the research process. While also always asking critical questions, this helped me to keep my research on track or back on track. The next person I would like to thank is Alexander Koutamanis, who was my second mentor. Alexander was always really concrete in his feedback and this helped me with making decisions throughout and even in the last phases of my research. He also always asked exactly the right questions to get the right research direction in mind again.

I would like to sincerely thank my graduation company, in special my company supervisor Ron Gerritsen at Cure + Care Consultancy. Who always stayed positive and benevolent, no matter which change of research scope I made. Moreover, he was always willing to help and to guide me in the right direction. Besides that, without the big network of Cure + Care Consultancy, all the interviews were not possible. Ultimately, I want to thank everyone who was part of my research, this end product was not possible without their input.

To conclude, I look back at a period with many ups and downs but were a most certainly a period in which I learned a lot about, doing research, smart tools, hospitals, politics in hospitals, organizations of hospitals and real estate management. In the end it has led to this final report, which was not possible without the support of all my supervisors and participants of this research, thank you all again!

Bas Wouters
Department of Management in the Built Environment
Faculty of Architecture and the Built Environment
September 2019

Abstract

Today, the deregulated Dutch healthcare system, the changing demographics and the growing shortage of medical specialists is putting pressure on the entire hospital and its employees. Thus, improving the patient experience, medical specialist's workflow and utilisation of space would enable hospitals to provide better care to its patients, while dealing with the deregulated healthcare sector, changing democraphics and pressures on the hospital and its staff. However, buildings today can perform better when being a 'smart' building and smart tools can help optimise buildings, by first measuring something about the building or something is requested from the user; This data is then used to achieve a goal. There are some studies about smart tools, but these studies are not focussed on integrating smart tools in the outpatient department. Therefor, the following research question has been developed: *Which 'smart' optimisations of the outpatient department could improve patient experience, medical specialist's workflow and utilisation of space?* Qualitative research is conducted, whereby literature is reviewed in combination with comparative research of four different Dutch hospitals. Based on the case study, in total fourteen potential optimisations are distinguished in three different focus areas (from most desired to nice to have): (1) Workflow: Diagnostics, finding workplace, digital forms, finding colleague, information (EPD), self measuring / controlling, and e-consult. (2) Patient experience: Information provision, wayfinding, check-in, and senior service. (3) Utilisation of space: Space use, Maintenance / tracking of (medical) equipment, and cleaning. The focus of potential optimisations is mainly focused on functional objectives with supporting user activities, increase patients' and employees' satisfaction, and improving productivity. Therefor, the advice is to look at mutiple potential optimisations at the same time and try to come to an integrated solution. This will create new valuable insights, improve the performance of the individual optimisations and stimulates automation. And ultimately, improving the patient experience, the medical specialist's workflow and the utilisation of space.

Key words - Smart tools – outpatient department – medical specialist – patient - utilisation of space – Real estate management

Executive Summary

Introduction

Before the early 2000's the level of activity of Dutch hospitals was dominated by the provision of clinical care, this level of activity is now shifting increasingly to outpatient care (College bouw ziekenhuisvoorzieningen, 2004). In 2006 the Dutch health care system was reformed, and market forces were introduced in health care. three "healthcare markets" have been introduced; (a) the health insurance market, (b) the healthcare procurement market, and (c) the healthcare provision market, By introducing these three markets, the patient has been given a central role. Furthermore, the reformation of the Dutch health care system has not only influence on the patient experience. But ever since the deregulations of laws on hospital real estate the hospitals have become completely responsible for their own real estate. These changes come with more opportunities to make independent accommodation choices, however these opportunities also come with the risks associated with these decisions (van der Voordt, 2016; van der Zwart, 2014).

Moreover, hospitals are also dealing demographic changes. People do get older and stay healthy for longer, but when they get sick, they usually get sick worse and more complicated (RIVM, 2018). Additionally, the working population compared to the elderly population is shrinking, the health sector is also greatly affected by this with an rising shortage of medical staff (Ministerie van VWS, 2018). It is therefore a two-part effect, on the one hand there is more and a more complex demand for care and the number of caretakers compared to the people in need of care is decreasing.

Concluding, the changes in the Dutch health care system, the changing demographics and the growing shortage of medical specialist's is putting pressure on the entire hospital and its employees. Thus, improving the patient experience, medical specialist's workflow and utilisation of space would enable hospitals to provide better care to its patients, while dealing with above mentioned changes and pressures on the hospital and its staff. A good starting point to improve the patient experience, medical specialist's workflow and utilisation of space is with optimising the outpatient department.

According to Buckman, Mayfield, and Beck (2014) there are three areas that determine building progression; longevity, energy and efficiency, comfort and satisfaction. A building can perform even better when being a 'smart' building. According to the research of Valks, Arkesteijn, and den Heijer (2018) that focusses on the applications that are available to make buildings "smart buildings", with the focus on the university campus. The research of Valks et al. (2018) further examines ways in which a building can be smart, identifying 'smart campus tools' that are used by various universities and organisations. These smart campus tools work in two steps: First something is measured about the building or something is requested from the user: for example in our case information about the location of an appointment with a medical specialist or the occupancy rate of a building (part); This data is then used to achieve a goal, for example increasing patient experience or making smarter use of the building portfolio. These smart campus tools are described by Valks et al. (2018) as: "service or product which collects real-time information on space use to improve the space use on the current campus on the one hand, whilst supporting decision making on the future space use on the other hand" (Valks, Arkesteijn & Den Heijer, 2018, p. 23).

Smart Technology is an umbrella term covering all forms of technologies which has (1) physical sensors with which to register data from its surroundings, (2) storage and computational capacity with which to store and analyse the data, as well as (3) the means to deliver either actionable advise tailored to the end-user or automated actions, based on the data input. Smart health technology adheres to the

above definition, with the clause than it is used with the purpose for, or within the domain of Health and Well-being (Patient@Home (2018). The way working of smart health technologies is in line with the that pf smart campus tools, the only difference is the scope. The first has a health purpose, while the latter has a campus and real estate purpose.

Problem statement

According to Patient@Home (2018) who did research about future of the Danish healthcare sector, there are big expectations for the potential of smart (health) technologies in hospitals. However, this type of technology is still in its infancy, but smart (health) technologies are expected to be commonplace in the future. Therefor, further research and development is needed, especially understanding the actual needs and challenges of the users and healthcare sector(Patient@Home, 2018). A study by Cisco (2017) confirms that by showing that more than half of the project with smart technology implementations does not make it further than the 'proof of concept' phase, demonstrating the difficulties that companies experience during the implementation of these new technologies. Still, according to a survey done in the same study by Cisco (2017), more than 60% of the participating companies is convinced that the current possibilities are still barely scratching the surface. Furthermore, Morgan (2014) indicates that the technological developments have a great potential to ease and streamline our lives and workplaces, but at the same time expresses the current lack of knowledge on the implementation in the real world. Therefor, it is important before implementing smart tools to explore the optimisation needs of the outpatient department.

Research objective and questions

Thus, based on the problem statement it can be said that there is a lack of knowledge in science and practice about: Which 'smart' optimisations of the outpatient department oould lead to improvement of the patient experience, medical specialist's workflow and utilisation of space.

Based on the objective of this research the following research question is addressed:

'Which 'smart' optimisations of the outpatient department could improve patient experience, medical specialist's workflow and utilisation of space?'

The main research question can be split up into the following sub-questions:

Outpatient department

- What are the characteristics of the outpatient department of the 21st century?
- Which activities take place at the outpatient department of the 21st century?
- How does real estate add value to the user and organisation?

Smart tools

- What are smart tools?
- How are smart tools related to real estate management?

Optimised outpatient department

- Which potential optimisations can be defined to improve the patient experience, medical specialist's workflow and utilisation of space?
- Which solution can be recommended to optimise the outpatient department?

Research methodology

Smart tools and the implementation of smart tools in the outpatient department is a fairly recent development. So research on smart tools in hospitals, especially in the Dutch hospital environment, are in a rather nascent phase. When subjects of a research are more in a nascent phase, qualitative research is the appropriate research method according to the methodological fit for management field research of Edmondson and McManus (2007).

This research consists of three different phases: literature review, empirical research, and synthesis. The phases make a distinction between the existing theories, the new data and the synthesis of the theories and data. The literature review has lead to an understading on real estate management theories, new hospital concepts and smart tools .

The empirical part of this research is built upon the input that is yielded from the literature study. This empirical phase of the research is done in the form of a comparative case study. The data of this case study is used to identify the potential optimisations of the outpatient department. The selected cases are: Alrijne Hospital, location Leiderdorp, Martini Ziekenhuis (hospital), Groningen, Meander Medical Centre, location Amersfoort, and Rode Kruis Ziekenhuis (hospital), Beverwijk.

The base structure of the interview protocol is based upon the NWOW Analysis Monitor by Kok et al. (2014), this includes the three dimensions Bricks, Bytes and Behaviour. Furthermore, to support the interviewee's with answering the questions two lists will be used during the interviews. The first list are the added values of hospital real estate. The added values of hospital real estate are derived from the research of van der Zwart (2014) and can be seen in Table 4.1. This will help the interviewee's with connecting the needs to specific added values. It also helps the research when bringing the findings of the different cases together. The second list is a list of sensors derived from the research of Valks, Arkesteijn, and den Heijer (2018). The data gathering is done with the use of semi-structured interviews, observations and document review. For the data assessment the framwork of the research Valks et al. (2018) is used.

Based on the analysis of the cases, different findings were formulated on potential optimisations. To come to concrete possible solutions the potential optimisations in the outpatient department, an app is developed to visualise the benifit of bringing the potential optimisations together. Based on all the findings of the different phases in this research will be discussed in the conclusion, discussion and recommendation section. This research ends with a reflection on the research process and the research findings.

Findings from the literature study

In the literature study, five of the research sub questions are answered. This is done by reviewing literature and has resulted in the findings below.

What are the characteristics of the outpatient department of the 21st century?

The outpatient department of the 21st century is based on four basic principles, being: (1) Design the care process from three perspectives: patients, employees and goods and services. (2) Reduce all processes to simple activities. Facilitate and support the activities as efficiently and patient-friendly as possible. Reorder health care programs activities back to processes. (3) Make information available independently of time and place. (4) Ensure that the environment matches the circumstances at that time. Therefor, ICT, information provision, digitalisation and automation (Smart tools) play an important role in the hospital of the future. Furthermore, the separated logistics from patient and employee flows, in combination with the just-in-time principle make the new concept work more efficient and effective.

Additionaly, standardisation and sharing of the consultation / examination rooms, physical separation between the consultation rooms, front office and back office leads to improved productivity.

Which activities take place at the outpatient department of the 21st century?

The patient treatment, consultation and aftercare, and making follow-up appointments take place in the consultation rooms. All other activities done by the medical specialist take place at the Knowledge & Expertise centre. This inspriring envrionment increases the innovation and user satisfaction by effective use of human resources. Improved flexibility and productivity is achieved, due to the flexible working concept. In combination with just-in-time leads this to also to reduced costs-controlled risks and an improved financial position. Improved culture by placing the patient central and making the patient the owner of the consultation.

How does real estate add value to the user and organisation?

Real estate management is based on the presumed added value of real estate on the performance of the organisation. There are four organisational perspectives perspectives; stategic, functional, financial and physical. According to the interviews with hospitals done in the research of van der Zwart (2014) hospital real estate can add value to the user and organisation by serving nine different goals; increase innovation, increase user satisfaction, improve culture, reduce costs, improve productivity, improve flexibility, support image, controlling risks, improve financial position. Additonally, van der Zwart states that for hospitals it is important that employee and patient satisfaction are separated added values and that healing environment a healthcare specific added value is.

What are smart tools?

Smart tools are part of the greater network of IoT, consisting of sensing (data collection), network (data processing), and application (information provision). Furthermore, a smart tool can be defined as a product or service providing the user or organisation with (real-time) information.

1. Collection of data
(Real-time) data collection with the use of raw data or sensors

2. Processing of data
Data has been added to the network (integrated platform) and has been processed in order to transform the data in to information

3. Provision of information
(Real-time) information is presented to the user or organisation with the use of a service or product in the form of an app or dashboard.

4. Future decision making
The provided (real-time) information create insights in better (future) alignment of real estate with the organisational objectives.

Figure 0.1: Visualisation of the principle of a smart tool

How are smart tools related to real estate management?

The information received in the application step can be used to influence the user or organisation's (accommodation) decision-making short- and long-term basis. Furthermore, smart tools can add value to the organisation when they are aligned with the perspectives and objectives of the organisation.

Findings from the case studies

The objectives of the case studies are to; (1) explore the potential optimisations of the outpatient department, (2) understand the objectives of the potential optimisations, and (3) assess the information required for the potential optimisations. In the case study the following research sub question is answered.

Which potential optimisation can be defined, what a the objectives of the optimisation and which information is required?

In total fourteen potential optimisations are distinguished in three different focus areas (from most desired to nice to have) (Table 0.1): (1) Workflow: Diagnostics, finding workplace, digital forms, finding colleague, information (EPD), self measuring / controlling, and e-consult. (2) Patient experience: Information provision, wayfinding, check-in, and senior service. (2)Utilisation of space: Space use, Maintenance / tracking of (medical) equipment, and cleaning. Eleven out of the fourteen assessed potential optimisations have generally not yet been implemented, and the remaining three are limited implemented without further integration.

	Potential optimisations	Current Implementation
Workflow		
	Diagnostics	Not implemented
	Finding workplace	Not implemented
	Digital forms	Limited implementation (not integrated)
	Finding colleague	Not implemented
	Information (EPD)	Implemented (not integrated)
	Self measuring / controlling	Not implemented
	E-consult	Not implemented
Patient experience		
	Information provision	Limited implementation (not integrated)
	Wayfinding	Generally not implemented
	Check-in	Generally not implemented
	Senior service	Not implemented
Utilisation of space		
	Space use	Not implemented
	Maintenance / tracking of (medical) equipment	Generally not implemented
	Cleaning	Not implemented

Table 0.1: Potential optimisations and current implementation (Own illustration)

The most mentioned goals where related to supporting the user activities and consist of improving the patient satisfaction, the employee satisfaction, productivity and flexibility. The most potential optimisations in service of an efficient work process where linked to strategic goals. Potential

optimisations that take processes or tasks outside the hospital where mentioned mainly in relation with reducing costs and improving financial position.

For the users the required information is mainly providing information about certain (digital) facilities or (medical) information. Within the 'user information' there is sometimes a separation made between patients and medical specialists. Users should have access to most of the optimisations information, except for space use and maintenance / tracking of (medical) equipment. The 'management information' should generate partly information about the usage of space or equipment, partly information about their patients and partly feedback on which functions of the different topics are relevant or are missing (how the patient and employee satisfaction is influenced). The most interesting and important observation is that potential optimisations benefit or even need each other's information to be useful.

To conclude, centralising the access to information and letting the different areas of potential optimisation communicate with each other is essential for a more efficient work process, better patient experience and more effective use of the building. However, this integrated approach towards optimisations has not yet been implemented by the interviewed hospitals.

Findings from the Synthesis

In the previous part of the research potential optimisations were identified that can contribute to optimising the outpatient department by improving the patient experience, workflow and utilisation of space. Based on these possible optimisations requirements, an possible solution is developed in the form of an app.

Which solution can be recommended to optimise the outpatient department?

A mobile app or user available dashboard makes all the information available in a central place can be a valid option for optimising on one hand the patient experience and on the other hand the workflow of the medical specialists. With this in mind three different type of apps have been defined (Table 0.2).

However, the target audience of the hospital needs be considered, not only a large portion of the patients is 60 years or older but for some hospitals a considerably part of their patients is functionally illiterate or digitally illiterate.

Medical staff app	Patient app	Facility app
Functionalities: • Diagnostics • Find workplace • Find colleague • Information (EPD) • Check-in notification • E-consult	Functionalities: • Digital forms • Information (EPD) • Self-measuring / controlling • E-consult • Information provision • Wayfinding • Check-in • Senior service	Functionalities: • Space use • Maintenance / tracking of equipment • Cleaning
Access: medical staff	Access: patients	Access: Facility staff

Table 0.2: Three different types of possible apps / dashboards (Own illustration)

In a user-oriented app as shown above there is still the potential to generate management information about the utilisation of the building. This can be done by analysing the data generated by all the individual users of the app by for example tracking the user's movements through the building or asking for feedback. The data of users need of course be anonymised before processed and the user must give his informed consent about using his data for optimisation of the utilisation of space.

An app or dashboard is just one solution and is not an ultimate solution but just an example of what bringing information together and presenting it in a single place can do for the user of the outpatient department. However, to show the possibilities a visual representation of an patient oriented app is shown below:

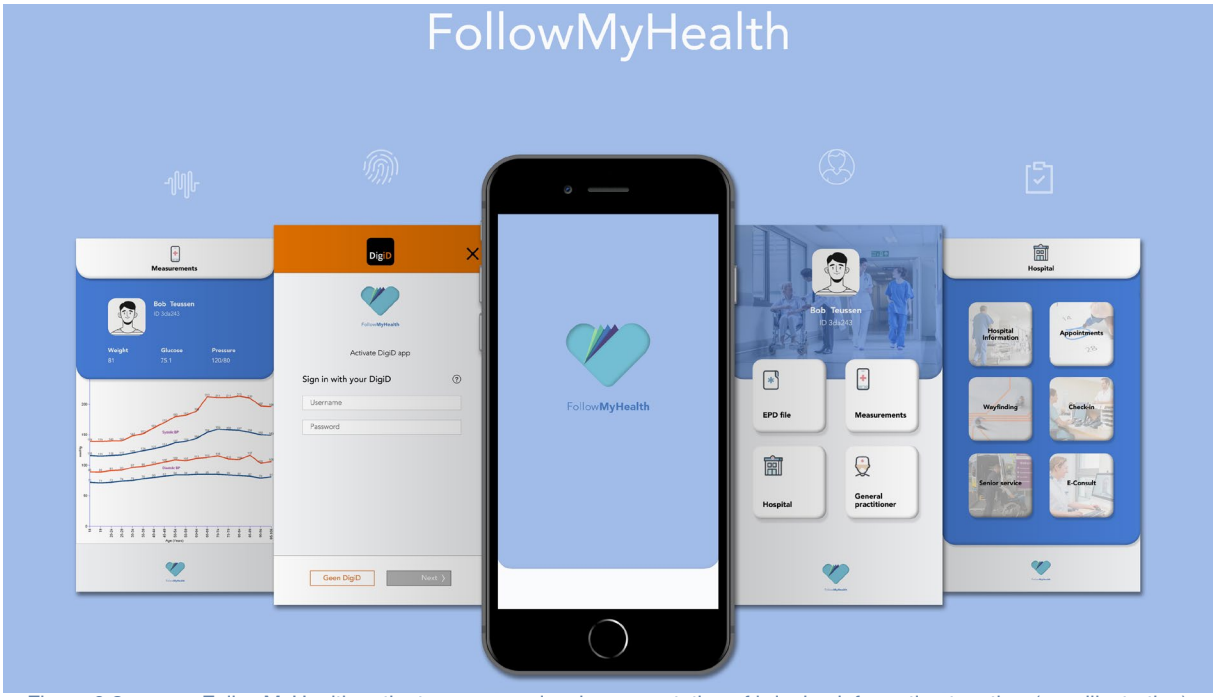

Figure 0.2: FollowMyHealth patient app as an visual representation of bringing information together (own illustration)

Conclusions

The answers of the research sub-questions are followed and lead to the research main question: Which 'smart' optimisations of the outpatient department improve patient experience, medical specialist's workflow and utilisation of space?

Based on extensive analysis of the empirical data gathered from Alrijne hospital, Martini hospital, Meander MC and Rode Kruis Ziekenhuis, fourteen 'smart' optimisations can be identified. These findings demonstrate the (future) potential of these optimisations for a 'smart' outpatient department and the usefulness of researching the potential for technological developments within the outpatient department. These fourteen different potential optimisations are analysed from different theories as found in the literature. It shows that the fourteen potential optimisations focus on different main areas (from most desired to nice to have);, medical specialist's workflow (finding workplace, digital forms, finding colleague, information (EPD), self-measuring / controlling, and e-consult), patient experience (Information provision, wayfinding, check-in, and senior service) and utilisation of space (Space use, Maintenance / tracking of (medical) equipment, and cleaning). The focus of potential optimisations is mainly focused on functional objectives with supporting user activities, increase patients' and employees' satisfaction, and improving productivity.

Ergo, the advice is to look at individual potential optimisations at the same time and try to come to an integrated solution. This will create new valuable insights, improve the performance of the individual optimisations and it stimulates automation. In the end it can improve the patient experience, the medical specialist's workflow and the utilisation of space. The patient experience can be improved by giving the patient the right information at the right time, enable patients to check on their own health at home and offer the patient services, helping the patient through their healing journey. The medical specialist's workflow can be improved by creating alternatives to physical contact and check-ups of the

patient, informing the patient, and making and comparing diagnostics of patients easier. The utilisation of space can be improved by measuring space use, tracking equipment, cleaning but most importantly to use information generated by services offered to users of the hospital and outpatient department. Moreover, the still emerging technologies will make the possibilities of tomorrow even greater than today. However, starting today will create an advantage in improving the patient experience, medical specialist's workflow and utilisation of space over other hospitals tomorrow.

Discussion

Some theoretical limitations are due to the fact that the added values as described in theory did not match the objectives of practice. Next, the slow technological developments within hospitals made researching the implementation of smart tools in the outpatient department difficulty and let to a change in scope to first define on which areas optimisation of the facilitation and support of activities and information availability independently of time and place was needed. Therefor, it can be stated that the hospital organisations are fairly traditional organisations when it comes to non medical related innovations. Other implications are the limited available knowledge about smart outpatient departments, the need for an alternative to digital solutions, and an app as possible solution is never flawless and sensitive to personal taste and preferences.

Limitations

The main limitation is a lack of implementation of smart tools in Dutch hospitals. This makes researching in this field more difficult and has led to a changing scope throughout this research. From; which smart tools can be defined in the outpatient department, to which 'smart' optimisation of the outpatient department can improve the patient satisfaction, medical specialist's workflow and utilisation of space. There is nothing wrong with changing the scope of the research. However, it did lead to some limitations, these limitations will be discussed below. Other limitations of the research are change is a sensitive subject in hospitals, the limited time for the research and limited amount of cases and interviewees.

Recommendations for practice

Based on the findings and the conclusions of this report, the following recommendations are given :

1. Set clear objectives for future optimisations
2. Integration of different platforms
3. Include the users in the process of setting objectives
4. Try new innovations with pilot projects
5. Be aware of privacy and security risks
6. Have always alternatives to digital solutions

Recommendations for further research

Due to the fact that smart tool research is a fairly new field of research, every research about smart tools would help to great a more mature body of knowledge, whereby the following areas of focus are recommended:

1. Conduct research at hospitals with smart tools implemented.
2. Same research again after implementation
3. Research the costs of smart tools in hospitals
4. Shift the scope of this research to other parts of the hospital

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Readers Guide

This research reports starts with presenting an introduction of the research topics and related concepts. and is thereonafter divided in to four parts as shown below.

Part I

The first part of the research consists of two chapters, the first chapter is the introduction and problem statment, followed by the research objective and questions. In the second chapter, the methodology of this research in introduced. The research methodology entails of four parts, the research strategy, the research methods, the data collection method and the data analysis method.

Part II

The second part of this research consist of the theories surounding the research topics and is the basis of the research. This part consists out of three chapters, starting with chapter 3, the introduction of the hospital of the 21st century concept, followed by chapter 4, the related real estate management theories, and ends with chapter 5, the concept of smart tools.

Part III

The third part of this research consists of the case study of four Dutch hospitals, Alrijne hospital, Martini hospital, Meander MC and Rode Kruis Ziekenhuis. Different findings from these cases are discussed and compared to the findings from the literature study in chapter 6.

Part IV

The findings of the case study served as the input for the synsthesis part. In this part the findings of the case study are linked to a possible solutions in chapter 7. In chapter 8 the research questions are answered and the implications and limitations are discussed. Based on chapter 8, recommendations for practice and further research is given. The research concludes with a reflection.

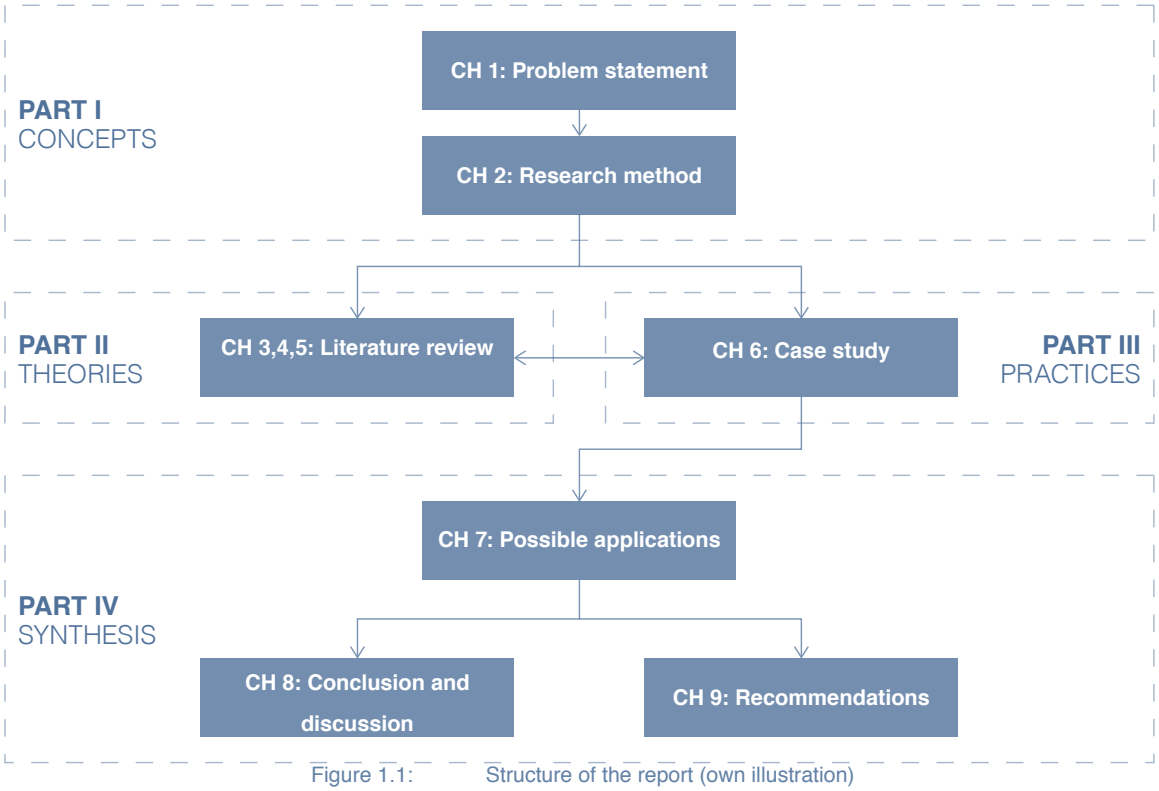


Figure 1.1: Structure of the report (own illustration)

PART I
CONCEPTS

1. Introduction

1.1. Problem statement

Before the early 2000's the level of activity of Dutch hospitals was dominated by the provision of clinical care, this level of activity is now shifting increasingly to outpatient care. Factors that play a role in this include (College bouw ziekenhuisvoorzieningen, 2004): (1) new possibilities in the medical-technical field, supported by ICT developments, as a result of which many treatments and examinations have become less burdensome for the patient and can be performed within an outpatient setting in situations where admission was previously required; (2) a change in the organisation of care: from supply / specialty-oriented organisation of care to a more integrated organisation of care from the patient's perspective. A greater emphasis is placed on the quality of services, patient treatment as well as the duration of the investigation process and the timing thereof.

College bouw ziekenhuisvoorzieningen (2004) describe in their research that the developments outlined above show that outpatient care in a hospital is increasingly being offered in a multidisciplinary manner. Regarding the outpatient department, a tendency can be observed to replace the more "traditional" set-up of the department with a more "standardised" set-up. The new construction plans assume this new set-up of the outpatient department indicate that the application of new IT techniques, such as Electronic Patient Dossier (EPD) and the ability to consult information independently of time and place, plays an important role in this. Furthermore, wrote in 2004 College bouw ziekenhuisvoorzieningen (2004) about the partly as a result of the (gradual) introduction of market forces in curative care are expected to further rationalisation and optimisation the use of the outpatient department in the future. Today, these developments are still ongoing. Thus, the level of activity is still shifting increasingly to outpatient care in the outpatient department.

In 2006 the Dutch healthcare system was reformed, and market forces were introduced in healthcare. three "healthcare markets" have been introduced; (a) the health insurance market, where citizens get their health insurance; (b) the healthcare procurement market, where healthcare insurers purchase healthcare from healthcare providers; and (c) the healthcare provision market, where patients receive care from healthcare providers, for example in hospitals. By introducing these three markets, the patient has been given a central role. patients are expected as consumers to be much more critical than before and to make informed choices between healthcare providers based on quality information. This is called "active choice" and would encourage healthcare providers to compete with each other by delivering better quality care (Victoor & Rademakers, 2015). According to the research of Victoor and Rademakers (2015) most patients who made an "active choice" did so because of a bad experience with the hospital or with a specific medical specialist. Thus, in this reformed Dutch health care systems the patient can actively choose their preferred hospital and do so based upon their experience with the hospital and hospital staff.

Furthermore, the reformation of the Dutch health care system has not only influence on the patient experience. But ever since the deregulations of laws on hospital real estate, which is part of the reformation of the Dutch health care system. the Dutch healthcare sector has been in a transition from governmentally controlled to regulated market forces. Which means that hospitals have become completely responsible for their own real estate. These changes come with more opportunities to make independent accommodation choices, however these opportunities also come with the risks associated with these decisions (van der Voordt, 2016; van der Zwart, 2014).

Before the deregulations a proposal for a new hospital building or changes to an existing one

had to be approved by the government and had to meet the planning regulations, because all the costs related to the building were reimbursed by the government. However, today the government is no longer reimbursing the costs, insurance companies are doing that. The way these costs are reimbursed are different than before, now all costs must be paid back by the income that is generated from diagnosis and treatment-combinations (van der Zwart, 2014) There has been set an all-inclusive price, which includes both medical costs and the costs for fixed assets, and from this a fixed percentage is reimbursed by the insurance company. Therefor, any decrease in production or higher accommodation costs will result in worse financial performance. Additionally, insurance companies are more selective when making contracts with hospitals. and are more market oriented. For the insurances companies it is an investment and therefore look more carefully to the quality and costs of the provided care (van der Voordt, 2016). This has led to higher than ever pressure on the performance of hospitals, meaning higher production in the same space or the same production with less space. Thus, need for more efficient and effective utilisation of the available space.

Moreover, hospitals are also dealing demographic changes. Meaning that the population is still growing, and people are getting older. The latter aspect in particular has an impact of the healthcare. People do get older and stay healthy for longer, but when they get sick, they usually get sick worse and more complicated (RIVM, 2018). Additionally, the working population compared to the elderly population is shrinking, the health sector is also greatly affected by this with an rising shortage of medical staff (Ministerie van VWS, 2018). According to a research of van den Brink, Herderschee, and Vleugels (2018), there was a shortage of 628 nurses, 671 specialist nurses, 528 supporting medical staff, and 290 medical specialists at the end of April 2018 in 63 Dutch hospitals. It is therefore a two-part effect, on the one hand there is more and a more complex demand for care and the number of caretakers compared to the people in need of care is decreasing. In the outpatient departments, where consulting and performing easy examination of predominantly non-admitted patients by medical specialists (in training) supported by specialised nurses takes place (College bouw ziekenhuisvoorzieningen, 2004), is this two-part effect also noticeable. Thus, when the shortage of medical staff is not dealt with there will be an increasingly need for a more efficient workflow of the medical staff.

Concluding, the changes in the Dutch health care system, the changing demographics and the growing shortage of medical specialist's is putting pressure on the entire hospital and its employees. Thus, improving the patient experience, medical specialist's workflow and utilisation of space would enable hospitals to provide better care to its patients, while dealing with above mentioned changes and pressures on the hospital and its staff.

1.1.1. Smart tools

As a researcher in the field of real estate management, a good starting point to improve the patient experience, medical specialist's workflow and utilisation of space is with optimising the outpatient department. According to Buckman, Mayfield, and Beck (2014) there are three areas that determine building progression; longevity, energy and efficiency, comfort and satisfaction. Progessing on all areas of a building will minimise its energy consumption, whilst consistently allowing maximisation of the performance, comfort and satisfaction of its occupants over a long lifespan (Buckman et al., 2014).

The second part of the definition of an optimised building is cosistent with the demand of improving the patient experience, medical specialist's workflow and utilisation of space. Buckman et al. (2014) explains that there are different methods to reach this level of optimisation:

1. the methods by which building operation information is gathered and responded to (intelligence);
2. the interaction between the occupants and the building (control);
3. the buildings physical form (materials and construction); and
4. the methods by which building use information is collected and used to improve occupant performance (enterprise).

A building can perform even better when being a ‘smart’ building. The definition that Buckman et al. (2014, pp. 98-99) use for ‘smart’ buildings is: buildings that integrate the above-mentioned methods with the aim of creating adaptive capacity instead of being reactive regarding the three components of building performance. The increased amount of information that this makes available ensures that this adaptivity is possible.

The research of Valks et al. (2018) further examines ways in which a building can be smart, identifying ‘smart campus tools’ that are used by various universities and organisations. These smart campus tools work in two steps: First something is measured about the building or something is requested from the user: for example in our case information about the location of an appointment with a medical specialist or the occupancy rate of a building (part); This data is then used to achieve a goal, for example increasing patient experience or making smarter use of the building portfolio. These smart campus tools are described by Valks et al. (2018) as: “service or product which collects real-time information on space use to improve the space use on the current campus on the one hand, whilst supporting decision making on the future space use on the other hand” (Valks, Arkesteijn & Den Heijer, 2018, p. 23).

Smart Technology is an umbrella term covering all forms of technologies which has (1) physical sensors with which to register data from its surroundings, (2) storage and computational capacity with which to store and analyse the data, as well as (3) the means to deliver either actionable advise tailored to the end-user or automated actions, based on the data input. Smart health technology adheres to the above definition, with the clause than it is used with the purpose for, or within the domain of Health and Well-being (Patient@Home (2018). The way working of smart health technologies is in line with the that pf smart campus tools, the only difference is the scope. The first has a health purpose, while the latter has a campus and real estate purpose.

According to Patient@Home (2018) who did research about future of the Danish healthcare sector, there are big expectations for the potential of smart (health) technologies in hospitals. However, this type of technology is still in its infancy, but smart (health) technologies are expected to be commonplace in the future. Therefor, further research and development is needed, especially understanding the actual needs and challenges of the users and healthcare sector(Patient@Home, 2018). A study by Cisco (2017) confirms that by showing that more than half of the project with smart technology implementations does not make it further than the ‘proof of concept’ phase, demonstrating the difficulties that companies experience during the implementation of these new technologies. Still, according to a survey done in the same study by Cisco (2017), more than 60% of the participating companies is convinced that the current possibilities are still barely scratching the surface. Furthermore, Morgan (2014) indicates that the technological developments have a great potential to ease and streamline our lives and workplaces, but at the same time expresses the current lack of knowledge on the implementation in the real world. Therefor, it is important before implementing smart tools to explore the optimisation needs of the outpatient department.

Thus, based on the problem statement it can be said that there is a lack of knowledge in practice about: Which ‘smart’ optimisations of the outpatient department could lead to improvement of the patient experience, medical specialist’s workflow and utilisation of space.

1.2. Research questions

Based on the problem statement it can be said that there is a lack of knowledge in science and practice regarding which 'smart' optimisations of the outpatient department lead to improvement of the patient experience, medical specialist's workflow and utilisation of space. In this research the following research question is addressed:

'Which 'smart' optimisations of the outpatient department could improve patient experience, medical specialist's workflow and utilisation of space? '

1.2.1. Sub questions

The main research question can be split up into the following sub-questions:

Outpatient department

- What are the characteristics of the outpatient department of the 21st century?
- Which activities take place at the outpatient department of the 21st century?
- How does real estate add value to the user and organisation?

Smart tools

- What are smart tools?
- How are smart tools related to real estate management?

Optimised outpatient department

- Which potential optimisations can be defined, what are the objectives of the optimisations and which information is required?
- Which solution can be recommended to optimise the outpatient department?

Answering the research questions indicates what is needed to optimise the outpatient department to improve the patient experience, medical specialist's workflow and utilisation of space. To answer the different questions a suitable research method is chosen, this method will be discussed in the next chapter.

2. Methodology

This chapter elaborates upon the used research method in order to gather the data needed to answer the proposed research questions. This chapter starts with the research strategy, followed by the used methods, the type of data collection, data analysis and ends with the ethical considerations.

2.1. Research strategy

Smart tools and the implementation of smart tools in the outpatient department is a fairly recent development. Therefor, research on smart tools in hospitals, especially in the Dutch hospital environment, are in a rather nascent phase. When subjects of a research are more in a nascent phase, qualitative research is the appropriate research method according to the methodological fit for management field research of Edmondson and McManus (2007). According to Bryman (2015), the emphasis of qualitative research is on words rather than on numbers. Furthermore, qualitative research often is based upon an inductive strategy, which entails rather theory building instead of theory testing. The qualitative research is executed with the use of a literature review and an empirical research, and both of which are combined in the synthesis of this research.

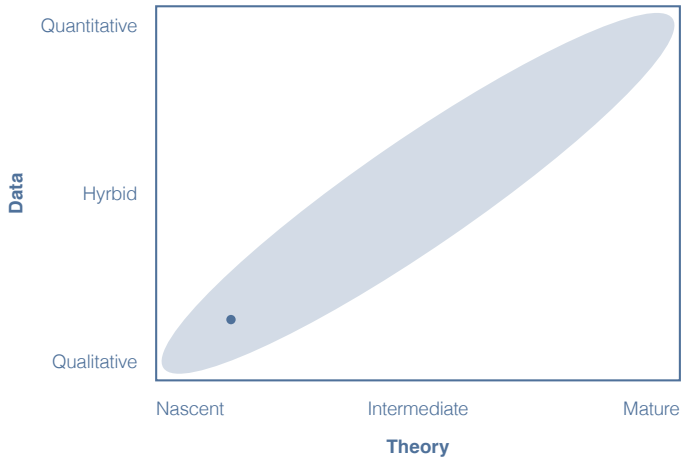


Figure 2.1: Methodological fit of this research (based on Edmondson & McManus (2007))

The objectives of the literature review are to understand the importance of stakeholders and added values in real estate management, define the characteristics and activities of the outpatient department of the 21st century and find out which smart tool theories are available. The data collection is done by doing a scientific literature review. In the next paragraphs the literature review will be explained more in depth.

The empirical part of the research is used to provide an insight in what the functions of smart tools in the outpatient department need to be. In order to gather this information, the empirical research method is useful. This has to do with the fact that empirical research is based on attaining knowledge based on experience and observation (Bryman, 2015). In his book about case studies, Yin (2017) explains that case studies are an empirical analysis which researches a current and relevant phenomenon within its real-world context. However, because there is not just one type of hospital and thus not one set of required functions for smart tools, a single case study would not give a complete enough impression of the real-world context. Hence, a multiple case study is a more logical choice. When doing a multiple case study and wanting to compare the different cases to get the best impression, a comparative design is logical choice. According to Bryman (2015) entails a comparative design two, or more opposed cases, and using the same or nearly identical methods for all the cases.

Although this research is focused on the outpatient departments of hospitals, there are still a lot of differences between all the outpatient departments. Due to the age, scale and organisational cultures of the different hospitals. Furthermore, more cases make establishing circumstances or patterns easier, which improves theory building (Bryman, 2015).

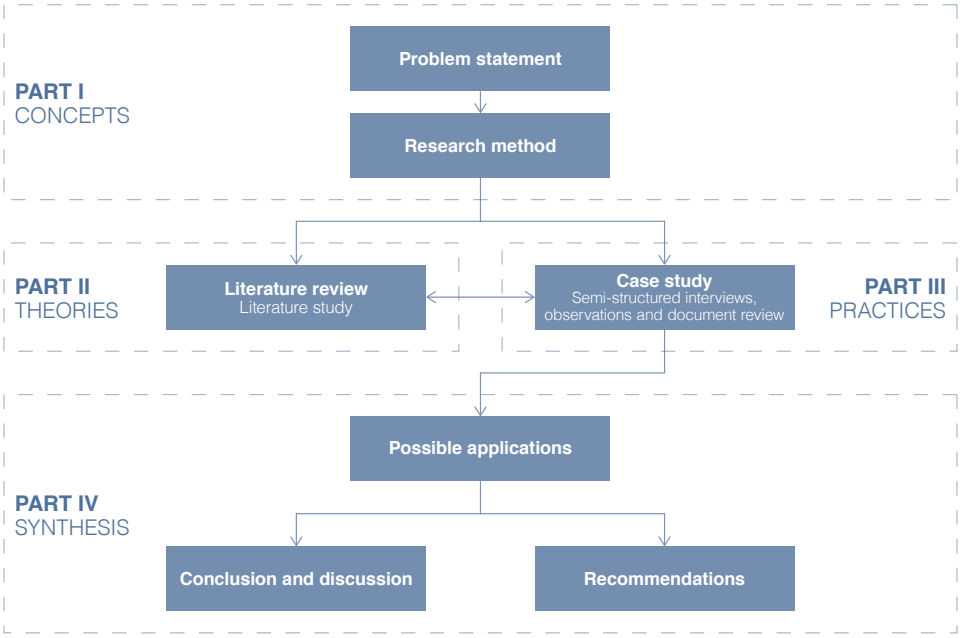


Figure 2.2: Research framework (Own illustration)

2.2. Research phases: methods and techniques to be used

This research consists of three different phases: literature review, empirical research, and synthesis. The phases make a distinction between the existing theories, the new data and the synthesis of the theories and data.

2.2.1. Phase 1: literature review

For the first phase of the research a literature review on real estate management theories, new hospital concepts and smart tools is conducted. In order to do this properly, a narrative literature review is done and will be explained in the next section.

Literature study

The literature study is done to gain knowledge about the available management theories, hospital of the 21st century concept and smart tools. The beforementioned topics are linked to the different sub questions. The topics and related sub questions are shown next:

Hospital of the 21st century

- What are the characteristics of the outpatient department of the 21st century?
- Which activities take place at the future outpatient department of the 21st century?

Real estate management

- How does real estate add value to the user and organisation?

Smart tools

- What are smart tools?
- How are smart tools related to real estate management?

The data collection of the literature study has resulted in an understanding of the different real estate management theories, the 21st century hospital concept and smart tools. This understanding is achieved with the use of a 'narrative' literature review, which according to Bryman (2015) used rather to understanding than generating knowledge. This gives an initial impression of the topics where this research is based upon. The process of discovery when reviewing the literature is therefore more uncertain than with a 'systematic' literature review and it might not always be clear from the start where it will take you (Bryman, 2015). The data from the literature review is gathered from Google Scholar, the Scopus database, white papers of companies and several internet sources. The selection of the literature is based on the quality of the source, the number of citations and the relevance of the research to the scope of this research.

2.2.2. Phase 2: Empirical research

The second phase of the research is built upon the input that is yielded from the literature study. This empirical phase of the research is done in the form of a case study. The data of this case study is used to identify the potential optimisations of the outpatient department. The related sub questions are shown next:

- Which potential optimisations can be defined, what are the objectives of the optimisations and which information is required?
- Which solution can be recommended to optimise the outpatient department?

Case studies

The second phase of the research are the case studies of Dutch outpatient departments. Interviews will be used to map the current and optimal characteristics of the outpatient department together with the organisational and user requirements for a flexible, efficient and effective outpatient department. Additionally, the facility manager of each outpatient department is asked about the capabilities of the current ICT infrastructure.

Case selection in qualitative research consists of two levels according to Bryman (2015). First select the context and then select the participants. The selection of case will be done by a strategic way of a selecting case, named purposive sampling (Bryman, 2015). The following criteria is used:

- The selected outpatient department must be situated in a general hospital. A general hospital is the most common hospital in the Netherlands. However, it cannot be an Academic hospital, because these hospitals have different standards, larger budgets and a specialised purpose towards the outpatient departments.
- The organisations should be open to the approach of the study of more flexible, effective and efficient outpatient department from both the organisational and user perspective.
- he organisations should be willing and able to give insight in the possibilities of the current ICT infrastructure and real estate possibilities.

The selection of the interviewees within the outpatient department will be done using criterion sampling. One of the interviewee's needs to have affinity with the faciliatory processes in the hospital, preferably the facility manager. The facility manager is preferred, because he or she is the facilitator in making a more flexible work environment work and can represent the organisational demands. The other one or two interviewee's per case must be actual users of the outpatient department. Preferable a medical specialist and an outpatient department manager. This has to do with need of mapping the user preferences. However, with exploring possible interviewee's it seems that talking to users, who are not managers, in hospitals is difficult. Therefor, for this research we settle for the managers related to the outpatient department. The subjects, input and findings of the case study can be seen in Figure 2.3 and will be done for every selected case described in the next section. In the case analysis part will be described how the different case findings will come together.

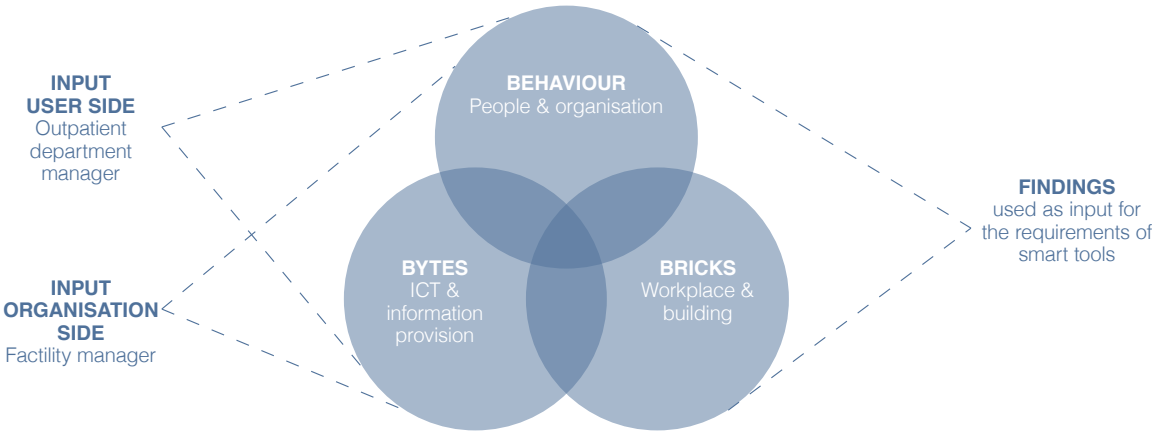


Figure 2.3: Cases input and findings (Own illustration based on Veldhoen & Company (2006) and Kok et al. (2014))

Selected cases

Based upon the above-mentioned criteria, cases were selected. For the selection of the cases the network of Cure + Care consultancy was used. The selected cases are:

- Alrijne Hospital, location Leiderdorp
- Martini Ziekenhuis (hospital), Groningen
- Meander Medical Centre, location Amersfoort
- Rode Kruis Ziekenhuis (hospital), Beverwijk

Semi-structured interviews

As described in the introduction, the aim of this research is to define the potential optimisation of the outpatient department which improve the patient satisfaction, medical specialist's workflow and utilisations of space. It is therefore important to gather the needs of the organisation and the users as best as possible. For this a combination of input from different researches is used. The base structure of the interview protocol is based upon the NWOW Analysis Monitor by Kok et al. (2014), this includes the three dimensions Bricks, Bytes and Behaviour. Furthermore, to support the interviewee's with answering the questions two lists will be used during the interviews. The first list are the added values of hospital real estate which are derived from the research of van der Zwart (2014) and can be seen in Table 4.1. This will help the interviewee's with connecting the needs to specific added values. It also helps the research when bringing the findings of the different cases together. The second list is a list of sensors derived from the research of Valks, Arkesteijn, and den Heijer (2018). This will help the facility manager with naming the sensors already used or linking a sensor to a organisational need.

For gathering the different preferences, a qualitative interview will be used. This is because with a qualitative interview is there a much greater interest in the interviewee's point of view (Bryman, 2015). This is possible, because qualitative interviewing is often more flexible and come to more rich and detailed answers, while being able to depart from an interview protocol with certain predefined themes (Bryman, 2015). Furthermore, Bryman (2015) states that when there is a clear focus on what to research it is likely that the interviews will be semi-structured interviews. Which will be the basis for the data collection of this research. However, in qualitative interviews it is important that there is enough leeway possible in the answers of the interviewee's and the order of questions and the way questions are asked can be altered during the interview (Bryman, 2015). This is important to capture the real preferences defined by the interviewee's not the interviewer. The interview protocols used in this research can be find in Appendix A and B.

Step 1: Transcribing the interviews

Recording and transcribing the interviews is has the several advantages according to Heritage (1984), these are the most important for this research:

- It helps to remove our own biases and natural limitations of our memories of what the interviewee's have said in interviews.
- It grants a possibility to more thorough diagnosis of what interviewee's have said.
- It allows for repeated examinations and cross examinations of the interviewees' answers.
- Therefor the interviews will be recorded and transcribed.

Step 2: Coding the interviews

Transcribing helps also with coding the interviews. For this research a thematic analysis method is chosen, and the coding will be done in AtlasTi. According to Bryman (2015) is the idea with a thematic analysis to construct an index of central themes and subthemes. The themes consist of the subjects used in the interview protocols, lists used in the interviews and repeating preferences and comments mentioned across the different interviews (Bryman, 2015). This makes cross comparing between the cases and organizing the data easier.

Case analysis

The case analysis consists of two steps first the individual cases are analysist and second the findings from these cases form the input for the required functions of smart tools in the outpatient department.

Step 1: Individual case analysis

Each case will be analysed individually. It starts with a general case description and some figures about the location, age and scale of the hospital (building). Second there will be a building analysis building analysis on the outpatient departments using the interviews and building plans. Thereinafter, the organisation and culture will be explained, the available data and missing data will be elaborated upon. And in the last section, sensors in use in the hospital and the already used systems in the organisation such as facility management or building management systems will be shown here. These systems can be useful for the future integration and exploration of smart tools. Because many developers of these systems also support or offer smart tools.

From the findings of the case will be drawn case specific conclusions and general conclusions. These conclusions will function as input for the next part about the required functions of smart tools.

Step 2: Potential optimisations

As explained in the last section will the conclusions of the cases be used as input for this part of the research. The structure of this part is adapted from the template as used in the 'smart campus tools' research of Valks et al. (2016), which can be seen in Appendix C. Only some small adaptations have been made, because the template is used the explain the functions of an existing smart tools and not the proposed required functions of smart tools.

2.2.3. Phase 3: Synthesis

Based on the analysis of the cases, different findings were formulated on potential optimisations. To come to concrete possible solutions the potential optimisations in the outpatient department, an app is developed to visualise the benifit of bringing the potential optimisations together. Based on all the findings of the different phases in this research will be discussed in the conclusion, discussion and recommendation section. This research ends with a reflection on the research process and the research findings.

2.3. Data collection

The table below shows the type of data collection in relation to the research question and the different methods for collecting data.

Phase	Type	Main and sub research questions	Research methods	Data collection
1	Literature study	What are the characteristics of the outpatient department of the 21st century? Which activities take place at the outpatient department of the 21st century? How does real estate add value to the user and organisation? What are smart tools? How are smart tools related to real estate management?	Literature review	Scopus, Google Scholar, Library and internet
2	Empirical	Which potential optimisations can be defined, what are the objectives of the optimisations and which information is required?	Case studies	Semi-structured interviews, observations and documents review
3	Synthesis	Which solution can be recommended to optimise the outpatient department?	Literature review, interviews, observations	Input phase 1 and 2, internet, questionaire and documentation review

Table 2.1: Research questions with methods and type of data collection

2.4. Data analysis & plan

A data plan describes how raw and processed data are collected and used in this research project, how it is stored and who is responsible for the data. The literature is mainly collected from the internet, while the interviews were recorded and transcribed. All the data is stored on the authors' laptop, which is secured.

According to Wilkinson et al. (2016) there are four foundational principles within the fair guiding principles. Your data needs to be findable, accessible, interoperable and reusable. Findable means for this research that the data and supplementary materials need to have sufficiently rich metadata and a unique and persistent identifier. Accessible means that the data and metadata are understandable for humans and machines. A data is deposited in a trusted repository, like the repository of the TU Delft, where my research will be stored after graduation. This will guaranty that is stays accessible. Interoperable means that the metadata uses a formal, accessible, shared and broadly applicable language for knowledge representation. For my research it is important to use formal English and make use of the right terminology. Reusable means that the data and collections used in this research have a clear usage license and provide accurate information on provenance.

2.5. Ethical considerations

Research and new innovations may be done or designed with good intentions. However, they can have unintended (negative) consequences for the people involved in the process. In this section, the ethical considerations of this research will be discussed.

2.5.1. Research method

Diener and Crandall (1978) define four different areas of ethical considerations in their research. According to them, the four areas are, whether there is: harm to participants, lack of informed consents, an invasion of privacy, and deception is involved. The research of Field and Hole (2002) adds an additional ethic consideration in the form of whether there is a proper debriefing. The in total five ethical considerations will be used to explain the ethical considerations taken care of for the research method. The areas of ethical considerations described by Diener and Crandall (1978) and Field and Hole (2002) are:

- Whether there is harm to participants;
- Whether there is informed consent;
- Whether there is deception involved;
- Whether there is invasion of privacy;
- Whether there is proper debriefing.

Below will be explained what those five ethical considerations mean for this research.

Harm to participants

Harm can encompass a number of facts: physical harm; physiological harm, such as: los of self-esteem and stress (Diener & Crandall, 1978). This also means that if the research will be published, there must be asked for permission to publish their names and interviews. Which is done during the recordings of the interviews.

Informed consent

Informed consent means for this research that the participants of the research should be made aware of what the interviews, and the research involves, what their rights are and that they can retreat from the research whenever they desire to do so (Bryman, 2015). Furthermore, during the interviews a consent form is supplied to the participants and can be filled in by the participants, additionally during the recordings of the interview is asked if the interview may be recorded and if the information gathered during the interviews can be used for the interview. This is done after a proper explanation about the what the research entails and where the interviews will be used for.

Deception

According to Bryman (2015) deception happens when a researcher represents their research as something other than what it actually is. This means also that active deception must always be avoided. It is therefore important to record the interviews and assumptions are checked with the participants.

Invasion of privacy

Privacy is very much linked to the area of informed consent, because informed consent is given by the participants on the basis of a detailed understanding of where the interviews are used for. So with given their informed consent, he or she acknowledges that their right to privacy has been abandoned for this particular moment and topic (Bryman, 2015). Furthermore, in the General Data Protection Regulation (GDPR) is stated that participants have the right of access, oblivion, rectification and supplementation, data portability, limitation of processing, a human look at decisions, and of objection of the use of their personal data at every given moment (European Commission, 2018).

Debriefing

Debriefing means that the participants of the interviews need to be made aware where the interviews where about, what will be done with the data, inform them about the results and thank them for their time.

PART II
THEORIES

3. Hospital of the 21st century

This chapter starts with the introduction of the hospital of the 21st century as defined by the College bouw zorginstellingen (Institute for construction of hospital facilities) of the Dutch government in cooperation with Veldhoen & Company, followed by an explanation of the 21st century outpatient department within the hospital of the 21st century, and ends with examples of the implementation of the hospital of the 21st century principle. The goal of the chapter is to provide answer to the sub-questions what the characteristics of the 21st century outpatient department are, which activities take place at the 21st century outpatient department and what are the organisational requirements for the 21st century outpatient department. These questions are answered with the use of a literature study.

3.1. Hospital of the 21st century

In a research conducted by the College bouw zorginstellingen (2006), the Dutch government has developed a concept for the hospital of the 21stt century. Being the last hospital concept developed by the Dutch government, before the deregulations of the Dutch healthcare sector. The design and use of the built environment are an important aspect of this research, also and especially because the changes in legislation and financing that have been initiated, mean that real estate is increasingly becoming an integral part of business operations. This requires an approach wherein the built environment is subservient to the integral hospital concept, can accommodate changes in the working method and the range of activities and that the course of care processes and logistical processes forms the input for the design assignment.

3.1.1. Basic principles

The College bouw zorginstellingen (2006) has defined four basic principles that are central to the hospital of the 21st century are:

1. Design the care process from three perspectives: patients, employees and goods and services.
2. Reduce all processes to simple activities. Facilitate and support the activities as efficiently and patient-friendly as possible. Reorder health care programs activities back to processes.
3. Make information available independently of time and place.
4. Ensure that the environment matches the circumstances at that time.

3.1.2. Functional structure of the hospital of the future

The College bouw zorginstellingen (2006) has developed a functional structure for the hospital based on the care process. This structure is shown schematically is shown below in Figure 3.1.

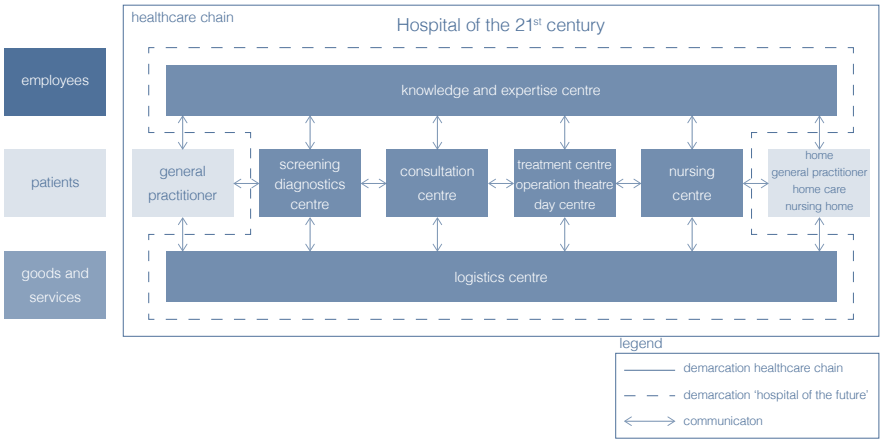


Figure 3.1: functional structure of the hospital of the 21st century (College bouw zorginstellingen, 2006)

The functional structure for the Hospital of the 21st century is derived from six activities that we can refer to as, investigating, talking, treating, nursing, knowledge gathering and sharing, and supporting. The last two activities play a role in the first four. The conversion of all processes to the six categories of activities is the key to the structure of the Hospital of the 21st century (see basic principle 2). The six centres are directly derived from the above activities, screening diagnostics centre, consultation centre (outpatient department), treatment centre, nursing centre, knowledge and expertise centre, and logistics centre (College bouw zorginstellingen, 2006). These six different centres can be seen as the 21st century demand of real estate according to van der Zwart (2014).

3.1.3. The three perspectives of the hospital of the 21st century

Veldhoen + Company (2006) have defined three perspectives as the basis for hospital of the 21st century. The first perspective is the IT and provision of information: these are the IT requirements to implement the 21st century way of working. The second perspective is the organisation. The organisational requirements and the support functions and patient approach are central. The third perspective is building and layout; the requirements for the building and the design elements are defined. The perspectives are comparable to the Bricks, Bytes and Behaviour principle, that has been broadly used to define the requirements for an activity based working work environment.

Ratio of areas between the centres

The following ratios of space utilisation of the centres to the total are derived from Figure 3.2, as shown below.

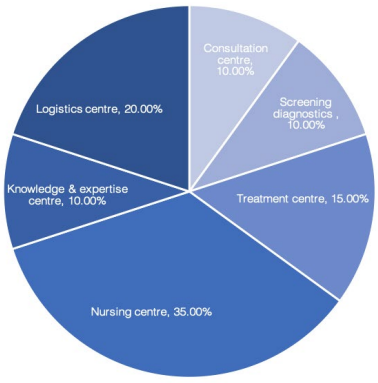


Figure 3.2: Ratio of areas between the centres (College bouw zorginstellingen, 2006)

3.1.4. The role of ICT in the hospital of the 21st century (bytes)

According to Veldhoen + Company (2006) in the Hospital of the 21st century , modern techniques are used to serve the patient as effectively and friendly as possible and to make the professionals work efficiently. By integrating new technologies in the processes, productivity increases, and the hospital can offer more and better care with fewer people.

Patient logistics are highly supported by technology. An appointment for the consultation hour centre is made via the internet and the hospital's electronic appointment system. The doctor makes the appointment, starts the care program and sends the relevant patient data to the Electronic Patient Dossier (EPD). If possible, the patient first goes to a diagnostic department before coming to the consultation with a specialist in the consultation centre (College bouw zorginstellingen, 2006).

Upon arrival at the hospital, the patient registers at one of the information kiosks in the Atrium. He makes himself known with his identification card (based on the national citizen service number). Through the column the patient receives information where she / he should be in the hospital; if desired, the map with location will be printed. If necessary, the patient can be brought to the location by the hostess Screens with information about the planned and registered patients hang in the back office of

the consultation hour centre. Based on this information, a consultation room is assigned to a meeting between patient and professional. The specialist or nurse enters the patient data directly into the EPD during the consultation (College bouw zorginstellingen, 2006).

At the end of the consultation, the care planner makes the follow-up appointments with the patient. The care planner can immediately arrange diagnostic examinations, schedule an operation and reserve a bed in the nursing centre. The patient has received all information at once. Appointments are scheduled as much as possible on one day, so that the patient must return to the hospital as little as possible: one-stop shopping.

From the perspective of the professionals, this means that treatments are standardized as much as possible through care programs: 80% of the disorders can be treated through care programs. The EPD can be viewed by professionals at any location in the hospital. Furthermore, once the patient's treatment is complete, the data is automatically passed on to the financial system, where the invoice is created; these links increase labour productivity (College bouw zorginstellingen, 2006).

Technology is also highly integrated in freight logistics. Goods and materials are transported from the central storage at the right time (just-in-time delivery) with lifts and carts to their destination. Automatic guided vehicles are used for this: these are unmanned carts that find their way through the hospital with the help of sensors and radiography. Separate traffic zones are required for these carts: the carts must not interfere with traffic zones for people (College bouw zorginstellingen, 2006).

In the Hospital of the 21st century, materials and goods are no longer stored in cupboards. The decentralised stocks are tailored to daily needs, they are automatically ordered and then stored in mobile carts in the departments. Patients and expensive resources are located and monitored using monitoring technology, including RFID technology (Veldhoen + Company, 2006).

3.2. Outpatient department of the 21st century

According to the research of the Veldhoen + Company (2006) are many hospitals currently struggling with a limited capacity of the outpatient department. The reason for this is that in recent years there have been developments in the healthcare sector, that have an impact on the process and capacity of the consultation centre. The changes are in the area of demand development, organisation, applied technology and productivity (College bouw zorginstellingen, 2006).:

- Increase in demand development due to aging, developments in medical technology and patient empowerment;
- Increase in the number of part-time employees within the specialist group;
- Increase in number of specialist nurses (nurse practitioners) and paramedics who hold independent consults;
- Increase in multidisciplinary and focused work in the outpatient department;
- Introduction of protocols and care programs for the bulk of the disorders;
- Application of technological developments:
    * Introduction of the Electronic Patient File.
    * Introduction of the Electronic Patients Appointments System.

The increase in demand, in the number of part-timers and in the number of consultative professionals means that the pressure on the capacity of the outpatient department is increased. The introduction of standardized care programs reduces the pressure on the outpatient department. The increase in multidisciplinary office hours (for example the spine office hours by orthopaedic surgeons, neurosurgeons and neurologists) requires flexible deployment of rooms. At the same time, digitisation provides opportunities for flexible use of consultation rooms; this increases the capacity of existing consultation centres (College bouw zorginstellingen, 2006).

3.2.1. Characteristics of the outpatient department (bricks)

The outpatient department consists of a front office with waiting area, combined consultation and examination rooms and a back office. In the back office, or interaction zone, the support tasks for the office hours are performed. Three types of consultation room can be distinguished based on the care processes (College bouw zorginstellingen, 2006):

1. Standard consultation / examination rooms for consulting hours that mainly consists of consults with the patient and possibly simple physical examination. 80% of the consultation rooms fall under this group. The area of a standard consultation room is 20.5 m2 (see Figure 3.3).
2. Consulting / research units where, in addition to consulting, physical examination takes place using relatively simple equipment: the “standard plus consulting unit” for the gynaecology field. The surface of these consultation rooms is identical to the standard consultation room.
3. Specifically, equipped consultation / examination treatment rooms, wherein small treatments are carried out or where very special equipment is used: ENT and ophthalmology. The surface of these specific consultation rooms differs from the surface of the standard consultation rooms. The activities and the required equipment determine the dimensions.

The layout of a standard consultation room in the Hospital of the 21st century is shown in the following figure.

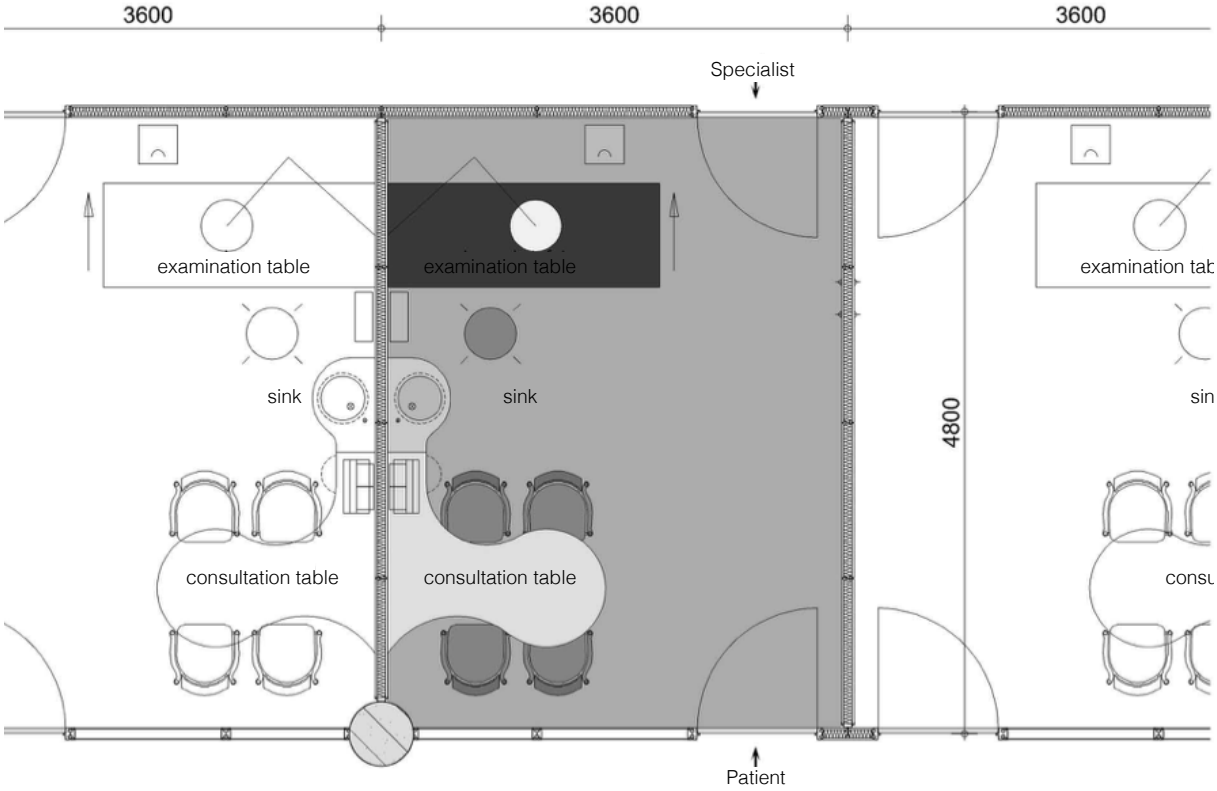


Figure 3.3: Standard colsultation room (College bouw zorginstellingen, 2006)

3.2.2. Process within the outpatient department of the 21st century

The process that takes place in the consultation centre is the basis for the calculation of the required number of consultation rooms. The consultation process is defined in the following in process steps (College bouw zorginstellingen, 2006): (1) make an appointment, (2) prepare consultation, (3) arrival / receipt of patient, (4) register patient, (5) treatment of the patient / consultation, (6) aftercare patient / make follow-up appointment, and (7) prepare consultation rooms for the next patient.

In the Hospital of the 21st century, process step 1 takes place digitally via the internet and the hospital's appointment system. The GP plays an initiating role in this. Process steps 3 and 4 take place in the patient area (the Atrium). The patient stays in the room during office hours. The duration of the consultation in the New Way of Working is determined by the duration of process steps 5 and 6. In addition, process step 7 also takes place in the consultation room. The duration of this last step is included in the duration of the consultation (College bouw zorginstellingen, 2006).

According to the Veldhoen + Company (2006) when, compared to traditional hospital accommodation and planning 30% fewer consultation rooms are needed in the Hospital of the 21st century. This is achieved with the standardisation of the consultation rooms, the flexible and person-independent use of the consultation rooms and decentralisation of the consultation rooms in one centre.

Process from the viewpoint of the patient

After arrival at the hospital, the patient registers centrally for the consultation in the front office area. The reporting takes place electronically, possibly with the support of a hostess or host. When registering, the patient receives information about waiting times and information about the location of the consultation hour and the associated waiting area. The hostess function is centralised. This means that the hostesses no longer work for one specific specialism (College bouw zorginstellingen, 2006).

The consultation starts by calling the patient in by the consulting professional in the designated consultation room. The allocation of consultation rooms is organized from the back office. The patient stays as much as possible in a consultation room reserved for him during the consultation period. The doctor and the nurse visit him here. Patient information is entered directly into the EPD during the consultation hour (College bouw zorginstellingen, 2006).

Any follow-up appointments are made by the surgery assistant with the patient in the same room. If this is not possible, the patient is asked to move to an adjacent facility to continue the conversation. The conversations with the patient take place as much as possible in the same room so that he must move as little as possible, including making follow-up appointments on the spot. After the consultation and with a possible follow-up appointment, the patient leaves the consultation room and the hospital (College bouw zorginstellingen, 2006).

Process from the viewpoint of the medical specialist

After arrival at the hospital, the employee changes clothes in the logistics block. From there, the employee has direct access to the knowledge and expertise centre and the adjacent back-office area of the consultation centre.

The employees in the back-office coordinate office hours. Through screens you can see which patients have registered at the front office and are ready in the waiting area. A consultation room is reserved for the meeting between employee and patient (College bouw zorginstellingen, 2006).

Depending on the type of office hour, the specialist or nurse starts the consultation. Other professionals can then take over the consultation, for example for wound care. The specialist is then available for the next patient in another consultation room within the same domain. Professionals who have a working relationship with each other are situated close to each other so that multidisciplinary office hours can be organized properly. This is made possible by the concentration of consultation rooms in one centre and by the standardization of the consultation rooms (College bouw zorginstellingen, 2006).

The basic principle when setting up the Hospital of the 21st century is to separate the work types: consulting, screening and treatment. A limited number of exceptions have been made for efficiency reasons. In several situations, treatment and screening are so strongly connected to speaking that the separation of facilities is inefficient. For example, the function examination rooms for lung medicine and cardiology are housed in the outpatient department. The equipment for laser treatment in ophthalmology

is also housed in the outpatient department. On the other hand, it has been decided to provide urology and dental surgery consulting rooms in the treatment centre (outpatient operating theatre) (College bouw zorginstellingen, 2006).

Specialism or subject areas find their home within domains. A domain includes consultation rooms, a back office and a knowledge and expertise centre.

3.2.3. Knowledge and expertise centre

In the last section, the knowledge and expertise centre (K&E centre) was already mentioned. The K&E centre is, in the Hospital of the 21st century, the brain and backbone of the hospital. In organisational and spatial terms this is the connecting factor between the various centres. From the K&E, the professional effortlessly walks into the other centres (College bouw zorginstellingen, 2006).

The K&E has distanced itself from fixed workplaces. Releasing fixed workplaces is made possible by digitizing information and thereby making it available independently of location and time. The specialist has given his room to the patient and receives the many different workplaces from the K&E in return. The environment is always adapted to his needs: privacy, social contact, concentration, meetings and networks (College bouw zorginstellingen, 2006).

In the K&E centre there will be library spaces for the specialists, where departmental consultations and training activities can take place. The activity analysis conducted among the specialists shows that specialists spend 20% of their time on consultations and training activities. By this is meant 20% of the total working time of the specialist. The working time varies per specialism. For individual work, the specialist has the choice of a workplace in the library or a workplace in the free space of the K&E centre (College bouw zorginstellingen, 2006).

Nurses, specialists and care planners work at K&E behind a laptop with a mobile phone, or they go through an EPD of a difficult case together, or they occur together team consultation or training activities. Bringing all professionals together in a connected knowledge and expertise centre stimulates collaboration and knowledge sharing and leads to quality improvement. Relaxation and restoration are also included in the K&E. Depending on the size of the department, the library is intended for one or more departments. A library space has an area of approximately 50 m^2. All employees have a locker here for storing their personal belongings (College bouw zorginstellingen, 2006).

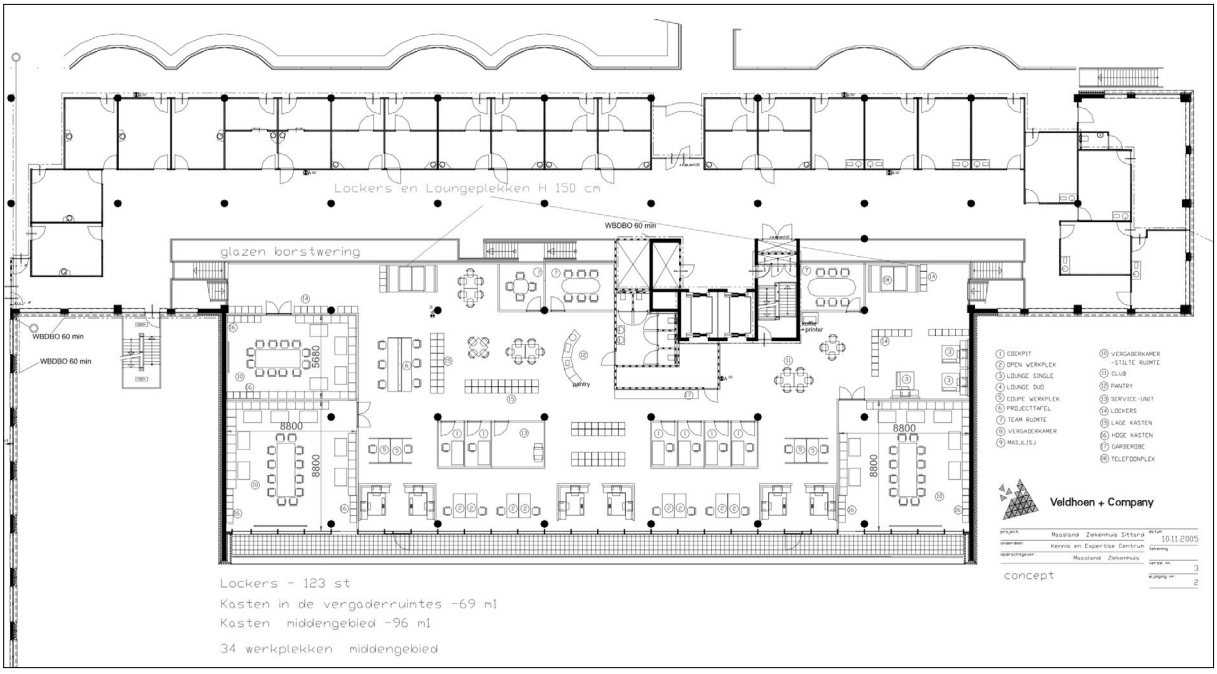


Figure 3.4: Connection consultation centre and Knowledge & Expertise centre (College bouw zorginstellingen, 2006)

3.3. Hospital of the 21st century real estate added values

The concept of the hospital of the future developed by Veldhoen + Company (2006) was implemented in the development of the Maasland hospital in Sittard, and van der Zwart (2014) has analysed this hospital concept in his dissertation. Below are shown, the real estate added values present in the hospital of the 21st century concept, according van der Zwart (2014).

3.3.1. Increase innovation

According to van der Zwart (2014), the main objective behind innovation, is the efficient application of human resources in an inspiring environment. Furthermore, he states that the knowledge centre enables the patient to encounter with the medical specialists and other medical staff. While, in the back office the focus is on efficiently sharing knowledge. A consequence of this decision was the replacement of the specialist's individual room with flexible workplaces in the centrally placed knowledge centres, including different types of workplaces for different types of needs.

3.3.2. Increase user satisfaction

According to van der Zwart (2014), medical specialists find their satisfaction in healing patients and this is achieved by the provision of the right activity at the right time and place. This entails that an effective application of human resources requires an inspiring and pleasant work environment with innovative ways of information sharing and communicating with colleagues and patients. In his analysis to van der Zwart (2014) also mentioned that an important questions is how people work together to reach organisational goals, so the interaction of medical specialists with patients in both ways. Furthermore, an inspiring environment contributes to the atmosphere of an interaction between the patient and the medical specialist. The by Maasland hospital defined atmosphere aspects are functionality, size, climate and sterility.

3.3.3. Improve culture

The organisational structure wherein the patient is the client in a demand-driven process is supported by the physical environment of the outpatient department (van der Zwart, 2014). Special about this concept is that the specialist visits the patient in a specially equipped consulting room and not vice versa. The consulting rooms are adjusted to the needs of the patient and that moment, so privacy, comfort and well-being are central. Patient flows are supported on the patient side with a front office and comfortable waiting facility (van der Zwart, 2014).

3.3.4. Reduce costs

The real estate investment made to build the Maasland hospital is seen as a long-term investment. Wherein the higher initial costs have to be made back with higher returns resulting from a higher efficiency and more profitable exploitation of the hospital building (van der Zwart, 2014). Therefore, are logistics really crucial in providing good just-in-time, enabling the healthcare professional to provide the right activity for the patient at the right moment in time. In the Maasland hospital is made use of a robotics logistic network, separated from the patient and employee flows (van der Zwart, 2014).

3.3.5. Increase productivity

The start of the hospital of the future concept started with the analysis of the work processes, this resulted in the six activities, mentioned in the beginning of this chapter. These concepts are also used in the Maasland hospital and their healthcare process is seen as a combination of these activities (Figure 3.1) (van der Zwart, 2014). Moreover, the productivity was increased by more efficient use of resources, including human resources, by separating the six activities and with the provision of demand driven facility services and a just-in-time concept for patient results, resulting in efficient

working processes (van der Zwart, 2014).

3.3.6. Improve flexibility

The hospital has focused on organisational flexibility. Therefor, goods and information are always available throughout the whole hospital. Furthermore, the standardisation of the consulting rooms makes more efficient and effective use of the available space possible (van der Zwart, 2014).

3.3.7. Support image

According to van der Zwart (2014), the image of the hospital organisation is formed by the focus on patient as customer, the guarantee of quality and wanting to be the frontrunning in regional healthcare continuum.

3.3.8. Controlling risks

Ensuring that the hospital building can contribute to the provision of state-of-the-art healthcare for the building's lifespan (40 years), is the focus of controlling real estate-related risks in the hospital of the future concept (van der Zwart, 2014). One of the most important risks mentioned by van der Zwart, are the continuously changing regulations and legislations for hospitals. The organisation of the Maasland hospital recognises the importance of an increased business focus in a process towards liberalisation of the healthcare market and they think that the implemented concept is the best way to do that (van der Zwart, 2014).

3.3.9. Improve financial position

According to van der Zwart (2014), the hospital is production resource and thus the real estate investment must be earned back by a higher efficiency. Because of the static nature of real estate and the specific use of a hospital, the hospital itself is not used for improving the financial position. However, in case of the Maasland hospital, the chosen location on a greenfield makes future urban developments in the area possible.

3.4. Outpatient department of the 21st century in practice

In this section some other implementations of the hospital of the future, in special the outpatient departments of the future, are discussed.

3.4.1. Erasmus MC

Since last year (2018) Erasmus MC has a new main building, the old main building was quite old after being used for more than 50 years. An academic hospital is a facility where technological progress plays a major role. Moreover, today's regulations and regulations set high standards. Adapting the building to modern requirements and regulations was not a realistic option, partly with a view to future developments (Erasmus-MC, n.d.). The total floor area of the hospital is not much larger than it was before. By working more efficiently, fewer square meters are needed. This is especially noticeable at the outpatient department. Because the different specialisms do not each have their own rooms but share spaces, the occupation of the consulting and treatment rooms can be planned more tightly. The available meters are used more efficiently (Erasmus-MC, n.d.).

3.4.2. Jeroen Bosch Hospital

The work processes in healthcare are in continuously changing. Proper real estate provides adequate space for these changing processes and offers the possibility to optimize the use of space. This was also the starting point for the new outpatient department of the Jeroen Bosch Hospital, being in use since 2011 (Braaksma & de Jong, 2015).

Flexible layout

Flexibility was an important starting point for the design of the consultation department of the Jeroen Bosch Hospital. The aim was to be able to absorb changes in the supply and demand as a result of production growth (or shrinkage), technological developments and changing work processes. This concerns both the extensibility and the changeability of the accommodation. For the sake of extensibility, multifunctional spaces have been included throughout the outpatient clinics. The structure plan is designed in such a way that any expansion is possible in the future. The changeability is guaranteed by a high degree of spatial standardization, both spaces themselves (dimensions, connections and layout), and the design of the outpatient clinic (Figure 3.5). Rooms are intended for performing an activity and are not assigned to one person. At the time of the formulation of the principles for the new construction of the Jeroen Bosch Hospital, more than 10 years ago, this was a new way of thinking. Today, the choice for maximum flexibility in the outpatient clinic is almost self-evident and standardization is increasingly being anchored in the design for new outpatient clinics (Braaksma & de Jong, 2015).

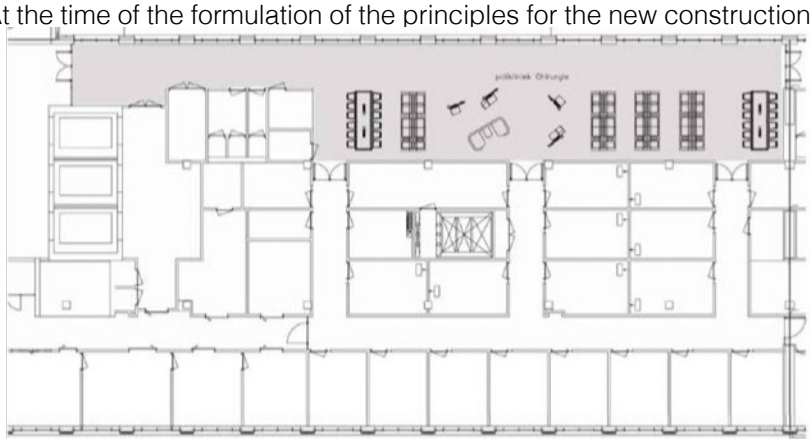


Figure 3.5: Outpatient department layout (Braaksma & de jong, 2015)

Physical separation of front and back office

To promote the flexible use of space, a distinction has been made between areas for patient-related activities and non-patient-related activities. Conditional for the functioning of this concept is that the facilities for non-patient-related activities are well and quickly accessible elsewhere in the hospital (Figure 3.6). In addition, well-functioning IT facilities are a requirement. In the design for the Jeroen Bosch Hospital, this separation was shaped by means of a knowledge centre with workstations for specialists, meetings and educational facilities. This knowledge centre also meets another important principle: knowledge exchange and meeting (Braaksma & de Jong, 2015).

Figure 3.6: separated back office (Braaksma & de Jong, 2015)

Outpatient department without a service desk

The ambition of the Jeroen Bosch Hospital is to be a digital hospital. The classic service desk, that often functions as the administrative centre for a paper workflow around statuses, punched plates (patient ID-card) and all kinds of forms, has given way to a modern concept. Digital availability of information, intelligent planning software and a more customer-focused approach to employees should form the basis for an efficient and more customer-friendly appointment system. Patients can organise their registration and appointments independently via digital systems (Figure 3.7), under the supervision of a hostess (Braaksma & de Jong, 2015).

Figure 3.7: deskless check-in (Braaksma & de Jong, 2015)

3.4.3. Why not all hospitals have implemented the hospital of the 21st century concept

Although, due to current developments, real estate is becoming more and more important. Real estate still has a static character, this means that today's real estate decisions will determine the context of processes for a least the next 20 years (van der Zwart, 2014). While developing a new hospital building will take on average 10 years. This kind of means that hospitals are already outdated the moment the built of the hospital is finished (van der Zwart, 2014). Therefore, changes to the hospital building start right after the opening of the hospital and will be an ongoing process. Furthermore, the (im)possibilities of the current situation may include restrictions on organisational changes that can be implemented and not every hospital has the prospects and means of replacing the entire hospital (Veldhoen + Company, 2006).

Moreover, the hospital of the 21st century concept is not only building related but also requires changes in the culture of a hospital organisation. Medical specialist must give their consulting room to the patient and be open to a more information and knowledge sharing environment, in for example the form of a knowledge centre. These changes can be quite difficult for medical specialists who have been working their entire career according to the same principle, the principle of ruling the hospital and holding on to what is theirs.

It is therefore important that a hospital building needs to be able align with the organisation, whether it is a new hospital building or an existing hospital building. This means that the building needs to be adaptable to future changes and knowing how the building is used and utilised is critical when needing to expand or make changes within the boundaries of the existing real estate.

3.5. Conclusions

Objective	Define characteristics of the outpatient department of the 21st century Understand which activities take place in the outpatient department of the 21st century
Questions	What are the characteristics of the outpatient department of the 21st century? Which activities take place at the outpatient department of the 21st century?
Method	Literature study

Based on the findings in the third chapter, the following conclusions can be drawn:

Characteristics and the activities of the outpatient department of the 21st century

- The four basic principles are: (1) Design the care process from three perspectives: patients, employees and goods and services. (2) Reduce all processes to simple activities. Facilitate and support the activities as efficiently and patient-friendly as possible. Reorder health care programs activities back to processes. (3) Make information available independently of time and place. (4) Ensure that the environment matches the circumstances at that time.
- The concept consists of six centres: screening diagnostics centre, consultation centre, treatment centre, nursing centre, knowledge and expertise centre, and logistics centre.
- The three perspectives are: (1) IT and information provision (bytes), (2) people and organisation (behaviour), and (3) work environment and building (bricks)
- ICT, information provision, digitalisation and automation (Smart tools) play a important role in the hospital of the future.
- In the Maasland hospital the concept is implemented and the nine added values of hospital real estate are incorporated.
- Separated logistics from patient and employee flows, incombination with the just-in-time principle make the new concept work more efficient and effective.
- Standardisation and sharing of the consultation / examination rooms
- Physical separation between the consultation rooms, front office and back office
- Knowledge and Expertise centre is the brain and backbone of the hospital and in organisational and spatial terms this is the connecting factor between the various centres.
- Treatment of the patient / consultation, aftercare of the patient and making follow-up appointments take place at the consultation rooms. All other activities done by the medical specialist take place at the Knowledge & Expertise centre.
- Increased innovation and user satisfaction by effective use of human resources in an inspiring environment
- Improved flexibility and productivity, due to the flexible working concept. In combination with just-in-time leads this to also to reduced costs controlled risks and an imrpoved finacial position.
- Improved culture by placing the patient central and making the consultation room the patient's.

4. Real Estate Management theories

This chapter starts with the introduction of the different Real Estate Management (REM) theories, followed by the explanation of how to align demand and supply, why stakeholder involvement is important and ends with the added values of hospital real estate. The goal of the chapter is to provide answer to the question how real estate adds value to the user and organisation. These question is answered with the use of a literature study.

4.1. Corporate and Public Real Estate Management

Organisations and people working at organisations need real estate in order to perform their job. However, the function of real estate in not purely operational. According to Haynes, Nunnington, and Eccles (2017), the function of real estate has shifted from a purely operational need to a strategic tool, which has even become an indispensable part of the company strategy. However only two decades ago, in many organisations there was no link between real estate and the organization itself (Nourse & Roulac, 1993). Nourse and Roulac (1993) also describe in their research that it is important to make a connection between real estate decisions and the general goals of the organisation. Today, CREM (corporate real estate management) is seen not only as a cost-saving method by both science and the market, but also as a way to add value to the organisation (Petrulaitiene, Rytkönen, Nenonen, & Jylhä, 2017). Haynes and Nunnington (2010) see business real estate as one of the resources of the organization. This alignment of business property is also called the alignment between supply of real estate and the demand of the organisation (de Jonge et al., 2009; Joroff, Lambert, & Louargand, 1993).

According to de Jonge et al. (2009), there are several specialisations within real estate management. Den Heijer (2011) describes three types in her research. The first is portfolio management, which is also referred to as the investors point of view of real estate management, focuses mainly on financial goals. The second is CREM which is real estate management done by organisations which are both the owners and occupiers of their real estate. This specialisation focuses on the organisation's performance (added values) in relation to the resources spent on real estate (costs). The third and last is PREM or Public Real Estate Management, which is the same as CREM but has additional public goals. For hospitals both CREM and PREM are applicable, but due to the recent changes and there for increasing importance of economic goals of hospitals the CREM theories will be used primarily.

The importance of CREM has also become known within the hospitals. Especially after the legislative changes in 2015 when the housing costs became an integral part of healthcare. This has taken care of a renewed view or the coordination between the hospital organisation and the accommodation. As mentioned earlier, hospitals themselves now bear the risk of properly recouping their investments and excessively high hospital costs result in higher health care rates compared to other institutions (van der Zwart, 2014).

However according to the research of van der Voordt, Prevosth, and van der Zwart (2012), the first priority for a hospital is to offer the best healthcare in the most cost-efficient way. Real estate and other facilities come in second place but are important resources to be able to optimally offer the organizational goals and the care processes. On the one hand, the building is there to provide the patient with his needs and well-being. On the other hand, the building must provide the health care provider with a pleasant and, above all, productive working environment. In terms of housing, the support of efficient health care processes proved to be the core problem.

4.2. Aligning demand and supply

According to den Den Heijer (2011) is managing real estate a continuous process consisting of implicit or explicit considerations about the match of demand and supply. In this process of finding the match that has the most added value to the organisations' performance, four coordination moments have been determined byDen Heijer (2011). Which den Den Heijer (2011) describes as the following management tasks in her research about the university campus (see Figure 4.1): (1) assessing the current campus (to determine the current match), (2) exploring changing demand (and determining the future match), generating future models for the campus (to match future demand and supply), and (4) defining projects to transform the campus (to the future campus).

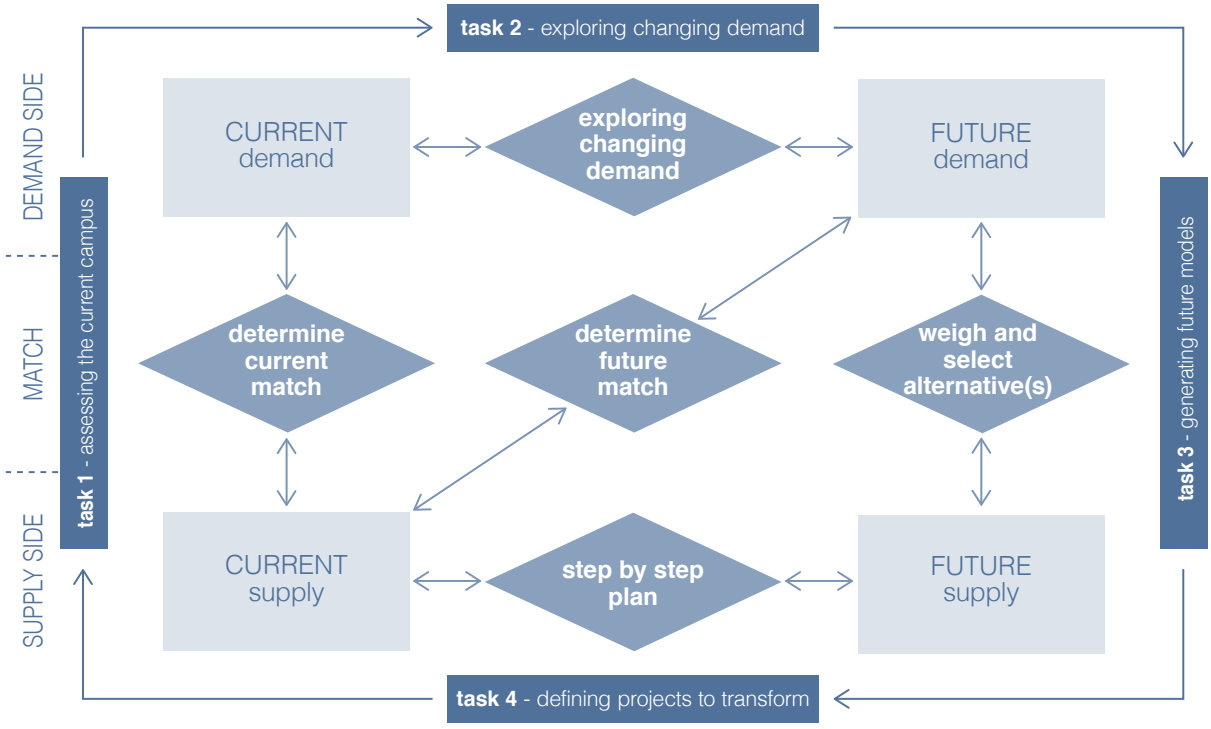


Figure 4.1: framework matching supply and demand of space, now and in the future (de Jonge *et al.*, 2009)

Furthermore, den Den Heijer (2011) elaborates on the fact that the complexity of real estate management is determined by the scope, entailing the whole building or just one department or floor area, and which stakeholder perspectives are included in the decisions.

4.3. Stakeholder perspectives

As stated in the above section, the complexity of real estate management is influenced by the stakeholder perspectives included in the decisions. Before elaborating on why this is the case and which stakeholders have which perspectives, the definition of stakeholders will be explained. According to the definition used by Winch (2009), are stakeholders those who can or think they can be influences by a decision or project. It is necessary for the real estate decision-makers to understand the interests of the different stakeholders and consider their interest when making real estate related decisions in order to align the demands with the supply (De Jonge et al., 2009).

In order to align the perspectives of the stakeholders with the perspectives on real estate Den Heijer (2011) has developed a model. In this model Den Heijer (2011) classifies four types of stakeholders and matching perspectives. It is a model that is derived from the CREM model as described by De Jonge (1996) and Krumm (1999). The classified stakeholders are the policy maker

with a strategic perspective on real estate; the controller with a financial perspective; the users with a functional perspective and the technical managers with a physical perspective (Figure 4.2). The four stakeholders are divided into four quadrants, with either the focus on the institution or real estate and on the strategic or operational level. According to Den Heijer (2011) reflects this CREM model still the definition of corporate real estate management "as a matching process between demand and supply, with activities from operational to strategic level and with the overall goal to optimally attune real estate to an institution's performance (p. 107)."

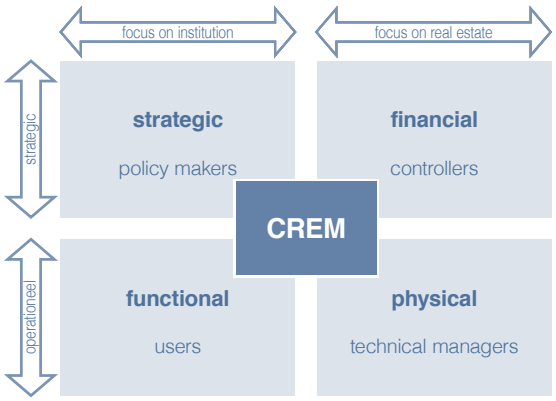


Figure 4.2: stakeholders are linked to the four perspectives on CREM (Den Heijer, 2011)

According to van der Zwart (2014) it is questionable whether the above mentioned perspectives are really directly linked to the particular stakeholders as defined by Den Heijer (2011). Although Den Heijer (2011) does state in her research that the four perspectives on real estate give an appealing opportunity to link real estate goals to the stakeholders' interests. Typically, stakeholders not specifically tent to have interest in the organisation's real estate, but rather an interest in the global performance of the organisation. Each individual stakeholder includes all the perspective but focuses especially on one or more perspectives. Furthermore, Den Heijer (2011) states that a policy maker must balance the different real estate perspectives in order to come to a suitable decision, and a technical manager has to come with both physical and technical possible solutions that match both the financial and functional perspectives.

Additionally, van der Zwart (2014) describes that the main interests of users of a hospital align with their activities i.e., the patients who go to a hospital to get treated, the medical specialists who treat the patients, and the hospital staff who assist in the treatment process. He also states that from these stakeholders' organisational objectives, the perspectives on real estate can be formulated, however these perspectives will not be exactly linked to the different stakeholder. Therefore, van der Zwart (2014) implies that the four different perspectives on real estate must be aligned to the stakeholders' organisational objectives as illustrated by Den Heijer (2011). This is necessary when aligning the stakeholders' interests with the global performance of the organisation. In the case of a hospital, the perspectives on real estate must be aligned with these result criteria to add to the organisational performance. Which is exactly the step introduced by Den Heijer (2011), in her research she transforms the stakeholder model in to four perspectives on real estate which in their turn enables the possibility to combine the four perspectives with the real estate added values. According to van der Zwart (2014) this makes it possible to describe the added values in terms of the four perspectives, instead of delegating one added value to a specific stakeholder. The benefit is that, for example it is possible to determine the strategic, financial, functional and physical effects of improving the productivity as an added value in hospital real estate (van der Zwart, 2014).

4.4. Added value of hospital real estate

In the last section productivity was mentioned as an added value in hospital real estate, however what does it mean that something is an added value in real estate. According to Den Heijer (2011) is the basis of real estate management is the presumed added value of real estate on the performance of the organisation. Den Heijer (2011) explains the importance of real estate by stating that if real estate has no impact on performance, no one would spend resources on it. Furthermore, one of the resources that organisations use to gain organisational objectives is real estate and by doing so adding value to the organisation (van der Zwart, 2014) The principle of adding value by real estate assumes that a better alignment of demand and supply can lead to added values for the organisation, which is the basis of CREM (Lindholm & Leväinen, 2006). So that is why real estate that improves the productivity can be an added value to the hospital organisation, but there are more added values of hospital real estate.

As explained in the above sections, CREM is managing the accommodation of a company, in this case a hospital, by aligning the real estate portfolio and services with the primary business processes, in this case offering the best healthcare in the most cost-efficient way, with the aim of realising the maximum added value for the hospital (van der Zwart, 2014). According to a research of van der Zwart and van der Voordt (2016), who held interviews with managers of 15 different newly build Dutch hospitals, there are nine main added values of hospital real estate. Sorted from the highest to lowest prioritised added values of hospital real estate: (1) increase innovation, (2) increase user satisfaction, (3) improve culture, (4) reduce costs, (5) improve productivity, (6) improve flexibility, (7) support image, (8) controlling risks, and (9) improve financial position. What these added values mean for the four stakeholder perspectives can be seen in Table 4.1. The bold text cells show the added values that were mentioned and elaborated upon the most by the interviewees.

Furthermore, van der Zwart (2014) concludes that the table shows that flexibility is an important added value to all perspectives. Supporting the image, improving culture and increasing innovation are strategic and functional added values. While reducing costs, controlling risks and improving the financial position are more financial-added values. Furthermore, van der Zwart (2014) states that the financial perspectives on real estate have a direct impact on the physical perspective, every financial choice is adapted into a physical choice. The physical environment has also effect on the user satisfaction and productivity, which are mainly Lastly, van der Zwart (2014) noticed that the financial perspectives are connected to the physical implications, while the strategic perspectives are connected to the functional perspective. Which strokes with the division between focus on institution and focus on real estate made by Den Heijer (2011) in the four perspectives on real estate.

Some other added values were also mentioned in the interviews, namely sustainability and healing environment (van der Zwart, 2014). However, sustainability was not perceived as a mean objective for hospitals, but more as an obligation to deal with the societal requirements and to show corporate social responsibility. The healing environment as a focus is of utmost importance for hospitals. Furthermore, van der Zwart (2014) states that while not explicit listed as an added value, it is implicit included in satisfaction and productivity. Although, van der Zwart (2014) admits that it would be useful to add this value to the added value list as a healthcare-specific real estate added value. He also states that adding sustainability as an added value, as Den Heijer (2011) did in her dissertation, would make the added values and hospital real estate in general better comparable with real estate of other sectors. Moreover, van der Zwart (2014) States that the findings can act as a recommendation for deciding on accommodation at both strategic and tactical levels and can therefor provide an important contribution to an accommodation strategy. The key findings defined by van der Zwart (2014) are shown below.

Added value of real estate	Perspectives on real estate			
	Strategic	Financial	Functional	Physical
Increase innovation	*** Continuous process of optimising healthcare services** *** Co-location of healthcare providers**	* Financing system with separated budgets for cure and care are contra- innovative	*** ICT patient information** *** Central waiting system** *** Use of patient lift systems**	* Places for medical staff to meet each other * Facilities like skills labs and knowledge centres * Minimal surgery in single patient bedrooms
Increase user satisfaction	* Human in general is central * Attracting and retaining good personnel	* Extra investment in real estate for healing environment	*** Wellbeing of patients** *** Planetree concept** *** Central waiting concept** *** Processes where medical process is central versus processes where patient stands central.**	*** Architectural quality of patient rooms** *** Single patient bedrooms**
Improve culture	*** Real estate as the outboard engine of the organisation** *** Improve comunication between staff and health- care professionals**		*** Front-back-office concept** *** Office concept** *** The building supports interaction between people**	* Paying attention to places where people can meet.
Reduce costs	* No more square metres than necessary	*** Future expansions based on new business plans.** *** Investment level that fits the scale of the building** *** Controlling investment costs and real estate related costs**	* Space reduction by shared workspaces * Strict budgeting of space per department	*** Life cycle costs including maintenance and energy** *** Sober plans with slim-fit buildings** *** Low initial investment costs** *** Sustainability to make hospital less reliant on energy resources**
Improve productivity	* Ensuring that healthcare professionals can do their work as efficiently as possible	* Yearly space budgeting per department based on production and turnover * Production rates * Empty beds	*** Optimally facilitating the healthcare processes** *** Front/back-office concepts** *** Healing environment** *** Single person bedrooms**	*** Centralization of high technical functions in hot floor** *** Spatial clustering** *** Separating logistics from patient and personnel.**

Added value of real estate	Perspectives on real estate			
	Strategic	Financial	Functional	Physical
Improve flexibility	*** Supporting changing business processes during the lifespan of the building * In initial phase important, during occupational phase a given fact.**	*** Extra investments in future flexibility * Pre investments in expandability * Possibilities to rent space**	*** Adaptability * Multi-functional use of space * Sharing consultant and treatment rooms, wards and other facilities * Flexible office concept**	*** Robust building that makes different layouts possible * Separate technical installations * standardisation* Supporting structure and fill-in * Expanding possibilities**
Support image	* Improve competitive advantage by using the building as a marketing tool, both for (potential) patients and employees	*** Extra investment in architectural quality**	* Healing environment * Percentage single bedrooms * Hospital recognisable as hospital	*** Nice and easily accessible location * Nice overall architectural appearance**
Controlling risks	* Risk reduction in healthcare processes	*** Business case * Marketability of real estate * Real estate in Private Limited Company * External clinics rented**	* Longer opening hours to optimize available capacity	*** Slim fit building with no more square metres than necessary * Outsourcing maintenance * Contractor and technology partner in initial and design phase**
Improve finance position	* Real estate is more a resource for production than an asset	*** Banks as stakeholder * Private investment in hospital real estate * Marketability of real estate * Real estate as an asset * (Potential) location value * Urban Area Development**	* Choice between optimizing healthcare processes during lifespan of building or marketability afterwards.	*** Choice between optimizing healthcare processes during lifespan of building or marketability afterwards.**

Table 4.1: Real estate perspectives on hospital real estate added values (van der Zwart, 2014).

4.4.1. Definitions of hospital real estate added values

Improving organisational culture of information exchange & stimulating innovation

By creating meeting places for healthcare professionals, the interpersonal relationships and communication within the organisation can be improved. This adds to the organisational culture and information exchange between colleagues, which helps to improve and innovate healthcare processes and services. These meeting places consist of employee centres with space for medical specialists for their back-offices activities, informal meeting places and classrooms for the exchange of knowledge (van der Zwart, 2014).

Support image

Van der Zwart (2014) describes that the architecture of the hospital building as an icon adds to the sustainable societal position of the hospital organisation.

Reduce accommodation costs

The prices of the offered healthcare products and services are directly related and influenced by (reduction of) the accommodation costs. Examples that van der Zwart (2014) mentioned include a fixed space related budget for departments, minimizing investment costs in renovation of new accommodations and reducing the life-cycle-costs of the building. This includes the energy costs and maintenance.

Reduce risk and increase financial possibilities

The methods of ensuring reduces risks and financial possibility in hospitals is primarily associated with the layer approach. In the layer approach the hospital is divided into four accommodation types: hot-floor, hotel, office and factory. Furthermore, it is also a possibility to create land value by developing hospital real estate on a purposeful location, which can be beneficial for future use (van der Zwart, 2014).

Patient satisfaction

Patient satisfaction is connected to the wellbeing of the patients and the beneficence that the physical environment brings to the healing process of the patients, a healing environment. Crucial elements of the patient satisfaction are: light, materials, noise, views on nature, orientation and routing, and privacy in consulting rooms (van der Zwart, 2014).

Employee satisfaction

An important added value in any professional environment is the satisfaction of employees and the building must support this. Because medical specialists are the key personnel of the hospital, functional and comfortable workplaces are required for the most effective and efficient delivery of care to the patients (van der Zwart, 2014).

Use flexibility

According to van der Zwart (2014) focuses the flexibility in use on the degree to which the building can adapt to (future) change in healthcare processes without extensive changes to the accommodation. This kind of flexibility makes it achievable to make the workplace conform the primary healthcare processes and this is essential for innovative ability of the hospital organisation to improve the processes.

Sustainability

Sustainability, within hospitals, focuses predominantly on the reductions of energy costs. This has to do with the fact that despite the increasing energy prices in the future, healthcare can still be delivered. Therefor, investments are mainly made in storing heat and cold in the soil, re-using waste-energy from the industry and other building related energy concepts (van der Zwart, 2014).

Increase productivity

Using the available space more efficiently is possible by the separation of the front- and back-office, and by sharing generic consulting rooms with several medical specialists at different times throughout the week. By increasing the productivity healthcare professionals should be able to do their work properly and efficiently. Furthermore, the separation of patient flows from employee and good flows is already widely used (van der Zwart, 2014).

4.5. Conclusions

Objective	Understand how real estate adds value to the user and organisation.
Questions	How does real estate add value to the user and organisation?
Method	Literature study

The goal of this chapter is to understand the principle of real estate management (in hospitals). Including, why stakeholder involvement and knowing the added values of hospital real estate are important for this process. Based on the findings in the first chapter, the following conclusions can be drawn:

Real Estate Management theories

- General real estate management differs from Corporate and Public Real Estate management (CREM and PREM) (investors point of view).
- CREM focuses on the organisation's performance (added values) in relation to the resources spent on real estate (costs).
- PREM is the same as CREM but with additional public goals.
- Theories on CREM are applicable on hospital real estate management.
- Priority for a hospital is to offer the best healthcare in the most cost-efficient way. Real estate and other facilities come in second place but are important resources to be able to optimally serve the organizational goals and the care processes.

Aligning demand and supply

- Real estate management is a continuous process of matching demand and supply.
- An optimal alignment between demand and supply can lead to added values for the organisation.
- The complexity of real estate management is determined by the scope.

Stakeholder perspectives

- Stakeholders are those who can or think they can be influences by a decision or project.
- In order to align demand and supply understanding the different stakeholder perspectives is necessary.
- Stakeholders and their perspectives on real estate are represented in the model of den Heijer (2011).
- This model makes it possible to combine the perspectives with the real estate added values.
- The benefit of describing the added value in terms of four perspective instead of delegating it to a specific stakeholder is to determine the strategic, financial, functional and physical effects of an added value in hospital real estate.

Added values of hospital real estate

- Real estate management is based on the presumed added value of real estate on the performance of the organisation.
- Flexibility is an added value to all perspectives.
- Supporting the image, improving culture and increasing innovation are strategic and functional added values.
- Reducing costs, controlling risks and improving the financial position are more financial-added values.
- The physical environment has effect on the user satisfaction and productivity.
- Financial perspectives are connected to the physical implications, while the strategic perspectives are connected to the functional perspective.
- Employee and patient satisfaction are separated added values.
- Healing environment is a healthcare specific added value.

5. Smart Tools

This chapter starts with the technological developments, followed by the introduction of internet of things, smart real estate, and ends with the definition of smart tools. The goal of the chapter is to provide answer to the sub-questions what smart tools are and how smart tools are related to real estate management. These questions are answered with the use of a literature study.

5.1. Technological developments

At present, the world is changing in a rapid pace due to the current technological revolution, which immensely influences our way of living and the performance and decision making of both us individuals and organisations (Morrar, Arman, & Mousa, 2017). This is called the fourth industrial revolution – also known as Industry 4.0 – which originates from the manufacturing industry but is applicable to all sectors. Industry 4.0 uses because of its origin the definition of “smart factory” (Dutton, 2014). A virtual copy of the physical world and decentralised decision making can be developed in a smart factory (Buhr, 2015).

Furthermore, physical systems can communicate and cooperate with humans and other physical systems in real time (Morrar et al., 2017). These direct and interdisciplinary communications can lead to several advantages such as smart and grounded decision making, improved services and systems and well-designed products (Cotteleer & Sniderman, 2017). Additionally, it can also create better insight in the use of resources, which can potentially lead more efficient use of resources and to cost reduction and improvement in performance (Cotteleer & Sniderman, 2017; Ślusarczyk, 2018).

5.2. Internet of Things

The concept of Industries 4.0 is on the communication and cooperation between physical systems and people in real-time with the use of Internet of Things (Morrar, Arman, & Mousa, 2017). The definition of Internet of Things (IoT) as stated by the European Commission is: ‘‘Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts” (RFID, 2008).

According to Chen et al. (2014) the network architecture of IoT can be split up into three different layers. The first layer is called the sensing layer, which for the biggest part consists of sensor networks. This layer is responsible for the acquisition of data. The next layer is the network layer. This layer is responsible for information transmission and processing. In which, remote transmission will be depending on the internet while direct transmission might be depending on sensor networks. The third and last layer is called the application layer. This layer supports the specific applications within IoT.

The sensing layer, which consists of information collection equipment is used in machines and systems around the world and have a network of sensors imbedded. In different fields are such sensors used and can collect different types of information. Examples of such data are logistical data, geographical data, astronomical data and environmental data. Moreover, transport facilities, public facilities, mobile equipment and household appliances can all be used as devices that collect information in IoT (Chen et al., 2014).

These information collection equipments are called smart connected products by Bäumer, von Oelffen, and Keil (2017); Porter and Heppelmann (2014), and they state that these smart connected products can be grouped into four on each other building function areas; monitoring, control, optimisation, and autonomy. Ranging from reactive to proactive, wherein a fully developed smart connected product, first monitored, then controls and optimised. Lastly the smart connected product

acts, which is the autonomous part, wherein it the above functions combined in a split second (Bäumer et al., 2017; Porter & Heppelmann, 2014). These four stages are visualised in Figure 5.1 shown below.

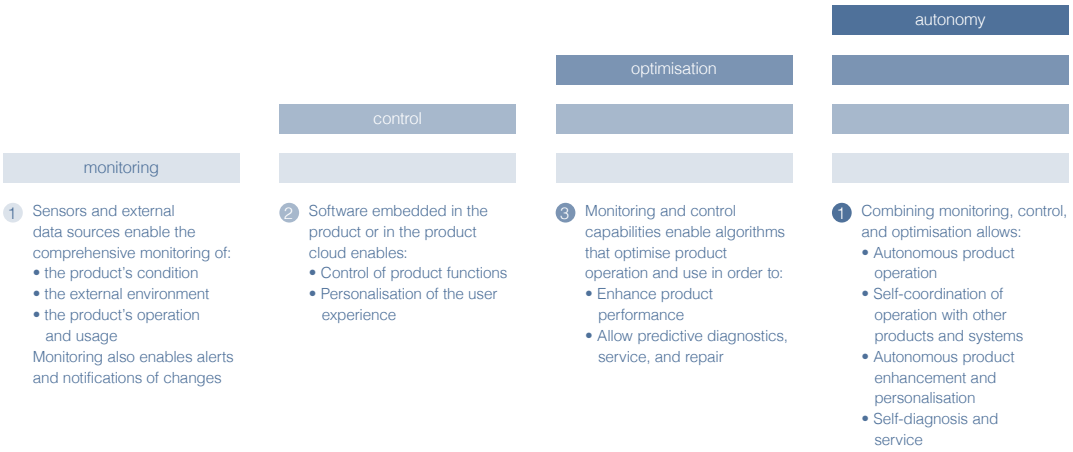


Figure 5.1: Capabilities of smart, connected products (Porter & Heppelman (2014)

When looking a greater scale to the network of Internet of Things a smart (connected) city or environment emerges. Such an environment is, according to Washburn et al. (2009), an environment that makes use of information and communication technologies in order to make the critical infrastructure components and services of an environment, such as administration healthcare, education, public safety, real estate, transportation and other utilities, more interactive, aware and efficient. These enables a new way of information driven governance, using real-time awareness and data analytics to assist in better decision making (Bartels, Daley, Parker, Evelson, & Muteba, 2009). Each system (building) within the greater system (city) can be made smart by enabling real-time interaction, with either a human or machine, in order to help with the data based decision making process (Bélissent, 2010). These individual systems in the field of real estate are often called intelligent/smart buildings or real estate.

5.3. Smart buildings

As briefly introduced in the last section are smart buildings part of a smart city. However, what makes a building smart, on which fronts can a building be made smart and why would that be interesting. As explained in the last sections with the integrations of Internet of Things, systems can be made more aware, interactive and efficient, this includes buildings. The development of not only the industry, but also buildings getting smarter is reflected in the market. There is an emerging growth of products on the market, which enable users / organisations to make buildings generate information. The most important driver for shift towards smarter buildings has to do with the, open information protocols and falling prices of technology, combined with the demand for a digital society and a more cost-efficient use of space (Arup, 2017).

Smart buildings and the development of buildings getting smarter is described in the research of Buckman et al. (2014). The development of building getting smarter can be seen in Figure 5.2. Traditionally buildings where not controlled, however due to the developments in technology and the abovementioned trends buildings are getting more controlled and even interactive. Which is in line with the demands of acquiring and applying information and knowledge about the building, its environment and its users in order to improve the

experience and the usefulness of the building and its environment to its users (Cook & Das, 2007). Thus, a smart building is a building that communicates with users and managers, that saves energy, better supports users and uses the building more efficiently. This is achieved by adding sensors, connecting network infrastructures and adding applications.

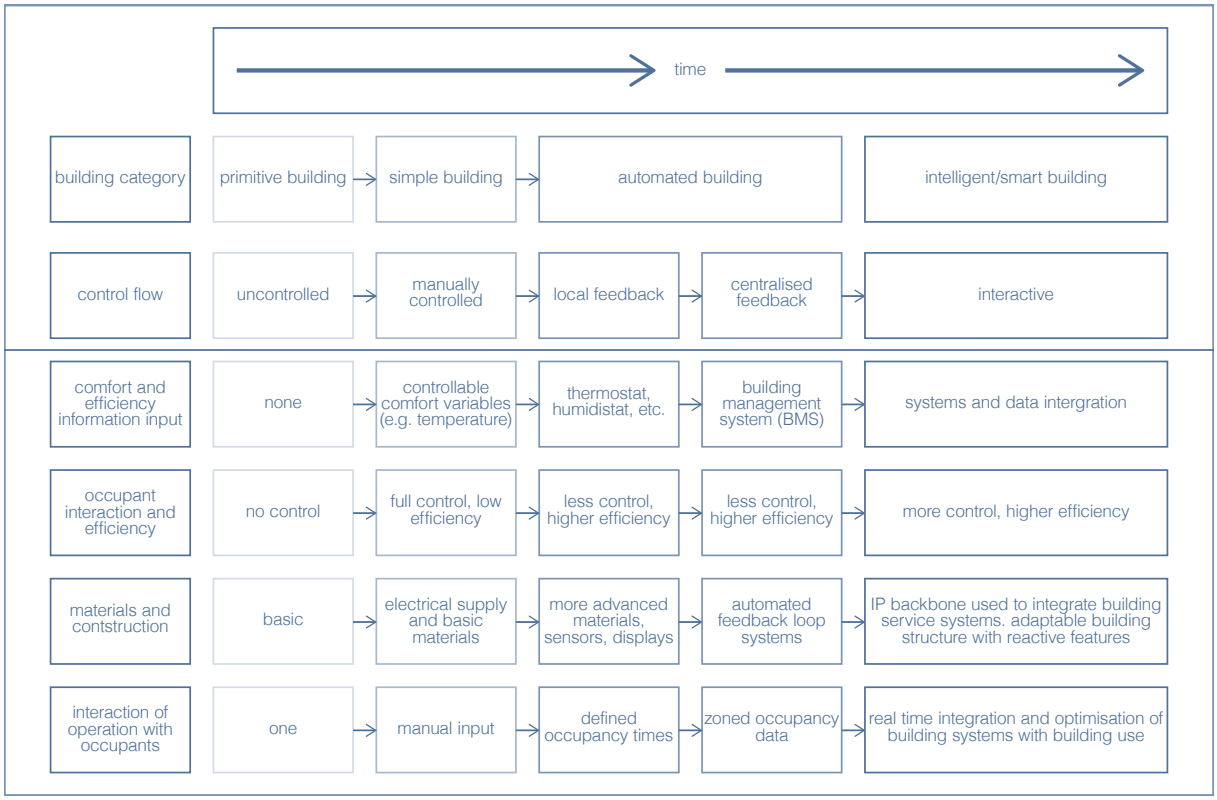
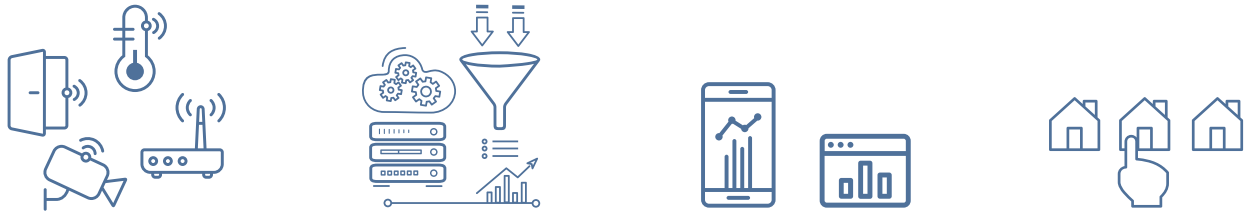


Figure 5.2: Smartness of buildings (Buckman *et al.*, 2014)

5.4. Smart tools

As described above there is a demand for acquiring and applying information and knowledge about the environment to the users. In smart buildings and IoT, as explained in the IoT section, there are three different layers, sensing (real-time data collection), network (processing of the data), and application (providing information to the user or organisation) (Chen et al., 2014). The service or product that provides the user or organisation with (real-time) information using the three layers is described in theory as a “smart tool”. The term smart tools defined in the research of (Valks, Arkesteijn & den Heijer, 2018), who did a study into the development of use of smart tools in campuses considers: “A smart tool is a service or product which collects (real-time) information on space use to improve the space use on the current campus on the one hand, whilst supporting decision making on the future space use on the other hand.” (Valks et al., 2018, p. 8).

Valks et al. (2018) states that by collecting (real-time) information, space use can be managed more effectively and efficiently and can help with future accommodation decision making. Additionally, by presenting this to the user it can influence the use of the building. Therefor, Valks et al. (2018) adds a fourth step to the three layers of IoT, defined by Chen et al. (2014), the potential of better (future) alignment of real estate with the organisational objectives. The principle and steps of a smart tool can be seen in Figure 5.3.



1. Collection of data
(Real-time) data collection with the use of raw data or sensors

2. Processing of data
Data has been added to the network (integrated platform) and has been processed in order to transform the data in to information

3. Provision of information
(Real-time) information is presented to the user or organisation with the use of a service or product in the form of an app or dashboard.

4. Future decision making
The provided (real-time) information create insights in better (future) alignment of real estate with the organisational objectives.

Figure 5.3: The principle and steps of a smart tool: improve the use of real estate with (real-time) information (own ill.)

5.4.1. Sensors

As explained in Figure 5.3, in order to provide (real-time) information, information has to be collected. This can be done by manually inserting information or by the use of sensors. The benefit of sensors is that they can collect (real-time) data without the interference of users. Valks et al. (2018) made in his research a list of sensors that collects data, which can be seen in Table 5.1. Valks et al. (2018) based this list of sensors on the research of utilisation collection technologies done by Serraview (2017), a research on indoor positioning methods by Mautz (2012), and his own research an international comparison of the use of smart tools on campuses. In his research Valks et al. (2018) focuses on the application for sensors the measure the use of space, however he mentions that sensors also can be used for optimising comfort, finding a suitable workplace or colleague, and maximising performance. Furthermore, the application of sensors can be used for all building categories mentioned in Figure 5.2.

Sensor type	Sensor description
Wi-Fi	The Wi-Fi network can be used as a sensor or as a grid of sensors. With the use of WiFi there can be estimated how many people are in the building or in the near environment of the building. This can be done in two ways, the first is by the amount of unique devices connected to the Wi-Fi acces points and the second is by the amount of devices trying to connect to all the Wi-Fi access points.
Bluetooth	Bluetooth is based on the same principle as Wi-Fi, however it transmits data over a shorter distance. Bluetooth is less able to penetrate walls than Wi-Fi and therefore more often used smaller areas. A method to measure the precense of people in a room is with the use of iBeacons. This is done by placing small devices (iBeacons) in space which connects with bluetooth enabled devices of people in the room. The position of people can be triangulated by the use of mutible iBeacons in a room.
RIFD	The RFID or Radio Frequency IDentification is a system that consists of two elements; a chip that contains information (receiver) and a reading device (transmitter). The measurement of the amount of people is based on the system of granting access to the building. By measuring the amount of check ins, a clear estimation of the space use can be given. The advantace of RIFD is that the receiver part of the system is passive and can therefore also be used to track products and equipment.
Cameras	Cameras can also measure the use of space, wherby two types of cameras can be distinguised which are infrared and video cameras. An infrared camera can only register objects that radiate heat and estimates makes an estimation based on that. While video cameras can be used in situation with enough light to register the amount of people in an area. For both methods not the camera, but software intepretates the data and measures the amount of people.

Infrared	The use of infrared (IR) sensors can be divided in two different types; Active (AIR) and Passive (PIR). The first type using AIR can be for example used to measure people passing by at the entrance of a building. While the second type using PIR in for example lighting systems, where the PIR sensor activates the light when it registers a movement. This way of measuring is however really limited due to the frequency of the measurements. One other use PIR sensors to measure the presence of people is putting a PIR sensor beneath the desk, which registers when a person gets seated and stands up.
Use of devices	The amount of used devices gives an indication of the amount of people present in a building, wing or even room. Devices can be computers, but also the abore mentioned mobile devices, pager, pin terminals and e.g.
Ultra-wideband	Ultra-WideBand (UWB) is comparable with RIFD, but enables a wireless transmission of data between devices over large distance. So in contradiction to RIFD it is not hindered by doors and walls. In real estate this type of sensor is not (yet) been use a lot, however in logistics it is a really common sensor.
CO2 sensors	Measuring the CO2 concentration of a room gives an estimation of the number of users in a particular area. However, there is always a delay in the in the measurement because the CO2 levels rise graduatly, so the measurement is not real-time and accurate.

Table 5.1: List of sensors that collect (real-time) information in buildings (derived from Valks et al., 2018)

5.4.2. Added value of smart tools

As stated in the above sections, smart tools have the potential to provide information for the alignment of real estate with the organisational objectives. The alignment of demand and supply is exactly what the purpose of CREM is. Furthermore, every real estate decision should add value to the organisation, and so should every technological investment. Additionally, because the smart tools need to add value to the organisation, they should be aligned with the perspectives and objectives of the organisation on real estate as shown in Table 4.1. This view is supported by Buckman et al. (2014) who states that the connection of smart building and their potential added values as: smart buildings will lead to improving drivers for progression in the built environment, drivers being energy and efficiency, longevity, comfort and satisfaction. Moreover, overtime the continuesly increasing amount of information from this wider range of sources will allow these systems to be more adaptable and add more value to the organisation.

5.5. Examples of smart tools in hospitals

In this section some of the different available smart tools are explored. With that said, the integration of smart tools is nihil in hospitals in the Netherlands. Certainly, when comparing to other sectors like the office sector and this means that there are no real solutions yet implemented in the healthcare sector concerning flexible working. There are only solution concerning the logistics flows and tracking materials in a hospital. This is explainable, because in the office sector is flex working to a much broader extent possible than that it is in the healthcare sector. The Smart Tools below are used for helping the patient and their experience in the hospital but could potentially be used to improve the efficiency of outpatient departments and are therefore included in the research.

5.5.1. Kiosk

The least smart solution is the touch-screen kiosk. In this kiosk the destination can be entered and an animation of the route in short segments is shown. Followed by a static overview of the complete route (Figure 5.4). According to the research Wright et al. (2010) the kiosk was mostly used by new patients and even new employees.
The downside is that patients need to know where to go upfront, in the Maastricht UMC+ a sign-in system is in use for patients with an appointment. This kiosk will print out a personalised route after signing in. The benefit of this type of kiosk is that there is no need to know the exact room number and the room (number) can change even within a view minutes of the check-in of the patient. However, after the check-in the services is static and not smart anymore.

Figure 5.4: Example of a kiosk in a hospital environment (derived from (Landro, 2014)

5.5.2. Smart signs

Traditionally patients are guided by static signs and symbols in the hospital. According to Smartsigns (n.d.) this way of guiding can be more personalised and smarter, with the use of smart signs. Smart signing goes further than only providing a personalised route. First, patients and visitors are welcomed at each entrance via a Welcome Display and recognized by a tag in the personal pound card or the invitation letter. The patient then receives appropriate information, such as a first route instruction, the average duration to the waiting room and whether there is a run-off in the doctor's schedule. Arriving in the waiting room, a Waiting Room Display welcomes patients in a friendly manner and informs them of the doctors on duty. Every patient receives a clear message when the doctor calls him / her to come to the treatment room. This call is accompanied by a directional indication. Informative Consulting Room Signs confirm that the patient is in the right room (Smartsigns, n.d.).

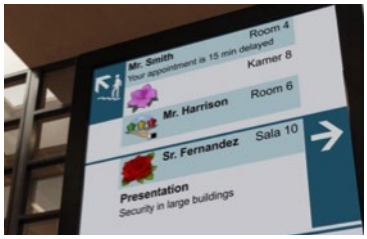


Figure 5.5: Example of smart signs (derived from Smartsigns, n.d.)

5.5.3. Mobile applications

In a research done by Aruba Networks (2014) in the Boston Children's Hospital a mobile application was used to improve the wayfinding and overall user experience. The application not only provided turn-by-turn directions, but also acted as a concierge (Figure 5.6). The patients were able to look up who clinicians are and their specialisations and where their offices are located. Furthermore, according to Aruba Networks (2014) the application was also capable to reroute patients when an elevator was closed without the patients ever knowing that the elevator was out of order. Additionally, the application has the ability to showcase all the resources of the hospital, such as a day-care or counselling, which patients may otherwise not have been aware of (Aruba Networks, 2014).

Additionally, patient notifications can help to reduce missed appointments and can provide the patient with new or update information, which can help to better find their way in the hospital (Gurol-Urganci, de Jongh, Vodopivec-Jamsek, Atun, & Car, 2013).

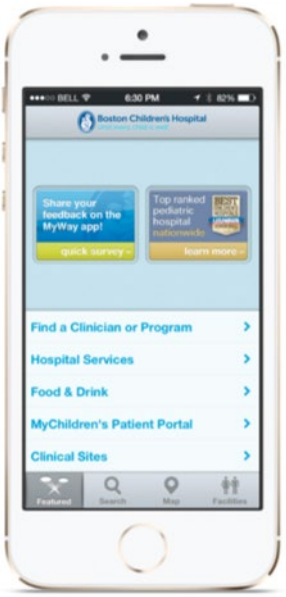


Figure 5.6: Example of a mobile application (derived from Aruba, 2014)

5.5.4. Tracking of users in the hospital

Prentow, Ruiz-Ruiz, Blunck, Stisen, and Kjærgaard (2015) researched user flows in a hospital complex in Aarhus, Denmark. They were able to track people entering and exiting the different buildings of the hospital complex. This research was done in order to help the hospital with planning an keeping track of hospital activities.

These tools can potentially help medical specialists with a better planning and more effective use of their time and the available spaces at the outpatient department. However, these tools would only assist and not solve the core problem.

5.6. Conclusions

Objective	Define the principle of a smart tool Understand the relationship between a smart tool and real estate management.
Questions	What are smart tools? How are smart tools related to real estate management?
Method	Literature study

The goal of this chapter is to understand what a smart tool is and how smart tools are related to real estate management. Based on the findings in the second chapter, the following conclusions can be drawn:

Definition of a smart tool and relation with real estate management

- There are four levels of capabilities of smart tools, monitoring, control, optimisation, and autonomy.
- A smart tool can be defined as a product or service which provides the user or organisation with (real-time) information.
- Smart tools are part of the greater network of IoT, which consists of sensing (data collection), network (data processing), and application (data provision)
- The information received in the application step can be used to influence the user or organisation's (accomodation) decision-making short and long term basis.
- Smart tools can add value to the organisation when they are aligned with the perspectives and objectives of the organisation.
- By adding sensors, connecting network infrastructures and adding applications you can make the building communicate with users and managers and save energy, better support your users and use your building more efficiently.

PART III
PRACTICES

6. Case studies

This part contains the empirical part of the research, containing the case studies of four Dutch hospitals. Firstly, the selection of the cases is explained and introduced. After this, the individual cases are introduced and analysed. From this the needed functionalities for smart tools are assessed, explained and analysed.

6.1. Case selection

Collecting information with the use of a case study is a method to obtain knowledge for the empirical part of a research. The objective for doing case studies is to gather relevant information about the needed functionalities for smart tools in the outpatient department of hospitals.

6.1.1. Selection procedure

The cases selected for this qualitative research, done with purposive sampling, meet the following requirements:

- The selected outpatient department must be situated in a general hospital, being the most common hospital in the Netherlands. However, it cannot be an Academic hospital, because these hospitals have different standards, budgets and purpose towards the outpatient departments.
- The organisations should be open to the approach of the study of more flexible, effective and efficient outpatient department from a user perspective.
- The organisations should be willing and able to give insight in the possibilities of the current ICT infrastructure and real estate possibilities.

Based upon these criteria, cases were selected. For the selection of the cases the network of Cure+Care consultancy was used. The selected cases are:

Alrijne ziekenhuis — Martini Ziekenhuis — meander MEDISCH CENTRUM — Rode Kruis Ziekenhuis Medisch Specialistische Zorg

Leiderdorp	2005-2006	45.000 m2	Groningen	1979 / 2007	~100.000 m2	Amersfoort	2010-2013	112.000 m2	Beverwijk	1974 / 1995	40.000 m2

6.1.2. Data collection

For the data collection are semi-structured interviews are used. The selection of the interviewees for the data collection within the outpatient department is done using criterion sampling. The selected participants are facility managers, for the organisations side, and outpatient department managers, for the user side.

Semi-structured interviews

For gathering the different preferences, a qualitative interview will be used. This is because with a qualitative interview is there a much greater interest in the interviewee's point of view (Bryman, 2015). Furthermore, Bryman (2015) states that when there is a clear focus on what to research it is likely that the interviews will be semi-structured interviews. This will be the basis for the data collection of this research. However, in qualitative interviews it is important that there is enough leeway possible in

the answers of the interviewee's and the order of questions and the way questions are asked can be altered during the interview (Bryman, 2015). This is important to capture the real preferences defined by the interviewee's not the interviewer. The interview protocols used in this research can be find in Appendix A and B.

6.1.3. Data analysis

For the data analysis, the template smart tools from the research Valks et al. (2016) has been used. The template can be found in appendix C. Which topics are used, how these topics are collected and by whom the information is collected can be seen in Table 6.1, shown below.

Which topic	How collected	By whom
Potential optimisations	Derived from interview	Interviewee
Why: objectives	Derived from interview	Interviewee
Why: goals (strategic, functional, financial, physical)	List of added values present during interviews	Interviewee
What: measurement (frequency, occupancy, identity, activity)	Derived from mentioned objectives	Own input
How: measurement (manual, booking, sensors)	Output from interviews and derived from mentioned objectives	Interviewee and own input
User information (user, management)	Derived from interview and mentioned objectives	Interviewee and own input
Acces level (management, support, users, open access)	Derived from mentioned objectives	Interviewee and own input
Current implementation (not implemented, limited implementation, implemented)	Derived from interview	Interviewee

Table 6.1: Explanation data analysis (Own illustration)

6.2. Cases

In this section the individual cases will be introduced and analysed. Every case starts with a case description. Followed by an analysis of the physical aspects of the building. Then the organisation and culture are explained. Next the potential optimisations is gathered. Lastly, if there are sensors used in the building, this the place that they will be mentioned, and the building management and facility management systems are explained.

6.2.1. Alrijne Hospital

Location	Leiderdorp	Construction year	2005-2006	Scale	45.000 m²

Figure 6.1: Alrijne hospital (AVD, n.d.)

Case description

The start of this hospital is at the end of the 19th century. In Leiden, people start to organise a hospital themselves to care for the sick, the elderly and the poor who cannot afford a doctor at home. Franciscan nuns start the Sint Elisabeth Hospital and the Protestant Diaconessenhuis is also opened. Sometime later in Alphen aan den Rijn the practice of Doctor Willem van Wermeskerken grows into a clinic and hospital in villa Rijnoord. Together with the nursing homes Leythenrode and Oudshoorn, these three historical initiatives form the backbone of the new organization of Alrijne Zorggroep in 2015. The rijne part of the name of the new health care group refers to the geographic hinterland, the region that connects the organisations and patients. The Al parts stands for all the care that we can and want to offer to all residents of the region (Alrijne Zorggroep, n.d.).

Building

The Alrijne healthcare group consists of 5 locations, Leiden, Leiderdorp, Alphen aan den Rijn, Katwijk and Sassenheim. This analysis is about the main location Leiderdorp, being approximately 45.000m2, and a relatively new building.

Organisation and culture

Although the hospitals have changed location, the number of beds has grown considerably and medical and nursing home care has improved spectacularly, the hospital organisation has still the same ideal: they believe that people will benefit from good care with personal attention. Many protocols have been developed in recent decades, making treatments more effective. However, standard treatment is not necessarily the best care for everyone. Alrijne wants and can always adjust their treatment method to the wishes and needs of the individual patient. In this way they combine the best of both worlds: good medical care with individual attention that makes the patient's life more pleasant.

However, Alrijne states that they are not there yet. The organisation is constantly learning and continues to develop. They learn from each other through the merger and work from the same conviction, but still use different methods in different hospitals. Alrijne is working on this and uses the 'best practices' of each organisation, to make their care become even better and that benefits their patients (Alrijne Zorggroep, n.d.). So currently there are still some organisational and cultural differences to overcome.

Potential optimisations

In this section the potential optimisations mentioned during interviews with Patricia van Hilten , Lisette van Aart and Chantal Schroder, on 22nd of August 2019, are gathered. The optimisations are described by the required objectives, goals, measurement (method), information, access levels and current level of implementation.

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Workflow							
Diagnostics	To make remote screening, diagnostics and checking on patients possible. This saves the patient with a trip to the hospital and saves the medical specialist precious time. It also can contribute to comparing results of different patients.	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation 4. Physical - improve flexibility	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	User: Information about the patient's health conditions, frequency of measurements and possible comparison with similar cases for better diagnostics. Management: Identity check of the patient. Information and feedback about use of the application.	Management, support, users	Not implemented
Finding workplace	To make the back-office more flexible and help with the employee satisfaction by helping the employees with a suitable place to work that fits their personal needs and activity.	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, improve culture 4. Physical - improve flexibility, reduce square metres	Occupancy	booking, sensors	User: Information about a suitable place to work that fits the personal needs and activity of the user. Management: Information about the usage of space and which type of workplaces are requested more often than others, the distance user have to travel to their desired work place and more. This can help with (future) accommodation decision-making.	Management, support, users	Not implemented
Digital forms	To make sure that the medical specialist can do his/her job as efficient as possible and connecting the data to the patients EPD saves even more time (in the future). Digital forms also make comparisons with other patients much easier.	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Increase innovation, improve culture 4. Physical -	identity	manual, booking	User: Gives the patient information about which information is required prior to an consult. It enables the medical specialist to receive the forms before an appointment, if there is need for additional information this can be requested upfront and helps with the efficiency and quality of the face to face consults. Management: Information about the patient and which type of question are found to be more difficult and require assistance. Results can also be compared to others for better provision of care and advice.	Management, support, users	Limited implementation (not integrated)
Finding colleague	To make the outpatient departments more flexible and enable employees to be deployed more flexibly throughout the hospital by helping colleagues to find each other.	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, improve culture 4. Physical - improve flexibility	Identity, activity	booking, sensors	User: Information about the whereabouts and availability of colleagues. Management: Information about the preferences of users and which places are more often used for collaboration and meeting up and information about work patterns of employees. This information can help with (future) accommodation decision-making.	Management, support, users	Management, support, users
Information (EPD)	To make al medical information digitally available to the patient and make it possible for the patient fill in and edit (missing) information.	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - increase innovation, improve culture 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking	User: Gives the patient information about their medical records and make it possible for the patient to fill in missing information or edit existing information. Provides the (current) medical specialist with the same information if the patient allows to share this information. Management: Identity check of the patient. Information and feedback about the use of the application.	Management, support, users	Implemented (not integrated)
Self measuring / controlling	To enable the patient perform self measuring / controlling with the help of e-health application. This can improve the frequency of the controls and more accurate measurements because the patient can be in do the measurements at home without a (stressful) hospital visit.	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	"User: Gives the patient information their health condition and when they need to do measurements (with the use of notifications or a personal phone call). Management: Identity check of the patient. Information and feedback about use of the application."	Management, support, users	Not implemented

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
E-consult	To have remote (video) contact with a patient. This can save the patient a trip to the hospital and can help with quick check-ups, even more so when combining with self measuring / controlling.	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility	Identity, (frequency, activity)	manual, sensors (when combined with self measuring / controlling)	User: Gives the patient the possibility to have a digital (face-to-face) consult without going to the hospital. Gives the medical specialist to have contact with the patient more frequently without the necessity to see the patient in real-life, work probably better in combination with self-measuring / controlling. Management: Identity check of the patient. Information and feedback about use of the application.	Management, support, users	Not implemented
Patient experience							
Information provision	To improve de communication to patients and provide the patient with information about waiting times and location of appointments. This is needed to improve the flexibility between the different outpatient departments	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - improve flexibility 4. Physical - improve flexibility	Occupancy	booking, (sensors)	User: General information about the hospital, information about their consult, waiting times, (waiting) locations, if their is still time to visit the hospital amenities, their doctor and more. Management: information about the patients waiting location and average waiting times. This provides insight in the waiting times of different departments and occupation of waiting rooms.	Management, support, users, open access	Limited implementation (not integrated)
Wayfinding	When making the different outpatient departments flexible throughout the day, meaning that in the morning a specialism occupies a certain space and in the afternoon a different specialism wayfinding becomes harder and support in wayfinding is therefor really important	1. Functional -Increase patient satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, improve flexibility 4. Physical - improve flexibility	Occupancy	sensors	User: information about the location of their consult, and other facilities and amenities of the hospital. And also information to guide the user to their destination. Management: Information about the occupancy of the building and which routes are more often used then others. This information can be used for future accommodation decision making.	Management, support, users, open access	Not implemented
Check-in	To make the check-in process smoother for the patient, to check the identity of the patient, to have less (higher educated) personnel, and to know that a patient has arrived.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs, control risks 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility	Occupancy, Identity	booking, (sensors)	User: Conformation of their appointment and the location of their consult. Management: Conformation of the patient's arrival and identity. Can also give information about the average arriving time before a consult, off course anonymously.	Management, support, users	Not implemented
Senior-service	The majority of patients are 60 plus and nowadays they are longer self sufficient. A senior service can offer a solution to this group. Patients are picked up at home and dropped off at the hospital. This would also address a large part of the parking problem. Where necessary, the patients can also be further guided in the process, the person who picks them up can help them during their whole visit and also during the consults with the doctor.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - controlling risks 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility	Identity	booking	User: information about the pick-up time (at home and hospital) and get supported during their visit. Management: Early information about the arrival and possible delays of the patient and information about travel times to the hospital in general.	Management, support, users	Not implemented
Utilisation of space							
Space use	To improve the flexible use of the building and to determine proper space use and utilisation and the space that can be rented or sold.	1. Functional - 2. Financial - controlling risks, improve financial position 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility, Reduce square metres	Occupancy	booking, sensors	Management: information about the usage and occupancy of space. Provides information for future accommodation decision-making.	Management, support	Not implemented
Maintenance / tracking of (medical) equipment	To keep track of all the (medical) equipment in the hospital, for what and when it is used and when it needs maintenance.	1. Functional - Improve productivity 2. Financial - controlling risks, reduce costs 3. Strategic - Increase innovation, improve flexibility 4. Physical - improve flexibility	Occupancy & Activity	booking, sensors	Management: information about the (medical) equipment in the hospital, where it is used, for what it is used, when it needs maintenance. This gives also input for the planning of appointments with patients that need to be planned around the maintenances or vice versa.	Management, support	Implemented (not integrated)

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Cleaning	To improve the effectiveness of the cleaning crew and provide the users with clean facilities at all times.	1. Functional - Increase patient satisfaction, increase employee satisfaction 2. Financial - controlling risks, reduce costs 3. Strategic - Increase innovation, improve flexibility 4. Physical - improve flexibility	Occupancy	booking, sensors	User: Users can give feedback about how clean a room is. Management: information about the usage of for example toilets, so they can be cleaned on the demand. Furthermore, the information can also be used for future accommodation decision-making.	Management, support, users	Not implemented

Table 6.2: Potential optimisations for Alrijne hospital (Own illustration)

Already used systems to build upon

Alrijne uses Ultimo as their facility management system, and they are currently adding all the spaces including equipment. For doorlocks Alrijne uses a system called Salto, that uses ID-cards of employees to give them access to specific places of the hospital. For the patient information system Alrijne uses HiX, also being their electronic patient dossier (EPD). Lastly, the building management system that Alrijne uses is called Kropman.

6.2.2. Martini hospital

Location	Construction year	Scale
Groningen	1979 / 2007	~100.000 m²

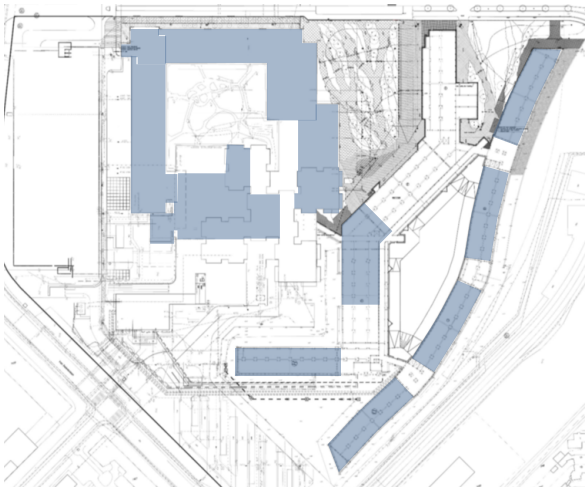
Figure 6.2: Martini hospital (SEED architects, 2013)

Case description

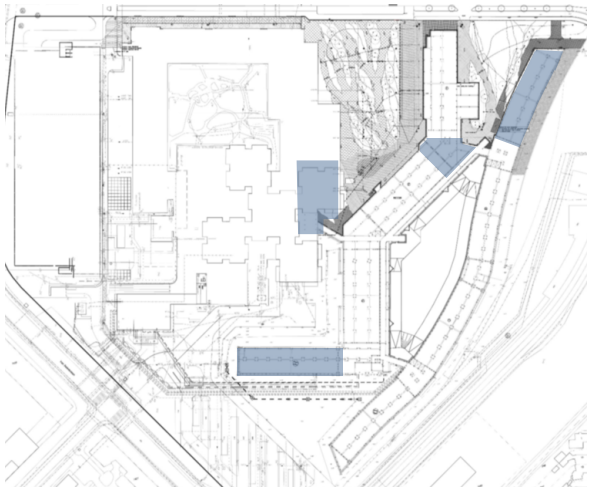
The Martini Hospital is a top clinical training hospital that distinguishes itself with a wide range of excellent medical specialistic care and several areas of expertise. Martini offers care in a hospitable environment and works closely with general practitioners and other care providers in the chain: together they strive for the best care. The care processes are organised efficiently, with the patient's request for care as a starting point. As a sustainable company, they are aware of their social responsibility and, among other things, invest in the sustainable employability of their professionals (Martini Ziekenhuis, n.d.).

Building

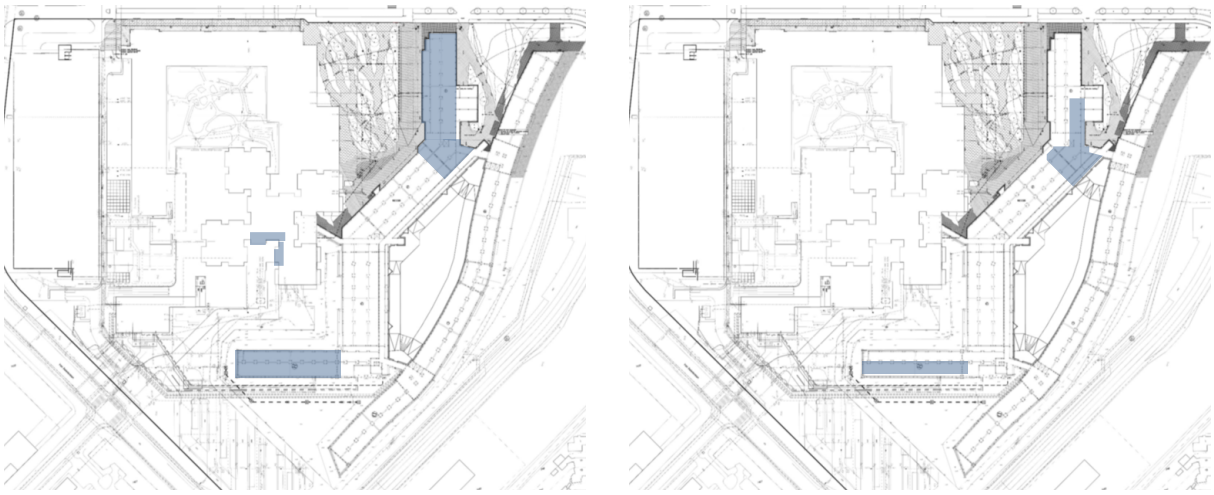
The building of the Martini Hospital consists of two parts, the old and new part. The old part consists of four towers, nowadays mainly housing the offices of the hospital, the hospital pharmacy and some outpatient departments on the ground floor. The new part of the hospital, built in 2007, consists of two snake-like buildings. Typical are the curved façade and the flexible concept. The industrial concept is based on standardisation. Both the building frame, consisting of uniform building blocks, and the facade panels and system walls are fully prefabricated (Martini Ziekenhuis, n.d.).



Ground floor



First floor



Second floor Third floor

Figure 6.3: Outpatient departments situated in Martini Hospital (Derived from Cure + Care Consultancy, 2019)

In the new building, an inpatient department can easily be converted into an outpatient department or office space. The construction concept leads to flexibility at all levels. An extension in form of a “drawer” can be added to the building. This offers the possibility to increase the floor area of the entire building by around ten percent, without structural modifications. The building is even designed and functionally arranged that, in twenty years’ time, it can serve as an office building. Furthermore, the outpatient rooms have standard dimensions, suitable for different specialisms (Martini Ziekenhuis, n.d.).

Almost all specialisms have their own outpatient department that are divided in a very traditional way. Few facilities are currently shared. There are strict walls and square meters in terms of ownership. Although, J. Nijhof, (personal communication, 15 July 2019) believes that in the future and in an ideal working environment functions of the different specialisms are shared, and that activity-based working can help with optimisation of space use. Furthermore, he believes that in the future there should be room for remote research, that can be two-way traffic, such as an e-consult or one way to assess digital questions. However, this also requires something for logistics, such spaces must also be within walking distance for the medical specialist. (J. Nijhof, personal communication, 15 July 2019).

Currently, Martini has 26 outpatient departments and in general these are traditionally laid out. They all have a waiting room with a counter and a treatment room and consultation room depending on the nature of the specialty. The examination rooms are general or rather specialised to support equipment questions. So that makes the exception and the flexibility in the outpatient department is rather specific to the research. For example, for ophthalmology you need a specific device, that device is then leading for the size of the room (J. Nijhof, personal communication, 15 July 2019).

According to J. Nijhof, (personal communication, 15 July 2019) some devices are mobile, but most specific devices are bolted down. This makes flexibility between specific outpatient departments more difficult. Although nowadays there is often a mobile version and he sees that mobility is increasing more and more. Therefor, it is perhaps not so much the question about the patient and the specialist coming together. But much more about how capacities and volumes relate to the future. How can you organise your scalability.

One of the issues within strategic real estate plans of Martini is about how Martini is going to organise the workplaces of specialists, at the moment being quite variable. Formally specialists are entitled to having a personal workplace in order to do their work nearby the treatment location. But according to J. Nijhof, (personal communication, 15 July 2019), that could be very generic, because administrative tasks are basic activities in terms of the facilitative requirements. Meaning that workplaces

lend themselves to be shared very well. When sharing facilities they should be in the vicinity of the outpatient department, it is not logical to make a specialist go out of the outpatient department for the use of a computer (J. Nijhof, personal communication, 15 July 2019).

Organisation and culture

J. Nijhof, (personal communication, 15 July 2019) emphasises that now many specialists have their own room, but this could be called a very expensive cloakroom. Because generally only in the early morning and in the afternoon the specialist is doing some work there, however, they want to be able to claim a place to work if necessary, but the occupation is super poor. Furthermore, there are soms changes noticable in some specialisms. However the changes in organisation and culture are a rather slow pace.

Potential optimisations

In this section the potential optimisations mentioned during interviews with Jos Nijhof (15 July 2019), Lars van der Ham (29 August 2019) and Martin de Vink (29 August 2019), are gathered. The optimisations are described by the required objectives, goals, measurement (method), information, access levels and current level of implementation.

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Workflow							
Diagnostics	To make remote checking on and diagnostics of patients possible. Safes time for both the patient and medical specialist and makes comparing results possible.	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	User: Information about the patient's health conditions, frequency of measurements and possible comparison with similar cases for better diagnostics. Management: Identity check of the patient. Information and feedback about use of the application.	Management, support, users	Not implemented
Finding workplace	To make the outpatient departments and their back-office more flexible and help the employees with a suitable place to work that fits their personal needs and activity.	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, improve culture 4. Physical - improve flexibility, reduce square metres	Occupancy, Activity	booking, sensors	User: Information a place to work that fits the personal needs and activity of the employee. Management: Information about the usage of space and which type of workplaces are requested more often than others, the distance a user has to travel to their desired work place and information about amount of time employees spent on certain tasks. This can help with (future) accommodation decision-making.	Management, support, users	Not implemented
Digital forms	To make providing information the hospital easier for patients and to make sure that the medical specialist can do his/her job as efficient as possible. Digital forms also make comparisons easier.	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Increase innovation, improve culture 4. Physical - -	identity	manual, booking	User: Gives the patient feedback about which information is required prior to an consult or the entire medical process. It enables the medical specialist to receive the forms before an appointment, if there is need for additional information this can be requested upfront and helps with the efficiency and quality of the face to face consults. Management: Information about the patient and which type of question are found to be more difficult and require assistance. Results can also be compared to others for better provision of care and advice.	Management, support, users	Limited implementation (not integrated)
Finding colleague	To make the outpatient departments more flexible, support cooperation between different outpatient departments and enable employees to be deployed more flexibly throughout the hospital by helping colleagues to find each other.	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, improve culture 4. Physical - improve flexibility	Identity, activity	booking, sensors	User: Information about the whereabouts, preferences of cooperation and availability of colleagues. Management: Information about the preferences of users and which places are more often used for collaboration and meeting up and information about work patterns of employees. This information can help with (future) accommodation decision-making.	Management, support, users	Not implemented

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Information (EPD)	To make al medical information digitally available to the patient and make it possible for the patient fill in and edit (missing) information.	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - increase innovation, improve culture 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking	User: Gives the patient information about their medical records and make it possible for the patient to fill in missing information or edit existing information. Provides the (current) medical specialist with the same information if the patient allows to share this information. Management: Identity check of the patient. Information and feedback about the use of the application.	Management, support, users	Implemented (not integrated)
Self measuring / controlling	To enable the patient perform self measuring / controlling with the help of e-health application. This can improve the frequency of the controls and more accurate measurements because the patient can be in do the measurements at home without a (stressful) hospital visit.	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	User: Gives the patient information their health condition without going to the hospital and when they need to do measurements (with the use of notifications or a personal phone call). This reduces the risks of being to late and improves the accuracy because the patient can to the measurements in a home environment. Management: Identity check of the patient. Information and feedback about use of the application.	Management, support, users	Not implemented
E-consult	To make consults for patients easier and for the medical specialist it can save time and check-ups can be scheduled more often, so better control of risks.	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - Controlling risks. 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility	Identity, (frequency, activity)	manual, sensors (when combined with self measuring / controlling)	User: Gives the patient the possibility to have a consult without going to the hospital. Gives the medical specialist to have contact / check-ups with the patient more frequently without the necessity to see the patient in real-life, work probably better in combination with self-measuring / controlling. Management: Identity check of the patient. Information and feedback about use of the application.	Management, support, users	Not implemented
Patient experience							
Information provision	To provide the patients with all the information they need when they need it in a digital environment.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility	Occupancy, Identity	booking	User: Information about their appointment, amenities of the hospital, treatments, medication and to plan new appointments. The user information differs per user (patient or visitor). Management: Information about the what information is important for the users and which functions are used the most.	Management, support, users, open access	Limited implementation (not integrated)
Wayfinding	To improve the routing in the hospital. currently the routing is done with the use of coloured signs which can be really confusing for patients. Furthermore, to improve the flexibility of the outpatient departments good wayfinding is necessary. At the moment the different outpatient departments are easy to recognise, but with standardised flexible outpatient departments this is no longer the case.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility	Occupancy	booking, sensors	User: information about the location of the consult and the best route to that location. Management: information about the routes people actually take in the hospital, can help with future accommodation decision-making.	Management, support, users, open access	Not implemented
Check-in	To decrease the amount of check-ins at different counters and also allows for central waiting near the hospital amenities and smaller decentral waiting areas	1. Functional -Increase patient satisfaction, Increase employee satisfaction 2. Financial - reduce costs 3. Strategic - Support image, increase innovation, improve culture 4. Physical - -	Occupancy, Identity	booking, sensors	User: information about the appointment, waiting times, where to wait and when to head to the consultation room. Management: information about the check-in and identity of the patient. Information about the occupancy of a central waiting area and the smaller decentral waiting areas.	Management, support, users	Not implemented

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Utilisation of space							
Space use	To take away the emotions and knowing by measuring and in the future even getting feedback of the building.	1. Functional -Increase flexibility 2. Financial - reduce costs 3. Strategic - Increase innovation 4. Physical - improve flexibility, reduce square metres	Occupancy, (activity)	booking, sensors	Management: Provides information about the occupancy and usage of the building, this helps with (future) accommodation decision-making. In the future the building knows how it is being used and gives recommendations to the user and management.	Management, support	Not implemented
Cleaning	To measure where it is busy, for example for toilet groups that are used more intensively. You want to clean those groups more intensively or you can relieve an area by creating extra toilet groups.	1. Functional -Increase flexibility, Increase patient satisfaction, increase employee satisfaction 2. Financial - reduce costs 3. Strategic - Increase innovation 4. Physical - improve flexibility, reduce square metres	Occupancy	sensors	Management: information about the usage of for example toilet groups. This helps with cleaning and (future) accommodation decision-making.	Management, support	Not implemented
Maintenance / tracking of equipment	To track the increasingly mobile (medical) equipment, to prevent things getting lost and help keeping track for maintenance	1. Functional -Increase flexibility 2. Financial - improves financial position, controls risks 3. Strategic - Increase innovation 4. Physical - improve flexibility	Occupancy, Activity	booking, sensors	Management: information about the whereabouts and status of equipment for maintenance.	Management, support, (users)	Not implemented

Table 6.3: Potential optimisations for Martini hospital (Own illustration)

Already used systems to build upon

Martini hospital uses Ultimo as enterprise asset and facility management system. With this facility management system Martini has the potential to control and be informed about everything that is going on in the building, however at the moment Martini only uses basis functionalities of Ultimo. These functionalities are reporting defects, requesting extra space and keeping track of equipment in rooms.

As building management system, Martini uses Siemens Desigo. With this building management system Martini can control the climate, lighting and all building systems from one dashboard.

6.2.3. Meander Medical Centre

Location	Construction year	Scale
Amersfoort	2010 - 2013	112.000 m^2

Figure 6.4: Meander Medical Centre(Atelier PRO, 2013)

Case description

Meander Medical Centre is a top clinical hospital and is a member of the Cooperating Top Clinical Training Hospitals (STZ). This means that Meander Medical Centre offers supra-regional facilities for research and treatment, has several expertise centres in house and does a lot of scientific research and education. Meander Medical Centre provides care to the more than 320,000 residents in the region (Meander MC, n.d.).

Building

Construction of the new hospital started in August 2010 and took three years to finish. According to the chairman of the board of directors Cees Meijers, is the result a place where Meander can bring the highest level of care and attention to their patients. The hospital has modern furnished single rooms with a private bathroom and sanitary facilities. This gives a lot of peace, space and privacy for the admitted patients. The hospital has a floor space of approximately 100,000 m2. It is a large building, but the highly functional design allows patients and visitors to find their way around the hospital. The hospital was designed by Atelier PRO architecture firm from The Hague. Patients and visitors can park their cars in the light and spacious parking garage under the building (Meander MC, n.d.).

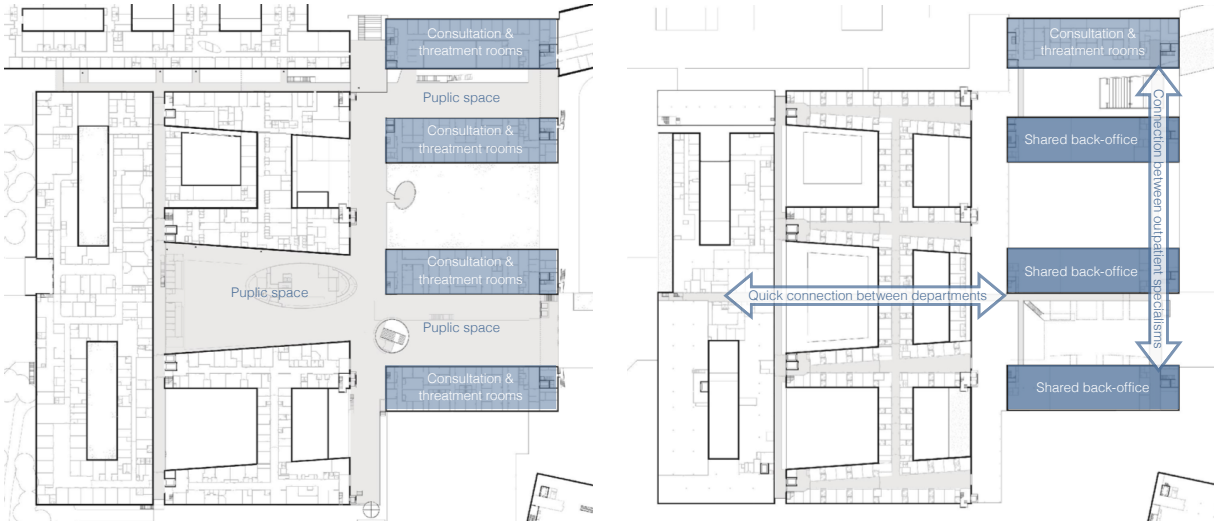


Figure 6.5: Floor plans Meander Medical Centre (Derived from: Atelier PRO, 2013)

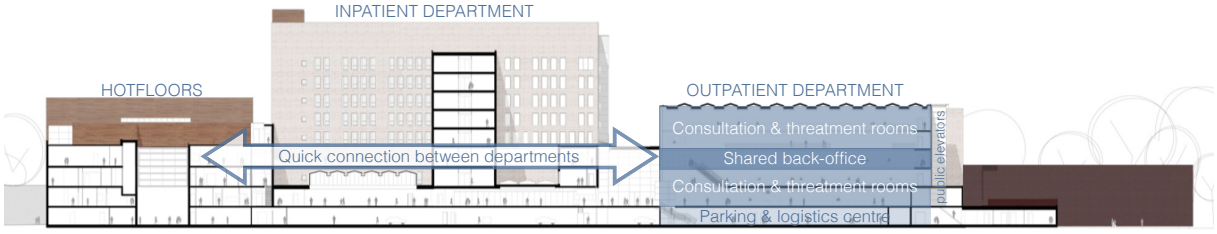


Figure 6.6: Section Meander Medical Centre (Derived from: Atelier PRO, 2013)

The logistic processes are all based on productivity. According to A. Trip (personal communication, 13 August 2019) was the question, how do we get the most out of the available functions? We are constantly working on that as an organisation. Efficiency has become the theme of this hospital. Logistics in particular, that is the basis for efficiency. The starting point for processes is that they should not disturb each other. This is possible because literally the physical support of the entire hospital takes place below the hospital (Figure 6.6). This also means that the transport of goods, such as the transport of beds, is separate from the transport of people. It may be that occasionally special instruments have been used at a gynaecology outpatient department and that they must be sterilised again. Then someone picks it up at the end of the day, via the special transport lift, without the patient noticing.

The design takes future extensibility and flexibility into account. For example, at the outpatient departments, extra space has been reserved for changes. This is done by placing small and large specialisms side by side. So that the larger specialism can displace the smaller one. But there are also possibilities for expansion in the form of annexes at the rear, in the same structure of the existing building. The elevators for patients are now at the end of the wing, but when the wing would be extended, they would be central in the wing. In addition, it is also possible to add more patient elevators at the same place (A. Trip, personal communication, 13 August 2019).

There is not a general standard developed for the outpatient departments. The standard has become quite customised to per specialism, wherein the method and special equipment are leading. For example, in cardiology, you always have a heart film measurement first. That means that the patient first must take an X-ray and have blood samples taken, you need specific spaces for this A. Trip, personal communication, 13 August 2019).

However, the consultation room or consultation / examination room is standardised for most

specialisms because that says something about the doctor's contract with the patient. A. Trip (personal communication, 13 August 2019) explains that there is always a table with a doctors chair, a computer and two patient chairs. That is the meeting place for doctors and patients. We have developed a standard for this, and half of the outpatient clinics are set up as standard. An exception is gynaecology, having a treatment chair instead of a treatment bench and a changing room for the patient. This makes this room larger than the standard room. Within the non-standard specialisms, a standard has been made, for example gynaecology has 8 standardised rooms (A. Trip, personal communication, 13 August 2019).

The back office is organised on the second floor. This layer is located between the outpatient departments (Figure 6.5). A transport corridor has also been made on this floor, with bridges to other departments. They ensure that there are short walking lines. Specialists use the back office as a base and never have to climb more than one or two stairs to a department. Department meetings takes place in the back office, as do training courses (A. Trip, personal communication, 13 August 2019).

Each department has its own office space. For example, within the specialism internal medicine there are 14 specialists and there are therefore 14 workplaces with computers. At these workplaces the specialists have access to patient records and can make calls with patients. Each department also has a multifunctional space, where, for example, the morning start can take place. There are also meeting rooms available that everyone can book within Meander. That can therefore also be the board of directors, for example. Although, the back office is empty for a very large part of the day, the examination rooms are used much more efficiently by separating these functions (A. Trip, personal communication, 13 August 2019).

Organisation and culture

A. Trip (personal communication, 13 August 2019) explains that culture has to do with two things, it has to do with how the people themselves are. They choose an organisation because it appeals to them and that they want to work there. The organization chooses people because they think they fit into that organisation. But changes in culture, that is a bit more difficult. Because you started working at a hospital for a certain culture. It could be that culture changes and of course it changes over time, other people come in, new ideas develop, new strategies emerge, new social developments happen, and we must go along with societal changes. Moreover, A. Trip (personal communication, 13 August 2019) states that it only becomes difficult when the culture change is too great. For example, suppose we would like to create different types of outpatient departments in an existing situation. However, we were able to make that cultural change with the help of the new building. Because initially all doctors were the owners of the consultation room, but six years ago we took the position that patients in the new building own the consultation room. The doctor visits the patient.

Potential optimisations

In this section the potential optimisations mentioned during interview with Albert Trip (13 august 2019) are gathered. The optimisations are described by the required objectives, goals, measurement (method), information, access levels and current level of implementation.

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Workflow							
Finding workplace	To improve the use of the shared back-office facilities.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, Increase innovation, improve culture 4. Physical - improve flexibility	Occupancy, Activity	booking, sensors	User: information about available spaces to book for work or meetings. Management: Information about the usage of the building and shared back-office facilities. Provides also feedback on the demand for which type of work place there is.	Management, support, users	Not implemented
Diagnostics	To keep track of the patients health and to compare their results with others to control risks and to provide better care.	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	User: provides the medical specialist with information about the health conditions of patients. Management: Provides insight in who their patients are and when they will be expected to go to the hospital. Gives opportunities to foresee peak moments.	Management, support, users	Not implemented
Digital forms	To make it easier for patients to fill in forms and it enables patients to deliver their information before the having a consult, saves time during consults.	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation 4. Physical - -	Identity	manual	User: information for the patient about what is needed from them for the hospital. This information can be used for the medical specialist to better prepare for consults and make their work more efficient. Management: Information about their patients, can be compared to provide better care.	Management, support, users	Limited implementation (not integrated)
Finding colleague	To improve the flexible use of the facilities and make it easier to find colleagues who are working throughout the hospital.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, Increase innovation, improve culture 4. Physical - improve flexibility	Identity, activity	manual, booking, sensors	User: information about the whereabouts of colleagues. Management: information about the whereabouts of their employees in case of an emergency and usage of the hospital / outpatient department in general.	Management, support, users	Not implemented
Information (EPD)	To provide one place to patients where they can find all their health care information and where they can provide this information to the hospitals.	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking	User: Patient's health care information available for the patients and the health care providers. Management: Information about the patient, including healthcare information. This can help to make the hospital more flexible.	Management, support, users	Implemented (not integrated)
Self measuring / controlling	To make it easier for patients to keep track of their health and to provide medical specialists with their health data to control risks.	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	User: Provides the patient with information about their health conditions, required measurements and can give reminders in case a patient forgets to do their measurement. This helps the medical specialist with remotely keeping track of the health conditions of patients and in this way control the risks. Management: Information about their patients health conditions and patient result can be compared, can help with providing better care.	Management, support, users	Not implemented
Patient experience							
Information provision	To provide patients and visitors with more personalised information about everything that is connected to a visit to the hospital.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, Increase innovation 4. Physical - improve flexibility	Occupancy, (Identity)	booking	User: Personalised information about the hospital, their appointment, receipts, medication, test results and treatment processes. Management: information about which information is more useful than others and which amenities or functions are looked up more than others.	Management, support, users, open access	Limited implementation (not integrated)

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Wayfinding	To help patients and visitors navigate through the hospital in a more personalised way. In the future it can also be used to stimulate people that need to rehabilitate to take the stairs or different route through the hospital with a nice outside view.	1. Functional -Increase patient satisfaction 2. Financial - - 3. Strategic - Support image, improve flexibility 4. Physical - improve flexibility	Occupancy, (Identity)	booking, sensors	User: information about which route to take depending on the mobility of the patient or visitor. Management: information about which routes patients and visitors really take and if less mobile patients and visitors are really led to elevators instead of stairs.	Management, support, users, open access	Limited implementation (not integrated)
Check-in	To improve the identification process of the patient, saves time for the medical specialist, and at the same time can give the patient information about which waiting area they are expected to be. It can also give the patient feedback if the patient has not yet filled in the digital questionnaire for the consult and direct the patient to someone who can help them.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image 4. Physical - improve flexibility	Identity	Booking, sensors	User: information about their appointment and if all the requirements before the appointment are met. Management: Check-in and identification of the patient.	Management, support, users	Not implemented
Utilisation of space							
Space use	To improve the standardisation and flexibility between outpatient departments and create an insight in utilisation of for example the shared back office or meeting rooms.	1. Functional -Increase flexibility 2. Financial - reduce costs 3. Strategic - Increase innovation, increase flexibility 4. Physical - improve flexibility, reduce square metres	Occupancy, (activity)	booking, sensors	User: Information about available (meeting)rooms. Management: information about the utilisation of space to improve the standardisation and flexibility between outpatient departments and a shared backoffice	Management, support, users	Not implemented
Maintenance / tracking of equipment	To keep track of the use of equipment, maintenance of equipment and replacement of equipment	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - reduce costs, controlling risks 3. Strategic - Support image, increase innovation 4. Physical - -	Occupancy, Activity	Booking, sensors	Management: information about the use, maintenance and replacements of equipment	Management, support	Not implemented

Table 6.4: Potential optimisations for Meander medical centre (Own illustration)

Already used systems to build upon

As enterprise asset and facility management system, Meander uses Ultimo. According to A. Trip (personal communication, 13 August 2019) registers Ultimo all requests for, for example, broken devices that need to be checked or space available for meetings. What is not registered via Ultimo and I personally think that is a shame is the consultation hour planning. There is no standard for that either. This is managed separately per outpatient department. I would rather standardise this so that I get a measurable overview.

Now only a request for space is submitted through Ultimo. At that moment the process starts, where does this application come from, where is space needed and why is space needed. The physical measurements start from here with looking at how the space is being utilised. For example, if there is less utilisation of the space on Thursdays and Fridays, then the department must change that first before they get extra space. All the measurements are done manual and only done when a request comes in.

As building management system, Meander uses Honeywell Enterprise Buildings Integrator (EBI). With this building management system Meander can control the climate, lighting and all building systems from one dashboard. This is for example used when an outpatient department wants to have an evening shift and at their part of the hospital needs to have lights on and climate working. Again, the request for changes are done through Ultimo (A. Trip, personal communication, 13 August 2019).

6.2.4. Rode Kruis Hospital

Location	Beverwijk	Construction year	1973 / 1993	Scale	40.000 m²

Figure 6.7: Rode Kruis hospital (Aerophoto Schiphol, 2013)

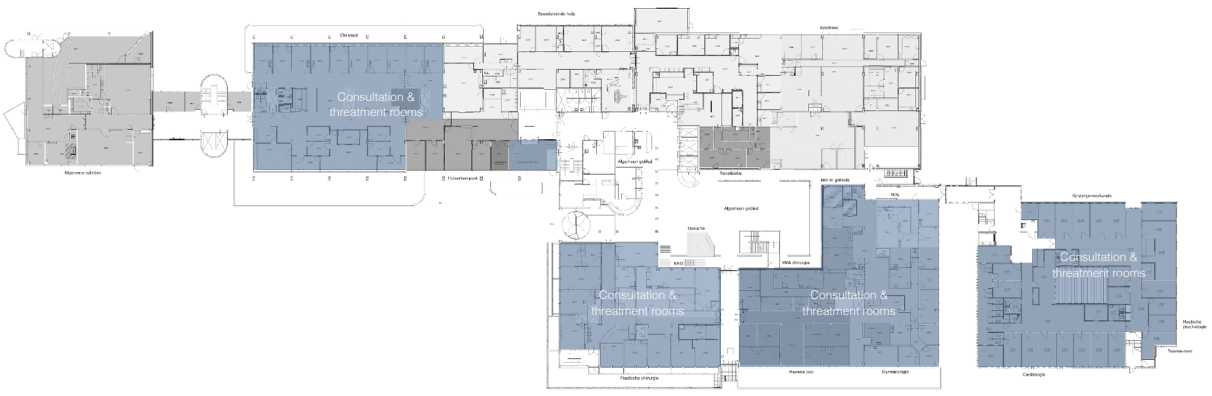
Case description

In the 1980s, a merger was initiated between the Rode Kuis ziekenhuis and the Sint Jozef Ziekenhuis on instructions of the government. The total number of beds must be reduced from 502 to 375. The merger leads to a lot of emotion, but the government does not yield. In 1988 the merger became a reality and both hospitals became known as the Rode Kruis Hospital Foundation. The Rode Kruis Ziekenhuis had two locations for about five years, but since 1993 all activities are located in Beverwijk. An outpatient department still exists in Heemskerk(Rode Kuis Ziekenhuis, n.d.).

The Rode Kruis Ziekenhuis is a medium-sized general hospital for the IJmond region and is part of the Zorg van de Zaak network. The centre for flesh burns of the Rode Kruis Ziekenhuis is at the national and international top. The Rode Kruis Ziekenhuis has 275 beds and around 1,450 people work there. Furthermore, hundreds of volunteers support healthcare staff (Rode Kuis Ziekenhuis, n.d.).

Building

The building of the Rode Kruis Ziekenhuis has grown over the years. The different parts of the hospital that are built in different time periods all have different style and appearance. This ‘organic’ growth of the hospital has also led to the fact that the outpatient departments are situated throughout two layers of the hospital and lack uniformity. The locations of the outpatient department can be seen in Figure 6.8.



Ground floor

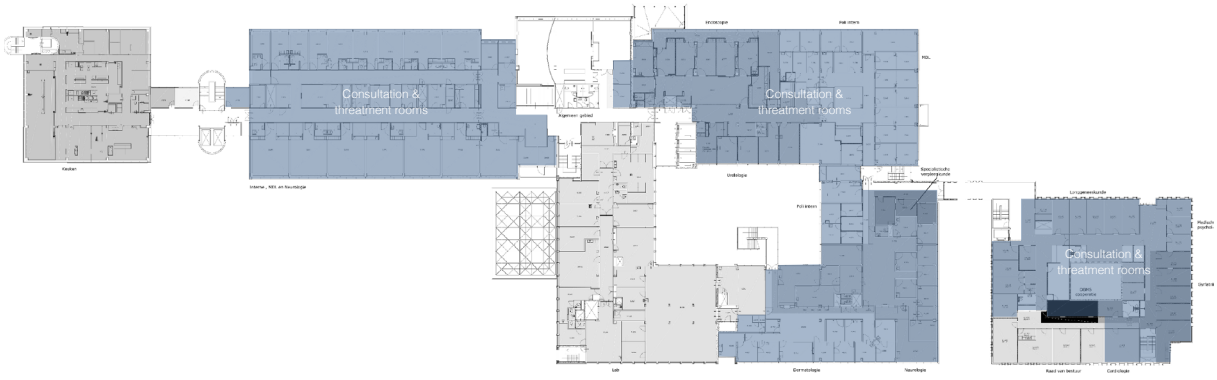


Figure 6.8: Floorplans Rode Kruis hospital (Derived from: Leeuwenkamp Architecten, 2018)

Organisation and culture

According to the Rode Kruis Ziekenhuis patients are always central. They always want to improve the quality of care and to offer the most complete possible package of professional care. That is why we work closely with general practitioners, home care, nursing homes and other care organizations in the region (Rode Kuis Ziekenhuis, n.d.). However, the organisation has dealt with a lot of financial troubles throughout its existence. This is noticeable when walking in the hospital, the hospital is missing uniformity in its appearance within the different outpatient departments and they are clearly behind on big maintenances.

Potential optimisations

In this section the potential optimisations mentioned during interviews with Mariska Lute, Jeroen Medendorp and Ingeborg Beers, on 2 July 2019, are gathered. The optimisations are described by the required objectives, goals, measurement (method), information, access levels and current level of implementation.

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Workflow							
Finding workplace	To improve the utilisation of the available space and to get insight in the actual utilisation of space.	1. Functional - improve employee satisfaction, improve productivity 2. Financial - Reduce costs 3. Strategic - Improve culture 4. Physical - reduce square metres, improve flexibility	Occupancy	booking, sensors	User: Information about where a work place is available. Management: information about the usage of space and helps dealing with space demand in a situation where space is scarce.	Management, support, users	Not implemented
Finding colleague	To help with finding colleagues when promoting the finding workplace optimisation to improve the utilisation of the available space.	1. Functional - improve employee satisfaction, improve productivity 2. Financial - Reduce costs 3. Strategic - Improve culture 4. Physical - reduce square metres, improve flexibility	Identity, occupancy	manual, booking	"User: Information about the whereabouts of colleagues when introducing a more flexible way of working. Management: information about the walking distances to a suitable place to work for employees."	Management, support, users	Not implemented
Diagnostics	To analyse the self measuring / controlling of the patients. This also enables the medical specialist to compare results and have results before a consult.	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	User: information about the medical condition and self measurements of patients.	Management, support, users	Not implemented

Potential optimisations	Why: Objectives	Why: goals (Strategic, Functional, Financial, Physical)	What: measurement (Frequency, Occupancy, Identity, Activity	How: measurement method (Manual, Booking, Sensors)	User information	Access level (Management, Support, Users, Open access)	Current implementation
Digital forms	To enable patient to fill in the forms digitally, which has an additional advantage of making it possible for the medical specialist to work more efficient.	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -	Identity	manual	User: Information about what the hospital requires from the patient. This information is because of the digital nature also earlier available for medical specialists.	Management, support, users	Limited implementation (not integrated)
Information (EPD)	To provide the patient with its medical information digitally, which leads to better patient satisfaction.	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	User: Medical information about the patient available to the patients and medical specialists. Management: Information about the hospital's patients.	Management, support, users	Implemented (not integrated)
Self measuring / controlling	To enable patients to do health controls at home. This improves the quality of the results, because the patient is in a safe environment (without stress).	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -	Frequency, identity, activity (patient's health conditions)	manual, booking, sensors	User: information for the patients about their medical conditions and which self measurements can be performed at home.	Management, support, users	Not implemented
Patient experience							
Information provision	To provide patients and visitors with better and more actual information about the (openings hours of) outpatient departments, appointments and waiting times.	1. Functional -Increase patient satisfaction, improve employee satisfaction, improve productivity 2. Financial - Reduce costs 3. Strategic - Support image, improve culture, increase innovation 4. Physical - -	Occupancy	booking	User: information about the openings hours of the different outpatient departments, waiting times, appointment. Management: Frequency of checked info, which information is more useful than others.	Management, support, users, open access	Limited implementation (not integrated)
Wayfinding	To improve the wayfinding in the hospital, this is needed because the hospital has changed several times over the years and can be quite difficult to navigate through for patients and visitors.	1. Functional -Increase patient satisfaction, improve productivity 2. Financial - - 3. Strategic - Support image, improve culture, increase innovation 4. Physical - -	Occupancy	sensors	User: Information about where which outpatient department is in the hospital and how to get their. Management: Gives information about the usage and occupation of the building and can support future accommodation decision making.	Management, support, users, open access	Not implemented (was but canceled)
Check-in	To have an alternative for patients to also check-in digitally or with the use of a kiosk. This not only speedup the check-in process, but also helps reduce the work pressure on employees.	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - Controlling risks, reduce costs 3. Strategic - Support image, increase innovation 4. Physical - -	Identity	Booking, (sensors)	User: Information about check-in and location and time of appointment. Management: information about identity and check-in of the patient. Gives information about the preferences of the patient if normal check-in also is monitored.	Management, support, users	Limited implementation (not integrated)
Utilisation of space							
Space use	To measure the actual use of space to support accommodation decision-making and eliminated the emotional discussion about space.	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks, reduce costs, improve financial position 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - Improve flexibility	Frequency, Occupancy	Booking, sensors	Management: information about the actual use of space.	Management	Not implemented
Maintenance / tracking of equipment	To decrease the amount of equipment that gets lost.	1. Functional - Increase employee satisfaction 2. Financial - Controlling risks, reduce costs 3. Strategic - - 4. Physical - -	Occupancy	sensors	Management (Support): information about the whereabouts of equipment	Management, support	Not implemented

Table 6.5: Potential optimisations for Rode Kruis hospital (Own illustration)

6.3. Comparing the potential optimisations

Based on the results of the interviews of the four cases, foureen different potential optimisations have been defined. The fourteen potential optimisations are illustrated in the next sections and ordered from most important to nice to have. The assessment of the different potential optimisations is based on the structure as used in the research of Valks et al. (2016).

6.3.1. Diagnostics

Diagnostics was mentioned to most during all the interviewes by all the interviewees as the one with the greatest potential for optimisation. L. van Aart (personal communication, 22 August 2019) explains that there is a lot of pressure on the outpatient departments. Not only are there a lot of consults planned with patients, patients also have to do regular check-ups. These check-ups take a lot of time while being fairly simple procedures. These procedures could take place somewhere else or potenially be done with the use of ehealth technologies. Moving the check-ups to another location does not solve the problem, but only moves the problem. While, using ehealth technologies and enabling patients to do own check-ups with the use of for example a smart watch leads to less presure on the outpatient departments. J. Nijhof (personal communication, 14 July 2019) adds that when enabling patients to do their own check-ups, (remote) diagnostics still are necessary. Although, these diagnostics do not have to take place in the consulting rooms of the outpatient department. These remote diagnostics can be performed location indepent by medical specialists in for example the back-office of the outpatient department. This is something that has not yet been developed, but is certainly interesting for the future. This also means that self measuring by patients need to be supported in the future.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To make remote screening, diagnostics and checking on patients possible. This saves the patient with a trip to the hospital and saves the medical specialist precious time. It also can contribute to comparing results of different patients.	To make remote checking on and diagnostics of patients possible. Safes time for both the patient and medical specialist and makes comparing results possible.	To keep track of the patients health and to compare their results with others to control risks and to provide better care.	To analyse the self measuring / controlling of the patients. This also enables the medical specialist to compare results and have results before a consult.	To make remote screening, diagnostics and checking on patients possible. This saves the patient with a trip to the hospital and saves the medical specialist precious time. It also can contribute to comparing results of different patients.
Why: goals	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation 4. Physical - improve flexibility"	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation 4. Physical - -	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - improve flexibility
What: measurement	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)
How: measurement method	manual, booking, sensors	manual, booking, sensors	manual, booking, sensors	manual, booking, sensors	manual, booking, sensors
user information	User: Information about the patient's health conditions, frequency of measurements and possible comparison with similar cases for better diagnostics. Management: Identity check of the patient. Information and feedback about use of the application.	User: Information about the patient's health conditions, frequency of measurements and possible comparison with similar cases for better diagnostics. Management: Identity check of the patient. Information and feedback about use of the application.	User: provides the medical specialist with information about the health conditions of patients. Management: Provides insight in who their patients are and when they will be expected to go to the hospital. Gives opportunities to foresee peak moments.	User: information about the medical condition and self measurements of patients.	User: Information about the patient's health conditions, frequency of measurements and possible comparison with similar cases for better diagnostics. Management: Identity check of the patient. Information and feedback about use of the application.
access level	Management, support, users	Management, support, users	Management, support, users	Management, support, users	Management, support, users
Current implementation	Not implemented	Not implemented	Not implemented	Not implemented	Not implemented

Table 6.6: Comparison of potential optimisation of diagnostics between cases (Own illustration)

6.3.2. Finding workplace

Finding a workplace was mentioned a lot of times as an issue when introducing a more flexible way of working in the back office. The reason why it ended up as second most important potential optimisation has probably to do with the fact that most back offices are not flexible yet and this is seen as a potential problem. Furthermore, contributing to this ranking is also the fact that at the Meander Medical Centre it was only possible to interview the facility manager, who has a different scope as the medical related interviewees.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To make the back-office more flexible and help with the employee satisfaction by helping the employees with a suitable place to work that fits their personal needs and activity.	To make the outpatient departments and their back-office more flexible and help the employees with a suitable place to work that fits their personal needs and activity.	To improve the use of the shared back-office facilities.	To improve the utilisation of the available space and to get insight in the actual utilisation of space.	To make the outpatient departments and their back-offices more flexible and help the employees with finding a suitable place to work that fits there personal needs and their current activity.
Why: goals	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, improve culture 4. Physical - improve flexibility, reduce square metres	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, improve culture 4. Physical - improve flexibility, reduce square metres	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, Increase innovation, improve culture 4. Physical - improve flexibility	1. Functional - improve employee satisfaction, improve productivity 2. Financial - Reduce costs 3. Strategic - Improve culture 4. Physical - reduce square metres, improve flexibility	1. Functional - improve employee satisfaction, improve productivity 2. Financial - Controlling risks, reduce costs 3. Strategic - Improve culture, improve flexibility, increase innovation 4. Physical - improve flexibility, reduce square metres
What: measurement	Occupancy	Occupancy, Activity	Occupancy, Activity	Occupancy	Occupancy, activity
How: measurement method	booking, sensors	booking, sensors	booking, sensors	booking, sensors	booking, sensors
user information	User: Information about a suitable place to work that fits the personal needs and activity of the user. Management: Information about the usage of space and which type of workplaces are requested more often than others, the distance user have to travel to their desired work place and more. This can help with (future) accommodation decision-making.	"User: Information a place to work that fits the personal needs and activity of the employee. Management: Information about the usage of space and which type of workplaces are requested more often than others, the distance a user has to travel to their desired work place and information about amount of time employees spent on certain tasks. This can help with (future) accommodation decision-making.	User: information about available spaces to book for work or meetings. Management: Information about the usage of the building and shared back-office facilities. Provides also feedback on which demand for which type of work place there is.	User: Information about where a work place is available. Management: information about the usage of space and helps dealing with space demand in a situation where space is scarce.	User: Information a place to work that fits the personal needs and activity of the employee. Management: Information about the usage of space and which type of workplaces are requested more often than others, the distance a user has to travel to their desired work place and information about amount of time employees spent on certain tasks. This can help with (future) accommodation decision-making.
access level	Management, support, users	Management, support, users	Management, support, users	Management, support, users	Management, support, users
Current implementation	Not implemented	Not implemented	Not implemented	Not implemented	Not Implemented

Table 6.7: Comparison of potential optimisation of finding workplace between cases (Own illustration)

6.3.3. Digital forms

Digital forms is mentioned by all the interviewees as an important way for process optimisation. According to A. Trip (personal communication, 13 August 2019) the patient satisfaction and input for process optimisation is gather at this moment in time, with the use of forms that patients can fill in. Since a while the paper forms are replaced with a digital one. A. Trip (personal communication, 13 August 2019) mentions the information about waiting time has the potential to give a lot of information and can be coupled to the planning of a department, specialist or equipment. M. de Vink (personal communication, 29 August 2019) adds that digital forms improve the satisfaction with the hospital for a lot of patients and enables the medical specialist to have the information before the consult. Digital forms are currently implemented at all interviewed hospitals, although with limited implementation, meaning that the forms are not compared to provide better care and the information is in a seperated system.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To make sure that the medical specialist can do his/her job as efficient as possible and connecting the data to the patients EPD saves even more time (in the future). Digital forms also make comparisons with other patients much easier.	To make providing information the hospital easier for patients and to make sure that the medical specialist can do his/her job as efficient as possible. Digital forms also make comparisons easier.	To make it easier for patients to fill in forms and it enables patients to deliver their information before the having a consult, saves time during consults.	To enable patient to fill in the forms digitally, which has an additional advantage of making it possible for the medical specialist to work more efficient.	To make sure that the medical specialist can do his/her job as efficient as possible and connecting the data to the patients EPD saves even more time (in the future). Digital forms also make comparisons with other patients much easier.
Why: goals	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Increase innovation, improve culture 4. Physical - -	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Increase innovation, improve culture 4. Physical - -	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation 4. Physical - -	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks, reduce costs 3. Strategic - Improve culture, increase innovation 4. Physical - -
What: measurement	identity	identity	Identity	Identity	Identity
How: measurement method	manual, booking	manual, booking	manual	manual	manual, booking
user information	User: Gives the patient information about which information is required prior to an consult. It enables the medical specialist to receive the forms before an appointment, if there is need for additional information this can be requested upfront and helps with the efficiency and quality of the face to face consults. Management: Information about the patient and which type of question are found to be more difficult and require assistance. Results can also be compared to others for better provision of care and advice.	User: Gives the patient feedback about which information is required prior to an consult or the entire medical process. It enables the medical specialist to receive the forms before an appointment, if there is need for additional information this can be requested upfront and helps with the efficiency and quality of the face to face consults. Management: Information about the patient and which type of question are found to be more difficult and require assistance. Results can also be compared to others for better provision of care and advice.	User: information for the patient about what is needed from them for the hospital. This information can be used for the medical specialist to better prepare for consults and make their work more efficient. Management: Information about their patients, that can be compared to provide better care.	User: Information about what the hospital requires from the patient. This information is because of the digital nature also earlier available for medical specialists.	User: Gives the patient feedback about which information is required prior to an consult or the entire medical process. It enables the medical specialist to receive the forms before an appointment, if there is need for additional information this can be requested upfront and helps with the efficiency and quality of the face to face consults. Management: Information about the patient and which type of question are found to be more difficult and require assistance. Results can also be compared to others for better provision of care and advice.
access level	Management, support, users	Management, support, users	Management, support, users	Management, support, users	Management, support, users
Current implementation	Limited implementation (not integrated)	Limited implementation (not integrated)	Limited implementation (not integrated)	Limited implementation (not integrated)	Limited implementation (not integrated)

Table 6.8: Comparison of potential optimisation of digital forms between cases (Own illustration)

6.3.4. Finding colleague

What for finding a workplace was the case is also the case for finding a collegue. However, it was mentioned by M. de Vink (personal communication, 29 August 2019) that when making the outpatient more flexible not only physically but also share medical staff between outpatient departments finding colleagues could be more difficult than in the current situation. This means that there is a potential optimisation not only in the back office of the outpatient department, but also in the front office part of the outpatient department. Although, good agenda management would reduce the need for this optimisation.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To make the outpatient departments more flexible and enable employees to be deployed more flexibly throughout the hospital by helping colleagues to find each other.	To make the outpatient departments more flexible, support cooperation between different outpatient departments and enable employees to be deployed more flexibly throughout the hospital by helping colleagues to find each other.	To improve the flexible use of the facilities and make it easier to find colleagues who are working throughout the hospital.	To help with finding colleagues when promoting the finding workplace optimisation to improve the utilisation of the available space.	To make the outpatient departments more flexible, support cooperation between different outpatient departments and enable employees to be deployed more flexibly throughout the hospital by helping colleagues to find each other.
Why: goals	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, improve culture 4. Physical - improve flexibility	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, improve culture 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, Increase innovation, improve culture 4. Physical - improve flexibility	1. Functional - improve employee satisfaction, improve productivity 2. Financial - Reduce costs 3. Strategic - Improve culture 4. Physical - reduce square metres, improve flexibility	1. Functional - improve employee satisfaction, improve productivity 2. Financial - Controlling risks, reduce costs 3. Strategic - Improve flexibility, improve culture, increase innovation 4. Physical - Improve flexibility
What: measurement	Identity, activity	Identity, activity	Identity, activity	Identity, occupancy	Identity, activity
How: measurement method	booking, sensors	booking, sensors	manual, booking, sensors	manual, booking	manual, booking, sensors
user information	User: Information about the whereabouts and availability of colleagues. Management: Information about the preferences of users and which places are more often used for collaboration and meeting up and information about work patterns of employees. This information can help with (future) accommodation decision-making.	User: Information about the whereabouts, preferences of cooperation and availability of colleagues. Management: Information about the preferences of users and which places are more often used for collaboration and meeting up and information about work patterns of employees. This information can help with (future) accommodation decision-making.	User: information about the whereabouts of colleagues. Management: information about the whereabouts of their employees in case of an emergency and usage of the hospital / outpatient department in general.	User: Information about the whereabouts of colleagues when introducing a more flexible way of working. Management: information about the walking distances to a suitable place to work for employees.	User: Information about the whereabouts, preferences of cooperation and availability of colleagues. Management: Information about the preferences of users and which places are more often used for collaboration and meeting up and information about work patterns of employees. This information can help with (future) accommodation decision-making.
access level	Management, support, users	Management, support, users	Management, support, users	Management, support, users	Management, support ,users
Current implementation	Not implemented	Not implemented	Not implemented	Not implemented	Not implemented

Table 6.9: Comparison of potential optimisation of finding colleague between cases (Own illustration)

6.3.5. Information (EPD)

Information (EPD) is mentioned by al the interviewees an example of this information is the since a few years introduced Electronic Patient Dossier (EPD). This gives the patient all the (medical) information they need and enables them to add missing information and share this information with hospitals and other health care providers. The current problem is connection of the EPD with other (hospital) systems, making it difficult for patients.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To make al medical information digitally available to the patient and make it possible for the patient fill in and edit (missing) information.	To make al medical information digitally available to the patient and make it possible for the patient fill in and edit (missing) information.	To provide one place to patients where they can find all their health care information and where they can provide this information to the hospitals.	To provide the patient with its medical information digitally, leading to better patient satisfaction.	To make al medical information digitally available to the patient and make it possible for the patient fill in and edit (missing) information.
Why: goals	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - increase innovation, improve culture 4. Physical - -	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - increase innovation, improve culture 4. Physical - -	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation 4. Physical - -	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -
What: measurement	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)
How: measurement method	manual, booking	manual, booking	manual, booking	manual, booking, sensors	manual, booking
user information	User: Gives the patient information about their medical records and make it possible for the patient to fill in missing information or edit existing information. Provides the (current) medical specialist with the same information if the patient allows to share this information. Management: Identity check of the patient. Information and feedback about the use of the application.	User: Gives the patient information about their medical records and make it possible for the patient to fill in missing information or edit existing information. Provides the (current) medical specialist with the same information if the patient allows to share this information. Management: Identity check of the patient. Information and feedback about the use of the application.	User: Patient's health care information available for the patients and the health care providers. Management: Information about the patient, including healthcare information. This can help to make the hospital more flexible.	"User: Medical information about the patient available to the patients and medical specialists. Management: Information about the hospital's patients.	User: Gives the patient information about their medical records and make it possible for the patient to fill in missing information or edit existing information. Provides the (current) medical specialist with the same information if the patient allows to share this information. Management: Identity check of the patient. Information and feedback about the use of the application.
access level	Management, support, users	Management, support, users	Management, support, users	Management, support, users	Management, support, users
Current implementation	Implemented (not integrated)	Implemented (not integrated)	Implemented (not integrated)	Implemented (not integrated)	Implemented (not integrated)

Table 6.10: Comparison of potential optimisation of information (EPD) between cases (Own illustration)

6.3.6. Self measuring / controlling

A part of the usefulness of self measuring / controlling has already been explained in the diagnostics section. It however also enables patients to be more in control of their own health and makes it possible to do more checks than normal and do the checks at home in a safe environment (L. van Aart, personal communication, 22 August 2019). It will work even better if paired with a smart watch and mobile application. This gives also the possibilities to send notifications to to patient when needing to do measurements. If the patient forgets to do the measurements a notification could also be send to the medical specialist, who then call the patient to remind the patient to do the measurements. Gathering all this information can also be used for comparison with others for providing better (future) care.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To enable the patient perform self measuring / controlling with the help of e-health application. This can improve the frequency of the controls and more accurate measurements because the patient can be in do the measurements at home without a (stressful) hospital visit.	To enable the patient perform self measuring / controlling with the help of e-health application. This can improve the frequency of the controls and more accurate measurements because the patient can be in do the measurements at home without a (stressful) hospital visit.	To make it easier for patients to keep track of their health and to provide medical specialists with their health data to control risks.	To enable patients to do health controls at home. This improves the quality of the results, because the patient is in a safe environment (without stress).	To enable the patient perform self measuring / controlling with the help of e-health application. This can improve the frequency of the controls and more accurate measurements because the patient can be in do the measurements at home without a (stressful) hospital visit.
Why: goals	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - -	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation 4. Physical - -	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve culture, increase innovation 4. Physical - -	1. Functional - improve employee satisfaction, improve patient satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - Improve flexibility, improve culture, increase innovation 4. Physical - -
What: measurement	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)	Frequency, identity, activity (patient's health conditions)
How: measurement method	manual, booking, sensors	manual, booking, sensors	manual, booking, sensors	manual, booking, sensors	manual, booking, sensors
user information	User: Gives the patient information their health condition and when they need to do measurements (with the use of notifications or a personal phone call). Management: Identity check of the patient. Information and feedback about use of the application.	User: Gives the patient information their health condition without going to the hospital and when they need to do measurements (with the use of notifications or a personal phone call). This reduces the risks of being to late and improves the accuracy because the patient can to the measurements in a home environment. Management: Identity check of the patient. Information and feedback about use of the application.	User: Provides the patient with information about their health conditions, required measurements and can give reminders in case a patient forgets to do their measurement. This helps the medical specialist with remotely keeping track of the health conditions of patients and in this way control the risks. Management: Information about their patients health conditions and patient results can be compared, and can help with providing better care.	User: information for the patients about their medical conditions and which self measurements can be performed at home.	User: Provides the patient with information about their health conditions, required measurements and can give reminders in case a patient forgets to do their measurement. This helps the medical specialist with remotely keeping track of the health conditions of patients and in this way control the risks. Management: Information about their patients health conditions and patient result can be compared, and can help with providing better care.
access level	Management, support, users	Management, support, users	Management, support, users	Management, support, users	Management, support, users
Current implementation	Not implemented	Not implemented	Not implemented	Not implemented	Not implemented

Table 6.11: Comparison of potential optimisation of self measuring / controlling between cases (Own illustration)

6.3.7. E-consult

An e(lectronic)-consult is related to the diagnostic and self-measuring section. It enables the patient and medical specialist to have more often check-ups without needed to go to the hospital as often. According to J. Nijhof (personal communication, 15 July 2019) this can release a lot of pressure on the physical outpatient departments. However, some additional facilities are needed to make sure that the medical specialist can have confidential conversations with patients through (video) calls.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To have remote (video) contact with a patient. This can save the patient a trip to the hospital and can help with quick check-ups, even more so when combining with self measuring / controlling.	To make consults for patients easier and for the medical specialist it can save time and check-ups can be scheduled more often, so better control of risks.	-	-	To make remote (video) contact easier for both the patient and medical specialist. This can save the patient a trip to the hospital and can help the medical specialist with better controlling risks with more check-ups, even more so when combining with self measuring / controlling.
Why: goals	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - - 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - Controlling risks. 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility	-	-	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productivity 2. Financial - Controlling risks 3. Strategic - improve flexibility, increase innovation, support image 4. Physical - improve flexibility
What: measurement	Identity, (frequency, activity)	Identity, (frequency, activity)	-	-	Identity, (frequency, activity)
How: measurement method	manual, sensors (when combined with self measuring / controlling)	manual, sensors (when combined with self measuring / controlling)	-	-	manual, sensors (when combined with self measuring / controlling)
user information	User: Gives the patient the possibility to have a digital (face-to-face) consult without going to the hospital. Gives the medical specialist to have contact with the patient more frequently without the necessity to see the patient in real-life, work probably better in combination with self-measuring / controlling. Management: Identity check of the patient. Information and feedback about use of the application.	User: Gives the patient the possibility to have a consult without going to the hospital. Gives the medical specialist to have contact / check-ups with the patient more frequently without the necessity to see the patient in real-life, work probably better in combination with self-measuring / controlling. Management: Identity check of the patient. Information and feedback about use of the application.	-	-	User: Gives the patient the possibility to have a digital (face-to-face) consult without going to the hospital. Gives the medical specialist to have contact with the patient more frequently without the necessity to see the patient in real-life, work probably better in combination with self-measuring / controlling. Management: Identity check of the patient. Information and feedback about use of the application.
access level	Management, support, users	Management, support, users	-	-	Management, support, users
Current implementation	Not implemented	Not implemented	-	-	Not implemented

Table 6.12: Comparison of potential optimisation of e-consult between cases (Own illustration)

6.3.8. Information provision

The optimisation of information provision is focused on providing patients with all the (medical) information they need (in a digital environment). L. van Aart (personal communication, 22 August 2019) gives providing patients with (real-time) waiting information safes the medical staff a lot of time and improves the overall patient expierence with the hospital, as an example. This information can be provide with the use of displays in the waiting room or personal waiting information with the use of notifications or an app. It however could also entail information about location / amenities within the hospital, appointments, available medical specialists, opening hours and more.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To improve de communication to patients and provide the patient with information about waiting times and location of appointments. This is needed to improve the flexibility between the different outpatient departments	To provide the patients with all the information they need when they need it in a digital environment.	To provide patients and visitors with more personalised information about everything that is connected to a visit to the hospital.	To provide patients and visitors with better and more actual information about the (openings hours of) outpatient departments, appointments and waiting times.	To provide patients and visitors with better, more actual and more personalised information. This includes information about waiting times, locations within the hospital and appointments and openings hours.
Why: goals	1. Functional - Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - improve flexibility 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, Increase innovation 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction, improve employee satisfaction, improve productivity 2. Financial - Reduce costs 3. Strategic - Support image, improve culture, increase innovation 4. Physical - -	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productiivity 2. Financial - Reduce costs 3. Stategic - Support image, increase innovation, improve flexibility 4. Physical - Improve flexibility
What: measurement	Occupancy	Occupancy, Identity	Occupancy, (Identity)	Occupancy	Occupancy, (Identity)
How: measurement method	booking, (sensors)	booking	booking	booking	booking
user information	User: General information about the hospital, information about their consult, waiting times, (waiting)locations, if their is still time to visit the hospital amenities, their doctor and more. Management: information about the patients waiting location and average waiting times. This provides insight in the waiting times of different departments and occupation of waiting rooms.	User: Information about their appointment, amenities of the hospital, treatments, medication and to plan new appointments. The user information differs per user (patient or visitor). Management: Information about the what information is important for the users and which functions are used the most.	User: Personalised information about the hospital, their appointment, receipts, medication, test results and treatment processes. Management: information about which information is more useful than others and which amenities or functions are looked up more than others.	User: information about the openings hours of the different outpatient departments, waiting times, appointment. Management: Frequency of checked info, which information is more useful than others.	User: Infromation about the hospital, outpatient departments, openingshours, appointments, waiting times, amenities, their doctors, medication, recepts, test results and threatment processes. Management: Information about the average waiting times of patients, which amenities they then use and feedback on which functions are most important to the patients and visitors.
access level	Management, support, users, open access	Management, support, users, open access	Management, support, users, open access	Management, support, users, open access	Management, support, users, open access
Current implementation	Limited implementation (not integrated)	Limited implementation (not integrated)	Limited implementation (not integrated)	Limited implementation (not integrated)	Limited implementation (not integrated)

Table 6.13: Comparison of potential optimisation of information provision between cases (Own illustration)

6.3.9. Wayfinding

Wayfinding was mentioned by the interviewees of the different cases as an problem for a lot of patients. According to A. Trip (personal communication, 13 August 2019) the hospital has a great interest in a mobile app to help patients with wayfinding in the hospital and with providing patients with the needed information related to their personal treatment plan and appointment. He mentions that an app can, for example, display the route towards your appointment when you enter the hospital. In such an app, a wheelchair user could get a different route than a someone who is able to walk or climb stairs. L. van den Ham (personal communication, 29 August 2019) mentions that the current wayfinding in the Martini hospital is done with coloured routing, however the routes are actually destinations and the colours are really confusing. In a situation like this personal wayfinding in the form of an app can help patients. The app could even be used to register when a patient enters the hospital premises. However, A. Trip (personal communication, 13 August 2019) brings up that this is really privacy sensitive and informed consent has to be given.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	When making the different outpatient departments flexible throughout the day, meaning that in the morning a specialism occupies a certain space and in the afternoon a different specialism wayfinding becomes harder and support in wayfinding is therefor really important	To improve the routing in the hospital. currently the routing is done with the use of coloured signs that can be really confusing for patients. Furthermore, to improve the flexibility of the outpatient departments good wayfinding is necessary. At the moment the different outpatient departments are easy to recognise, but with standardised flexible outpatient departments this is no longer the case.	To help patients and visitors navigate through the hospital in a more personalised way. In the future it can also be used to stimulate people that need to rehabilitate to take the stairs or different route through the hospital with a nice outside view.	To improve the wayfinding in the hospital, this is needed because the hospital has changed several times over the years and can be quite difficult to navigate through for patients and visitors.	To improve the routing and wayfinding in the hospital. This helps when wanting to make the different outpatient departments more flexible and interchangeable.
Why: goals	1. Functional -Increase patient satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, improve flexibility 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction 2. Financial - - 3. Strategic - Support image, improve flexibility 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction, improve productivity 2. Financial - - 3. Strategic - Support image, improve culture, increase innovation 4. Physical - -	1. Functional - Increase patient satisfaction, improve productiivity 2. Financial - Reduce costs 3. Stategic - Support image, increase innovation, improve flexibility 4. Physical - Improve flexibility
What: measurement	Occupancy	Occupancy	Occupancy, (Identity)	Occupancy	Occupancy
How: measurement method	sensors	booking, sensors	booking, sensors	sensors	booking, sensors
user information	User: information about the location of their consult, and other facilities and amenities of the hospital. And also information to guide the user to their destination. Management: Information about the occupancy of the building and which routes are more often used then others. This information can be used for future accommodation decision making.	User: information about the location of the consult and the best route to that location. Management: information about the routes people actually take in the hospital, can help with future accommodation decision-making.	User: information about which route to take depending on the mobility of the patient or visitor. Management: information about which routes patients and visitors really take and if less mobile patients and visitors are really led to elevators instead of stairs.	User: Information about where which outpatient department is in the hospital and how to get their. Management: Gives information about the usage and occupation of the building and can support future accommodation decision making.	User: information about where which outpatient department is, what the best route is to the patients appointment, best waiting area, nearby amenities, preferences of using stairs or elevator depending on the mobilitiy of the patient or visitor. Management: Information about which routes patients and visitors really take and if they take stairs or elevators. Also gives information about the utilisation and occupation of the building, supporting (future) accomodation decision making.
access level	Management, support, users, open access	Management, support, users, open access	Management, support, users, open access	Management, support, users, open access	Management, support, users, open acces
Current implementation	Not implemented	Not implemented	Limited implementation (not integrated)	Not implemented (was but canceled)	Generally not implemented

Table 6.14: Comparison of potential optimisation of wayfinding between cases (Own illustration)

6.3.10. Check-in

Check-in as an potential optimisation was mentioned because of two reasons. The first one is to know that the patient is arrived at the hospital and the patient identity is checked (P. van Hilten, personal communication, 22 August 2019). The second one is to provide the patient with information about their appointment and possible delays. The second one can be, accoding to L. van den Ham (personal communication, 29 August 2019), really useful to improve the patient's satisfaction by not needing to check-in at a counter at the entrance of the hospital and again at the counter of the outpatient department. It also makes a central waiting concept surrounded with amenities possible, with smalle decentral waiting places at the outpatient department. This, according to L. van den Ham (personal communication, 29 August 2019) could really improve the patient's experience and productivity of the hospital staff.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To make the check-in process smoother for the patient, to check the identity of the patient, to have less (higher educated) personnel, and to know that a patient has arrived.	To decrease the amount of check-ins at different counters and also allows for central waiting near the hospital amenities and smaller decentral waiting areas	To improve the identification process of the patient, saves time for the medical specialist, and at the same time can give the patient information about the waiting area they are expected to be. It can also give the patient feedback if the patient has not yet filled in the digital questionnaire for the consult and direct the patient to someone who can help them.	To have an alternative for patients to also check-in digitally or with the use of a kiosk. This not only speedup the check-in process, but also helps reduce the work pressure on employees.	To improve the check-in and identification process of the patient, saving time for the medical specialist, and at the same time can give the patient information about their appointment and waiting times. This can also allow for a central waiting area to be developed near hospital amenities and therefor smaller decentral waiting areas.
Why: goals	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs, control risks 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction, Increase employee satisfaction 2. Financial - reduce costs 3. Strategic - Support image, increase innovation, improve culture 4. Physical - -	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - reduce costs 3. Strategic - Support image 4. Physical - improve flexibility	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - Controlling risks, reduce costs 3. Strategic - Support image, increase innovation 4. Physical - -	1. Functional - Increase patient satisfaction, increase employee satisfaction, improve productiivity 2. Financial - Reduce costs 3. Stategic - Support image, increase innovation 4. Physical - Improve flexibility
What: measurement	Occupancy, Identity	Occupancy, Identity	Identity	Identity	Occupancy, Idenity
How: measurement method	booking, (sensors)	booking, sensors	Booking, sensors	Booking, (sensors)	Booking, sensors
user information	User: Conformation of their appointment and the location of their consult. Management: Conformation of the patient's arrival and identity. Can also give information about the average arriving time before a consult, off course anonymously.	User: information about the appointment, waiting times, where to wait and when to head to the consultation room. Management: information about the check-in and identity of the patient. Information about the occupancy of a central waiting area and the smaller decentral waiting areas.	User: information about their appointment and if all the requirements before the appointment are met. Management: Check-in and identification of the patient.	User: Information about check-in and location and time of appointment. Management: information about identity and check-in of the patient. Gives information about the preferences of the patient if normal check-in also is monitored.	User: Information about their appointment, waiting times, adviced waiting location, and if all the requirements before the appointment are met. Management: Feedback on check-in and identification information of the patient. Can also give information about average ariving time and waiting time patients.
access level	Management, support, users	Management, support, users	Management, support, users	Management, support, users	Management, support, users
Current implementation	Not implemented	Not implemented	Not implemented	Limited implementation (not integrated)	Generally not implemented

Table 6.15: Comparison of potential optimisation of check-in between cases (Own illustration)

6.3.11. Senior service

Senior service is only mentioned in one interview. P. van Hilten (personal communication, 22 August 2019) explaines that senior service is service that can pick up patients at home and drive them to the hospital and afterwards home again. Additionaly, the patients can also be assisted during their hospital visit. She states that the majority of the patients is 60 plus and they are longer self sufficient. M. de Vink (personal communication, 29 august 2019) mentions that in the province of Groningen a lot of the patients has problems with reading and writing. So potentially a service like this can help this group of people. Additionaly, P. van Hilten (personal communication, 22 August 2019) explaines that not only the patient satisfaction is influenced by a service like this, but also the logistic flows of patients can be better monitored and controlled. When the patient leaves their home the tracking starts. This can help with (future) logistic and planning optimisations.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	The majority of patients are 60 plus and nowadays they are longer self sufficient. A senior service can offer a solution to this group. Patients are picked up at home and dropped off at the hospital. This would also address a large part of the parking problem. Where necessary, the patients can also be further guided in the process, the person who picks them up can help them during their whole visit and also during the consults with the doctor.	-	-	-	The majority of patients are 60 plus and nowadays they are longer self sufficient. A senior service can offer a solution to this group. Patients are picked up at home and dropped off at the hospital. This would also address a large part of the parking problem. Where necessary, the patients can also be further guided in the process, the person who picks them up can help them during their whole visit and also during the consults with the doctor.
Why: goals	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - controlling risks 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility	-	-	-	1. Functional -Increase patient satisfaction, Increase employee satisfaction, improve productivity 2. Financial - controlling risks 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility
What: measurement	Identity	-	-	-	Identity
How: measurement method	booking	-	-	-	booking
user information	User: information about the pick-up time (at home and hospital) and get supported during their visit. Management: Early information about the arrival and possible delays of the patient and information about travel times to the hospital in general.	-	-	-	User: information about the pick-up time (at home and hospital) and get supported during their visit. Management: Early information about the arrival and possible delays of the patient and information about travel times to the hospital in general.
access level	Management, support, users	-	-	-	Management, support, users
Current implementation	Not implemented	-	-	-	Not implemented

Table 6.16: Comparison of potential optimisation of senior service between cases (Own illustration)

6.3.12. Space use

Measuring space use was mentioned in interviews with all the hospitals, but only by the facility managers. According to J. Nijhof, (personal communication, 15 July 2019) measuring space use will help to gain insight into how a medical specialist functions, how an outpatient department functions and what the occupation and utilisation look like. Everyone now knows that the outpatient department is optimally occupied in the morning, and as the day progresses fewer and fewer people are using the outpatient department. At the same time, that data does need hard data to make choices with each other or when choices are made. How does it reflect in the numbers. In the next 10 to 15 years a growth between 10 and 20 percent is expected. J. Nijhof, (personal communication, 15 July 2019) explains that the easiest solution is to build but also the most expensive and permanent solution. It is better to change the behaviour and culture, and then data can help with the decision making.

A. Trip (personal communication, 13 August 2019) mentions the example of a waiting room that has a capacity of 30 patients and has consequently peaks of 35-40 patients, where measuring space use could be useful. He also mentions that a connection between the facility management system and planning system of a particular outpatient department is necessary to monitor the planning and actual use. Furthermore, he also mentions number of patients with a wheelchair in the waiting room also influences the capacity and monitoring this could be useful.

In the back office of an outpatient department is measuring space use also useful to measure the utilisation of the workplaces and the multipurpose / meeting rooms. A. Trip (personal communication, 13 August 2019) explains that the multipurpose / meeting rooms are free to use for all the hospital staff. The rooms can be booked with the use of the facility management system; however, the actual utilisation is not monitored.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To improve the flexible use of the building and to determine which space is used and utilised properly and which space can be rented or sold.	To take away the emotions and knowing by measuring and in the future even getting feedback of the building.	To improve the standardisation and flexibility between outpatient departments and create an insight in utilisation of for example the shared back office or meeting rooms.	To measure the actual use of space to support accommodation decision-making and eliminated the emotional discussion about space.	To improve the flexibility and standardisation of space with measuring the actual utilisation of space.
Why: goals	1. Functional - 2. Financial - controlling risks, improve financial position 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - improve flexibility, Reduce square metres	1. Functional -Increase flexibility 2. Financial - reduce costs 3. Strategic - Increase innovation 4. Physical - improve flexibility, reduce square metres	1. Functional -Increase flexibility 2. Financial - reduce costs 3. Strategic - Increase innovation, increase flexibility 4. Physical - improve flexibility, reduce square metres	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks, reduce costs, improve financial position 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - Improve flexibility	1. Functional - Increase flexibility, Improve productivity 2. Financial - Controlling risks, reduce costs, improve financial position 3. Strategic - Support image, increase innovation, improve flexibility 4. Physical - Improve flexibility, reduce square metres
What: measurement	Occupancy	Occupancy, (activity)	Occupancy, (activity)	Frequency, Occupancy	Occupancy, (activity)
How: measurement method	booking, sensors	booking, sensors	booking, sensors	Booking, sensors	Booking, sensors
user information	Management: information about the usage and occupancy of space. Provides information for future accommodation decision-making.	Management: Provides information about the occupancy and usage of the building, helping with (future) accommodation decision-making. In the future the building knows how it is being used and gives recommendations to the user and management.	User: Information about available (meeting)rooms. Management: information about the utilisation of space to improve the standardisation and flexibility between outpatient departments and a shared Backoffice	Management: information about the actual use of space.	Management: Information about the usage and occupancy of space. Provides management with information that support (future) accommodation decision-making
access level	Management, support	Management, support	Management, support, users	Management	Management, support
Current implementation	Not implemented	Not implemented	Not implemented	Not implemented	Not implemented

Table 6.17: Comparison of potential optimisation of space use between cases (Own illustration)

6.3.13. Maintenance / tracking of equipment

Maintenance / tracking of (medical) equipment was mentioned by all the facility managers of the interviewed hospitals. A. Trip (personal communication, 13 August 2019) explains that in the outpatient departments a lot of specialised equipment is used. The equipment used, needs to be serviced and checked regularly. Information about the whereabouts and status of the equipment is useful to streamline the maintenance process. P. van Hilten (personal communication, 22 August 2019) adds that knowing when equipment is used is really useful for planning maintenances and can improve the productivity by a lot even more so if the patient planning is algined with the maintenance planning.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To keep track of all the (medical) equipment in the hospital, for what and when it is used and when it needs maintenance.	To track the increasingly mobile (medical) equipment, to prevent things getting lost and help keeping track for maintenance	To keep track of the use of equipment, maintenance of equipment and replacement of equipment	To decrease the amount of equipment that gets lost.	To track (medical) equipment and the use and maintenance of the equipment.
Why: goals	1. Functional - Improve productivity 2. Financial - controlling risks, reduce costs 3. Strategic - Increase innovation, improve flexibility 4. Physical - improve flexibility	1. Functional -Increase flexibility 2. Financial - improves financial position, controls risks 3. Strategic - Increase innovation 4. Physical - improve flexibility	"1. Functional - Increase mployee satisfaction, improve productivity 2. Financial - reduce costs, controlling risks 3. Strategic - Support image, increase innovation 4. Physical - -	1. Functional - Increase employee satisfaction 2. Financial - Controlling risks, reduce costs 3. Strategic - - 4. Physical - -	1. Functional - Increase employee satisfaction, improve productivity 2. Financial - Controlling risks, reduce costs 3. Strategic - Increase innovation 4. Physical - Improve flexibility
What: measurement	Occupancy & Activity	Occupancy, Activity	Occupancy, Activity	Occupancy	Occupancy, Activity
How: measurement method	booking, sensors	booking, sensors	Booking, sensors	sensors	Booking, sensors
user information	Management: information about the (medical) equipment in the hospital, where it is used, for what it is used, when it needs maintenance. This gives also input for the planning of appointments with patients needing to be planned around the maintenances or vice versa.	Management: information about the whereabouts and status of equipment for maintenance.	Management: information about the use, maintenance and replacements of equipment	Management (Support): information about the whereabouts of equipment	Management: Information about the whereabout, status and maintenance of (medical) equipment. This gives also input for the planning of appointments with patients versus the maintenance schedules.
access level	Management, support	Management, support, (users)	Management, support	Management, support	Management, support
Current implementation	Implemented (not integrated)	Not implemented	Not implemented	Not implemented	Generally not implemented

Table 6.18: Case comparison of potential optimisation of maintenance / tracking of equipment (Own illustration)

6.3.14. Cleaning

Cleaning was mentioned only in two interviews with facility managers of two different hospitals. J. Nijfhof (personal communication, 15 July 2019) explains that it is interesting to know how many outpatients there are, where it is busy, but that also applies to toilets. When toilet groups are used intensively, and you want to clean them more intensively. With creating toilet groups in that area you can ensure that that area is less burdened and you can start distributing your outpatient departments differently. Those kinds of issues become much more relevant from a facilitative perspective and hard data can then be very useful.

Profile

	Alrijne	Martini	Meander	Rode Kruis	Consensus
Why: Objectives	To improve the effectiveness of the cleaning crew and provide the users with clean facilities at all times.	To measure where it is busy, for example for toilet groups that are used more intensively. You want to clean those groups more intensively or you can relieve an area by creating extra toilet groups.	-	-	To improve the effectiveness of the cleaning crew and to measure where it is busy. Furthermore it also makes sure that users have clean facilities at all times.
Why: goals	1. Functional - Increase patient satisfaction, increase employee satisfaction 2. Financial - controlling risks, reduce costs 3. Strategic - Increase innovation, improve flexibility 4. Physical - improve flexibility	1. Functional -Increase flexibility, Increase patient satisfaction, increase employee satisfaction 2. Financial - reduce costs 3. Strategic - Increase innovation 4. Physical - improve flexibility, reduce square metres	-	-	1. Functional - Increase patient satisfaction, increase employee satisfaction 2. Financial - Reduce costs 3. Strategic - Increase innovation 4. Physical - Improve flexibility
What: measurement	Occupancy	Occupancy	-	-	Occupancy
How: measurement method	booking, sensors	sensors	-	-	booking, sensors
user information	User: Users can give feedback about how clean a room is. Management: information about the usage of for example toilets, so they can be cleaned on the demand. Furthermore, the information can also be used for future accommodation decision-making.	Management: information about the usage of for example toilet groups. This helps with cleaning and (future) accommodation decision-making.	-	-	Management: information about the usage of for example toilet groups. This helps with cleaning and (future) accommodation decision-making.
access level	Management, support, users	Management, support	-	-	Management, support, users
Current implementation	Not implemented	Not implemented	-	-	Not implemented

Table 6.19: Comparison of potential optimisation of cleaning between cases (Own illustration)

6.3.15. Conclusion

The above mentioned fourteen potential optimisations are gathered below. The efficient work process theme was valued the highest by all the interviewees, followed by the patient experience and facilitate & effective use of building. Within the themes the potential optimisations are ranked from most important to nice to have.

	Potential optimisations	Current Implementation
Medical specialist's workflow		
	Diagnostics	Not implemented
	Finding workplace	Not implemented
	Digital forms	Limited implementation (not integrated)
	Finding colleague	Not implemented
	Information (EPD)	Implemented (not integrated)
	Self measuring / controlling	Not implemented
	E-consult	Not implemented
Patient experience		
	Information provision	Limited implementation (not integrated)
	Wayfinding	Generally not implemented
	Check-in	Generally not implemented
	Senior service	Not implemented
Utilisation of space		
	Space use	Not implemented
	Maintenance / tracking of (medical) equipment	Generally not implemented
	Cleaning	Not implemented

Table 6.20: Potential optimisations and current implementation (Own illustration)

In the next paragraph, the fourteen are analysed in order to identify how they contribute to the different objectives and what information and access is need to have a positive impact on the work process, patient experience and use of the building.

6.4. Analysis of the potential optimisations

The fourteen potential optimisations have been analysed whereby the focus was on understanding the goal and the objectives for each optimisation, to find out required information is that these optimisation need to generated and who has access to this information. All these findings are structured in Table 6.21. Coding the different interviews resulted in the different optimisations in combination with added values. Required information and access, are the findings on how these potential optmisations can work together to have potentially an even bigger optimisation. These different findings are compared and used as input for chapter 7.

6.4.1. Objectives are primarily functional

Due to the lack of integration of smart tools in (the interviewed) hospitals, the goals are difficult to determine. However, when thinking about potential optimisations there should be the ambition to improve something and to achieve certain goals. During the interviews the interviewees were asked to think about the possible goals when talking about areas that require optimisations. In order to help the interviewees, the ten added values of hospital real estate as defined by van der Zwart (2014) were used. Additionally, the interviewees mentioned an eleventh added value, reducing square metres, was also introduced in the research of Den Heijer (2011).

In Table 6.21, for each of the potential optimisations, the goals are listed as derived from the interviews and coding. The results show that almost all the potential optimisation focus on both the functional perspective that (support user activities) while combined with a second dominant perspective.

Potential optimisations	Main goal(s)	Increase innovation	Increase patient satisfaction	Increase employee satisfaction	Improve culture	Reduce costs	Improve productivity	Improve flexibility	Support Image	Controlling risks	Improve financial position	Reduce square metres
Workflow												
Diagnostics	Functional, financial	⚑	⚑	⚑	⚑		⚑	⚑		⚑		
Finding workplace	Functional, Strategic			⚑	⚑	⚑	⚑	⚑				⚑
Digital forms	Functional, financial		⚑	⚑	⚑	⚑	⚑			⚑		
Finding colleague	Functional, strategic			⚑	⚑	⚑	⚑	⚑				⚑
Information (EPD)	Functional, Strategic		⚑	⚑	⚑		⚑			⚑		
Self measuring / controlling	Functional, financial	⚑	⚑	⚑	⚑		⚑			⚑		
E-consult	Functional, Strategic		⚑	⚑			⚑	⚑	⚑			
Patient experience												
Information provision	Functional, Physical		⚑	⚑		⚑	⚑	⚑	⚑			
Wayfinding	Functional, Physical	⚑	⚑			⚑	⚑	⚑	⚑			
Check-in	Functional, Physical		⚑	⚑			⚑	⚑				
Senior service	Functional, Physical		⚑	⚑			⚑	⚑		⚑		

Potential optimisations	Main goal(s)	Increase innovation	Increase patient satisfaction	Increase employee satisfaction	Improve culture	Reduce costs	Improve productivity	Improve flexibility	Support Image	Controlling risks	Improve financial position	Reduce square metres
Utilisation of space												
Space use	Physical, Financial					⚑	⚑	⚑		⚑	⚑	⚑
Maintenance / tracking of (medical) equipment	Physical, Financial	⚑		⚑		⚑	⚑	⚑		⚑		
Cleaning	Functional, Physical		⚑	⚑		⚑		⚑				

Table 6.21: Required goals for improvements (Own illustration)

Strategic

The most part of the potential optimisations in service of an efficient work process were linked to strategic goals. While interestingly enough almost none of these potential optimisations are linked to the goal of supporting the image of the hospital. While the potential optimisation for improving the patient experience are all linked to the supporting the image of the hospital. It would be expected that both would be linked to supporting the image of the hospital, because both have influence on the image that the patient has of the hospital.

Financial

Potential optimisations that take processes or tasks outside the hospital where mentioned mainly in relation with reducing costs and improving financial position. If there are less tasks that take up a lot of time, but do not reimburse a lot, there is more time for more complicated activities that reimburse more. Furthermore, the facilitate and effective use of the building related optimisations where also mentioned potential cost saving measures.

Physical

Physical related goals are mainly related to the patient experience and effective use of the building. Where improving flexibility was the most mentioned physical goal.

Functional

In twelve of the fourteen potential optimisations the functional goals where seen as the most important goals. Being quite logically because the functional perspective supports the user activities and eleven of the fourteen potential optimisations are related to supporting user activities. Increasing the patient satisfaction and increasing the employee satisfaction, in combination with improve productivity where the most mentioned functional goals. All the hospitals state that the patient is central, and it is therefor no coincidence that these goals were mentioned the most times. However, it also potentially means that the current satisfaction is not up to standard, that is a bit worrisome. Furthermore, in the problem definition the patient experience and efficient work process including satisfaction was mentioned as one of the main current problems and these results confirm this problem. Optimising on the functional perspective would help a great deal with these issues.

6.4.2. Required information and access

The potential optimisations relate to different phases of the patient's care process. Some relate to before or after the hospital visit and some during the hospital visit. As seen can be seen in Table 6.22 the only potential optimisations that have no user access are two of the facility related optimisations, seeming logical because these are not mentioned because they support the user but are meant for management purposes.

With the other twelve potential optimisations both the user and the management should be supplied with information about the related topic. For the users this is mainly providing information about certain (digital) facilities or (medical) information. Within the 'user information' there is sometimes a separation made between patients and medical specialists. The 'management information' should generate partly information about the usage of space or equipment, partly information about their patients and partly feedback on which functions of the different topics are relevant or are missing (how the patient and employee satisfaction is influenced).

The most interesting and important observation from the required information is the fact that a lot of seperated potential optimisations benefit from information sharing with other potential optimisations. Some optimisations, like diagnostics and self measuring and controlling are not even possible without other optimisations.

Potential optimisations	Information		Access levels			
	User information	Management information	Management	Support	Users	Open access
Workflow						
Diagnostics	User: Information about the patient's health conditions, frequency of measurements and possible comparison with similar cases for better diagnostics.	Management: Identity check of the patient. Information and feedback about use of the application.	⚑	⚑	⚑	
Finding workplace	User: Information a place to work that fits the personal needs and activity of the employee.	Management: Information about the usage of space and which type of workplaces are requested more often than others, the distance a user has to travel to their desired work place and information about amount of time employees spent on certain tasks. This can help with (future) accommodation decision-making.	⚑	⚑	⚑	
Digital forms	User: Gives the patient feedback about which information is required prior to an consult or the entire medical process. It enables the medical specialist to receive the forms before an appointment, if there is need for additional information this can be requested upfront and helps with the efficiency and quality of the face to face consults.	Management: Information about the patient and which type of question are found to be more difficult and require assistance. Results can also be compared to others for better provision of care and advice.	⚑	⚑	⚑	
Finding colleague	User: Information about the whereabouts, preferences of cooperation and availability of colleagues.	Management: Information about the preferences of users and which places are more often used for collaboration and meeting up and information about work patterns of employees. This information can help with (future) accommodation decision-making.	⚑	⚑	⚑	
Information (EPD)	User: Gives the patient information about their medical records and make it possible for the patient to fill in missing information or edit existing information. Provides the (current) medical specialist with the same information if the patient allows to share this information.	Management: Identity check of the patient. Information and feedback about the use of the application.	⚑	⚑	⚑	
Self measuring / controlling	User: Provides the patient with information about their health conditions, required measurements and can give reminders in case a patient forgets to do their measurement. This helps the medical specialist with remotely keeping track of the health conditions of patients and in this way control the risks.	Management: Information about their patients health conditions and patient result can be compared, this can help with providing better care.	⚑	⚑	⚑	
E-consult	User: Gives the patient the possibility to have a digital (face-to-face) consult without going to the hospital. Gives the medical specialist to have contact with the patient more frequently without the necessity to see the patient in real-life, work probably better in combination with self-measuring / controlling.	Management: Identity check of the patient. Information and feedback about use of the application.	⚑	⚑	⚑	
Patient experience						
Information provision	User: Information about the hospital, outpatient departments, openings hours, appointments, waiting times, amenities, their doctors, medication, receipts, test results and treatment processes.	Management: Information about the average waiting times of patients, which amenities they then use and feedback on which functions are most important to the patients and visitors.	⚑	⚑	⚑	⚑
Wayfinding	User: information about where which outpatient department is, what the best route is to the patients appointment, best waiting area, nearby amenities, preferences of using stairs or elevator depending on the mobility of the patient or visitor.	Management: Information about which routes patients and visitors really take and if they take stairs or elevators. Also gives information about the utilisation and occupation of the building, this can support (future) accommodation decision making.	⚑	⚑	⚑	⚑
Check-in	User: Information about their appointment, waiting times, advice waiting location, and if all the requirements before the appointment are met.	Management: Feedback on check-in and identification information of the patient. Can also give information about average arriving time and waiting time patients.	⚑	⚑	⚑	
Senior-service	User: information about the pick-up time (at home and hospital) and get supported during their visit.	Management: Early information about the arrival and possible delays of the patient and information about travel times to the hospital in general.	⚑	⚑	⚑	
Utilisation of space						
Space use	-	Management: Information about the usage and occupancy of space. Provides management with information that support (future) accommodation decision-making	⚑	⚑		
Maintenance / tracking of (medical) equipment	-	Management: Information about the whereabout, status and maintenance of (medical) equipment. This gives also input for the planning of appointments with patients versus the maintenance schedules.	⚑	⚑		
Cleaning	-	Management: information about the usage of for example toilet groups. This helps with cleaning and (future) accommodation decision-making.	⚑	⚑		

Table 6.22: Required information and access (Own illustration)

6.5. Conclusions

Objective	explore the potential optimisations of the outpatient department. Understand the objectives of the potential optimisations. Assess the information required for the potential optimisations
Questions	Which potential optimisations can be defined, what are the objectives of the optimisations and which information is required?
Method	Case-study research: semi-structured interviews, observations, documentation.

According to the case study of four general hospitals in the Netherlands, the following potential optimisations were assessed:

- In total fourteen potential optimisations are distinguished in three different focus areas (from most desired to nice to have):
  - Workflow: Diagnostics, finding workplace, digital forms, finding colleague, information (EPD), self measuring / controlling, and e-consult.
  - Patient experience: Information provision, wayfinding, check-in, and senior service.
  - Utilisation of space: Space use, Maintenance / tracking of (medical) equipment, and cleaning.
- Eleven out of the fourteen assessed potential optimisations have generally not yet been implemented, and the remaining three are limited implemented without further integration.

Objectives are primarily functional:

- The most mentioned goals where related to supporting the user activities and consist of improving the patient satisfaction, the employee satisfaction, productivity and flexibility.
- The most potential optimisations in service of an efficient work process where linked to strategic goals.
- Potential optimisations taking processes or tasks outside the hospital where mentioned mainly in relation with reducing costs and improving financial position.

Required information and access level:

- For the users this is mainly providing information about certain (digital) facilities or (medical) information.
- Within the ‘user information’ there is sometimes a separation made between patients and medical specialists.
- The ‘management information’ should generate partly information about the usage of space or equipment, partly information about their patients and partly feedback on which functions of the different topics are relevant or are missing (how the patient and employee satisfaction is influenced).
- Users should have access to most of the optimisations information, except for space use and maintenance / tracking of (medical) equipment.
- The most interesting and important observation is that potential optimisations benefit or even need each other’s information to be useful.

To conclude, centralising the access to information and letting the different areas of potential optimisation communicate with each other is essential for a more efficient work process, better patient experience and more effective use of the building. However, this integrated approach towards optimisations has not yet been implemented by the interviewed hospitals.

PART IV
SYNTHESIS

7. Possible optimisation solution

The goal of this chapter is to come to possible a solution that can contribute to optimising the outpatient department by improving the patient experience, workflow and utilisation of space. Therefor, this chapter focusses on how with which possible solutions the outpatient department can be optimised and what kind of possible 'tools' could be recommended to use for it. This will provide an answer to the research question of which solution can be recommended to optimise the outpatient department.

7.1. Bringing optimisations together

As stated in the last previous chapter, the main objective was to support the user activities, including goals set to improve the patient experience, employee experience, productivity and flexibility. Some potential optimisations even potentially take processes or tasks outside the hospital, leading to cost reduction. Furthermore, the power of these optimisations lies in centralising the access to information and letting the different areas of potential optimisation communicate with each other is essential for a more efficient workflow, better patient experience and more effective use of the building.

Today almost, everyone has a smartphone or personal computer at its disposal. People are used to have access to information place and time independent. Therefore, an app on a mobile device or dashboard on a personal computer would be a sensible choice to bring the information together. However, as explained in the smart tool chapter and shown again in Figure 7.1 below, the data needs first be collected and processed before it can be presented to the user in the form of an app or dashboard. Nevertheless, for this example of bring optimisations together only way of presenting the information to the user will be eloborated upon, because the collection and processing of the data is different for every specific hospital and outpatient department.

1. Collection of data
(Real-time) data collection with the use of raw data or sensors

2. Processing of data
Data has been added to the network (integrated platform) and has been processed in order to transform the data in to information

3. Provision of information
(Real-time) information is presented to the user or organisation with the use of a service or product in the form of an app or dashboard.

4. Future decision making
The provided (real-time) information create insights in better (future) alignment of real estate with the organisational objectives.

Figure 7.1: The principle and steps of a smart tool

7.2. Program of requirements for a app or dashboard

To determine which functionalities a dashboard should have, and which would be nice to have the potential optimisations of the last chapter will be used. In the last chapter fourteen potential optimisations in three focus areas where assessed and ranked from most important to nice to have. However, putting all potential optimisations in one app or dashboard is not possible due to the fact the required 'user' information sometimes needs to be accessible for the public, but sometimes also only for the patient or medical specialist due to the privacy sensitive information. Furthermore, the utilisation of space related potential optimisations requires only 'management information'. Therefore, it is not possible to develop one app or dashboard, but to make at least three different apps or dashboards. Making different apps or dashboards does not mean that information sharing between the apps or dashboard is not possible,

only the access levels are different between the apps. An alternative could be to develop one app with availability of functionalities depending on the access level of the user. However, for the simplicity three different apps, being a medical staff app, a patient app and a facility app are defined below.

Medical staff app	Patient app	Facility app
Functionalities: • Diagnostics • Find workplace • Find colleague • Information (EPD) • Check-in notification • E-consult	Functionalities: • Digital forms • Information (EPD) • Self-measuring / controlling • E-consult • Information provision • Wayfinding • Check-in • Senior service	Functionalities: • Space use • Maintenance / tracking of equipment • Cleaning
Access: medical staff	Access: patients	Access: Facility staff

Table 7.1: Three different types of possible apps / dashboards (Own illustration)

7.2.1. Points of attention

When seeing an app or dashboard as a solution for potential optimisations the following points of attention need to be considered:

- Accessible for everyone even for functionally illiterate or digitally illiterate users. This issue was expressed as utmost important by M. de Vink (personal communication, 29 August 2019) and L. van den Ham (personal communication, 29 August 2019).
- Make short sentences and avoid jargon or difficult words.
- Include a functionality that reads the texts for the users.
- Always include the possibilities to request / call help within the app.
- Provide decent alternatives to digital solutions
- Integration of different services, making it as easy as possible for the patients so that they more willing and likely to use it.
- For a lot of optimisations is the identity of the patient important, this brings privacy and security issues to the table. Integration of DigiD is recommended because it is an official approved digital means of identification. However, when users do not want to use DigiD or are not able to use it, give them the opportunity to still use all not identity required functions of the app.

7.3. An mobile app as possible solution

This mobile app is an example of how the required information of the potential optimisations can be brought together for patients. In this example the potential workflow and patient experience optimisation functionalities included in the functionallities of the patient app as shown before in Table 7.1 are included. On the following page, a visual representation of the requirements of the patient app ‘FollowMyHealth’ is presented in Figure 7.2.

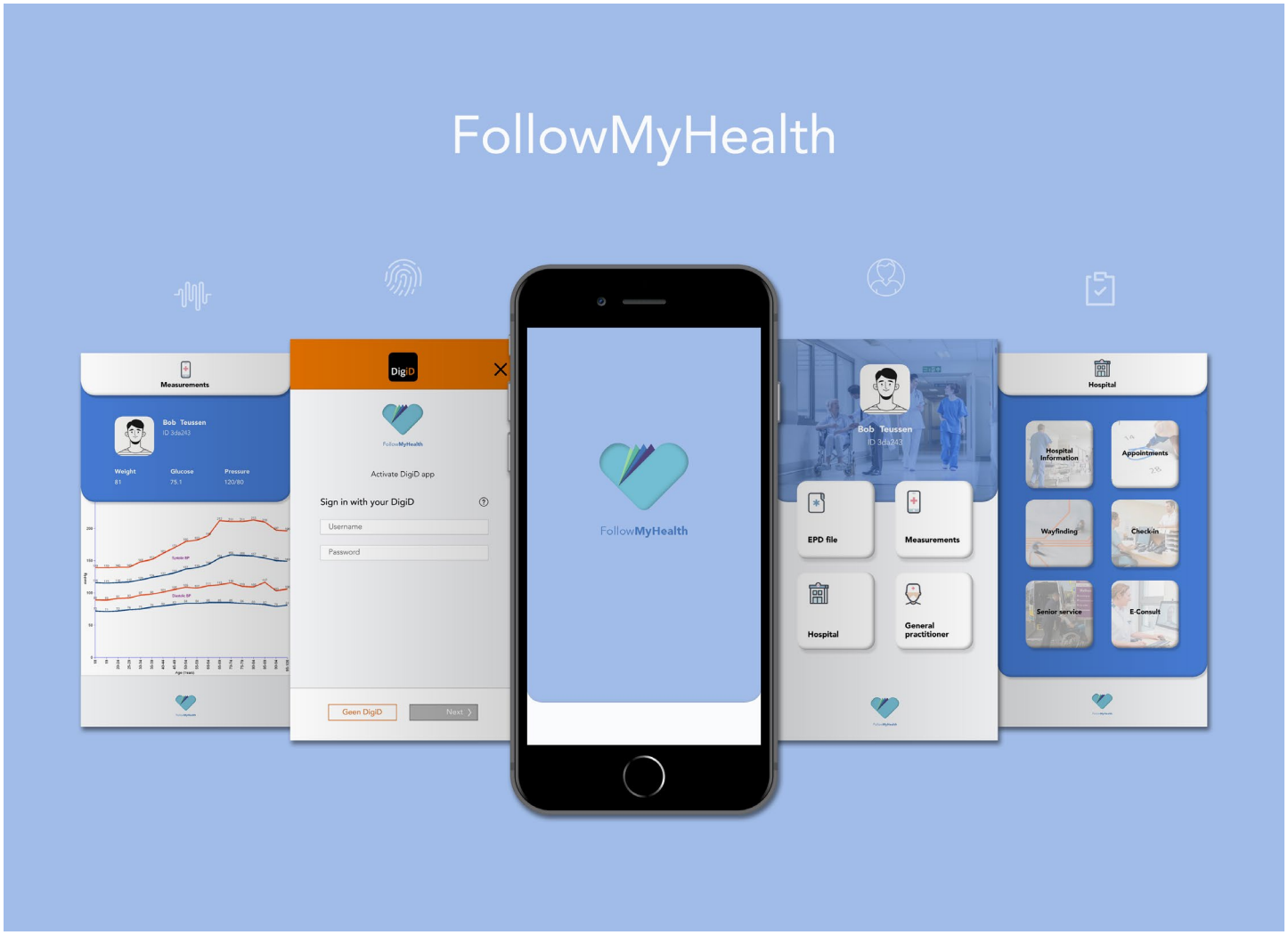


Figure 7.2: FollowMyHealth app as a possible solution (Own Illustration)

7.4. Conclusion

Objective	To come with a possible solution to optimise the outpatient department.
Questions	Which solution can be recommended to optimise the outpatient department?
Method	Literature review, interviews, observations

- A mobile app or user available dashboard makes all the information available in a central place can be a valid option for optimising on one hand the patient experience and on the other hand the workflow of the medical specialists.
- However, the target audience of the hospital needs be considered, not only a large portion of the patients is 60 years or older but for some hospitals a considerably part of their patients is functionally illiterate or digitally illiterate.
- In a user-oriented app as shown above there is still the potential to generate management information about the utilisation of the building. This can be done by analysing the data generated by all the individual users of the app by for example tracking the user's movements through the building or asking for feedback. The data of users need of course be anonymised before processed and the user must give his informed consent about using his data for optimisation of the utilisation of space.
- An app or dashboard is just one solution not an ultimate solution but just an example of what bringing information together and presenting it in a single place can do for the user of the outpatient department.


Bob Teussen
ID 3da243
EPD file
Measurements
Hospital
General practitioner

8. Conclusions

The goal of this chapter is to arrive to conclusions acquired from the research, by answering the sub research questions and the main research question in the first part of this chapter. The second part of this chapter consists of a discussion about the conclusions, the limitations, validity and reliability of the conclusions and this research.

8.1. Answering the research questions

Before answering the main research question, which 'smart' optimisations of the outpatient department could improve patient experience, medical specialist's workflow and utilisation of space, the conclusions of the seven sub-questions are presented.

8.1.1. Research sub-question 1

Objective	Define characteristics of the outpatient department of the 21st century.
Questions	What are the characteristics of the outpatient department of the 21st century?
Method	Literature study

The four basic principles are: (1) Design the care process from three perspectives: patients, employees and goods and services. (2) Reduce all processes to simple activities. Facilitate and support the activities as efficiently and patient-friendly as possible. Reorder health care programs activities back to processes. (3) Make information available independently of time and place. (4) Ensure that the environment matches the circumstances at that time.

Therefor, the concept consists of six centres: screening diagnostics centre, consultation centre, treatment centre, nursing centre, knowledge and expertise centre, and logistics centre. Furthermore, in the concept three perspectives are defined: (1) IT and information provision (bytes), (2) people and organisation (behaviour), and (3) work environment and building (bricks).

This has resuled in the following characteristics:

- ICT, information provision, digitalisation and automation (Smart tools) play an important role in the hospital of the future.
- Separated logistics from patient and employee flows, in combination with the just-in-time principle make the new concept work more efficient and effective.
- Standardisation and sharing of the consultation / examination rooms
- Physical separation between the consultation rooms, front office and back office
- Knowledge and Expertise centre is the brain and backbone of the hospital and in organisational and spatial terms this is the connecting factor between the various centres.

8.1.2. Research sub-question 2

Objective	Understand which activities take place in the outpatient department of the 21st century.
Questions	Which activities take place at the outpatient department of the 21st century?
Method	Literature study

Treatment of the patient / consultation, aftercare of the patient and making follow-up appointments take place at the consultation rooms. All other activities done by the medical specialist take place at the Knowledge & Expertise centre.

This led to the following added values:

- Increased innovation and user satisfaction by effective use of human resources in an inspiring environment
- Improved flexibility and productivity, due to the flexible working concept. In combination with just-in-time leads this to also to reduced costs-controlled risks and an improved financial position.
- Improved culture by placing the patient central and making the patient the owner of the consultation.

8.1.3. Research sub-question 3

Objective	Understand how real estate adds value to the user and organisation.
Questions	How does real estate add value to the user and organisation?
Method	Literature study

Real Estate Management theories

General real estate management differs from Corporate and Public Real Estate management (CREM and PREM) (investors point of view). CREM focuses on the organisation's performance (added values) in relation to the resources spent on real estate (costs). PREM is the same as CREM but with additional public goals.

Theories on CREM are applicable on hospital real estate management. However, the priority for a hospital is to offer the best healthcare in the most cost-efficient way. Real estate and other facilities come in second place but are important resources to be able to optimally serve the organisational goals and the care processes.

Aligning demand and supply

Real estate management is a continuous process of matching demand and supply. Wherein, an optimal alignment between demand and supply can lead to added values for the organisation. Furthermore, the complexity of real estate management is determined by the scope.

Stakeholder perspectives

Stakeholders are those who can or think they can be influenced by a decision or project. In order to align demand and supply understanding the different stakeholder perspectives is necessary. The stakeholders and their perspectives on real estate are represented in the stakeholder model of den Heijer (2011). This model makes it possible to combine the perspectives with the real estate added values.

The benefit of describing the added value in terms of four perspective instead of delegating it to a specific stakeholder is to determine the strategic, financial, functional and physical effects of an added value in hospital real estate.

Added values of hospital real estate

Real estate management is based on the presumed added value of real estate on the performance of the organisation. For hospitals the following added values contribute to the hospital organisation:

- Flexibility is an added value to all perspectives.
- Supporting the image, improving culture and increasing innovation are strategic and functional added values.
- Reducing costs, controlling risks and improving the financial position are more financial-added values.
- The physical environment has effect on the user satisfaction and productivity.
- Financial perspectives are connected to the physical implications, while the strategic perspectives

are connected to the functional perspective.
- Employee and patient satisfaction are separated added values.
- Healing environment is a healthcare specific added value.

8.1.4. Research sub-question 4

Objective	Define the principle of a smart tool.
Questions	What are smart tools?
Method	Literature review

A smart tool can be defined as a product or service providing the user or organisation with (real-time) information. The smart tool can be explained according to the visualisation in Figure 5.3. Smart tools are part of the greater network of IoT, consisting of sensing (data collection), network (data processing), and application (data provision). There are four levels of capabilities of smart tools, monitoring, control, optimisation, and autonomy.

8.1.5. Research sub-question 5

Objective	Understand the relationship between a smart tool and real estate management.
Questions	How are smart tools related to real estate management?
Method	Literature review

Smart tools can add value to the organisation when they are aligned with the perspectives and objectives of the organisation. The information received in the application step can be used to influence the user or organisation's (accommodation) decision-making short- and long-term basis.

By adding sensors, connecting network infrastructures and adding applications you can make the building communicate with users and managers and save energy, better support your users and use your building more efficiently.

8.1.6. Research sub-question 6

Objective	explore the potential optimisations of the outpatient department. Understand the objectives of the potential optimisations. Assess the information required for the potential optimisations
Questions	Which potential optimisations can be defined, what are the objectives of the optimisations and which information is required?
Method	Case-study research: semi-structured interviews, observations, documentation.

According to the case study of four general hospitals in the Netherlands, in total fourteen potential optimisations are distinguished in three different focus areas (from most desired to nice to have):
- Workflow: Diagnostics, finding workplace, digital forms, finding colleague, information (EPD), self measuring / controlling, and e-consult.
- Patient experience: Information provision, wayfinding, check-in, and senior service.
- Utilisation of space: Space use, Maintenance / tracking of (medical) equipment, and cleaning.

Eleven out of the fourteen assessed potential optimisations have generally not yet been implemented, and the remaining three are limited implemented without further integration.

Objectives are primarily functional:
- The most mentioned goals where related to supporting the user activities and consist of improving

the patient satisfaction, the employee satisfaction, productivity and flexibility.
- The most potential optimisations in service of an efficient work process where linked to strategic goals.
- Potential optimisations taking processes or tasks outside the hospital where mentioned mainly in relation with reducing costs and improving financial position.

Required information and access level:
- For the users this is mainly providing information about certain (digital) facilities or (medical) information.
- Within the 'user information' there is sometimes a separation made between patients and medical specialists.
- The 'management information' should generate partly information about the usage of space or equipment, partly information about their patients and partly feedback on which functions of the different topics are relevant or are missing (how the patient and employee satisfaction is influenced).
- Users should have access to most of the optimisations information, except for space use and maintenance / tracking of (medical) equipment.
- The most interesting and important observation is that potential optimisations benefit or even need each other's information to be useful.

To conclude, centralising the access to information and letting the different areas of potential optimisation communicate with each other is essential for a more efficient work process, better patient experience and more effective use of the building. However, this integrated approach towards optimisations has not yet been implemented by the interviewed hospitals.

8.1.7. Research sub-question 7

Objective	To come with possible a solution to optimise the outpatient department.
Questions	Which solution can be recommended to optimise the outpatient department?
Method	Literature review, interviews, observations

A mobile app or user available dashboard makes all the information available in a central place can be a valid option for optimising on one hand the patient experience and on the other hand the workflow of the medical specialists. However, the target audience of the hospital needs be considered, not only a large portion of the patients is 60 years or older but for some hospitals a considerably part of their patients is functionally illiterate or digitally illiterate.

In a user-oriented app as shown above there is still the potential to generate management information about the utilisation of the building. This can be done by analysing the data generated by all the individual users of the app by for example tracking the user's movements through the building or asking for feedback. The data of users need of course be anonymised before processed and the user must give his informed consent about using his data for optimisation of the utilisation of space.

Finally, an app or dashboard is just one solution, not an ultimate solution but just an example of what bringing information together and presenting it in a single place can do for the user of the outpatient department.

8.1.8. Main research question

Objective	To explore which 'smart' optimisations of the outpatient department could contribute in improving the patient experience, the medical specialist's workflow and utilisation of space. This will lead to a better understanding of 'smart' optimisations in the outpatient department, which can contribute to improved decision-making for the facility manager about integrating smart tools.
Questions	Which 'smart' optimisations of the outpatient department could improve patient experience, med-ical specialist's workflow and utilisation of space?
Method	Explorative empirical research

Based on extensive analysis of the empirical data gathered from Alrijne hospital, Martini hospital, Meander MC and Rode Kruis Ziekenhuis, fourteen 'smart' optimisations can be identified. These findings demonstrate the (future) potential of these optimisations for a 'smart' outpatient department and the usefulness of researching the potential for technological developments within the outpatient department.

These fourteen different potential optimisations are analysed from different theories as found in the literature. It shows that the fourteen potential optimisations focus on different main areas (from most desired to nice to have); medical specialist's workflow (finding workplace, digital forms, finding colleague, information (EPD), self-measuring / controlling, and e-consult), patient experience (Information provision, wayfinding, check-in, and senior service) and utilisation of space (Space use, Maintenance / tracking of (medical) equipment, and cleaning). The focus of potential optimisations is mainly on functional objectives with supporting user activities, increase patient and employee satisfaction, and improving productivity.

However, during the interviews and afterwards coding the transcriptions it became clear that the potential optimisations seem influence not just one area and one stakeholder group. Still this deemed influence has not yet been confirmed in practise, because eleven out of the fourteen assessed potential optimisations have generally not yet been implemented, and the remaining three are limited implemented without further integration. Therefor, the effects of the influences cannot be measured at this moment in time. Although, this integrated approach towards optimisations has not yet been implemented by the interviewed hospitals. It can be concluded that, centralising the access to information and letting the different areas of potential optimisation communicate with each other is essential for a more efficient work process, better patient experience and more effective use of the building.

An example solution is the in chapter 7 suggested patient-oriented app, integrating both potential optimisations of the medical specialist's workflow and patient experience. It both gathers by the medical specialist's requested information of the patient and presents the patient's requested information to the patient. It is even possible to also generate management information for the facility manager about the utilisation of the building by analysing the data generated by all the individual users of the app. This can be done by for example tracking the user's movements through the building or asking for feedback. The data of users need of course be anonymised before processed and the user must give his informed consent about using his data for optimisation of the utilisation of space.

Ergo, the advice is to look at individual potential optimisations at the same time and try to come to an integrated solution. This will create new valuable insights, improve the performance of the individual optimisations and it stimulates automation. In the end it can improve the patient experience, the medical specialist's workflow and the utilisation of space. The patient experience can be improved by giving

the patient the right information at the right time, enable patients to check on their own health at home and offer the patient services helping the patient through their healing journey. The medical specialist's workflow can be improved by creating alternatives to physical contact and check-ups of the patient, informing the patient, and making and comparing diagnostics of patients easier. The utilisation of space can be improved by measuring space use, tracking equipment, cleaning but most importantly to use information generated by services offered to users of the hospital and outpatient department.

Moreover, the still emerging technologies will make the possibilities of tomorrow even greater than today. However, starting today will create an advantage in improving the patient experience, medical specialist's workflow and utilisation of space over other hospitals tomorrow.

8.2. Discussion

The findings of this research are discussed in this section. The main topics that will be discussed are; the relation between the existing theories and the findings of this research, relation between the findings and practice and the limitations, validity and reliability of this research.

8.2.1. Theoretical implications

The findings from the literature study, covered in chapters 3, 4, and 5, are discussed in this paragraph. The focus in this section is to identify the relation between the findings of the research and findings from theory.

Added values

In a literature study to added values of hospital real estate, in this research the nine added value's as stated in the theoretical framework based on the dissertation of van der Zwart (2014) were used as the input for the interviews. The utilisation of this theoretical framework in during the case interviews proved to be useful. However, during the interviews it became clear that there are also other added values important for outpatient departments. Reducing square metres was mentioned a view times as an added value, and is included in the theoretical framework based on the dissertation of Den Heijer (2011) but was not acknowledged in the research of van de Zwart.

The second change in added values was in splitting up an existing added value in to two new added values. The added value user satisfaction was recognised by all the interviewees as important, however should be split up into patient satisfaction and employee satisfaction. This separation of patients and employees was declared as important because both user groups are important stakeholders in the hospital and have objectives. The satisfaction of the patient is connected to the well-being of the patient, while the satisfaction of the employee is connected to a good, functional and comfortable place to work efficiently.

Both changes in added values where added to the added values list during the empirical part of the research. Therefor, the nine added values, used during the theoretical part of this research, have grown with two added values to a total of eleven added values during the empirical part of this research.

Smart tool

The research of Valks et al. (2018) wherein smart tools are defined was focused on the application of smart tools on university campuses. The scope of this research was on the outpatient department of hospitals, creating insights that enlarged the existing smart tools knowledge by focusing om a different type of real estate with different type of users and related objectives. However, the scope of smart tools is focused on the university campus made it difficult to find of if the potential improvements could be seen as smart tools. Furthermore, there is not a universally accepted definition of a smart tool, this made researching to existing health care related 'smart tools' even more difficult.

'Smart' Outpatient department

The College bouw zorginstellingen (2006) has defined four basic principles that are central to the hospital of the 21st century. The empirical part of this research focuses on two of the four basic principles that are central in the hospital of the 21st century; (1) Facilitate and support the activities as efficiently and patient friendly as possible and (2) Make information available independently of time and place. Although, this concept is developed thirteen years ago and used for the development of new hospitals like one of the cases, Meander Medical Centre, the goals of these principles are still not completely fulfilled. It seems that progress is going slow. Particularly when looking at the implementation

of technologies that facilitate and support the activities as efficiently and patient friendly as possible. Reasons for these slow developments are partially related to the culture in the hospitals, wherein the medical specialists play an important role. Hospitals depend on the work of the medical specialists, giving the medical specialist say in the decision making of hospitals. Combined with the financial difficulties some hospitals experience, this has resulted in a lot of postponed or even canceled projects and innovations.

With the introduction of the obligatory EPD integration, the hospitals are working on making information available independently of time and place, however the introduction is still in its infancy. These slow developments made researching the implementation of smart tools in the outpatient department difficulty and let to a change in scope to first define on which areas optimisation of the facilitation and support of activities and information availability independently of time and place was needed.

8.2.2. Practical implications

The findings from different elements of the empirical part of this research that covered chapters 6 and 7, are discussed in this paragraph.

Case studies

The first practical implication are the studied cases of this research. The cases are selected on basis of willingness and the connection of the graduation company of the research with these cases. This has resulted in a selection of four outpatient departments of hospitals in the Netherlands, that have no smart tools implemented yet. Furthermore, as mentioned in the above section is not a universal understanding about the definition of smart tools. This is something that was experienced during the interviews. The definition had to be explained in detail, however it seemed that for the medical related interviewees the definition was still quite difficult to grasp. This made gathering useful information in some of the interviews difficult.

Traditional sector towards technological developments not directly related to care

Another point of discussion is the need for innovation. As experienced during the interviews and seen from the available hospital concepts in literature, hospital organisations are traditional organisations. It must be pointed out that the Dutch health care sector is in a transition period from government regulated to more market oriented and that when it comes to directly care related innovations hospitals are not traditional. However, the general consensuses towards innovation to optimise the workflow, the patient experience in a hospital and the utilisation of space are still fairly traditional. However, as stated in the conclusions section, starting today with innovating in these areas will create an advantage in improving the patient experience, medical specialist's workflow and utilisation of space over other hospitals tomorrow and will lead to improvement of the provided care.

Alternative to digital solutions

As explained before in the empirical part of this research there should always be an alternative to the use of technologies. The technologies should complement to the existing service not replace it in its entirety. Not only because of a large portion of the patients is 60 years or older but for some hospitals a considerable part of their patients is functionally or digitally illiterate.

An app as optimisation solution

As explained before in the chapter six of this research an app or dashboard is just one possible solution, not the ultimate solution but just an example of what bringing information together and presenting it in a single place can do for the user of the outpatient department. Real estate (management) can benefit from this information gathering and presentation. For example, it can gather information about the

usage of the building and give control and oversight of who is when in which part of the building. This is important for fire safety, planning, future (real estate) decision making, and ultimately change the way the building is used

Furthermore, an app is just one part of the smart tool principle, without the collection and processing of the data the app or dashboard is just a digital index with static information that is put in by hand, and is not able to present real-time information to its user. As discussed above an app or dashboard might also not be the solution for everyone, so an app can be a solution, but not the sole solution.

8.2.3. Limitations of the research

As mentioned before there is a lack of implementation of smart tools in Dutch hospitals. Making researching in this field more difficult and has led to a changing scope throughout this research. From which smart tools can be defined in the outpatient department, to which 'smart' optimisation of the outpatient department can improve the patient satisfaction, medical specialist's workflow and utilisation of space. There is nothing wrong with changing the scope of the research. However, it did lead to some limitations, these limitations will be discussed below.

In general change is a sensitive topic to discuss in hospitals. Meaning, that interviewing patients, hospital staff and even medical specialists is difficult, because the hospital organisations are afraid of unrest when certain questions are asked to which the organization itself may not have answers. Therefor, when investigating which improvements in especially the areas of patient satisfaction and medical specialist's workflow are sensitive subjects to ask patients or medical staff. However, to still get results interviews with different managers were conducted. While interviewing managers yielded enough information, it could be the case that due to political reasons the results were limited due to interviewees not answering completely freely. This has resulted in potential limitations in the neutrality and credibility of this research.

The next limitation are the challenges when dealing with data analytics and coding. In this research is not a specific format used for analysing the potential optimisations. This has resulted in a higher risk of subjectivity, due to the researcher's observations and interpretations. Furthermore, also misinterpretation of the gathered information could have led to different results. In order to prevent such changes of subjectivity and misinterpretation, feedback from the interviewees on the result could have been asked. Another solution, that is highly recommended for future research is to improve the validity of this research with the use an expert panel / Delphi panel to validate the results of the research.

The last limitation was the limited time for this research. Consequently, there was only time for a limited amount of cases. Additionally, if more time was available the possible solutions part could have been explored more and market parties could have been approached to see if they have smart tools that match the required potential optimisations. Ultimately, this would have led to a more complete overview of the possibilities.

9. Recommendations

This chapter aims on the recommendations derived from the conclusions and discussion of this research. Starting with some recommendations for practice followed by some recommendations for future research.

9.1. Recommendations for practice

Based on the findings and the conclusions of this report, several recommendations for practice are given to hospitals who have want to optimise the outpatient department and improving the patient experience, medical specialist's workflow and utilisation of space.

Set clear objectives for future optimisations

During the interviews, the interviewees explained that the list of added values helped them with explaining how potential optimisations could contribute to the organisation. Meaning that when defining future optimisations, setting clear objectives helps with reaching the right goals with these optimisations and really contributing to the users and organisation of hospitals.

Integration of different platforms

As explained earlier on in this research, integration is key when wanting to maximise the optimisations. To this extent, when hospitals are deciding on implementation of new technologies think about the (future) integration with other technologies and existing systems. This will not only maximise the optimisations but can also be financial beneficial in the future.

Include the users in the process of setting objectives

The importance of the viewpoint of the user has been explained before in this research. But once again, involving the users early in the process will generated insight in setting objectives that are beneficial for the users and as many hospitals state with providing care: 'patient is central'. This should also be the case with implementing new technologies.

Try new innovations with pilot projects

Although, as stated before hospital organisations are traditional organisations when dealing with technological developments. According to one of the interviewees; J. Nijhof (personal communication, 15 July 2019) the hospital environment is the ideal environment for these kind of pilot projects. Therefore, it is really a shame not yet seeing a lot of smart tool pilot projects in hospitals.

Be aware of privacy and security risks

As mentioned before, privacy and security risks are important. Certainly, when dealing with information about the identities of the patients and employees. There are protocols that ensure safety and privacy, and using a government approved service like DigiD would help when dealing with this problem.

Have always alternatives to digital solutions

Pointed out many times before, but to emphasise it once more. Digital solutions are not for everyone and there should always be a low tech alternative (M. de Vink, personal communication, 29 August 2019). Or develop / use technological solutions that can be used for elderly and functionally or digitally illiterate.

9.2. Recommendations for further research

In general, it is recommended to do more research, both qualitative and quantitative research towards smart tools in general and the integration of smart tools in hospitals. Due to the fact that smart tool research is a fairly new field of research, every research about smart tools would help to great a more mature body of knowledge.

Conduct research at hospitals with smart tools implemented.

The main reason the scope of this research changed to potential optimisations, instead of studying the implementation of smart tools in hospitals, is the lack of implementation of smart tools in Dutch hospitals. However, Radboud UMC is currently developing a new hospital building in which smart tools will be central to optimise medical processes and the use of the building. When this building has been developed, this would be an excellent case to research the implementation of smart tools in the hospital environment.

Same research again after implementation

As stated by J. Nijhof (personal communication, 15 July 2019) the hospital environment is an ideal environment for pilot projects. Thus, when the cooperating hospitals of this research decide to integrate smart tools, this research can be used to check if the mentioned optimisations with related objectives of this research are implemented or if the wishes for optimisations are changed.

Research the costs of smart tools in hospitals

Something that has been completely untouched in this research are the costs related to developing and implementing smart tools for the hospital environment. Costs are an important factor and can even make or break implementation of certain developments. Therefor is it recommended for the future to conduct research into the costs of implementing smart tools (for the hospital environment).

Shift the scope of this research to other parts of the hospital

The outpatient department is averagely around twenty percent of the total space of an hospital. Thus, there are a lot more areas a research could focus on. For example, in the inpatient department the beds of the patients are the most crucial part and these need to be used as efficient as possible. Keeping track of this and finding a way to optimise this with the use of smart tools could be an interesting research topic. Another option is to focus more on the hospital logistics, not only the transport of goods through the hospital, but also the logistical flow of patients and medical staff.

10. Reflection

10.1. Research process

During the summer holidays I already started with researching some of the topic and the PREM topic seemed at that time the most interesting and promising one. At the end of the first week I had to make the choice of topic already. However, I really wanted to see what every topic had to offer and join every presentation. But at the same time my elective course, also given by this faculty (RE valuations) was already started and the presentations overlapped with the lectures of that course. That was not the best start. Furthermore, together with the topic, the first mentor had to be chosen in that same short time window. For me this was hard, because I did not know all the mentors personally and not knowing for sure that is would be the right topic. However, I did choose to go for the topic of PREM in combination with smart tools.

After some researching and meeting, PREM seemed to be aiming more for the big picture and I got more interested in the smart tools part. In the second or third week I scheduled an appointment with my graduation company to see if they had some ideas or problems, they encounter during their consultancy job for hospitals and other healthcare facilitators. After this conversation with my graduation company I started with the problem of hidden vacancy in hospitals, that after a few weeks seemed to be a hard topic to find relevant scientific articles for. Therefor, after some while I diverted to a different topic, but then it was almost time for P1. However, the weekend the P1 presentation I decided to switch again to a different topic, again more in the direction of PREM.

However, after my P1 presentation I switch again a couple of times. Then started to work on wayfinding that in the end transformed into patient experience in combination with smart tools. Therefor, before I got my topic straight it was already mid-December, not an effective process. I had the feeling that I was going through a stagnant process instead of an iterative process, where I was only working on one level in circles and always came up with a slightly different topic, without getting deeper into my work. This has been a huge learning process for me, as I have never had to do such research before. Furthermore, towards p2 was a period with many ups and downs and it also did not help that I did a lot of other courses such as valuations (7ects), Python for geomatics (5ects), Operational research methods (3ects), Case Study methods (3etcs) and Scientific writing (2ects).

After my P2 presentation again changed the scope of my research from patient experience towards new ways of working in the outpatient department. That later on became more clearly developed as potential optimisation of the outpatient department that improve the patient experience, medical specialist's workflow and utilisation of space. I used the two months of summer holiday to do my interviews. Due to my internship at Cure+Care Consultancy, who have direct contact with hospitals on a day to day basis, was arranging several interviews quite easy. The interviewees of the four different studied hospitals were all nice and willing to help with my research. Although, some interviews were postponed due to changes within the organisation making planned interviewees no longer available. However, in the end, more than enough information about the innerworkings of the outpatient department and the potential optimisations from the perspectives of patient experience, medical specialist's workflow and utilisation of space was gathered with the interviews.

The feedback from my P3 was good and critical, I had to make the scope of my research clearer and decide where to focus on and which parts of the research to drop. This resulted in dropping the market exploration and designing an own solution for the potential optimisations. Furthermore, the four weeks between p3 and p4 were very busy finishing up the analysis of the case study, writing the report. This whole process took way more time than expected and needed to also work all the weekends on the report. The adaptions and changes made in this period took a lot of time to change in the report and because this report is quite large, the spelling and quality control get more difficult with every page that is added. In the end the report it is quite different from what I expected at the beginning of this journey. But I am certainly proud of the result.

10.2. Research topic

This research was conducted within the chair of Public Real Estate, that focuses: 'focuses on the challenges of managing public real estate portfolios by building theory on improving decision-making processes and finding new concepts for the built environment' (Delft University of Technology, n.d.). The main focus of this chair the university campus, described in the dissertation of Alexandra den Heijer (2011) as 'managing the university campus'. In 2014 Johan van der Zwart wrote his dissertation about managing hospital real estate. What is completely in line with a part of my research. In 2016 the first research focused on smart tools was published and in 2018 the second was. Although, the research was focused on smart tools, the researches were again scoped towards managing the university campus. My research is not scoped to the university campus, therefor it can be stated that my research does not perfectly fit within the current scope of the chair of Public Real Estate. However, my research can broaden the scope and builds on earlier research done within the chair about managing hospital real estate. It would, however, be interesting to have a more general focus towards smart tools and managing public real estate in the chair of Public Real Estate.

10.3. Goals and findings

The initial goal of this research was to help facility managers to help integrate smart tools effectively in the hospital environment, that can help the facility manager in making future accommodation decision making. While at the same time contribute to adding new knowledge about smart tools in hospitals to the existing body of knowledge. Due to the several changes in the scope throughout my research process, the goals and objectives changed with this. The end goal of the research is to provide facility managers with the information about which optimisations of the outpatient department can help to improve the patient experience, medical specialist's workflow and utilisations of space.

When looking at the findings of the research in comparison to the initial expected findings it is clear that no smart tool implementations have been found. But that there is an oversight of which potential optimisations are necessary, that can serve for a program of requirements when wanting to implement smart tools. These smart tools can improve the patient experience, medical specialist's workflow and utilisation by optimising the outpatient department. In the end this result is for me much more interesting, because of focus on the needs of the users and not solely looking at products and the results these products have made.

10.4. Dissemitation

This research is not only interesting for facility managers as described in the above section, but other stakeholders in practice and the scientific community. In this section the dissemination potentials for the research are elaborated upon.

Facility managers of hospitals

The findings of the research are relevant for the facility managers of hospitals. The different potential optimisations are the result of interviews with users about which information and objectives are at stake when wanting to optimise the outpatient department.

Universities

This research adds knowledge to the research about smart tools and smart outpatient departments or hospitals. More research about these topics is important to create a mature body of knowledge and to create a common understanding about the definitions of smart tools and smart outpatient departments or hospitals.

Developers of smart tools

This research can be a source of information for developers of smart tools who want to develop smart tools that optimise the outpatient department. With this research they have information about how the outpatient department can be improve with the use of smart tools for the two most important stakeholders of the hospital, the patient and medical specialist.

10.5. Relevance

It is important for this research to have both relevance to society as to science, in this section the relevance will be explained. To start with the fact that, smart tools are a relatively new development and according to the research of Cisco (2013) the agile technological developments have great potential to improve the customer experience, productivity, efficiency and innovation in a variety of fields, including healthcare and the built environment. In addition, also mentioned in the problem definition, there have been some major changes in the way hospital real estate is financed. Meaning that the hospitals have become completely responsible for their own real estate. This leads to more opportunities, but also more risks (van der Voordt, 2016; van der Zwart, 2014). For example, the hospitals are now more than ever judged at their medical production. More production means more possibilities for future investments.

Furthermore, not only is there more pressure on the real estate and financial aspects of the hospital. But also, other resources like good medical staff is getting scarcer. According to a research of van den Brink et al. (2018), there is a shortage of 628 nurses, 671 specialist nurses, 528 supporting medical staff, and 290 medical specialists at the end of April 2018 in 63 hospitals. This shortage of medical staff means longer waiting lists and less medical production. This means that optimisation of the outpatient department are necessary to guarantee good quality of care for the future.

By improving the efficiency and effectiveness of the outpatient department and making sure that the medical specialists can focus on their core tasks instead of searching for an appropriate workplace or colleagues and provide all the users with the appropriate information at the location and time they need it. The scarce resources can be used more efficiently, and the medical production could potentially improve and even the patient satisfaction will could improve. Additionally, according to one of my interviewees, J. Nijhof (personal communication, 15 July 2019) the hospital environment is an ideal environment for pilot project. So why not start today with making ‘smart’ outpatient departments and hospitals in general.

References

Alrijne Zorggroep. (n.d.). Over Alrijne. Retrieved from https://www.alrijne.nl/over-alrijne

Appel-Meulenbroek, R., Groenen, P., & Janssen, I. (2011). An end-user's perspective on activity-based office concepts. Journal of Corporate Real Estate, 13(2), 122-135.

Aruba Networks. (2014). The Challenge of Wayfinding in Hospitals and Mobile Technology as an Answer. Retrieved from https://www.arubanetworks.com/pdf/solutions/EB_BostonChildrensHospital.pdf

Arup. (2017). Reimagining property in a digital world. Retrieved from London: https://www.arup.com/perspectives/publications/research/section/reimagining-property-in-a-digital-world

Bartels, A. H., Daley, E., Parker, A., Evelson, B., & Muteba, C. (2009). Smart computing drives the new era of IT growth. Forrester Inc.

Bäumer, U., von Oelffen, S., & Keil, M. (2017). Internet of Things: Legal Implications for Every Business The Palgrave Handbook of Managing Continuous Business Transformation (pp. 435-458). London: Palgrave Macmillan.

Bélissent, J. (2010). Getting clever about smart cities: New opportunities require new business models. Cambridge, Massachusetts, USA.

Braaksma, J., & de Jong, J. (2015). Van concept naar praktijk. FMT Gezondheidszorg, 16-18.

Brunia, S., De Been, I., & van der Voordt, T. J. (2016). Accommodating new ways of working: lessons from best practices and worst cases. Journal of Corporate Real Estate, 18(1), 30-47.

Bryman, A. (2015). Social research methods (5th ed.): Oxford university press.

Buckman, A., Mayfield, M., & BM Beck, S. (2014). What is a smart building? Smart and Sustainable Built Environment, 3(2), 92-109.

Buhr, D. (2015). Social innovation policy for Industry 4.0: Friedrich-Ebert-Stiftung, Division for Social and Economic Policies.

Chen, M., Mao, S., & Liu, Y. (2014). Big data: A survey. Mobile networks and applications, 19(2), 171-209.

Cisco. (2013). Embracing the Internet of Everything To Capture Your Share of $14.4 Trillion. Retrieved from https://www.cisco.com/c/dam/en_us/buy/cisco-capital/apjc/assets/pdfs/ioe-economy.pdf

Cisco, C. V. N. I. (2017). Global mobile data traffic forecast update, 2016–2021. white paper, 0018-9545.

College bouw ziekenhuisvoorzieningen. (2004). Spreekuurafdeling, poliklinische behandeling en algemeen orgaanfunctieonderzoek. Bouwmaatstaven voor nieuwbouw.

College bouw zorginstellingen. (2006). Het ziekenhuis van de toekomst - ontwikkelingen in het spreekuur centrum. (592). Utrecht: Twin Design.

Cook, D. J., & Das, S. K. (2007). How smart are our environments? An updated look at the state of the art. Pervasive and mobile computing, 3(2), 53-73.

Cotteleer, M., & Sniderman, B. (2017). The forces of change: Industry 4.0. Deloitte Insights, December, 18, 2017.

De Jonge, H. (1996). De toegevoegde waarde van concernhuisvesting. Paper presented at the NSC-conference, Amsterdam. Amsterdam.

de Jonge, H., Arkesteijn, M. H., den Heijer, A. C., Vande Putte, H. J. M., de vries, J. C., & van der Zwart, J. (2009). Corporate Real Estate Management: Designing an Accommodation Strategy: TU Delft, Faculty of Architecture, Department Real Estate & Housing.

De Kok, A., Koop, J., & Helms, R. W. (2014). Asessing the New Way of Working: Bricks, Bytes and Behavior. Paper presented at the 18th Pacific Asia Conference on Information Systems 2014.

Den Heijer, A. C. (2011). Managing the University Campus: Information to support real estate decisions: Eburon Uitgeverij BV.

Diener, E., & Crandall, R. (1978). Ethics in social and behavioral research: U Chicago Press.

Dutton, W. (2014). Putting things to work: social and policy challenges for the Internet of things. info, 16(3), 1-21.

Edmondson, A. C., & McManus, S. E. (2007). Methodological fit in management field research. Academy of management review, 32(4), 1246-1264.

Erasmus-MC. (n.d.). Het nieuwe ziekenhuis. Retrieved from https://www6.erasmusmc.nl/nieuwbouw/waaromnieuwbouw/

Gurol-Urganci, I., de Jongh, T., Vodopivec-Jamsek, V., Atun, R., & Car, J. (2013). Mobile phone messaging reminders for attendance at healthcare appointments. Cochrane Database Syst Rev, 12(12), CD007458.

Haynes, B., & Nunnington, N. (2010). Corporate real estate asset management. London: Estates Gazette.

Haynes, B., Nunnington, N., & Eccles, T. (2017). People: The importance of the interaction between people and real estate Corporate Real Estate Asset Management (pp. 204-220): Routledge.

Hoendervanger, J. G., De Been, I., Van Yperen, N. W., Mobach, M. P., & Albers, C. J. (2016). Flexibility in use: Switching behaviour and satisfaction in activity-based work environments. Journal of Corporate Real Estate, 18(1), 48-62.

Holland, P., & Bardoel, A. (2016). The impact of technology on work in the twenty-first century: exploring the smart and dark side. The International Journal of Human Resource Management, 27(21).

Johnson, J., Mawson, A., & Plum, K. (2015). Effectively Measuring Knowledge Worker Productivity: White Paper. Iowa: Allsteel Inc.

Joroff, M. L., Lambert, S., & Louargand, M. (1993). Strategic management of the fifth resource: corporate real estate: International Development Research Council.

Kim, J., Candido, C., Thomas, L., & de Dear, R. (2016). Desk ownership in the workplace: The effect of non-territorial working on employee workplace satisfaction, perceived productivity and health. Building and Environment, 103, 203-214.

Kleijn, M., Appel-Meulenbroek, R., Kemperman, A., & Els, H. (2012). CREM and activities at the modern workplace: A study of the variables influencing the use of workplaces in an activity based office design. Retrieved from

Krumm, P. J. M. M. (1999). Corporate real estate management in multinational corporations: a comparative analysis of Dutch corporations: Arko.

Lindholm, A.-L., & Leväinen, K. I. (2006). A framework for identifying and measuring value added by corporate real estate. Journal of Corporate Real Estate, 8(1), 38-46.

Martini Ziekenhuis. (n.d.). Over het Martini Ziekenhuis. Retrieved from https://www.martiniziekenhuis.nl/Over-Martini/

Mautz, R. (2012). Indoor positioning technologies. (Habilitation Thesis), ETH Zurich, Zurich.

Meander MC. (n.d.). Dit is Meander. Retrieved from https://www.meandermc.nl/patientenportaal/dit-is-meander

Memelink, S., & Voogd, E. (2017). Cultuur en persoonlijkheid bepalen succes van werkomgeving. SWP magazine, 18-21.

Miles, M. B., Huberman, A. M., Huberman, M. A., & Huberman, M. (1994). Qualitative data analysis: An expanded sourcebook: sage.

Ministerie van VWS. (2018). Werken in de zorg. Retrieved from https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/jaarplannen/2018/03/14/actieprogramma-werken-in-de-zorg/Actieprogramma-Werken-in-de-Zorg.pdf

Morgan, J. (2014). A simple explanation of'the internet of things'. Forbes/Leadership.

Morrar, R., Arman, H., & Mousa, S. (2017). The fourth industrial revolution (Industry 4.0): A social innovation perspective. Technology Innovation Management Review, 7(11), 12-20.

Nourse, H., & Roulac, S. (1993). Linking real estate decisions to corporate strategy. Journal of real estate research, 8(4), 475-494.

Petrulaitiene, V., Rytkönen, E., Nenonen, S., & Jylhä, T. (2017). Towards responsive workplaces–identifying service paths for time-and place-independent work. Journal of Corporate Real Estate, 19(3), 144-156.

Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. Harvard business review, 92(11), 64-88.

Prentow, T. S., Ruiz-Ruiz, A. J., Blunck, H., Stisen, A., & Kjærgaard, M. B. (2015). Spatio-temporal facility utilization analysis from exhaustive wifi monitoring. Pervasive and mobile computing, 16, 305-316.

RFID. (2008). Internet of Things in 2020; a roadmap for the future. Retrieved from http://www.smart-systems-integration.org/public/documents/publications/Internet-of-Things_in_2020_ECEPoSS_Workshop_Report_2008_v3.pdf

RIVM. (2018). Chronische aandoeningen en multimorbiditeit. Retrieved from https://www.volksgezondheidenzorg.info/onderwerp/chronische-ziekten-en-multimorbiditeit/cijfers-context/huidige-situatie#node-aantal-mensen-met-chronische-aandoening-zorg-bij-de-huisarts

Rode Kuis Ziekenhuis. (n.d.). Over ons. Retrieved from https://www.rkz.nl/home_over_ons

Sadek, A. H. (2015). A comprehensive approach to facilitate wayfinding in healthcare facilities. Paper presented at the Design4Health 2015 European Conference.

Serraview. (2017). Managing Workplace Utilization. Leveraging the IoT to take advantage of underutilization in the workplace. Retrieved from http://info.serraview.com/workplace-utilization-free-guide

Ślusarczyk, B. (2018). Industry 4.0: are we ready? Polish Journal of Management Studies, 17.

Smartsigns. (n.d.). Smart Hospitality. Retrieved from https://www.smartsigns.nl/smart-hospitality-voor-optimale-gastvrijheid-professionaliteit-en-efficiency/

Valks, B., Arkesteijn, M., & den Heijer, A. (2018). Smart campus tools 2.0: An international comparison.

van den Brink, R., Herderschee, R., & Vleugels, A. (2018). Personeelstekorten ziekenhuizen nemen dramatisch toe. NOS. Retrieved from https://nos.nl/artikel/2234675-personeelstekorten-ziekenhuizen-nemen-dramatisch-toe.html

van der Voordt, D., Prevosth, J., & van der Zwart, J. (2012). Adding value by FM and CREM in Dutch hospitals. The added value of facilities management: concepts, findings and perspectives, 2012, blz. 205-222.

van der Voordt, T. J. M. (2016). Adding value by health care real estate: parameters, priorities, and interventions. Journal of Corporate Real Estate, 18(2), 145-159.

van der Zwart, J. (2014). Building for a better hospital: Value-adding management & design of healthcare real estate: TU Delft.

van der Zwart, J., & van der Voordt, T. J. (2016). Adding Value by Hospital Real Estate: An Exploration of Dutch Practice. HERD: Health Environments Research & Design Journal, 9(2), 52-68.

Van Meel, J., Martens, Y., & van Ree, H. J. (2010). Planning office spaces: a practical guide for managers and designers: Laurence King London.

Veldhoen + Company. (2006). Het ziekenhuis van de toekomst - Ontwikkelingen in het spreekuurcentrum (592). Retrieved from Utrecht:

Victoor, A., & Rademakers, J. (2015). Waarom kiezen patiënten niet voor het 'beste' ziekenhuis?*. Ned Tijdschr Geneeskd.(159).

Walter, U., Edvardsson, B., & Öström, Å. (2010). Drivers of customers' service experiences: a study in the restaurant industry. Managing Service Quality: An International Journal, 20(3), 236-258.

Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N., & Nelson, L. E. (2009). Helping CIOs understand "smart city" initiatives. Growth, 17(2), 1-17.

Winch, G. M. (2009). Managing construction projects: John Wiley & Sons.

Wright, P., Soroka, A., Belt, S., Pham, D. T., Dimov, S., De Roure, D., & Petrie, H. (2010). Using audio to support animated route information in a hospital touch-screen kiosk. Computers in human behavior, 26(4), 753-759.

Yin, R. K. (2017). Case study research and applications: Design and methods: Sage publications.

Zimring, C., Joseph, A., & Choudhary, R. (2004). The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity. Concord, CA: The Center for Health Design.

Appendices

Appendix A: Interview protocol Facility Manager
Appendix B: Interview protocol Outpatient Department Manager
Appendix C: Template smart tools from Valks et al. (2016)
Appendix D: Patient Journey

Appendix A

Interview protocol facility manager [naam ziekenhuis]

Door:	Bas Wouters		
Interview:	Datum: 13 augustus 2019	Tijd:	9:00
Geïnterviewde:	Naam: [naam geïnterviewde]	Functie:	[functie geïnterviewde]

Het interview protocol bestaat uit verschillende onderdelen. Er wordt gestart met *1. Alvorens het interview* en geëindigd met *7. Na het interview*. Dit betreft de introductie en het bedankje en valt buiten het eigenlijke interview. Deel 2 t/m 6 is het eigenlijke interview, waarin *2. Algemene introductie*; de introductie is, *3. Behaviour*; de persoonlijke omgeving betreft, *4. Bricks*; de fysieke omgeving omvat, *5. Bytes* over de technologische omgeving gaat en *6. Evaluatie en beëindiging* de afronding van het eigenlijke interview is.

1. Alvorens het interview

1. Introductie van mijzelf
2. Het doel van dit interview is om de behoefte te inventariseren omtrent het (toekomstige) werken in de poliklinieken. Dit is relevant omdat er de laatste jaren een verandering binnen de zorg gaande is, waar steeds meer wordt afgerekend op de gedraaide productie en er steeds minder mensen beschikbaar zijn om zorg te bieden aan een steeds grotere groep patiënten. Hierdoor is het van belang dat het werken in de poliklinieken zo optimaal mogelijk verloopt en de medewerker geen hinder ondervindt tijdens zijn of haar werkzaamheden en zich kan focussen op patiëntgerichte zorg. De behoefte inventarisatie is onderverdeeld in drie onderwerpen, de Bricks (fysieke omgeving), Bytes (digitale omgeving) en Behaviour (persoonlijke omgeving).
3. Toestemming vragen voor opname interview (bij start opname nogmaals toestemming vragen)

2. Algemene introductie

Kennismaking en opening interview.

1. Wat is uw achtergrond betreffende studie en werkervaring?
2. Wat is uw huidige functie bij [naam ziekenhuis]?
3. Sinds wanneer bekleedt u uw huidige functie?
4. Hoe zou u uw functie en bijbehorende werkzaamheden omschrijven en welke verantwoordelijkheden horen daarbij

3. Behaviour

De eerste vragen van het interview gaan over Behaviour. Dit gaat over hoe er wordt gewerkt op de poliklinieken en gaat daarom in op de organisatie en samenwerking.

Organisatie (Bij alles toegevoegde waarde aanhalen!)

1. Zou je mij kunnen vertellen hoe de polikliniek vanuit de medewerker gezien georganiseerd is? (voorbeelden noemen)
    a. Wat vind je dat hier goed aan gaat?
        i. Hoe komt het dat die aspecten goed georganiseerd zijn?
    b. Wat vind je dat hier beter aan zou kunnen?
        i. Wat is hiervoor nodig om dit beter te kunnen organiseren?
            1. Is dat (wat zojuist is beschreven) dan ook hoe de ideale polikliniek er uit ziet?
2. Uit welke activiteiten bestaat de werkdag van een medisch specialist?
    a. Hoeveel procent van de tijd wordt per activiteit besteed?
    b. In welke ruimte / plek vinden deze activiteiten plaats?
    c. Gaat dit in de toekomst veranderen?
        i. Zo ja, hoe gaat dit veranderen?
            1. Gaan de soort werkzaamheden veranderen en omschrijf hoe?
            2. Gaat de locatie veranderen en omschrijf hoe?

Samenwerken (Bij alles toegevoegde waarde aanhalen!)

1. Zou je mij kunnen vertellen hoe er volgens jou optimaal samengewerkt zou kunnen worden? (voorbeelden noemen)
    a. In hoeverre gebeurt dit nu al?
    b. Wat is ervoor nodig om de samenwerking te optimaliseren?

Resultaatgericht werken (Bij alles toegevoegde waarde aanhalen!)

1. In hoeverre is het volgens jou van belang dat er resultaatgericht wordt gewerkt?
    a. Welke aspecten zijn volgens jou van belang bij resultaatgericht werken? (voorbeelden noemen)
        i. Wordt op dit moment volgens jou al op deze manier gewerkt?
            1. Wat is daar op dit moment goed aan?
            2. Wat zou daar beter aan kunnen?
    b. Op welke wijze is de organisatie van de polikliniek aangepast naar de missie, visie en ambitie van het ziekenhuis?
        i. Hoe bevalt deze manier?

Vertrouwen, autonomie, cultuur en motivatie (Bij alles toegevoegde waarde aanhalen!)

1. Hoe belangrijk is het om zelf te kunnen beslissen over waar gewerkt kan worden en voor wie is dit belangrijk? (voorbeelden noemen)
    a. Waarom is dit wel/niet belangrijk en bij welke werkzaamheden?
    b. In hoeverre is het nu al mogelijk?
        i. Wat is ervoor nodig dit mogelijk te kunnen maken?
    c. Wordt hier ook op aan gestuurd om dit te motiveren?

4. Bricks

De volgende vragen gaan over Bricks. Dit gaat over de fysieke werkomgeving van de poliklinieken en gaat daarom in op het gebouwgebruik, de werklocatie en werkplek ontwerp.

Gebouwgebruik (Bij alles toegevoegde waarde aanhalen!)

1. Wat zou volgens jou de optimale polikliniek indeling zijn en waarom? (voorbeelden noemen)
    a. Is de polikliniek op dit moment ook al zo ingedeeld / hoe is de polikliniek nu ingedeeld?
        i. Waarom wel/niet?
2. Wat is er goed aan de huidige polikliniek indeling en waarom? (voorbeelden noemen)
    a. Wat zou er beter kunnen en wat is daarvoor nodig? (voorbeelden noemen)

Flexibele werklocatie en werkplek ontwerp (Bij alles toegevoegde waarde aanhalen!)

1. Wat is de huidige werk situatie en werkplek ontwerp?
    a. Welk soort kantoor ontwerp is er?
    b. Hoe worden op dit werkplekken toegewezen?
2. In hoeverre is er in de buurt van of binnen de polikliniek de mogelijkheid om een passende werkplek voor de verschillende werkzaamheden te vinden? (Denk ook aan: stilte werkplekken, plekken waar samengewerkt kan worden, (in)formele vergaderplekken)
    a. Wat is daar op dit moment goed aan?
    b. Wat zou daar beter aan kunnen?
    c. In hoeverre is het op dit moment mogelijk om een werkplek te reserveren of te weten dat een bepaalde werkplek beschikbaar is?

5. Bytes

De volgende vragen gaan over Bytes. Dit gaat over de digitale werkomgeving van de poliklinieken en gaat daarom in op de beschikbaarheid van informatie en communicatie en over apparaten.

Beschikbaarheid van informatie en communicatie

1. Over welke informatie zou je graag beschikken / is nodig voor het ideaal uitvoeren van de werkzaamheden op de poliklinieken? (noem voorbeelden) (Bijvoorbeeld: informatie over of patiënten er al zijn of waar collega's zijn of een ruimte vrij is)
    a. Welke toegevoegde waarde zou het beschikken over deze informatie hebben?
    b. In het momenteel al mogelijk om over deze informatie te beschikken?
        i. Zo ja, hoe kom je aan deze informatie?
        ii. Zo nee, waarom niet / wat zou er voor nodig zijn om aan deze informatie te komen?
2. Hoe zou er volgens jou zo optimaal mogelijk intern gecommuniceerd kunnen worden binnen de poliklinieken?
    a. In hoeverre is het op dit moment al mogelijk om zo te communiceren?
    b. Wat zou er verbeterd kunnen worden en wat is daarvoor nodig?
        i. Welke toegevoegde waarde zou het op deze manier communiceren hebben?
3. Hoe zou er volgens jou zo optimaal mogelijk met / naar de patiënt gecommuniceerd kunnen worden binnen de poliklinieken?
    a. In hoeverre is het op dit moment al mogelijk om zo te communiceren?
    b. Wat zou er verbeterd kunnen worden en wat is daarvoor nodig?
        i. Welke toegevoegde waarde zou het op deze manier communiceren hebben?

Apparaten

1. Welke apparaten zouden kunnen bijdragen aan een betere werkomgeving / het beter kunnen vinden van een geschikte werkplek?
    a. In hoeverre is dit nu al mogelijk?
    b. In welke mate zou het gebruik / ondersteuning van eigen apparaten hierbij kunnen bijdragen?
        i. In hoeverre is dit nu al mogelijk?
    c. Welke toegevoegde waarde zouden deze apparaten hebben?
2. Welke apparaten zouden bijdragen aan een betere samenwerking / het beter kunnen vinden van collega's?
    a. In hoeverre is dit nu al mogelijk?
    b. In welke mate zou het gebruik / ondersteuning van eigen apparaten hierbij kunnen bijdragen?
        i. In hoeverre is dit nu al mogelijk?
    c. Welke toegevoegde waarde zouden deze apparaten hebben?

Gebouwmetingen

1. Worden er gebouw metingen uitgevoerd?
    a. Zo nee, waarom niet en zou je wel wat willen weten? ***(in geval van ja, door gaan naar b.)***
    b. Zo ja, op welk niveau? (gebouw, afdeling, ruimte of werkplek) **(toegevoegde waarde aanhalen!!)**
    c. wat voor soort metingen, hoe worden die gedaan en op welk niveau? (gebouw, afdeling, ruimte, werkplek)
        i. Wanneer op gebouw of afdeling niveau wordt gemeten:
            1. Wat voor soort metingen worden er gedaan en hoe en met welke interval? (jaren, maanden, dagen, uren, minuten of seconden)
                a. Hoe wordt er gemeten aan de hand van roosters of worden hiervoor sensoren gebruikt?
                    i. Welke sensoren? (impliciet of expliciet)? *(denk aan PIR voor verlichting, het meten van een ingelogde PC, tag om de deur te openen, wifi, bluetooth iBeacon, RIFD, camera, CO2 meter, wearables en ultra wideband)*
        ii. Wanneer op ruimte- of werkplekniveau wordt gemeten:
            1. Weten / meten jullie of een (ruimte/werkplek) bezet is? (*toegevoegde waarde!)*
                a. Zo ja, hoe, waarmee en met welke interval? (rooster, handmatig of sensoren)
                b. Zo nee, waarom niet?
            2. Weten / meten jullie hoe een (ruimte/werkplek) benut wordt?) *Toegevoegde waarde!*
                a. Zo ja, hoe, waarmee en met welke interval? (rooster, handmatig of sensoren

    b. Zo nee, waarom niet?
3. Weten / meten jullie wie een (ruimte/werkplek) gebruikt? (vanaf hier privacy belangrijk) *Toegevoegde waarde?*
    a. Zo ja, hoe, waarmee en met welke interval? (rooster, handmatig of sensoren)
    b. Zo nee, waarom niet?
4. Weten / meten jullie welke activiteit er op een (ruimte/werkplek) gebeurt? *Toegevoegde waarde?*
    a. Zo ja, hoe, waarmee en met welke interval? (rooster, handmatig of sensoren)
    b. Zo nee, waarom niet?

6. Evaluatie en beëindiging

1. Is er nog iets wat je zou willen toevoegen?
2. Geïnterviewde bedanken voor de tijd.
3. Afsluiting en einde opname.

7. Na het interview

1. Meedelen wat er verder met het interview zou worden gedaan.

Appendix B

Interview protocol polikliniek manager [naam ziekenhuis]

Door:	Bas Wouters		
Interview:	Datum: 13 augustus 2019	Tijd:	9:00
Geïnterviewde:	Naam: [naam geïnterviewde]	Functie:	[functie geïnterviewde]

Het interview protocol bestaat uit verschillende onderdelen. Er wordt gestart met *1. Alvorens het interview* en geëindigd met *7. Na het interview.* Dit betreft de introductie en het bedankje en valt buiten het eigenlijke interview. Deel 2 t/m 6 is het eigenlijke interview, waarin *2. Algemene introductie*; de introductie is, *3. Behaviour*; de persoonlijke omgeving betreft, *4. Bricks*; de fysieke omgeving omvat, *5. Bytes* over de technologische omgeving gaat en *6. Evaluatie en beëindiging* de afronding van het eigenlijke interview is.

1. Alvorens het interview

1. Introductie van mijzelf
2. Het doel van dit interview is om de behoefte te inventariseren omtrent het (toekomstige) werken in de poliklinieken. Dit is relevant omdat er de laatste jaren een verandering binnen de zorg gaande is, waar steeds meer wordt afgerekend op de gedraaide productie en er steeds minder mensen beschikbaar zijn om zorg te bieden aan een steeds grotere groep patiënten. Hierdoor is het van belang dat het werken in de poliklinieken zo optimaal mogelijk verloopt en de medewerker geen hinder ondervindt tijdens zijn of haar werkzaamheden en zich kan focussen op patiëntgerichte zorg. De behoefte inventarisatie is onderverdeeld in drie onderwerpen, de Bricks (fysieke omgeving), Bytes (digitale omgeving) en Behaviour (persoonlijke omgeving).
3. Toestemming vragen voor opname interview (bij start opname nogmaals toestemming vragen)

2. Algemene introductie

Kennismaking en opening interview.

1. Wat is uw achtergrond betreffende studie en werkervaring?
2. Wat is uw huidige functie bij [naam ziekenhuis]?
3. Sinds wanneer bekleedt u uw huidige functie?
4. Hoe zou u uw functie en bijbehorende werkzaamheden omschrijven en welke verantwoordelijkheden horen daarbij

3. Behaviour

De eerste vragen van het interview gaan over Behaviour. Dit gaat over hoe er wordt gewerkt op de poliklinieken en gaat daarom in op de organisatie en samenwerking.

Organisatie (Bij alles toegevoegde waarde aanhalen!)

1. Zou je mij kunnen vertellen hoe de polikliniek vanuit de medewerker gezien georganiseerd is? (voorbeelden noemen)
    a. Wat vind je dat hier goed aan gaat?
        i. Hoe komt het dat die aspecten goed georganiseerd zijn?
    b. Wat vind je dat hier beter aan zou kunnen?
        i. Wat is hiervoor nodig om dit beter te kunnen organiseren?
            1. Is dat (wat zojuist is beschreven) dan ook hoe de ideale polikliniek er uit ziet?
2. Uit welke activiteiten bestaat de werkdag van een medisch specialist?
    a. Hoeveel procent van de tijd wordt per activiteit besteed?
    b. In welke ruimte / plek vinden deze activiteiten plaats?
    c. Gaat dit in de toekomst veranderen?
        i. Zo ja, hoe gaat dit veranderen?
            1. Gaan de soort werkzaamheden veranderen en omschrijf hoe?
            2. Gaat de locatie veranderen en omschrijf hoe?

Samenwerken (Bij alles toegevoegde waarde aanhalen!)

1. Zou je mij kunnen vertellen hoe er volgens jou optimaal samengewerkt zou kunnen worden? (voorbeelden noemen)
    a. In hoeverre gebeurt dit nu al?
    b. Wat is ervoor nodig om de samenwerking te optimaliseren?

Resultaatgericht werken (Bij alles toegevoegde waarde aanhalen!)

1. In hoeverre is het volgens jou van belang dat er resultaatgericht wordt gewerkt?
    a. Welke aspecten zijn volgens jou van belang bij resultaatgericht werken? (voorbeelden noemen)
        i. Wordt op dit moment volgens jou al op deze manier gewerkt?
            1. Wat is daar op dit moment goed aan?
            2. Wat zou daar beter aan kunnen?
    b. Op welke wijze is de organisatie van de polikliniek aangepast naar de missie, visie en ambitie van het ziekenhuis?
        i. Hoe bevalt deze manier?

Vertrouwen, autonomie, cultuur en motivatie (Bij alles toegevoegde waarde aanhalen!)

1. Hoe belangrijk is het om zelf te kunnen beslissen over waar gewerkt kan worden en voor wie is dit belangrijk? (voorbeelden noemen)
    a. Waarom is dit wel/niet belangrijk en bij welke werkzaamheden?
    b. In hoeverre is het nu al mogelijk?
        i. Wat is ervoor nodig dit mogelijk te kunnen maken?
    c. Wordt hier ook op aan gestuurd om dit te motiveren?

4. Bricks

De volgende vragen gaan over Bricks. Dit gaat over de fysieke werkomgeving van de poliklinieken en gaat daarom in op het gebouwgebruik, de werklocatie en werkplek ontwerp.

Gebouwgebruik (Bij alles toegevoegde waarde aanhalen!)

1. Wat zou volgens jou de optimale polikliniek indeling zijn en waarom? (voorbeelden noemen)
    a. Is de polikliniek op dit moment ook al zo ingedeeld / hoe is de polikliniek nu ingedeeld?
        i. Waarom wel/niet?
2. Wat is er goed aan de huidige polikliniek indeling en waarom? (voorbeelden noemen)
    a. Wat zou er beter kunnen en wat is daarvoor nodig? (voorbeelden noemen)

Flexibele werklocatie en werkplek ontwerp (Bij alles toegevoegde waarde aanhalen!)

1. Wat is de huidige werk situatie en werkplek ontwerp?
    a. Welk soort kantoor ontwerp is er?
    b. Hoe worden op dit werkplekken toegewezen?
2. In hoeverre is er in de buurt van of binnen de polikliniek de mogelijkheid om een passende werkplek voor de verschillende werkzaamheden te vinden? (Denk ook aan: stilte werkplekken, plekken waar samengewerkt kan worden, (in)formele vergaderplekken)
    a. Wat is daar op dit moment goed aan?
    b. Wat zou daar beter aan kunnen?
    c. In hoeverre is het op dit moment mogelijk om een werkplek te reserveren of te weten dat een bepaalde werkplek beschikbaar is?

5. Bytes

De volgende vragen gaan over Bytes. Dit gaat over de digitale werkomgeving van de poliklinieken en gaat daarom in op de beschikbaarheid van informatie en communicatie en over apparaten.

Beschikbaarheid van informatie en communicatie

1. Over welke informatie zou je graag beschikken / is nodig voor het ideaal uitvoeren van de werkzaamheden op de poliklinieken? (noem voorbeelden) (Bijvoorbeeld: informatie over of patiënten er al zijn of waar collega's zijn of een ruimte vrij is)
    a. Welke toegevoegde waarde zou het beschikken over deze informatie hebben?
    b. In het momenteel al mogelijk om over deze informatie te beschikken?
        i. Zo ja, hoe kom je aan deze informatie?
        ii. Zo nee, waarom niet / wat zou er voor nodig zijn om aan deze informatie te komen?
2. Hoe zou er volgens jou zo optimaal mogelijk intern gecommuniceerd kunnen worden binnen de poliklinieken?
    a. In hoeverre is het op dit moment al mogelijk om zo te communiceren?
    b. Wat zou er verbeterd kunnen worden en wat is daarvoor nodig?
        i. Welke toegevoegde waarde zou het op deze manier communiceren hebben?
3. Hoe zou er volgens jou zo optimaal mogelijk met / naar de patiënt gecommuniceerd kunnen worden binnen de poliklinieken?
    a. In hoeverre is het op dit moment al mogelijk om zo te communiceren?
    b. Wat zou er verbeterd kunnen worden en wat is daarvoor nodig?
        i. Welke toegevoegde waarde zou het op deze manier communiceren hebben?

Apparaten

1. Welke apparaten zouden kunnen bijdragen aan een betere werkomgeving / het beter kunnen vinden van een geschikte werkplek?
    a. In hoeverre is dit nu al mogelijk?
    b. In welke mate zou het gebruik / ondersteuning van eigen apparaten hierbij kunnen bijdragen?
        i. In hoeverre is dit nu al mogelijk?
    c. Welke toegevoegde waarde zouden deze apparaten hebben?
2. Welke apparaten zouden bijdragen aan een betere samenwerking / het beter kunnen vinden van collega's?
    a. In hoeverre is dit nu al mogelijk?
    b. In welke mate zou het gebruik / ondersteuning van eigen apparaten hierbij kunnen bijdragen?
        i. In hoeverre is dit nu al mogelijk?
    c. Welke toegevoegde waarde zouden deze apparaten hebben?

6. Evaluatie en beëindiging

1. Is er nog iets wat je zou willen toevoegen?
2. Geïnterviewde bedanken voor de tijd.
3. Afsluiting en einde opname.

7. Na het interview

1. Meedelen wat er verder met het interview zou worden gedaan.

Appendix C

TUD-2 **TU Delft** **Pilot education spaces**

phase **Pilot**

scale **1 building 2.500 m2**

duration **Q3 2016 - present**

Project description

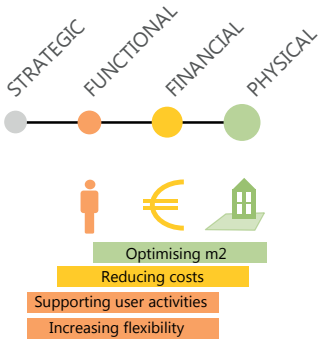
The initiative has been taken because TU Delft wants to get better insight into the use of facilities on campus. The university has been growing in terms of student population for years and that results in pressure on the education spaces. Four years ago we had 1 seat in an education space per student; now we have about 0,85 seat per student. In order to monitor what the effect of this change is on the use of space and to be able to schedule more efficiently in the future, the university decided to start measuring the frequency and occupancy rates real-time for education spaces. Wi-Fi has been selected as preferred method.

Foreseen developments

The next step in this project is to measure frequency and occupancy in education spaces on a campus level.

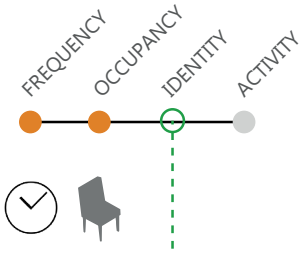
Profile

Why: Objectives



Optimising m2 has priority. On the long term this is achieved because schedulers receive information about the actual use of spaces by users. With that information it is possible to evaluate the space use and search for better solutions together with teachers.

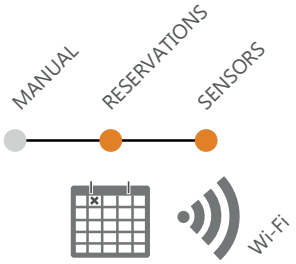
What: Measurement



Wi-Fi data is anonymised on-site before it goes to the cloud. In addition a different encryption is used so users can never be tracked for longer than one day if anyone is able to deanonymise the data.

The amount of devices in the building at a certain moment. That is converted via algorithms to an amount of people.

How: Measurement method



Wi-Fi registers both the amount of connected devices and connection attempts. Based on the signal strength between device and access point the location of a device in the building can be pinpointed.

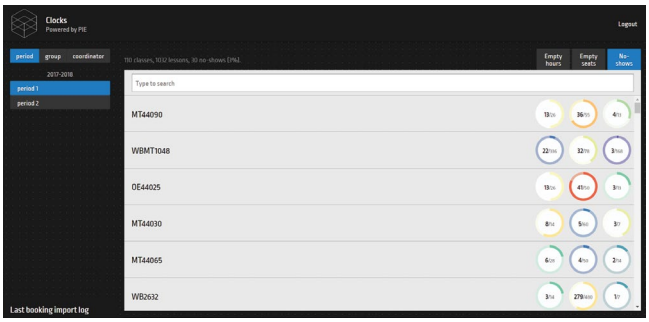
TUD-2 **TU Delft** **Pilot education spaces**

functionalities
Monitoring space use

space types
Education spaces

User information

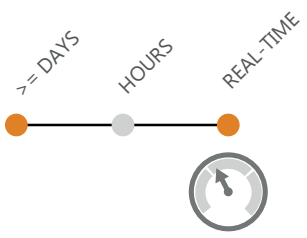
The user (scheduler) receives a report with in it per course the amount of bookings, the amount of no-shows, empty hours (partly used bookings) and the average occupancy. This makes the performance in relation to the schedule visible.



Management information

The manager can see the same reports as the scheduler and also the PIE dashboard in which the whole building is visible. PIE is not linked to the scheduling data, but shows real-time what the use of spaces in the building is in relation to their capacity.

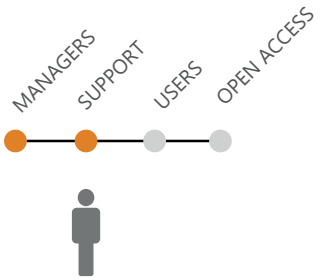
Actuality of the information



PIE displays real-time data.

The information in Clocks is visible real-time; for lectures currently underway a tentative frequency and occupancy is shown. The report shows data per period.

Access levels



The scheduling team has access to Clocks.

A few project team members and two people from the management of a faculty have access to Clocks and PIE.

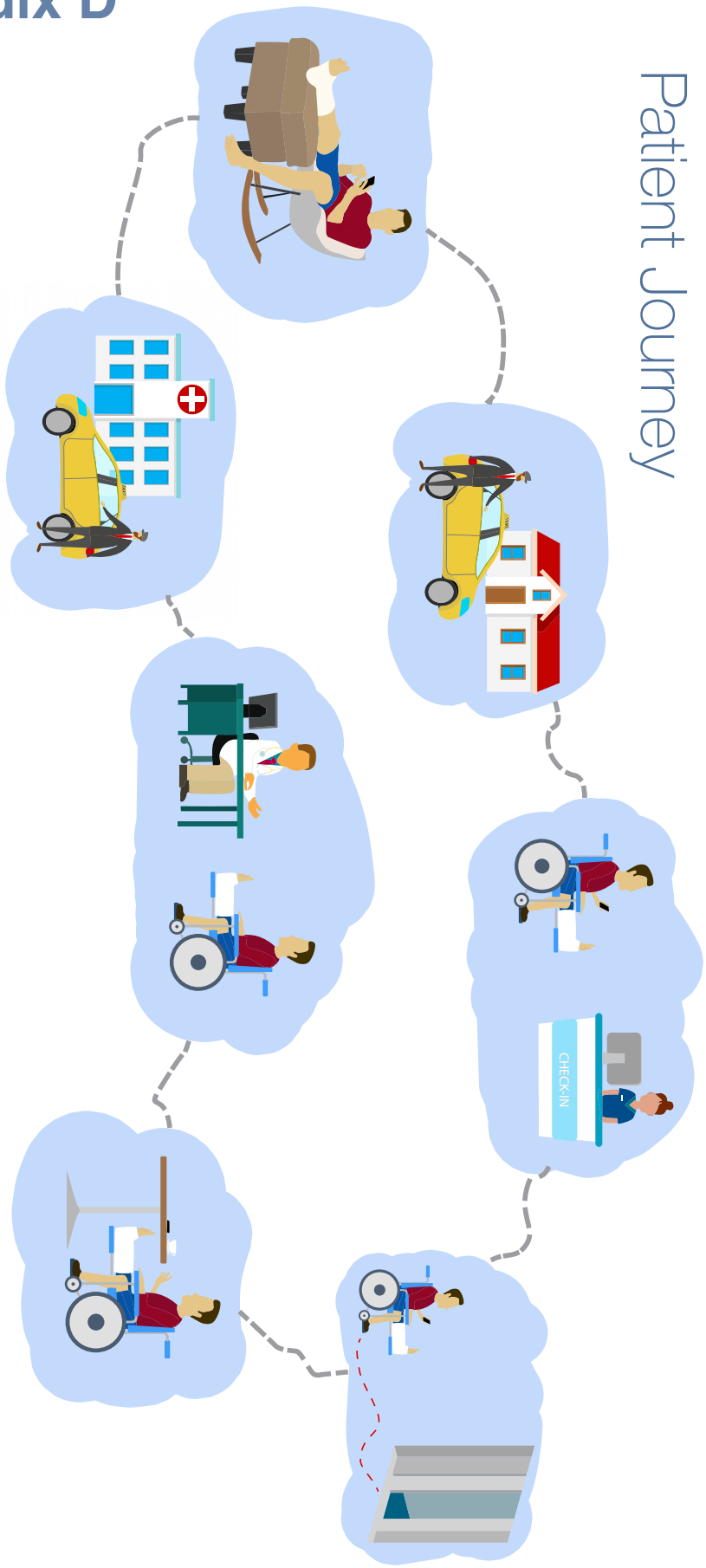
Benefits

Implementing a system with which the schedulers can evaluate the space use of lecture halls has been identified as one of the measures that enable the university to move to a more efficient space use. The university intends to move from a policy of 0,9 education spaces/student to 0,81 education spaces/student. The pilot is not aimed at assessing what efficiency can be achieved, rather to get experience with the method and testing the results with Wi-Fi in a second building.

Side notes

The reason that this pilot is undertaken is because of the results in the proof of concept in the faculty of Industrial Design Engineering were not as positive as expected. The lecture halls showed promising results, but the other spaces in the building did not. Multiple causes were identified: an open central hall with multiple floors adjacent to it, the pedestrian flows in the hall and around the building, the layout of access points and the way in which the network allocates users to access points. The pilot in 3mE is a test to see if the results in another building are comparable.

Appendix D



This research is conducted in partial fulfilment of the requirements for the degree of Master in Science at the Delft University of Technology in combination with a graduation internship at Cure + Care Consultancy.