

THE FUTURE OF HOSPITAL CARE

A Journey Towards Patient-Centric Hospitals

Lecturer: Hans Glerum

Client: Joost van der Sijp

Written by...

Suki Lam

Mireia Muntané Martí

Sunbel Safaraz

Vincent Anthonia

In collaboration with...



THE HAGUE
UNIVERSITY OF
APPLIED SCIENCES



CONTENT

01 INTRODUCTION

02 LITERATURE REVIEW

03 THEORETICAL FRAMEWORK

04 RESEARCH APPROACH

05 RESULTS

06 CONCLUSION & DISCUSSION

07 IDEATION

08 BUSINESS MODEL CANVAS

09 REFERENCES

10 APPENDIX

01 Introduction

THE PROJECT

The World Health Organization (2016) predicts that no countries will have an average life expectancy of less than 50 years by 2025. By that time, the number of jobs in care will increase considerably while the number of world population will also have increased up to 8 billion people, making it very difficult to provide good quality healthcare. Taking into account the fact that the world will always need healthcare, hospitals predict a considerably increased number of patients received every year in the near future. The shortage of nurses is an issue that already happens today and it will not get any better unless we find new ways of working. Investing and supporting innovation and technology will help us perform certain tasks and automatize certain processes, that way making nurses and doctors jobs faster and efficient while increasing patients care processes. That is the main reason why designers, engineers and researchers need to get together and develop smart products that will help healthcare providers deliver better, efficient and more effective outcomes to the large amount of patients expected.

Students from The Hague University of Applied Sciences collaborated with Haagse Medisch Centrum (HMC) located in Antoniushove to discover some of the improvements that could be made in such hospital in order to increase its nurses' efficiency and lead to a more patient-centric approach. HMC is a medical centre clinic that operates in three different locations around The Hague: Antoniushove, Bronovo and Westeinde. The locations differ in atmosphere and specialization. Antoniushove specializes in oncology, whereas Bronovo in elective care and Westeinde in acute pathology. HMC is at the top of best clinical hospitals in The Netherlands. It is especially

popular for having such a wide range of international patients but also for its specialization in highly complex acute care, oncological care, female and paediatric care, elderly care and infectious diseases. In addition, HMC conducts a large amount of scientific research projects and has a training center for doctors. Patients all over the region are treated here and it has one of the largest numbers of emergency department patients in the Netherlands.

Not only research results and conclusions have been described in this report, but also a quick ideation process that ended with a brainstorm of possible products that aim to serve as inspiration for the team that takes over this assignment during the Design part of the course. It has also been considered important to introduce, even at this early stage of the project, the business model canvas, in order to keep the key stakeholders and key activities in mind at all times. Note that the business model canvas may evolve during the second period of the project, according and meeting all users wishes, nurses needs and product requirements.

Team A

02 Literature Review

THE RESEARCH TEAM

Four students from The Hague University of Applied Sciences, coming from both campus Den Haag and Delft, came together to conduct this user-centred research with the aim of developing later on a smart device that can solve the current nurses workload issue while enhancing patients' own ability to recover faster.

With different cultural backgrounds from The Netherlands, Spain and Pakistan, they created together an international and multidisciplinary team composed by two bachelor students from User Experience (UX), one from Industrial Design Engineering (IDE) and the other one from Technical Business Management.

The Team believes in the appropriate use of technology and the adequate implementation of it in the world of healthcare. Meeting users' needs and satisfying their desires often becomes a complex task that requires a balanced combination of scientific and user research applied on design techniques, in a way that can ensure great quality products which offer great quality services/functions/features.

1. Healthcare as a determinant of social and economic growth of a nation

The pursuit of health and well-being is important to all people globally. World's population growth is creating a need for improving the accessibility to a safe and decent health care system and service, as well as long-term employment. Humans aspire to live a longer life while also keeping better health, and that is due to higher living standards, new technologies and longer lifespans. That being the main reason among others, the Commission (WHO, 2016) aims to prioritize health employment and education for all world's political leaders plans, as well as it tries to inspire action by describing healthcare not only as a system but also as an economy. An intersectoral approach has been taken to address workforce issues, involving finance, education, labour, health and social sectors, giving recommendations of adding value and support to the efforts being made currently such as the Global strategy on human resources for health: workforce 2030.

A dynamic healthcare market has been shown to promote and support education and workplace notably for women and young people, which highlights the potential political economical and social benefits of focusing on health and social sectors. It is clear, therefore, that in order to promote economic success of nations, it is of importance to allocate resources to healthcare workers. Definitely a major interest for healthcare system founders and decision makers should be preparing sufficient healthcare professionals for the coming future while investing on them and keeping them.

Netherlands stands out specially for its excellent standard healthcare, rated as the best in Europe. It demonstrates excellence on almost every criteria of healthcare but still leaves room for improvement in aspects such as, for instance, the waiting time. It is also noteworthy to point out the increase of accessible primary care centres by opening 160 of them 14 hours a day 7 days a week (Expedita, 2017). In The Netherlands, more than 10% of GDP is spent on health, which is a number that stays among the highest in the European Union. Importantly, in the 2019 Budget Memorandum the Dutch government stated that some measures have been taken and agreements have been made with the Ministry of Health, Welfare and Sports. Compared to what it was predicted to happen, the increased costs of healthcare will lower around €2 billion, not taking away the fact that healthcare will continue to be the largest and fastest-growing item of the government expenditure in the next year (Government of The Netherlands, 2018).

2. The demand for more nurses and need for efficiency

Unavailability of healthcare providers, stress-ridden nursing staff or medication errors involving a patients are, among others, some of the consequences of nursing shortage that society can already experience today. There are a few key factors that contribute in this cause which will keep on increasing unless we look into potential paths that can decrease the risk of shortage of nurses in the future.

Population growth is an important factor affecting hospitals and their capacity. Increased population means increased number of patients in hospitals, causing a sudden amount of workload for caretakers when it comes to daily data recording of long term stay patients (Fruits, n.d). The problem, however, does not only end with a heavier workload for nurses but also, it is important to state that nurses large amount of workload and high levels of stress are often correlated to their tendency of quitting their profession (McKechnie, 2016). This phenomenon is known as "nurse burnout" and it is defined according to the each nurse's emotional tiredness, mental exhaustion and chronic stress causing reduced feeling of personal accomplishment.

In 2015, Wang et. al. cross-sectional study registered burnout and exhaustion scores in response to a Nurse Job Stressor Scale which were above average, and that is an indicator of moderate levels of burnout. Importantly, burnout feelings have been found to result in lower quality of work performance. A different study conducted by Jack Needleman et.al. in 2011 indicated that insufficient amount of nurses was related to an increased patient mortality rate on a 6% higher compared to centres with sufficient nursing staff.

Another interesting cause of the nursing shortage and their increased amount of workload is due to ageing Baby Boomers (Rosseter, 2017). With this generation being a significant segment of the healthcare workforce and their retiring period of time already reaching now a few consequences are predicted to affect the quality of healthcare service. Not only the fact that they are already at their retiring age, but also due to ageing, the need more care services and improved facilities is increasing considerably (Lopez, 2016).

In conclusion, the World Health Organization (2016) predicts that by 2030, there will be a need of 40 million healthcare workers more and also, due to population aging, some individuals might develop more complicated needs, usually deriving from their chronic diseases, which are the ones that require the most comprehensive behavioral health services from nurses (Dangremond, 2015; McClure, Teasell, & Salter, 2015). Everyone should understand these factors as a call for action, and unifying with each other, look for new ways to increase the number of healthcare workers while also helping them perform their most repeated tasks more efficiently.



3. The importance of patient's mobility for a faster recovery

Patients who are staying longer in hospitals due to comorbidity and complicated procedures usually have difficulties on making any physical movement on their own, and that often results in a longer recovery time. Patients will be less compliant to start doing exercises as it reduces their pain from their illness (Hopkins, 2014). Hopkins presents results from his study that patients that were hospitalized for a long period of time and were aged around 65 had ulcers due to immobilization for a long periods of time.

Every patient's own will to move is an important key factor for their recovery process, especially for elderly patients. As previously mentioned, immobilization can easily increase the chances of suffering from muscle atrophy, ulcers or blood clots, and for some patients it can even cause a permanent functional decline. Studies show that it is especially dangerous for hospital patients to stay for a long period in a bed or chair, and that the sooner one becomes active him or herself, the better.

Rehabilitation at one's possible level is crucial for every recovery process, and it has shown to help prevent issues that could lead to readmission at the hospital, while it also has shown to enhance function, patient satisfaction and quality of care.

Finally, one can also assume the relation between longer recovery periods and the economic performance of a hospital. M.T. Groot pointed out that patients staying longer in hospitals have noticeably high hospitalization costs, and those are one of the main reasons why hospitals are currently making extra costs. The author reveals an average of long term hospitalization costs for a patient of almost 12.000 euros. From such number, one can deduct that an important amount of hospitals have to assume part of these costs themselves.



Photo by Rawpixel on Unsplash

4. Patients and hospital staff as co-designers

Healthcare codesign refers to the staff in healthcare and patients working together in improving products and services of the hospital. Based on the study done by Glenn Robert and his colleagues that experience shows as an essential catalyst for improvement in terms of healthcare delivery. Patients should take an ongoing role in identifying, implementing and evaluating improvements to the services provided by healthcare (Robert, 2015). Moreover, patients usually provide essential insights, wisdom and ideas which can be extremely helpful in bringing a change in healthcare institutions.

An example of such is when the PEG (percutaneous endoscopic gastrostomy) tube was created. After rigorous research done by healthcare staff members including nurses the tube was implementing. A lot of doctors were skeptical of its use which is why further research was done using patient's experience and that is when it became successful and it remained in use since then.

There has been growing attention in the value of applying design in improving the healthcare. To get more insight the interaction with the user and provider, co-designing is very essential to get more focus on the characteristics of a service. The patient and hospital staff interaction is referred to as touchpoints. These "touchpoints" are emotional interactions both negative and positive, and for both parties it's crucial for the overall experience of receiving and delivering care (Robert, 2015).

03 Theoretical Framework

1. Program of Requirements (PVE)

If the current situation and needs for improvement are sufficiently well-founded, the translation can be made according to product design. But before it is outlined, the first principles need to be clearly mapped out in a Program of Requirements (PVE). The PVE describes the product that must meet the functional, production-technical level. In order to define the design condition, this research uses the so called ISO norm which needs to be strictly taken into account for the design of the future hospital room. The ISO standards that are most relevant for this project are the following:

ISO 13485 - Quality management systems --Medical devices

The focus is on risks associated with the safety and performance of medical devices and compliance with regulatory requirements. In addition, the standard asks organizations to be more stringent when it comes to outsourcing processes by putting into place controls, such as written agreements, for assessing their suppliers – again based on risk.

ISO 27001 - Information security

Here the focus is on the process of dealing with the security of information, with the aim to ensure the confidentiality, availability and integrity of information within the organization. Electronic health record (EHR) systems and Health information technology (HIT)

Electronic health record (EHR) is the systematized collection of patient and population electronically-stored health. The purpose of an EPD is usually to support the current or future care process around a patient.

Health information technology (HIT) is information technology applied to health and health care. It supports health information management across computerized systems and the secure exchange of health information between consumers, providers, payers, and quality monitors.

ISO 9001 - Quality management systems -- Requirements

This can be used to assess whether the organization is capable of meeting the requirements of customers, the applicable laws and regulations and the requirements of the organization itself.

ISO 14001 - Environmental management system

This can be used to help the organizations improve their environmental performance through more efficient use of resources and reduction of waste, gaining a competitive advantage and the trust of stakeholders.

2. Patients

When coming up with the potential target group, it was important to recognize where the problem sits and who could benefit from the product. It was clear that patients and nurses are the target group. In terms of patients, this project focuses on the people who, for example, recently had surgery and they are in the process of recovery. Depending on the type of surgery, they are often the ones whose mobilization is a key factor for a good and fast recovery.

In an article written by Dorothy Foltz-Gray, the author mentions some of the most common hospital admission and the amount per year. The author also explains how a patient could possibly get the type of health problems.

Diabetes. Being overweight, inactive and age 45 and older are three prominent risk factors for type 2, or adult-onset, diabetes. Common reasons for hospitalization due to diabetes include strokes, heart attacks, ulcers and dehydration from elevated blood sugar levels.

Medication problems. Drug reactions of some sort can lead to a higher number of patients staying in the hospital longer than expected. Medications that are most commonly involved are corticosteroids, blood thinners, sedatives and sleep aids.

Pneumonia. As we age, our waning immune system makes us more vulnerable to both bacterial and viral pneumonia. Other conditions like diabetes, stroke and flu can predispose you to pneumonia as well. Pneumonia is the most common infection but urinary tract infections are considerably common as well.

Stroke or other conditions related to blood vessels in the brain. When blood flow is cut off to part of the brain — because of a clot in an artery or a blood vessel that burst — the result is a stroke, which kills brain cells and can lead to death.

Based on the research, one can say that patients that suffer from heart problems, stroke and tumors such as cancer tend to stay longer in hospitals (Foltz-Gray, 2016). It is noteworthy to go back to the importance of mobilizing when recovering after surgery, as the immobilization of a patient can lead to a high need of readmission at the hospital in a short range of time.

04 Research Approach

3. Nurses

On a daily basis, nurses have to keep up with a lot of systematic and continuous collection of data, which includes sorting, analyzing and organizing that data. In an article written by Toney-Butler TJ and Unison-Pace WJ, it said that, "the nursing assessment includes gathering information concerning the patient's individual physiological, psychological, sociological, and spiritual needs.", which is the first to a successful evaluation of the patient. Obtaining vital signs such as "temperature, respiratory rate, heart rate, blood pressure and pain level using an age or condition appropriate pain scale" is a part of the assessment of collection data.

When it comes to the functions of the nurse, it is important for them to identify the assessment and the responsibilities that is needed in order to plan and provide good individual care. In order to accomplish this, nurses need to meet patients needs in linguistically appropriate, culturally competent manner, evaluate response to care for the patients, have community support, assess and reassess the patients that are admitted into the hospital and have a safe discharge plan when they are ready to leave the hospital.

According to the previous authors, as a nurse, one strives to complete the following: "admission history and physical assessment as soon as the patient arrives at the unit or status is changed to an inpatient, data collected should be entered on the Nursing Admission Assessment Sheet and may vary slightly depending on the facility, additional data collected should be added, and documentation and signature either written or electronic by the nurse performing the assessment."

Introduction

Using an evaluative study approach, the research tried to gather nurses and patients opinions about the current shortage of nurses and their vision for the future hospitals. Other key factors have been described which appeared to be somewhat related to nurses performance and efficiency.

The main goal for this research was to find out where technology must be implemented in order to help increase efficiency in nurses' performance by automatizing some of the most repeated actions in the daily data measuring process.

Not only nurses have been looked into as the main focus, but also patients and the different effects that the current hospital environment has on them and their own recovery. Motivation and will to recover faster are two important factors that, in the future, might help hospitals in becoming less busy.

It is also worth mentioning that the research period has been a total of ten weeks, and that may not have been sufficient amount of time for such an extensive topic. Further steps are stated and explained at the end of this report by giving some recommended directions or guidelines in order to facilitate the job to whoever decides to continue this research.



Photo by Mireia Muntané Martí

Approach of data collection

Various research methods were used in order to collect and validate data. Both qualitative and quantitative data were collected during the research, as both were just as important and useful for the generation of theories and conclusions. Qualitative data was gathered through desk research, while also through interviews with patients and observations at the HMC Antoniushove. Quantitative data was collected through an online questionnaire targeted to people who had been a patient before regardless the hospital's location, and a paper based questionnaire for nurses of the HMC Antoniushove hospital.

Throughout the whole project period, secondary data was collected mainly but not exclusively through online desk research. The main objective for this method was to gather general but also essential information about the main issue.

First, research on the International Organization of Standardization norm, also known as ISO-

norm, was done to generate a theoretical framework of the official standard requirements set for any product in the field of healthcare. As the statement of need and support of the reasons for the research, the shortage of nurses and its effects to hospitals were the main focus for the literature review. Additionally, desk research on the role of the patient was done in order to determine the correlation between the patient's own motivation for mobilization and the efficient performance of nurses.

Structured interviews were used to deeply understand the experience of patients who were staying at the hospital in question during the research period. Within thirty minutes, patients were able to express their feelings and wishes by answering questions that opened up debate regarding their role in their recovery process and the interaction they have with the nurses on a daily basis.

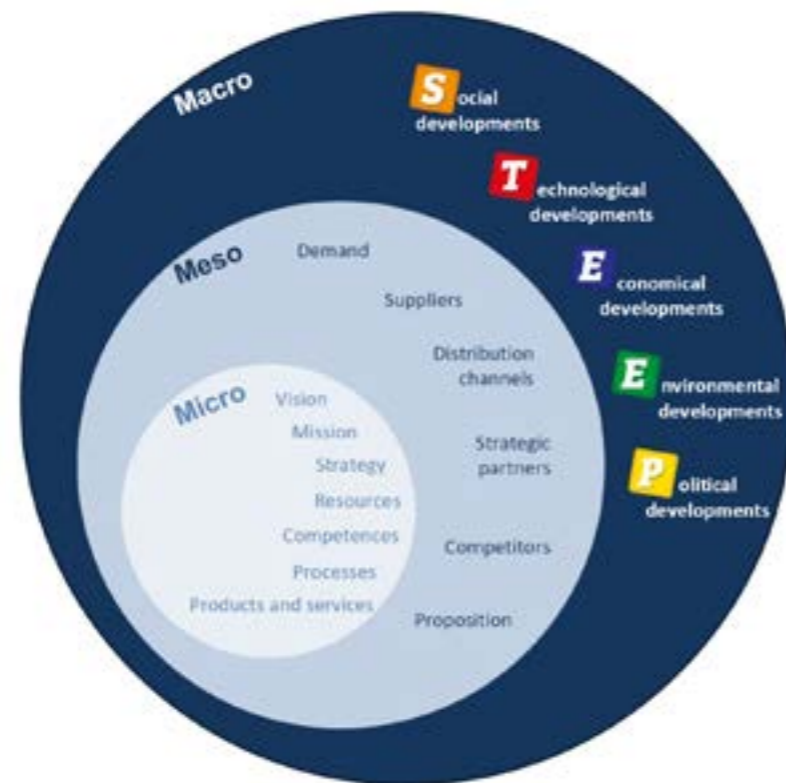
Three different observations were carried at the HMC Antoniushove during different visits. First acquaintance with Mariëlle Schut,

one of the nurses who helped the research team get closer to the patients, focused on getting information about the current hospital beds functions and features, and also the tooling that nurses currently use to record the patient's daily data measurements. On the second observation, more attention was paid on the characteristics of the environment where the patient rooms are situated. Having a closer look at the variety of frames and paintings that are hung in the corridor walls, the types of light provided in the individual rooms, corridors and common areas, and at the colors used for other interior design elements. The main goal for this observation was to find out whether the interior elements of the hospital may be influencing positively or negatively the patients experience during their recovery time at the hospital. Last but not least, a new observation on patient data recording was carried out with the consent and permission of both patient and nurse given. Looking specifically at how the measuring tools were used by both nurse and patient, and also at the interaction between them two. That provided a much clearer idea of how the process is done now and how much involved and informed the patient is.

Approach of data analysis

1. Situation analysis for the product plan

To map the current situation of HMC hospital, a situation analysis is made. In this, the opportunities and threats in different environments are analyzed. In order to study the situation in a business-based way, the clarification of business context in different environments is supported by the micro-meso-macro model. First we look at the macro environment, this is where the organization has no control; such as legal measures, market trend and market size. Afterwards, the meso environment is looked at, for example the customers and competitors. When there is clarity in how and why the efficiency of the future hospital room is influenced. Can an overview be made where MHC can improve at this moment with their design for the new hospital room.



1.1 MACRO - DESTEP

Using DESTEP analysis, the external factors that influence the opportunities or threats to the organization are examined. This includes market trends, social and cultural development, technological, economical, environmental and political developments.

1.2 MESO

The Customer Analysis is part of the situation analysis and is used to map the external environment of the organization. The opportunities and threats arising from this serve as input for the SWOT analysis on which the final strategy choice and product is based.

To define the characteristics of the customer groups one must answer the following questions:

Who - who are the current and potential customers?

What - what do the current and potential customers do to be active with the current service/ product?

Where - where do the current and potential customers use our current service/ product to be active?

When - when do the current and potential customers use our current service/ products to be active?

Why - why do the current customers and potential buyers use our current service/ products to be active? Why not?

05 Results

2. Concept generation approach

On the basis of the information gathered from the Product Plan so far, ideas are generated in a creative process. By means of brainstorming, sketches and models, the product idea is made visual and understandable. A number of concept variants are drawn from the best ideas, which also highlight the materials and production techniques used.

By testing the concepts against the starting points of the PVE, the advantages and disadvantages can be weighed against each other. For example, a well-founded choice can be made for the best concept, which can be further developed into an industrial product.

FIELD RESEARCH

Survey Results

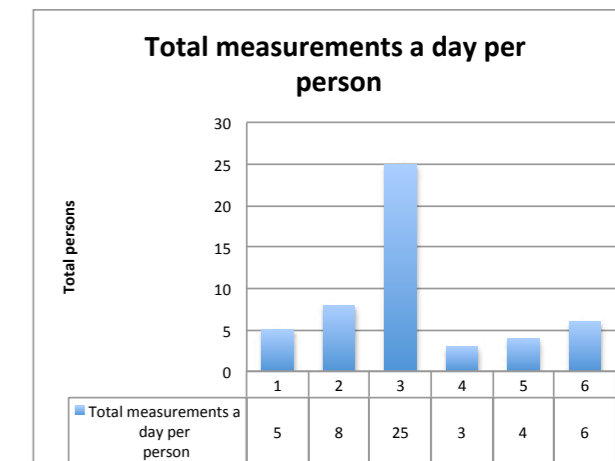
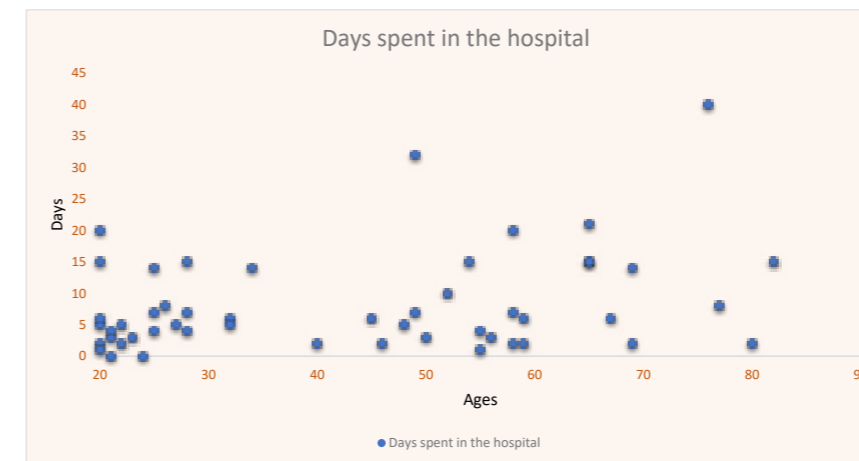
The result of the survey showed that there are two main groups staying for the longest times in the hospital. Patients underneath the age of 30 years have a high density at stay for less than 6 days and patients above the age of 30 year have a less density for less than 6 days spent in the hospital. The density of the patients who are over 60 years old are the lowest, their recovery time is significantly scattered. Furthermore, no links were found between the large and small operation in terms of residence time.

Three times a day is the most common total measurement a day for the patient. According to the interview and observation with one of the nurses, nurses spent a considerably high amount of time during their shift at collecting and registate of the measurements data. The result of the nurses survey shows that, in total, they spent on average 2 out of their 8 hours workday on data collecting for an average of 6 patients per day. This means 20

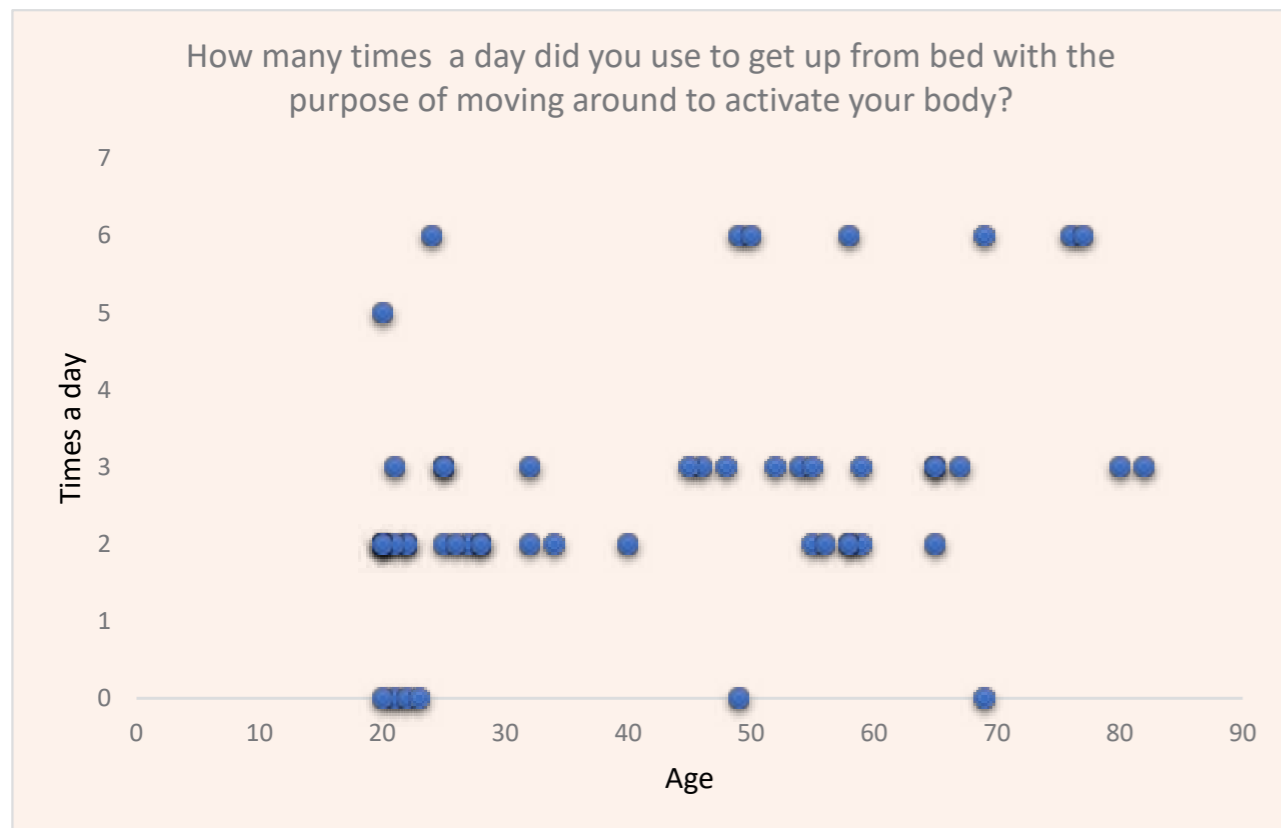
minutes to measure a patient 3 times a day and almost 7 minutes per measurement time. An important factor influencing the slowness of this process is the unavailability of COW (Computer On Wheels). There are only a few in the hospital and they are currently essential for the measuring data process, yet there are not enough for nurses to find an available one at any time.

It is also important to point out that the data measuring process is not an individual concerning issue, but also the transferring data process, which often can take even longer than the measuring.

The system of collecting an registate the data must be changed, it takes more time then the nurses even realise.



The graph below shows the data of how many times a day a patient got up from bed, this is distinguished with the different age groups. It can be seen that more patients around the age 50 to 70 like to get up at least 3 times a day, on the other hand the much younger age group from 20 to 35 year old, they like to get up 2 times a day. From this it can be deducted that patients ranging from 50 and above are more likely to get up the bed to move around while younger not that much. Not only that, in the graph it shows a pattern of the dots mostly scattered in the days 2 and 3 which deducts that patients most likely move around two to three times a day during their stay.



Patients Interviews

Patients admit that the process of data recording is often quite long but, because they know it's necessary, they accept it and generally they don't find it disturbing or painful.

The nurses' affection is always highly valued and appreciated, and sometimes that even serves as a motivation for the patients to obey what the nurses recommend. It is true, however, that the patients also have a feeling of need for more staff members.

According to the survey results, 84% of the patients would like to be informed about their health status. Currently, nurses do not tell the patients about their health status unless the patient asks for it. It is also important to mention that nurses are much less likely to tell the patient when their health status has gone worse.

70% of the patients agreed that knowing about positive progress would definitely motivate them mentally and physically.

Regarding the time of the day when patients feel more active, more than 50% of the patients interviewed felt the most active in the morning, 28% of the patients in the afternoon and 12% of the patients in the evening. Depending on each case, however, the optimal amount of times of becoming active may vary.

A personalized active program with notification about their improvement and progress should help the patient be more active.

Motivation for Mobility

Regarding internal motivation, the most given answer the patients for being active is getting better as soon as possible to go back home.

An interesting point was made by other patients who agreed that walking in the hospital is important as it is a safe environment, where they know they will receive immediate help if they fall or hurt themselves.

The third motivation is rather a prevention for their muscles to get sore or stiff when they are not being active for too long of time.

Some also pointed out that it feels much better to go to different environment, even if it is still inside the hospital, but different area, as staying in the room laying on the bed for too long time can cause them headache.

So information about how that being active influence them recovery time or how some exercise help them to prevent their muscles to get sore or stiff would motivate them to be more active.

Having some considerate conversation or attention from the nurses for personal comfort and interaction is the most voted external motivation for the patients to become active.

The second most given answer is to have interesting painting or playful photograph on the wall to look at when they walk around the building. Photograph of animals with some information of historical facts to enrich their knowledge and entertain them self or their visitors.

Others likes to walk around the hospital garden, to meet other people in the hospitals or go to other places to look through the windows for different kinds of views of the neighbourhood.

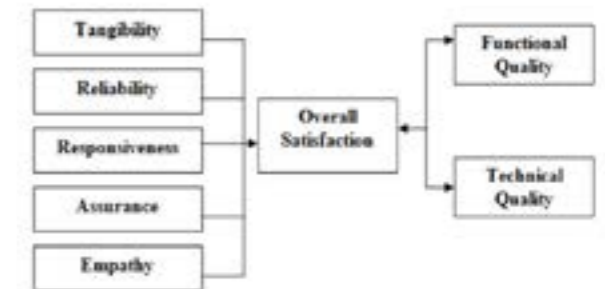
Having a rewarding system that is constantly changing according to their daily accomplishments would motivate them to be more active. Herewith an artwork/painting that is changing every time they have arrived at the frame can be used as an example to show their hard work of being active.

Restrictions

A few patients agreed that the machines are too sensitive, meaning they can go off really easily and they will cause a lot of different sounds. Just by moving around or getting up it will gives alarm immediatly, this not only gives the nurses a false alarm, but also it decreases their motivation and willpower to get up or being active.

Customer Satisfaction

To investigate the current situation with regard to customer satisfaction according to current patients and nurses, this survey is supported by the Zeithaml Customer Satisfaction Model (Meertens, 2011). Here the situational factors and the customer satisfaction of the current customer are mapped. Customer satisfaction knows factors that can and can not be influenced by HMC hospital. The personal and situational factors are not influenced by the HMC hospital, but these factors do, however, have a major influence on customer satisfaction. It is important that these factors are inventoried.



Nurses Interviews

Regarding mobility, most of the nurses recommend to encourage the patients to move many times for a short period rather than fewer times for a longer period. By being active frequently, they will prevent the patients to get tired from walking for long periods of time, and there will be less chance that the muscles get sore or stiff, and it will also allow an optimal blood circulation.

Furthermore when it comes to the data collection, nurses spent around two of their eight hours of working day in collecting data of around six patients. The weight of one same patient is collected around three times a week and it needs to be recorded too.

Daily, the COW (Computer On Wheels) is used by various nurses to process patients data in the system, but there is only a few of them in the hospital, which makes their availability quite restricted. That emphasizes the issue of transmitting the data. As mentioned earlier, the patients appreciate the nurses coming to see them and asking them personally how they have been doing. However, the nurses consider that the problem relies mostly on the data recording instead of measuring. Sometimes even two nurses are needed for only one patient.

All the nurses agreed that vital functions measurements takes most of the time and effort to transfer manually in the system. They believe that in the future, they will have medical equipment that exports patients data to the computers automatically.

Vital signs (often shortened to just vitals) are a group of the 4 to 6 most important signs that indicate the status of the body's vital (life-sustaining) functions. These measurements are taken to help assess the general physical health of a person, give clues to possible diseases, and show progress toward recovery. There are four primary vital signs: body temperature, blood pressure, pulse (heart rate), and breathing rate (respiratory rate).

Observations

Bed features and functions

The beds provided in the hospital have standard mattresses, however for patients that stay longer they have breathable mattresses. HMC has one hospital bed that has a weighing scale.

The hospital beds already have a system which allows the bed to be turned into three different positions:

1. Forward tilt (To easily slide immobile patients from one bed to another, also so that it's easier for nurses to collect data)
2. Backward tilt
3. Chair

Moreover, other than the three different positions the bed can also be elevated upwards by 30cm and downwards 30cm (making it more convenient for the patients and nurses).

Every bed has a remote control device which allows freedom for the patients to move it into the positions mentioned before and also a button in red for emergencies.

Environment

From the observation it was acquired that the corridor walls of the hospital had dull frames/ artwork on the corridor walls of the patients area, providing therefore less motivation for patients to move around. Not only that, the lightning in the rooms is too white, which allows the nurses to be able to see clearly when they are doing their job, but it does affect the patient negatively.

See below a comparison between common spaces at the hospital and patients areas.

Common Spaces



Patients Area (frames)



Personas - Fictional Characters

Due to privacy regulations of the hospital, it is not allowed to ask the patients about their personal data related to their health. However, creating personas helps visualize the potential users of a product and contextualize them, to later on create scenarios over them and “test” the idea of the product.

Out of the previous secondary research conducted regarding the most common illnesses, three fictional characters that simulate three different potential users of our product were created and quoted with comments received during the field research.

The quotes of each character are based on information gotten during the interviews with both patients and nurses and they provide information about their experience at the hospital regarding the issues that this report discusses (mobility, data measurement, etc.).

PERSONA 1



Name: Michael

Age: 25 years old

Reasons for being at the hospital: Patient, shoulder surgery

Michael's words about his hospital stay experience:

“The whole process of recording the data is very long and I get very tired of it. I still try to get up around four times a day, but it requires a lot of will power and energy, which sometimes I don't have. It's a lot of hours at the hospital alone, my family can only visit me in the evenings and actually, I wish I knew someone else staying at the hospital who I could talk to when time passes by slow.”

PERSONA 2



Name: Edward

Age: 37 years old

Reasons for being at the hospital: Nurse

Edward's words about his hospital work experience:

“I usually recommend patients to move more times for a shorter time, rather than less times for longer. It is important to frequently mobilize their body, and we nurses, as busy as we always are, sometimes forget to remind some patients to get up from bed. I wish some of our tasks could be automatized, we all think it shouldn't be that difficult, I like technology and smart devices, I just can't design products myself.”

PERSONA 3



Name: Viola

Age: 65 years old

Reasons for being at the hospital: Patient, heart attack

Viola's words about her hospital stay experience:

“Two days since I suffered my first heart attack and I feel much better. The doctors and nurses are telling me how important it is that I get proper rest and take it easy, they know I'm a very active person usually. But definitely I've also been told to walk for some minutes every day, a few times per day. I am being treated well and very professionally here, but I can't wait until I'm back home with my family and friends.”

DESK RESEARCH

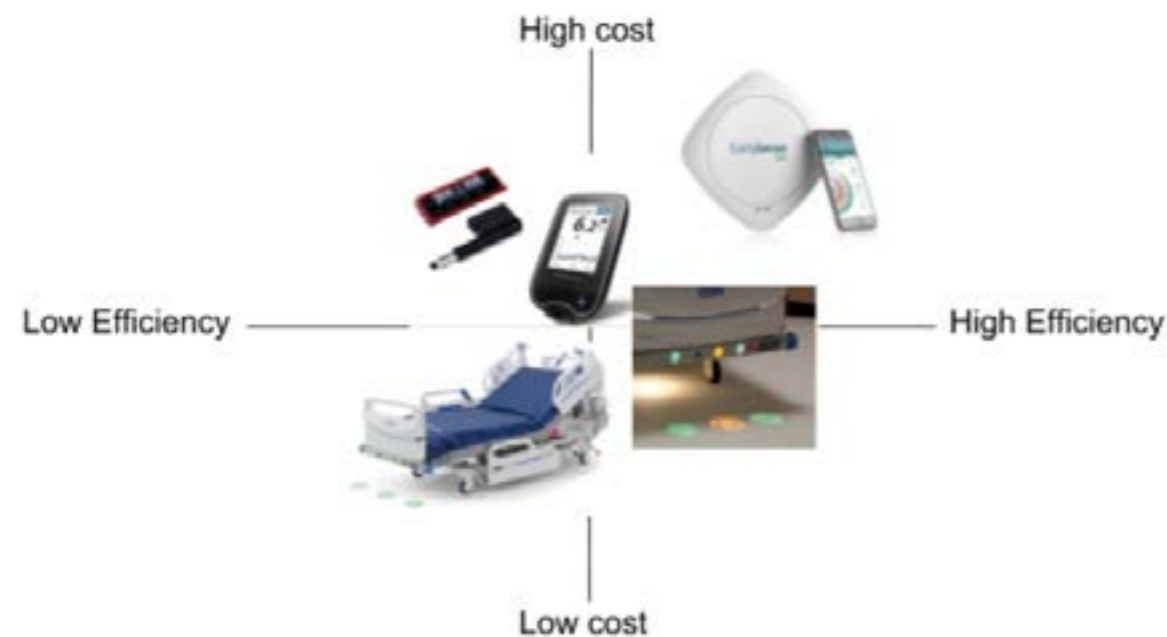
Market Research

The global smart medical devices market was valued USD 3.58 billion in 2016 and is expected to reach USD 24.46 billion by 2025 at a CAGR of 24.0% over the forecast period.

The smart medical devices market has been analyzed on the basis of product type, distribution channel, end user, and region.

Smartphones play a significant role in the healthcare industry. Increase in adoption of smartphones globally, rising demand for wireless & smartphone-compatible medical devices, increasing awareness and focus on health & fitness, and growing demand for home healthcare are factors anticipated to propel market growth.

Smart clothing and smart blood pressure monitors are expected to garner a huge market share over the forecast period.



Use of medical devices globally

Due to rapid advancements in technology in terms of medical devices there is also a large increase in its consumers. For instance, the efficiency of fitness devices has lured many users in wanting to know their heart rate. The same as for diabetic patients. As mentioned by Amanpreet Singh in his article about integration of smart technology, that physicians are using smart medical devices to detect vital signs of various diseases. These smart devices have helped reduce the workload of many health-care providers such as nurses.

The growth of population may also be the primary growth factor of smart devices being used at some hospitals. Some of the devices that are available and being used in the medical market are therapeutic devices, diagnostic and monitoring devices. Dpendancy of medical insituitions in smart devices is increasing due to the accurate results that are obtained and most importantly that cost of care. Smart medical devices iliminates the need of healthcare professionals for little needs like regular check ups.

Moreover, there are a lot of hospitals that are implementing the use of smart beds that have different functionalities such as detecting when a patient is getting up or leaving the bed or when a bed is occupied. This kind of bed automatically implements itself based on the patients characteristics or disease, it ensures that there is appropriate support.

Based on the market research done by Amanpreet Singh he refers to the pie chart shown in the figure below:



In the pie chart it shows the global revenue made by smart medical devices in 2016 and in the US it shows that \$ 15,143 is made.

The leading companies that are in the globally medical devices market are Apple, Abbott Laboratories, Dexcom, Fitbit, Johnson & Johnson, F. Hoffmann-La Roche, NeuroMetrix, Samsung Electronics and Sonova (Singh, 2018). These companies can be seen as producing more smart beds with coming of time because of their innovative approach in this field.

Existing Smartbed Technology

There are some existing products that work for making the lives easier for patients and nurses such as this new project initiated by Hill-Rom name Centrella. It covers the following specifications such as optimized patient safety, it is designed in a way that it helps keep the patients safe. Also, looking into the user experience of this product it takes into account the patient satisfaction by giving feedback. Not only that, it has a graphical caregiver Interface touchscreen that has a panel which makes it easier for the caregiver to use controls and it makes it efficient for them.

There are some features the Smart bed offers which covers the specifications mentioned before:

Enhanced Patient Satisfaction Features

USB port to charge the patients phone (covering patient's needs)

Patient Pedant is a setting which can be optimized according to every person's needs and allows them to feel autonomous ("entertainment controls, and a live nurse call button with visual confirmation of placed calls") (Hill-rom services, 2018).

A Storage Area which holds patient's personal items, including devices and reading material.

Automatic Contour Feature elevates the knees automatically when the head is moved or elevated.

Yourbed: Hill-Rom.com allows the patients to give feedback based on their experience.

Optimized Patient Safety Features

Safety Alerts provides alerts which caution the patients and caregivers in case of any danger:

- "Brake not set"
- "Call light not connected"
- "Please don't get up"
- "Your care team has been called"
- "Function not available"

Feature Labeling

Safeview+System shows visual projections of the safety status, which informs patients about their health status.

Nightlight helps the patient when they want to move around from or to the bed illuminating their path guiding them.

Slideguard Feature

Illumiguide Siderail Handgrip has a siderail feature which allows patients to easily grasp and hold themselves.

Enhanced 3-Mode Bed Exit includes silence, auto reset and visual/audible safety prompts.

Advanced Caregiver-Focused Technology

Graphical Caregiver Interface (GCI) Touchscreen are easy to use panels for the caregiver to collect information.



Another smart device in the medical devices market is EarlySense. In comparison to the smartbed, EarlySense is a device that collects data of patients without disturbing them.

The product works in the following ways: The product is allocated under the mattress and it has sensors which collect data while the patient is sleeping and then the health data can be seen on the app that they provide for the user's smartphone. The company of this product focuses on efficiency and making the lives of the patients easier which is why their product isn't wearable, cumbersome or visible (EarlySense, 2017).

The EarlySense company comprises of different types of devices which have different features and characteristics namely EarlySense percept, EarlySense live, EarlySense live + smartshare. All of these different types of devices work the same way but comprise of different kinds of data is collected. Some of the features that are collected by this device includes heart-rate, breathing, stress level and sleep cycles.

A Market Analysis has been made comparing a few of the smart devices mentioned earlier, according to their strongest/weakest features.

Future Visions

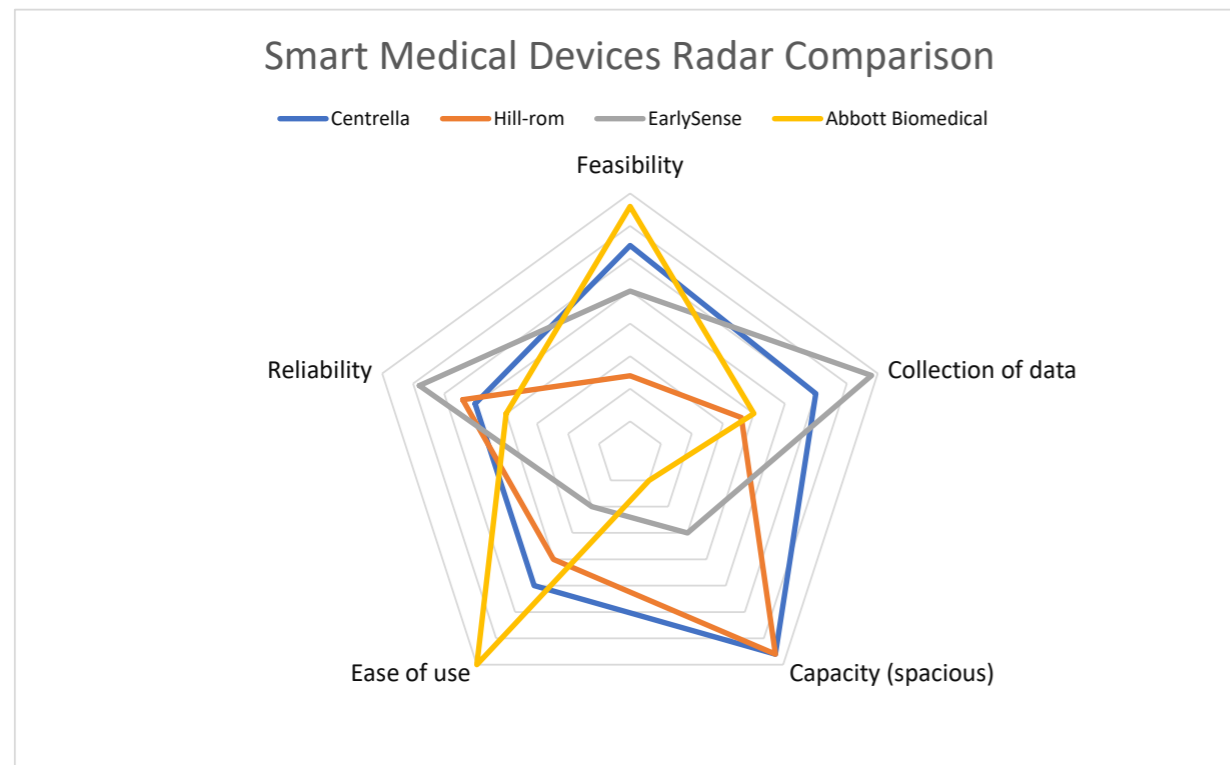
It is clear that the world will always need healthcare, and it is predicted that a few factors will even increase this need in the future. First of all, the average life expectancy in 2025 will reach 73 years, which means more people will be needing healthcare at the same time. Currently, a main topic is being discussed globally: how to make healthcare processes more efficient and more effective in order to be able to handle the large amount of population that is predicted for the future.

Research discusses a few promising future developments regarding healthcare, and these include some such as increase of patient involvement, important penetration of smart devices and greater health information exchange and interoperability.

HIE (Health Information Exchange) is one of the important advancements which is supposed to be the one attracting more attention in the near future. Soon it is expected to be able to implement HIE in smart devices such as wearable technologies like smart watches or wristbands which will be able to exchange information with the hospital in a much easier way.

Such technology could not only facilitate hospitals tasks by providing instant access to the patients information, but also, it could even help monitor vital signs. Potential issues could arise when different organizations use different systems and eventually they are required to interface.

Another great advancement is the implementation and increased use of robotic technology in hospitals. Not only to conduct very precise and specific surgeries but also to medicate patients, this way avoiding the risk of medication error. Moreover, some robots are also thought to do specific cleanings in hospitals in order to reduce healthcare-associated infections.



06 Conclusions

After talking to potential users about their experiences, some conclusions have been drawn out of what the patients expressed during the interviews.

It is clear that every patient values and enjoys the company of a nurse and feels closer to them having them come personally to their room and asking them how they are feeling. Therefore, it is important to keep this relationship between nurses and patients. With the introduction of a new smart product that mainly helps nurses carry the data recording process faster, while motivating the patient to become active, it is still relevant to not take the connection between nurses and patients for granted. It is important to connect both groups and keep enjoying each others' company.

From both primary and secondary research, an ideation process has followed (see pages 36 & 37) and for that, it is important to remember that there are two different target groups for this product; nurses and patients, and the product needs to function adequately for both groups. Moreover, four main characteristics have been selected as strong requirements for the product as they have been considered essential.

First, the product must involve certain interaction with the patient. The patient must feel the need of doing something to the product for it to respond, this way enhancing the activity of the patient.

Second, the product must be informative. It must provide both patients and nurses with the sufficient information regarding the patients health status. Regarding the patient, it is highly important to emphasize the positive progress in order to motivate them.

Third, the product must engage the patient to their recovery process with some sort of motivation that pushes them to move more frequently. It is important to not only attract a patient with the product on the first time, but also to keep them satisfied with the product and connected to it.

Fourth and last, the product must provide some sort of an incentive that makes the patient feel rewarded. The ultimate goal is to become active, and the product must reward them somehow when that goal is accomplished.

With these four main requirements, it is clear that there will be a strong need for user testing when designing the features of the new smart product. As mentioned previously, patients as co-designers will ensure that the product is user friendly, comfortable and interesting, this last one especially for the patients.



The next categorization that the group came up with was to divide the categories in two again. This time it would be personal devices and hospital devices. The purpose of this categorization was to see which of the sketch

products would be a product that a patient can also use at their home or out in public. Whereas the hospital devices would be devices that are specifically used in hospitals.

Personal / Hospital devices



In the last categorization, the group chose to combine the sketch products that would seem most similar to each other. For example, in the image above, there is a shirt and some socks. The two sketch products just mentioned are put together because they

both fall in the clothing part. The purpose of this categorization was for the group to see which of the products could be used together to get a better idea for the final product.

Combinations



08 Business Model Canvas

As a last step, the group decided for combining the two ideas below. The way they could be combined would basically consist in connecting both devices. While one is a personal device for each patient, and the other one is essentially an interior design element, they could wirelessly connect to each other.

Even though there is a whole idea development process ahead, the result is the following so far, and that should not restrict or limit any further step.

On the following spread, the Business Canvas Model is shown. It is based on the product that was thought of after the ideation and selection process was carried out. Even though the final idea is not developed yet, an initial business model canvas puts the main focus of the product is on the value proposition, which is about the value that the main target of the product desires and needs to receive. Main functions and ways of problem solving are stated. Connected to that there are customer segments, which shows who are the potential users of the product and other stakeholders.

Because the product will be used mainly by the hospital, a rough draft of the Revenue Streams has been made and specified how the subscription should be made. It is possible to rent the product and test it out on different patients for a three months, especially the wristband. Also, another advantage of the wristband is that it is also suitable for personal use from home.

FINAL COMBINATION

SMART FRAME

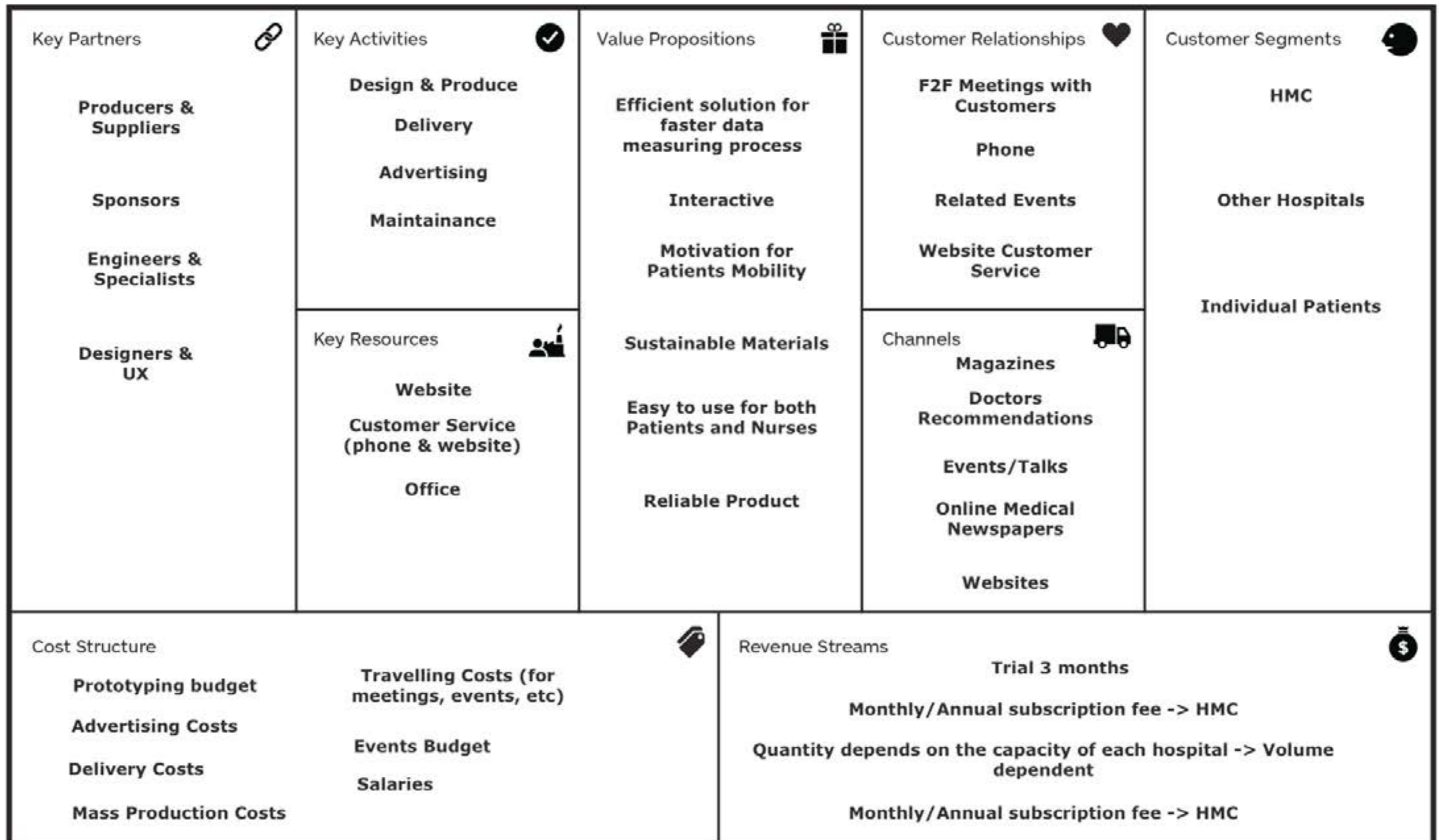


a few in the corridors

place finger here & the painting changes for a new one.



Wrist band - smart wearable design: measures data, also at home



09 References

World Health Organization. (2016). Working for health and growth: investing in the health workforce. Retrieved from High-Level Commission on Health Employment and Economic Growth: www.who.int

Expatica (Updated 2017). Healthcare in The Netherlands. Retrieved from Expatica: https://www.expatica.com/nl/healthcare/Healthcare-in-the-Netherlands_100057.html

Government of The Netherlands. (September 18th, 2018). 2019 Budget Memorandum: Investing in and preparing for the Netherlands' future. Retrieved from: <https://www.government.nl/latest/news/2018/09/18/2019-budget-memorandum-investing-in-and-preparing-for-the-netherlands-future>

Dangremond, C.K. (2015) A visual overview of health care delivery in The United states. In J. R. Knickman & A.R. Kovner, (Eds.), *Jonas and Kovner's health care delivery in The United States* (11th ed., pp. 13-28). New York, NY: Routledge.

Wang, S., Liu, Y., & Wang, L. (2015). Nurse burnout: personal and environmental factors as predictors. *International Journal of Nursing Practice*, 21, 78-86.

Leider, J.P., Coronado, F., Beck, A.J., Harper, E. (2017) Reconciling Supply and Demand for State and Local Public Health Staff in an Era of Retiring Baby Boomers. *American Journal of Preventive Medicine*. Volume 54. Issue 3, pp. 334-340.

McKechnie, T. (2016). CALL FOR NURSES: The Multi-Dimensional Manifestation of Nursing Shortage on Patient Care. *Journal of Healthcare Improvement and Patient Safety*. Issue 2.

Rosseter, R. (2017, May 18). Nursing Shortage Fact Sheet. American Association of Colleges of Nursing. Retrieved from: <https://www.aacnnursing.org/News-Information/Fact-Sheets/Nursing-Shortage>

Lopez, A.M. (2016). The Baby Boomers are Booming: The Future of Nursing and Home Health Care. *DePaul Journal of Healthcare Law*. Volume 18 (2).

Needleman, J., Buerhaus, P., Pankratz, V.S., Leibson, C.L., Stevens, S.R., & Harris, M. (2011). Nurse Staffing and Inpatient Hospital Mortality. *The New England Journal of Medicine*. 364 (11).

Hopkins, A. (2014, September 12). Patient stories of living with a pressure ulcer. Retrieved from <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2648.2006.04007.x>

Harwell, K. (2018, April 24). The Impact of Early Mobility on Patient Recovery. Retrieved from Kindred: <https://www.kindredhealthcare.com/resources/blog-kindred-continuum/2018/04/24/the-impact-of-early-mobility-on-patient-recovery>

Groot, M. T. (March). Costs of Prostate Cancer, Metastatic to the Bone, in The Netherlands. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0302283803000071>

Robert, G., Cornwell, J., Locock, L., Purushotham, A., Sturmey, G., & Gager, M. (2015). Patients and staff as codesigners of healthcare services. *BMJ*, 350, [g7714]. DOI: 10.1136/bmj.g7714

Cresswell, K. & Sheikh, A. (2015). Health Information Technology in Hospitals: current issues and future trends. *Future Hospital Journal* 2015. Vol 2. No 1: 50–6

Market Research References

Centrella™ Smart Bed. (n.d.). Retrieved September 26, 2018, from <https://www.hill-rom.com/usa/Products/Category/Hospital-Beds/centrella-smart-bed/>

EarlySense® Live™. (2017). Retrieved October 11, 2018 from <https://www.earlysense.com/digital-health/health-sleep-monitors/>

N.a. (2017). Smart Medical Devices Market Analysis. Retrieved October 30, 2018 from <https://www.grandviewresearch.com/industry-analysis/smart-medical-devices-market>

Singh, A. (2017). Integrating Smart Technology into Medical Devices. Retrieved October 29, 2018 from https://www.rfidjournal.com/articles/view?17827&fbclid=IwAR3pKWdjVQrwW-UVeIQP78Jk0Eflrow5ZOywt_FFhet-kl85pbbz8fk4jsY

10 Appendix

See Appendices on the separate document.