HOW IOT CAN IMPROVE THE AMBULANCE SERVICE IN THE NETHERLANDS

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EXECUTIVE SUMMARY

This report presents the outcome of the master thesis of Reinee Heutink, graduating in Strategic Product Design from the Delft University of Technology. The assignment was written by VodafoneZiggo with the question 'what is the impact of Internet of Things (IoT) on society?' This question has evolved into a more focused question after analyzing the company and exploring IoT. The question has become: 'how can VodafoneZiggo improve the ambulance services with IoT in the Netherlands?'. Three subquestions are answered in this graduation report, to finally find the answer to this main question.

VodafoneZiggo & IoT

Method

An internal, external and context analysis have been executed to dive deeper in the world of VodafoneZiggo and IoT.

The world of VodafoneZiggo

Vodafone and Ziggo merged in 2017. The company wants to contribute positively to the Dutch society. Besides this, their goal is to create 'ready businesses', which means that companies should respond quickly to opportunities in the market. IoT is one of the building blocks of a ready business.

The power of IoT

IoT connects objects via the internet. In this way, these objects become intelligent and are able to communicate and interact with people, applications, and with each other (Vodafone IoT Barometer 2016, 2016). Providing the Dutch ambulance service with VodafoneZiggo's IoT can make this a 'ready business', having positive impact on society.

1. What is the current situation for the ambulance service in the Netherlands?

Via literature and field research, insights in the ambulance service were gathered.

At the moment, emergency services often arrive too late. Only one out of three ambulances succeeds in meeting the standard (Nos.nl, 2017). The arrival time depends on several steps in the process. There is a challenge in the end of the process where the collaboration between ambulances, the reporting room and emergency departments (EDs) can be enhanced. By doing this the arrival times might improve due to an increase in efficiency which saves time at the end of the process.

During field research, several problems were found. Because the time to execute this study was limited, a selection was made to narrow down the design direction. The problem statement is formulated as follows:

The collaboration between reporting room, ambulance staff and EDs is inefficient because:
1. ambulances have no direct insight in patient stops
2. the ED has no insight in arriving ambulances

The corresponding goal is:

Design an IoT based logistic concept that improves the collaboration between reporting room, ambulance staff, and EDs by giving the ambulance staff direct insight in patient stops and the EDs insight in arriving ambulances.

2. What IoT solution can solve the problem(s)?

Considerations

Via an iterative process a final concept is developed; an IoT based system where several devices share information. One simple action in the ambulance is required to activate the system that makes sure that an ambulance can share real time information with the most eligible ED. But who activates the system and which device is used for this? What information is needed at the ED and who needs to receive it via what kind of device? The answers to these questions were found in meetings with experts. An important insight was that the current 'digitaal ritformulier' (DRF) already has the function to announce the arrival of the ambulance to the ED.

The suggested solution; the CommunicAid

The CommunicAid (Figure 1 on page 6) is based on the existing DRF. In this DRF the patient announcement function is not used because it takes too much time. Besides this, the patient announcement is received by the secretary at the ED. It seems that it does not reach the right people.

The CommunicAid solves these problems. The ambulance nurse fills in several fields in the DRF. Based on this and several external factors the system decides which ED is most eligible. These external factors are patient stops set by EDs, the current location of the ambulance, other ambulances on their way to an ED and which hospital is responsible for PCI-, AAAA- and neuro service at the moment. From the moment the

Figure 1. Concept explanation in a nutshell.

ambulance nurse clicks 'vooraankondigen' (patient announcement), the real time information will be shared with the eligible ED and the reporting room.

With the CommunicAid patient stops at the ED will be set digitally. As soon as an ED does this, the reporting room gets an announcement and the DRF notifies it. It will make sure that the certain hospital is not available anymore in the DRF. One hour later, the patient stop is canceled automatically so the ED becomes available again.

IoT is required for the information flows between the different devices; the DRF in the ambulance needs to share real time information with the ED and the reporting room, and the ED needs to share the patient stops with the DRF and the reporting room.

Validation

The concept was validated by user tests with all three parties. The participants got an explanation of the CommunicAid and needed to do three exercises. These exercises were done on an iPad via a simulation of the new DRF made with the 'Invision app'. The screens of the ED and reporting room were imitated on a laptop. During validation, several small changes came up to improve the CommunicAid.

3. What will be the societal impact of this solution if VodafoneZiggo implements it?

Implementing the system brings some complications with it. In the healthcare sector there is a lack of motivation to take initiative. The ambulance service is commercial and competitive. Besides this, all parties work in their own systems that are not able to 'talk' to each other. To make it even more complex, not only all parties work in different systems, also the systems differ between regions. This makes it complicated, expensive and actually unrealistic to design a solution that fits every region, unless we start from scratch. The final subquestion was:

'Is the solution scalable?'

The CommunicAid should be used as a wake up call. Implementing the system in the Rotterdam-Rijnmond region should prove that IoT indeed can improve the ambulance service in the Netherlands. Rotterdam-Rijnmond is chosen because the system is designed based on the outcome of the field research. Most elaborate research took place in this region. We can assume that this solution is not scalable.

The societal impact of implementing the CommunicAid in the Rotterdam-Rijnmond region can be direct and positive. For the ambulance nurses communication flows improve with the CommunicAid and the system can save time; when ED nurses can anticipate on the arrival of an ambulance, it might prevent long waiting times. Being able to anticipate on what is going to happen can create rest at the ED. For the reporting room employees implementing the CommunicAid will reduce their workload by automating communication flows.

VodafoneZiggo will deliver the IoT-connections required for the system. An advice is to involve a design agency in the design process as 'the driving force of the project'. Next to that, VodafoneZiggo should partner up with ENAI, NAVARA and Chipsoft. These parties seem to be the most optimal partners for this project because they developed the current used systems in Rotterdam-Rijnmond.

Each profiting party should invest a share in the CommunicAid. This means that the ambulance service and reporting room should invest a part of the budget they get from the healthcare insurers and the EDs the other part. Of course they need to be involved in the design process as well. The design agency thus needs to ascertain a group of people with a representative of each party (VodafoneZiggo, the partners, and the end users).

A roadmap is made to visualize the steps for implementation of the CommunicAid.

Final conclusion

This study shows that there are many inefficiencies in the ambulance service in the Netherlands which create a huge amount of possibilities for improvement. However, the problem in the acute healthcare sector is that all parties work in different systems and even the systems differ between regions. This makes it complicated, expensive and actually unrealistic to design a solution that fits every region, unless we start from scratch. The main question was:

'How can VodafoneZiggo improve the ambulance services with IoT in the Netherlands?'

The CommunicAid should work as a wake up call to prove that IoT indeed can improve the ambulance service in the Netherlands by integrating the systems. It should be the start of a major change in the acute healthcare. An important future goal should be to harmonize the operations in acute healthcare in all regions for all involved parties.

VodafoneZiggo can start this big improvement in the ambulance service by supplying the IoT-connections required for the implementation of the CommunicAid.

GLOSSARY AND ABBREVIATIONS

A

A1-ride
When someone is at risk of life the ambulance needs to arrive within 15 minutes. This is defined as an A1-ride.

A2-ride
It is called an A2-ride when there is no risk of life but there is a chance of serious health damage. In case of an A2-ride the ambulance should arrive within 30 minutes.

AZN
'Ambulancezorg Nederland' is the umbrella party that connects the RAVs.

B

B-ride
B-rides are scheduled ambulance rides. It is used for example to bring a patient from one hospital to another.

C

CityGIS
The system in the ambulance that receives information from the reporting room (route and first patient information).

D

DIA (Directe Inzet Ambulance)
The sign to the ambulance staff about the fact that there is an emergency, given by the reporting room employee.

DRF (digitaal ritformulier)
The DRF is the patient file filled in by the ambulance nurse. When this is done, it will be sent to the ED. The file comes in as PDF file and is linked to the EPD of the patient.

E

ED
Emergency department

EPD
Elektronisch patientendossier (electronic patient file). This file includes all patient history of one person and is only visible for the patients GP and the hospital.

EMC
Erasmus Medical Center, a hospital in the Rotterdam-Rijnmond region where most field research during this project took place.

G

GMS
Geintegreerd meldkamer systeem (Integrated reporting room system) is a system all reporting rooms work with (as well as the police and fire brigade) to easily be able to share information.

GP
General practitioner

H

Hix
The computer program where all patient information is documented in the EPDs. Hix also gives insights about the patients in the rooms at the ED. This information can be adjusted on the computer and is shared with the Schipholbord so every nurse can consult the overview at one glance.

I

Internet of Things (IoT)
The Internet of Things (IoT) connects objects such as cars, buildings and machines via the internet. In this way, these objects become intelligent and are able to communicate and interact with people, applications and with each other (Vodafone IoT Barometer 2016, 2016).

L

LoRa-network
The LoRa-network (Long Range Low Power) is the LPWA-technique KPN is working with.

LPWA (Low Power Wide Area)
LPWA describes a collective name of wireless communication technologies that are designed to support IoT deployments (Narrowband IoT: pushing the boundaries of IoT, 2017).

N

NB-IoT (Narrowband-IoT)
NB-IoT is a LPWA-technique that provides a new way of connecting devices that require small amounts of data, over long periods, even in hard to reach places (u-blox, 2017).

P

Patient announcement
By doing a 'patient announcement', the ambulance nurse fills in some information in the DRF before arriving at the ED. This information is sent ahead, so the ED can anticipate on the patient.

Patient stop
When a patient stop is set, the ED will be temporarily (one hour) spared from arriving ambulances.

PCI-, AAAA- and neuro service
PCI-, AAAA- and neuro service are specializations of certain hospitals. The responsibility for these services changes between hospitals. At the moment, the reporting room has an overview of the responsibility schedule for these services.

ProQA
ProQA is an American triage system used in the reporting room. It is based on safety and risk avoidance; there is a standardized protocol format to provide the very best in service and speed (Emergencydispatch.org, 2017).

R

RAV (Regionale Ambulancevoorziening)
An RAV is the cooperation between the ambulance service and the ambulance reporting room in a region. In the Netherlands, we have 25 RAVs.

Reporting room
A reporting room receives 112 calls. Via a triage system, the reporting room employee working on the incoming side follows a protocol to help the person in the emergency situation. The outgoing side of the reporting room is responsible for sending a DIA to a certain ambulance. Besides this, they manage the distribution of the ambulances.

ROAZ
Regionaal Overleg Acute Zorg (Regional Conference Acute Healthcare) is a consultation where the ambulance service and EDs communicate about the collaboration between these different parties.

S

Schipholbord
The Schipholbord is a big screen at the ED that shows the overview of the department. This way, the ED nurses can see for each room which patient is inside and what the condition is. The information on the Schipholbord is received from the computer next to the screen, where everything is documented in Hix.

Sigfox
Sigfox also belongs to the LPWA family.

Smart city
'Municipalities that use information and communication technologies to increase operational efficiency, share information with the public and improve both the quality of government services and citizen welfare' (Rouse, 2017).

Societal value
Societal value can be divided in environmental impact, social impact and economic impact. For definitions of these expressions, read the chapter "Creating societal impact" on page 18.

T

Triage
Triage is assessing patients into various categories according to the seriousness of the injuries or illness. It happens in the reporting room on the incoming side as well as at the ED.

U

Unstable patient
When a patient is unstable, the care needs to be handed over immediately from ambulance staff to the ED nurse(s) when arriving at the ED.

CONTENT

INTRODUCTION

This graduation report is built up in several parts, all starting with a short introduction like this, which explains what can be found in that part of the report. The 'introduction' of this graduation report describes the assignment, defines the research question and explains the project set up.

ASSIGNMENT; IMPROVING THE AMBULANCE SERVICE WITH IOT

This graduation project is a research for VodafoneZiggo about the impact of the Internet of Things (IoT) on society. The outcome of the research should be valuable for the business to business (B2B) market. After literature research into this very broad topic, the context is defined and this is visualized below (Figure 2). IoT is the main topic and the base for smart cities. Within the smart city the subcategories 'smart mobility', 'healthcare' and 'people' are visualized and come together in the ambulance services focus.

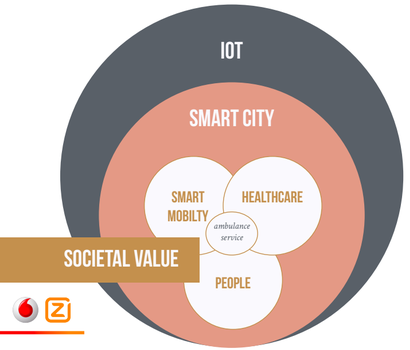


Figure 2. Context of the assignment; the focus is on the ambulance service in the Netherlands.

The societal value aspect is an important requirement from VodafoneZiggo for this research; the company has the ambition to contribute positively to the society. Therefore, creating societal significance is a main focus.

Problems in ambulance service

In 7% of the cases, an ambulance in Amsterdam arrives too late (RTL Nieuws, 2017). The national norm is 5% thus it happens too often. One reason for this is the loss of time in finding an empty ambulance. According to Sevil (2016) the greatest time loss happens in reporting an emergency. Is this indeed the bottleneck?

On October 25th 2017, the Dutch news announced that only one out of three ambulance services succeeds in meeting the standard (Nos.nl, 2017). The news item states that the problem originated by the lack of ambulance staff. This makes that there is a shortage of available ambulances. Another issue is the fact that the stands are not located optimally, according to Fred Seifert (Nos.nl, 2017).

Arriving too late is a problem with several causes. Not only a shortage of ambulance employees and struggles in finding an empty ambulance are an issue, also traffic jams and unexpected situations such as construction zones might delay an ambulance.

In the process from calling 112 to bringing the patient in the hospital, many methods of communication between several parties are used. There might be room for improvement in these areas as well. According to 70% of the ambulance staff members a better collaboration with acute care partners is necessary and 58% says that the information provision needs to be improved (Marktscan acute zorg, 2017).

Research question

Finding the part in the process where efficiency can be increased is part of this project. The research question is:

'How can VodafoneZiggo improve the ambulance services with IoT in the Netherlands?'

As visualized in Figure 3 on page 13, this project starts with an internal- and external analysis on VodafoneZiggo, an analysis on IoT, and on the context of the ambulance services, 'smart cities'.

The research question is divided into three subquestions. The insights from these subquestions are translated into an answer to the main question.

The current situation for ambulance services is analyzed, an IoT solution for the problem(s) is developed and finally the impact on society if VodafoneZiggo implements this solution is discussed. In this last part the question if this concept is scalable is answered. If this is the case, the positive impact on society is bigger than when the concept only works in one region in the Netherlands.

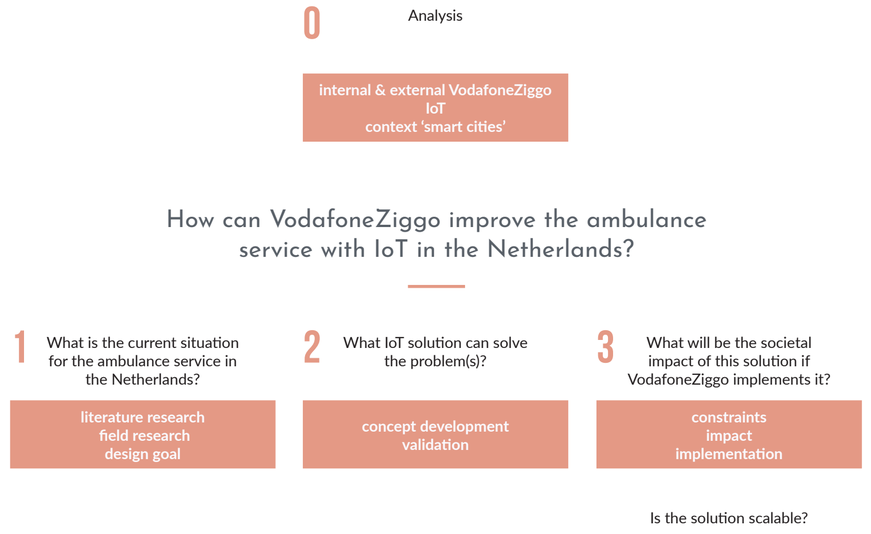


Figure 3. Structure of the project; the project started with a company analysis. The research question is formed afterwards and is divided in three subquestions that are answered in this report.

INTERNAL ANALYSIS

VodafoneZiggo

The internal analysis of VodafoneZiggo explains why the companies merged and what their expertise is, with special attention for IoT. This part also mentions the business to business side of VodafoneZiggo. Their focus on creating societal impact is the last chapter in this section. This internal analysis is relevant to get a better feeling for the company. The information is mainly gathered online and by talking with employees internally.

COMBINING VODAFONE AND ZIGGO

VodafoneZiggo is a Dutch joint venture of VodafoneGroup, one of the biggest telecommunication companies in the world, and Liberty Global, the biggest international TV and internet provider. The company provides video, broadband internet, mobile services and fixed line-telephony to consumers and businesses. Since January 2017, they deliver 5 million mobile-, 4 million TV-, more than 3 million broadband internet - and 2,5 million fixed line-telephony connections (Vodafone.nl, 2017).

Why together?

Nowadays, people want to be connected and have safe access to the internet, entertainment and company applications, anytime anywhere. To guarantee the best experience to the customer, the companies thought that integration of fixed and mobile services is necessary; it makes it possible to improve the existing services and develop new integrated communication- and entertainment services (Vodafone.nl, 2017).

By combining Ziggo's fast broadband network and Vodafone's mobile network, they created a strong fixed and mobile service company for the Dutch B2C (business to consumer) and business to business (B2B) market (Vodafone.nl, 2017).

Mission & vision

Because Vodafone and Ziggo collaborate since January 2017 the company is still busy with the merger. Both Vodafone and Ziggo had their own strong competitive advantages, vision and mission (these can be found in the pink and brown blocks on this page). Now these are merged to the three pillars in the gray block. For VodafoneZiggo it is all about technology. VodafoneZiggo wants everybody to be able to take part in the digital society in an accessible and responsible way. The company wants to increase their positive impact and reduce the negative impact by striving for societal value (VodafoneZiggo, 2017).

It is interesting to see how two large companies as these are merging and working on becoming one strong business.

Internet of Things

Besides offering video, broadband internet, mobile services and fixed line-telephony, the Internet of Things (IoT) also plays a big role on the B2B side of the company. The IoT achievements are hardly used in communicating the strengths of the company to the market. The next chapter will talk about IoT.

Vodafone

MISSION
Empower everybody to be confidently connected

VISION
Always easiest

VALUES
The Vodafone way

SLOGAN
Power to you

(Vodafone Integrated Report 2015-2016, 2016)

Ziggo

FOUR PILLARS
digital society
customer trust
responsible business
limit environmental impact

(Ziggo.com, 2017)

VodafoneZiggo

digital life
responsibility
smart business

(VodafoneZiggo, 2017)

VODAFONEZIGGO'S INTERNET OF THINGS

IoT connects objects such as cars, buildings and machines via the internet. In this way these objects become intelligent and are able to communicate and interact with people, applications, and with each other (Vodafone IoT Barometer 2016, 2016). According to the Vodafone IoT Barometer 2017/18 (2017), the number of large scale IoT projects has doubled in the last year; twice as many companies are using more than 50,000 connected devices.

Experience

Vodafone has more than 20 years of experience in IoT, which was first called machine to machine (M2M) communication. They have delivered several of the worlds leading M2M solutions (Creating a smarter world, 2014). Therefore the company has been acknowledged as market leader for IoT connectivity for some years, connecting about 60 million devices worldwide today (van Vianen, 2017). This provides the opportunity to make life more efficient, safe, energy efficient and sustainable.

On the Vodafone website the IoT mission is formulated as:

'Make information more available and improve organizations by connecting people and objects in an integrated and smart way.'
(Vodafone.nl, 2017).

IoT is not new anymore, but its potential is still expanding in many different domains. The pink box on the side of the page gives an idea of some of the IoT applications that VodafoneZiggo enables together with a partner.

Narrowband-IoT

Narrowband-IoT (NB-IoT) is a Low Power Wide Area-technique (LPWA) that connects devices in an efficient way. Appendix A explains more about LPWA-techniques and the benefits from NB-IoT compared to the other LPWA-techniques (LoRa and Sigfox). VodafoneZiggo has nationwide NB-IoT network coverage, which connects devices and machines with the biggest network in the world (Vodafone.nl, 2017). The technology works on Vodafone's own frequency spectrum so there is no interference with other signals.

NB-IoT provides a new way of connecting devices that require small amounts of data over long periods of time, even in hard to reach places (u-blox, 2017). Because NB-IoT applications use only a small amount of data this technique does not have any negative consequences for the capacity of the 4G network that mobile phone customers use (Vodafone.nl, 2017).

For this project, NB-IoT is not required; the 'usual' IoT works perfectly for this application.

Business to business

As explained in the introduction of this report this project should be applicable for the B2B market. IoT is one of the building blocks to create 'ready businesses'. The next chapter explains more about ready businesses.

Example cases that can be named as 'ready businesses'

VANMOOF
VANMOOF and Vodafone together developed a smart IoT application; an integrated sim card and GPS implemented in a bike frame. Stolen bikes can be tracked down really fast.

WASTE PROCESSING
A Vodafone IoT solution provides the technology communication with waste bins. This solution lowered the CO2 emission with 18 percent because of this much more effective way of waste collection.

TAXI-E
TAXI-E is the first electronic taxi service in Europe. The taxi drivers drive more efficient and sustainable due to the Vodafone IoT solution.

SHARE A PORSCHE
Thanks to a cooperation between Vodafone's IoT and Porsche, you are able to share a Porsche with a small group of people. The car communicates all necessary information with a corresponding app.

(Vodafone.nl, 2017)

B2B; AMBULANCE SERVICE AS A 'READY BUSINESS'

Next to B2C, the company has a B2B side. This project is relevant for VodafoneZiggo's business to business market.

VodafoneZiggo's goal is to create 'ready businesses' (Figure 4), which means that companies should respond quickly to opportunities in the market. IoT is one of the building blocks of a ready business (Vodafone.nl, 2017).

In the last 5 years the number of businesses that launched IoT projects increased from 12% to 29%, many of them committing more resources to IoT. The Internet of Things has even become critical for the way of operation of many companies and the services they provide to their customers. This happens in many different sectors, from manufacturing to healthcare, and farming to consumer electronics (Vodafone IoT Barometer 2017/18, 2017).

IoT is not just about automating processes. Companies invest in IoT (81% of adopters say they're spending more on IoT) and the connected devices to create new services and to change their businesses (Vodafone IoT Barometer 2017/18, 2017).

"85% of adopters believes that IoT will be critical for the future success of any organization in their sector."

The biggest expectation for organizations is to improve efficiency by using IoT. The most commonly seen benefits of implementing IoT are consequently better business insights, reduced costs, and improved employee productivity (Vodafone IoT Barometer 2017/18, 2017).

Why VodafoneZiggo?

VodafoneZiggo has a wide range of end to end solutions which simplifies applying IoT for consumers and for organizations. High quality hardware and/or software are combined with IoT connectivity services and are tested, supplied and supported by VodafoneZiggo. This makes it easy for businesses to deliver and deploy IoT solutions in multiple fields (Vodafone.com, 2017).

VodafoneZiggo invested in fixed networks, mobility, IoT, cloud solutions, big data and analytics. Therefore they are the partner of choice for businesses, but also for cities and governments all over the world (Why Vodafone for Ready Cities infographic, 2017). In the Netherlands VodafoneZiggo is partnering with five cities with the goal of making them smarter by applying IoT. These cities are mentioned in the chapter "Smart cities" on page 22.

Ambulance service

Providing the ambulance service with VodafoneZiggo's IoT can make this a ready business as well. The efficiency in the ambulance service can improve. This can create positive impact on society, which is one of VodafoneZiggo's objectives. The next chapter goes into this value in more detail.

Figure 4. Ready business (Vodafone.nl, 2017).

CREATING SOCIETAL IMPACT

Vodafone and Ziggo both started and supported several initiatives with societal value and will continue this as VodafoneZiggo. The company has the goal to contribute positively to the Dutch society (VodafoneZiggo, 2017).

Societal value can be divided in environmental impact, social impact and economic impact (definitions can be found in the boxes on the right). In other words, it can be described as the impact on people, the planet and profit.

"VodafoneZiggo wants to contribute positively to the Dutch society"

In this research the focus will be on social impact with the environmental and economic aspect in mind. The user should be central. Activities can have immediate and direct impact, but can also have a more long term effect (Social Impact Scotland, 2017). It is important to keep this in mind by understanding what kind of effect IoT can have on society. In the final part of this report we refer to this aspect again.

"Environmental impact is the impact on the environment created by an industry, service, plan, or project" (Collinsdictionary.com, 2017).

"Social impact is the effect of an activity on the community and well-being of individuals and families" (BusinessDictionarycom, 2017).

"Economic impact is a financial effect that something (new) has on a situation or person" (Dictionary, 2017).

EXTERNAL ANALYSIS

VodafoneZiggo

The external analysis highlights VodofoneZiggo's competitors. The information is mainly gathered via online research.

VODAFONEZIGGO'S COMPETITION ON IOT

Because VodafoneZiggo is a big company that provides various services, the company has many competitors in several domains. The obvious competitors are providers of video, broadband internet, mobile services and fixed line-telephony to consumers and businesses. However, this project is about IoT so this chapter discusses the competitors in B2B IoT world (Figure 5).

KPN

First of all, KPN is the biggest direct competitor of VodafoneZiggo as provider of the mobile network and internet connections. KPN like VodafoneZiggo, focuses on the impact of products on society, customer experience and the quality and reliability of their network (KPN Verkort Jaarverslag 2016, 2016). In the annual report of KPN (2016) can be found that the company completed the implementation of their 'LoRa-network' (Long Range Low Power) even earlier than expected. Because of this the Netherlands was the first country in the world with a nationwide network for IoT-applications. The LoRa-network connects people and products via the internet permanently in an energy efficient way.

KPN is working towards #SMARTer2030, a strategy focused on reducing CO2 with 40% in 2030 with ICT (KPN Verkort Jaarverslag 2016, 2016). This means KPN is a big competitor of VodafoneZiggo. However, as earlier explained VodafoneZiggo has nationwide Narrowband-Internet of Things network coverage. VodafoneZiggo's NB-IoT connects devices and machines with the biggest network in the world (Vodafone.nl, 2017). The VodafoneZiggo Narrowband-IoT network has a lower latency than the KPN LoRa network. This means that the VodafoneZiggo network is faster than the KPN network. More competitive advantage of this NB-IoT network over the KPN LoRa-network can be found in Appendix A.

Frightful five

Amazon, Apple, Facebook, Google and Microsoft are defined as the 'frightful five' by the American press (Duivestein, 2017). We cannot imagine a world without these huge companies anymore, and they expand their power to more and more domains. Apple and Google for example are active in healthcare, Microsoft invests in education, Facebook builds its own district in Silicon Valley and Amazon announced that they took over 'Whole Foods'. When one of these tech companies enters a new market, the existing companies in that market saddle (Noort, 2017). The frightful five are partnering with Sigfox (a LPWA-technique), which provides their IoT network. Appendix A explains more about Sigfox.

The frightful five are ahead in IoT. That is why they are competition for VodafoneZiggo.

Why VodafoneZiggo?

VodafoneZiggo has several competitors on IoT in the B2B market. However, as mentioned earlier VodafoneZiggo is partnering with five cities in the Netherlands with the goal of making them smarter. These five cities are mentioned in the next chapter "Smart cities" on page 22. This partnership makes VodafoneZiggo an argumentative party to solve the issues in ambulance service in the urban areas in the Netherlands.

Figure 5. Competitors of VodafoneZiggo in IoT.

CONTEXT

IoT is the base for smart cities, which are 'municipalities that use information and communication technologies to increase operational efficiency, share information with the public and improve both the quality of government services and citizen welfare' (Rouse, 2017). This part of the report dives deeper into the concept of smart cities, which is the context of the project.

SMART CITIES

G5
Amsterdam
Utrecht
Rotterdam
Eindhoven
the Hague

As a communication provider, VodafoneZiggo provides networks, technology and solutions that help cities and regions with economic development, efficiency, sustainability and better citizen engagement for large-scale urban change (Why Vodafone for Ready Cities, 2016). Cities are the context for this project; they are trying to deal with the fact that acute healthcare is overcrowded (Marktscan acute zorg, 2017).

Smart city strategy

The world urbanizes and digitizes quickly. The pressure on mobility, energy supplies, the environment and healthcare in cities increases quickly, while the circular economy, sharing economy and new technologies challenge the existing systems. All these developments encourage cities to become smart. Businesses, science and citizens participate to adapt to this improved environment. However, a new way of thinking and organizing is needed to get there; a smart city strategy (van Beurden, 2017).

A common strategy

Global developments as climate change, exhaustion of raw materials, digitizing and the third industrial revolution challenge societal systems. The growth of cities is huge which is in line with the fact that data traffic and applications of new technologies concentrate in cities (van Beurden, 2017). Cities get more and more responsibility; they have to implement innovations or even develop them while they often do not have enough capacity (knowledge or resources). Each city struggles with the same difficulties. With a common strategy knowledge and experiences about success and failures can be shared and cities can develop concepts faster (van Beurden, 2017). In general, all cities strife for the same goal:

'Improve quality of life of citizens in a sustainable way.'

Smart city features

All cities give a different interpretation to the term 'smart city'. They have their own priorities and choose for a different focus, depending on specific challenges and strengths of a city (van Beurden, 2017).

The 'G5' ('grote 5', mentioned in the block on top of this page) are the five biggest cities in the Netherlands. These cities experience the highest pressure on urban infrastructure which applies to facilities such as houses, healthcare and mobility (van Beurden, 2017). Subsequently becoming smart has a high priority for these cities.

In Appendix B the general topics and smart city features can be found next to the specific focus points for each of the G5 cities.

Smart city components

Within the concept of smart cities several components can be distinguished. The project started with the insight that these components (Figure 6) all formed opportunities and even can be combined.

The decision to look into the improvement of the ambulance service with an IoT initiative automatically selected the key component 'smart healthcare'. Smart healthcare is defined as 'the provision of health services by using the context-aware network and sensing infrastructure of smart cities' (Solanas, 2015).

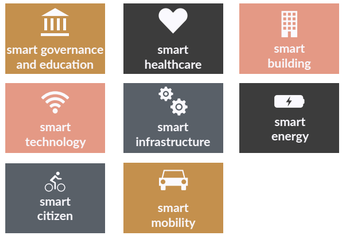


Figure 6. Smart city components.

AMBULANCE SERVICE

This part of the report gives general insights in the ambulance service found in literature. It explains the structure of the ambulance service in the Netherlands, the difference in urge per ride and additional relevant information about this emergency service. Finally, the technology that is currently used in this sector is discussed.

AMBULANCE SERVICE IN GENERAL

'A comprehensive system which provides the arrangements of personnel, facilities and equipment for the effective, coordinated and timely delivery of health and safety services to victims of sudden illness or injury' (Moore, 1999).

Organization

In the Netherlands there are about 780 ambulance vehicles. These are distributed over twenty-five independent regions (RAVs, 'regionale ambulance voorziening') and the amount of vehicles per region differs. Each region has several stands from where the vehicles can depart to emergency situations (Ambulancezorg.nl, n.d.). Figure 7 gives an overview of the locations of the stands. It is legally required that every location is reachable within 15 minutes. At the moment 385.000 people in the Netherlands cannot be reached in time in case of an emergency (Verlaat, van der Meulen and Schoof, 2017).

In the different regions several transport services are active; 'het Witte Kruis', 'UMCG', 'Ambulance Amsterdam' and 'RAV BMWN' are examples (Wijga and van Ekdom, 2015). All ambulance regions are separate organizations and they are not working together properly. The AZN (Ambulancezorg Nederland) is the umbrella party that connects all 25 RAVs.

Vision

The vision for ambulance service in 2025 (Ambulancezorg in 2025, 2017) is:

'Organizing acute healthcare together on a regional level'

This means that the acute healthcare should become a coherent organization. The ambulance service needs to become a more important party in the acute healthcare organization. All partners need to get on the same page and work together more smoothly. Sharing information, clear logistics and introduction of new technological possibilities are points of attention (Ambulancezorg in 2025, 2017).

Tasks

The ambulance has four main tasks; accessing emergency care, care in the community, care during the ride, and care upon arrival to receiving care at the health care facility (Razzak and Kellermann, 2002). The ambulance service is for many people the first contact to healthcare services during emergencies and life-threatening injuries. It is therefore important that this service runs fluently. The rapid development of medical technology with the introduction of multi-functional compact monitoring systems makes it already more manageable to give the right care in an uncontrolled environment of pre hospital settings.

Urgency

When someone is at risk of life the ambulance needs to arrive within 15 minutes. This is defined as an A1-ride (Demensenvandeambulance.nl, 2017). In this case every second counts. The nationwide key performance indicator (KPI) is to be on time in at least 95% of the cases. This goal has not been achieved in 2016 (Figure 8 on page 25). It is called an A2-ride when there is no risk of life but there is a chance of serious health damage. Then, the ambulance should arrive within 30 minutes. B-rides are scheduled in advance (Demensenvandeambulance.nl, 2017). On yearly basis all ambulances together drive 1,2 million times which increases every year with 4% (Volksgezondheidenzorg.info, 2017). To make

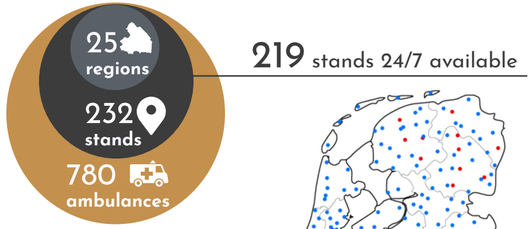


Figure 7. Locations of the ambulance stands. N.B. The red dots are stands that are only active in day- and evening times, the blue dots are available 24 hours a day (Volksgezondheidenzorg.info, 2017).

Figure 8. A1 rides in 2016; the Key Performance Indicator (KPI) was 95%. However, only 93% of the ambulances arrived in time.

it more tangible; it is about 74 rides per 1000 inhabitants. 48% of these are even A1 rides. The amount of ambulance rides during the day and in the evening are about equal. During nighttime this is way less. Most rides are in cities. Figure 9 sums up a few facts about the ambulance rides in 2016.

Taking a patient to the emergency department

From the moment someone calls 112 until the ambulance brings the patients in the hospital several time frames can be defined. The focus in this project is on the phase where the ambulance drives to the hospital (the reason for this is explained in the next part of the report). Information about what happens before can be found in Appendix C. When a patient needs to go to the hospital the ambulance takes him there. Many hospital emergency departments (EDs) are full these days (Berdowski, et al., 2017). Especially elderly who live longer independently are more likely to need emergency care. In ten years time the number of 65-plus people who needed emergency care after falling increased with 40% (RTL Nieuws, 2017).

The amount of emergency rides with the ED as final destination increases. Also, the amount of patients arriving at the ED via ambulance increased from 17% in 2013 to 21% in 2016 (Marktscan acute zorg, 2017).

Pressure on acute healthcare

EDs are allowed to set 'patient stops' when it is too crowded. During a patient stop the ED will be temporarily (one hour) spared from arriving ambulances. Figure 10 shows the number of patient stops at EDs in the regions Noord-Holland and Flevoland. The number is increasing exponential (Berdowski, et al., 2017).

Acute healthcare is accessible, but pressure in this sector increases. Because of this pressure on the first aid, ambulances that arrive with a patient need to wait until there is room for the patient or they need to go to another hospital. Much time is lost in both situations. Collaboration and coordination is needed to make sure the long term accessibility of acute healthcare (Marktscan acute zorg, 2017).

The next chapter dives into the technology that is currently used in the ambulance service.

*During a **patient stop** the ED will be temporarily spared from arriving ambulances. People coming on their own are always welcome. The ED calls the reporting room to set a patient stop when it is too crowded at the ED. This stop will take one hour ('SEH tijdelijk ontzien', 2016).*

1.313.251 ambulance rides in 2016. 75% of these were urgent

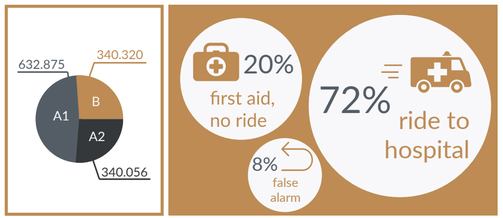


Figure 9. Facts about the ambulance rides in 2016 (Ambulancezorg.nl, 2017).

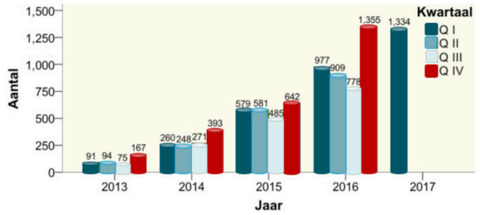


Figure 10. Increasing number of patient stops at EDs (Berdowski, et al., 2017).

TECHNOLOGY IN THE AMBULANCE SERVICE

Already some technology is implemented to make the ambulance service better, easier and more efficient. This chapter explains what technology is already used in and around the ambulance. The information is mainly received during the first visit of the field research which will be discussed in the next part of the report. The technology that is used in the reporting room can be found in Appendix D.

Overall communication

C2000 is the network for all the communication between all emergency services (the police, fire department, ambulance services and parties like the Royal Military Police). The emergency services communicate with the reporting room via a portophone (C2000.nl, 2017).

Ambulance

Just after a 112 call, when a reporting room employee is following protocols with a patient to help him, the ambulance staff gets the emergency message via a Pager (Figure 11), a portable device the ambulance nurse keeps with him. The pager shows the urgency (A1/A2) and the location of the emergency. Based on this information the ambulance staff does not know yet what happened.

CityGIS (Figure 12) is a system in the vehicle. It calculates the route and the information typed by the reporting room employee appears on the CityGIS as well. In this way the ambulance staff gets more information about the situation of the patient. When the story is not clear the nurse uses the portophone to ask for more information. This device is used to communicate quickly with the reporting room.

The nurse has an application with protocols on a telephone. The nurse and driver discuss the protocols to make sure they remember what to do in the certain situation.

In the back of the car is a monitor (Figure 13) to measure the oxygen level, make electrocardiograms and measure blood pressure. The measurements are printed by this monitor and need to be documented manually at the laptop or iPad, depending on what the ambulance region is using. Via this laptop or iPad all patient information needs to be captured in the digital patient file (DRF, 'digitaal ritformulier' in Dutch). The nurse runs through several pages where different information needs to be filled in, a system which takes much time.

Conclusion

Some technology is already implemented to help the ambulance staff and reporting room employees do their job. The ambulance staff works with six different devices already. This is something to take into account when designing a concept. Several steps in the process are devious now. For example the fact that the monitor prints out the measurements, which need to be documented manually in the DRF afterwards. With IoT the monitor would be able to send its measurements to the DRF directly. There is an opportunity to create efficiency in the ambulance services by applying IoT to improve the way of working.

To find out how IoT can do this a dive into the field is needed to find out what the problems exactly are. Therefore the next part of this report elaborates on field research.

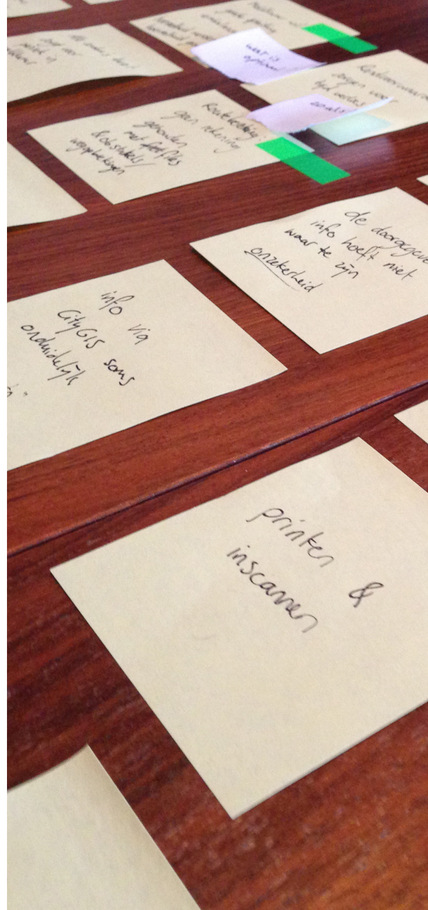
Figure 11. Pager; the ambulance staff receives first information from the reporting room via a pager.

Figure 12. CityGIS; the ambulance staff receives the route and information typed by the reporting room employee via the CityGIS in the vehicle.

Figure 13. Monitor; with the monitor, the ambulance nurse performs patient measurements.

FIELD RESEARCH

Field research is done to assess the issues found in literature (mentioned on page 12, in the introduction part of the report). This part of the report first explains the approach of the field research and then discusses the findings. The findings from the first visit are discussed extensively, the follow up findings are written down more compact. The work shadowing experiences at the ED, reporting room and ambulance give more practical insights. This part ends with an important conclusion.



APPROACH; GATHERING INSIGHTS FROM ENRICHMENT TO SATURATION

Goal

As mentioned in the introduction part of this report on page 12, literature research shows that ambulances often arrive too late and that ambulances are delayed when there is no room at the emergency department of a hospital. This field research will look deeper into the problems that cause the delays. The goal of the field research is therefore getting more insights in the way of working, the process and the communication flows of the ambulance service. The actual problems and (latent) needs need to become clear. The researcher wants to find out in which part of the process efficiency can be increased.

Next to the literature research where a part of the question already has been answered, this field research completes the picture of the current situation, as been asked in subquestion 1:

'What is the current situation for the ambulance service in the Netherlands?'

Participants

Figure 14 gives an overview of the participants of this field research. Via www.ambulancezorg.nl/contact the contact information of all regional ambulance facilities can be found. The researcher sent eleven mails to different regions but only two of them reacted in a positive way (Zuid-Holland zuid which resulted in the visit in Dordrecht and Hilversum). Via personal network a visit to the ambulance stand in Haaglanden was arranged. A previous graduation student, Valeria Pannunzio, who also did her graduation about the ambulance service sent her contacts an email as well. Via one of them the researcher arranged an appointment at the ambulance stand in Bilthoven.

Also two people working at the ED and ambulance service of the Erasmus MC (EMC) in Rotterdam contributed to this project. Via these people the researcher got an entrance to the work shadow moments at the ED and in the reporting room. The reporting room employee arranged a work shadow moment at the ambulance service.

In Appendix E participant profiles are visualized. These give general information about the participating regions.

LOCATION	DATE	EMPLOYMENT PARTICIPANT(S)	CONTACT VIA	USED METHOD
Dordrecht	Oct 20th 2017	ambulance nurse & driver	email via ambulancezorg.nl	interviewing
Haaglanden	Nov 10th 2017	reporting room coordinator	personal network	presenting findings & interviewing
Bilthoven	Nov 14th 2017	healthcare computer scientist	previous graduate student	presenting findings & interviewing
Erasmus MC	Nov 16th 2017	ROAZ-coordinator acute care & policy officer ambulance care	general mail address EMC ED	presenting findings & interviewing
Hilversum	Nov 20th 2017	policy officer ambulance care	email via ambulancezorg.nl	presenting findings & interviewing
ED EMC	Nov 29th 2017	ED nurse	previous contact EMC	work shadowing
Reporting Room Rotterdam	Dec 4th 2017	reporting room employee	previous contact EMC	work shadowing
Ambulance shift	Dec 8th 2017	ambulance nurse and -driver	reporting room employee	work shadowing

Figure 14. This overview shows information about the participants of the field research.

Research methods

The qualitative research methods 'semi-structured interviewing' (Fylan, 2005) and 'observation' (Spradley, 2016) are applied to gather elaborate insights. During the visits different approaches were used to get deeper information every time. The exact approach per visit is shortly explained in the following subheads.

During the first visit (Dordrecht) most information was gathered because all information was new. The follow up visits gave the researcher new information which complemented the previous gathered knowledge every time. So during the first visit a lot of shallow information was gathered, while the follow up visits provided every time a bit elaboration. Figure 15 visualizes roughly the type and amount of insights gathered during every visit.

Dordrecht

To gather information during the visit in Dordrecht the researcher conducted interviews with an ambulance nurse, ambulance driver and reporting room employee. The location of the interview with the nurse and driver was an ambulance stand. The interview with a reporting room employee was in the reporting room. This enabled the researcher to get a feeling for the work environment as well. During the interview with the nurse, she showed the vehicle and how they interact with the existing systems. This orienting field research was based on several topics. It started with general questions about company structure, different responsibilities/tasks and difference between regional ambulance facilities. Then, task oriented questions about what a workday looks like, the interaction between people and devices, fixed protocols, devices they work with, challenges they encounter and moments of stress were asked, followed up by process related questions about different stages, problems during these stages and time loss. Besides this, the researcher asked about communication between the reporting room and ambulance staff, about what information different parties would like to know earlier, about miscommunication and finally about what technology is already used.

By asking these kind of questions the researcher gathered relevant knowledge and created empathy for the ambulance service. This created a good base for the follow up research (the outcome can be found in the next chapter).

Haaglanden & Bilthoven

Based on the problems that were mentioned in Dordrecht (discussed in the next chapter) new questions came up. The approach was to present the earlier found problems and ask their view on these. The follow up visits gave more elaborate insights in the interesting problem areas. Moreover, the ambulance regions differ in their way of working so it is interesting to compare.

The findings from the visit in Dordrecht (see next chapter) were discussed. In Haaglanden, the problems were not recognized but the interviewee could imagine that other regions have these. The interviewee in Bilthoven did confirm the findings.

Erasmus MC & Hilversum

The problems found in Dordrecht (see next chapter) and confirmed and complemented in Bilthoven were mapped out and defined deeper. During the visit at the EMC the interviewees confirmed the conclusions again. New deeper questions were answered. In Hilversum the same approach was used. However, no new insights were gathered; the information collection was saturated.

Work shadowing

To gain understanding of the behavior of the people in the acute healthcare the research method 'work shadowing' (Recknagel, n.d.) was applied and brought new insights. These can be found later in the report.

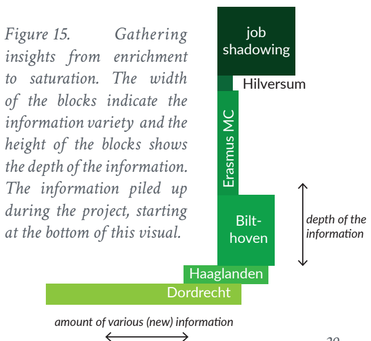


Figure 15. Gathering insights from enrichment to saturation. The width of the blocks indicate the information variety and the height of the blocks shows the depth of the information. The information piled up during the project, starting at the bottom of this visual.

RESULTS FIRST VISIT
Dordrecht

Thanks to the first visit in Dordrecht several relevant insights came up. These are divided in insights in the process, and the problems the ambulance staff talked about, both discussed in this chapter. This chapter ends with the key insights of this first visit.

Process
Figure 16 on page 31 visualizes the process from starting an ambulance shift to bringing the patient in the hospital. The figure is divided into the three involved parties; the reporting room on top, which is the party which is most important in the beginning of the process, the ambulance in the middle and the hospital at the bottom. The time indications come from the ambulance Amsterdam annual report (Duijf, Hogen Esch and Smid, 2016) and can also be found in Appendix C.

The process in Figure 16 on page 31 begins with the start of an ambulance shift where the driver checks the vehicle and the nurse checks the equipment. When this is finished, the nurse signs in by calling the reporting room. From now on the waiting starts.

When someone calls 112, the national reporting room in Driebergen connects the person with the reporting room in the right region. The reporting room employee activates a 'DIA' (directe inzet ambulance). CityGIS calculates the route and the ambulance leaves. During the ride the ambulance staff receives more information about the case, which was collected by the reporting room employee. When the information is not totally clear, the nurse contacts the reporting room employee using the portophone. Eventually the ambulance staff reviews the relevant protocol during the ride.

After picking up an unstable patient the ambulance staff calls the ED to make sure an ED team is ready to take over the patient care. When a patient is stable, there is no communication before arriving at the ED. When arriving at a crowded ED the ambulance has to wait. During patient transfer the patient information is shared verbally. After all, the ambulance nurse fills in the DRF. This file is printed in the ambulance and given to the ED.

Findings
A lot of short communication happens between the different parties. For communication many devices are used and several actions are already automated. For example, when the reporting room employee activates a DIA the proQA system (a system used in the reporting room to follow the right protocols in emergency situations) sends the location of the emergency to the CityGIS automatically. The CityGIS then calculates the most optimal route to get there. The information about the emergency typed by the reporting room employee also appears on the CityGIS screen in the vehicle automatically.

Another interesting aspect is the fact that the ambulance staff only warns the ED in advance when they carry an unstable patient. When this is not the case, the ambulance just drives to the ED and has to wait if it is crowded until there is room for the patient at the ED. The ambulance stays occupied so is not available for other emergencies.

Communication between the reporting room and ambulance staff seemed really flawless. Communication between the ambulance staff and the ED on the other hand, seemed devious. The ambulance nurse fills in the DRF to communicate the condition of the patient, the administered medication, to explain what happened, etc. This goes via the laptop inside the vehicle and takes much time. There is a printer in the vehicle. The ambulance nurse prints the file, gives it to the secretary at the ED and he/she scans it in to digitize it again. Moreover, filling in the DRF is mostly done after patient transfer because of the duration of this action. The ED does not receive this information at a convenient moment. Besides this way of communication the ambulance nurse also needs to share the same information verbally with the doctor in the hospital.

Conclusion
Based on this first visit in Dordrecht the figure on page 31 is developed to visualize what happens in the process.

The communication between the reporting room and ambulance staff is already pretty fluent. The communication between the ambulance staff and the ED on the other hand can be improved. The next step is to cluster the problems the interviewees mentioned.

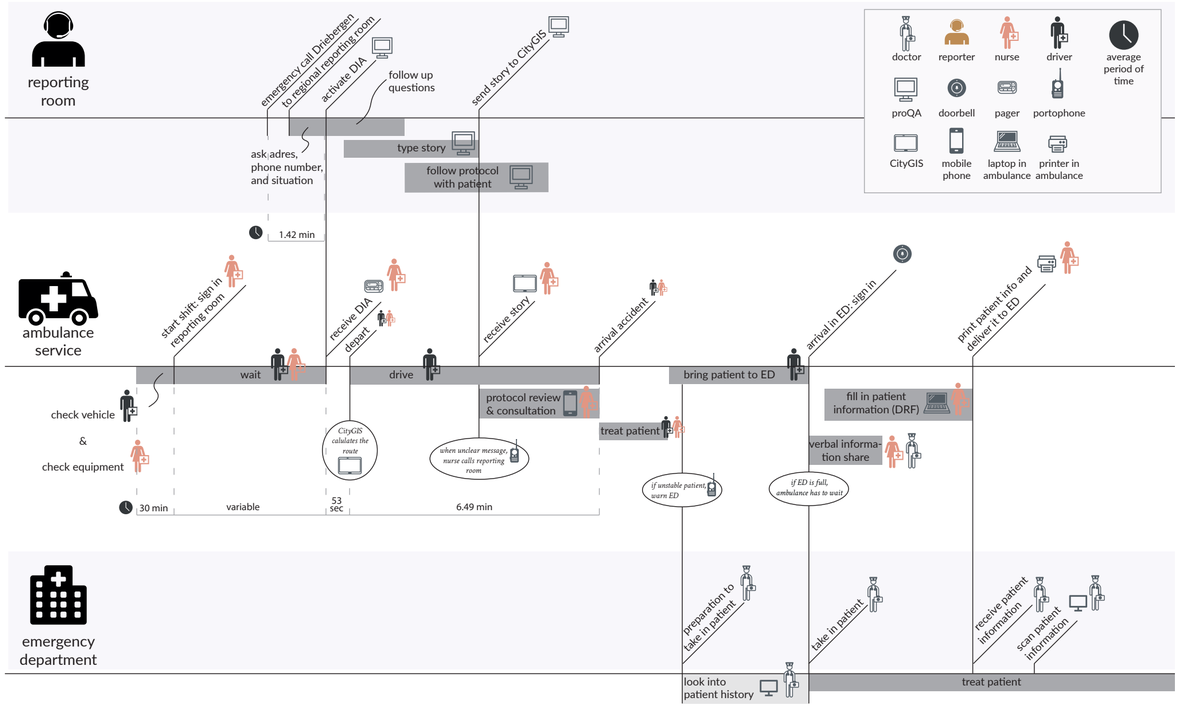


Figure 16. Process flow from starting an ambulance shift to bringing the patient to the ED, based on the findings during the first field research. The figure is divided into the three involved parties; the reporting room, the ambulance and the ED. Especially at the end of this process the communication flows seem devious. This refers to the communication between the ambulance and the ED.

Mapping the problems

In Figure 17 on page 33 the problems that came out of the field research in Dordrecht are mapped in different stages. Phase 1 is defined as the phase where someone calls 112, so contact between a patient (or bystander) and a reporting room employee takes place. In phase 2 the reporting room and ambulance are communicating while the ambulance drives to the patients location and during phase 3, the ambulance drives with the patient to an ED.

The problems in the darker circles are most interesting for VodafoneZiggo. In this chapter is explained why. The pink balls attached to the gray circles indicate questions linked to the certain problem.

Phase 1

The detected issues in the first phase where someone calls the alarm number, are not very interesting for VodafoneZiggo: these problems are hard to solve with IoT. These are human factors and cannot be replaced by technology. It happens that, because of the stressful situation, people call too late, withhold relevant information (accidentally), or provide wrong information. If a patient says that the situation is life threatening, the reporting room employee must send an ambulance even if he knows that the situation is harmless (for example when someones knee hurts). This is due to the very safe triage system (Appendix D).

Phase 2

In phase 2 most communication between reporting room and ambulance takes place.

The information on the pager when an emergency message comes in tells only little information. However, CityGIS makes sure that the ambulance staff gets more information about the situation as soon as this is available.

The fact that the reporting room wants most optimal distribution can be an interesting direction. First, 'optimal' needs to be defined. There is a disagreement now; some people think that the number of ambulances per square meters of land is optimal, others think that number of ambulances per population is optimal.

Information via the CityGIS is sometimes unclear. To fill the gaps of information, the ambulance staff can communicate with the reporting room via the portophone.

The panic in the reporting room that arises when all ambulances are busy is a secondary problem. This would not be the main focus but if the core of the problem is solved, this is automatically solved with it. Making sure that the ambulance staff is busy with an emergency as little time as possible (but of course doing their work precisely and take care of the patient as good as possible) will help.

Now, the route calculation of CityGIS does not take into account traffic jams, obstacles or road constructions. This can cause life threatening delays. IoT might be able to solve this problem. Therefore this direction can be interesting as well.

There is often miscommunication between the general practitioners (GPs) and the ambulance staff. It happens that a GP asks for an emergency ride but also goes to the patient himself. The ambulance service is scarce; now two caregivers go to one situation which is unnecessary.

Phase 3

In phase 3 the ambulance drives from the patients location to the ED. The encountered problems in this phase are all about communication: the communication between ambulance staff and ED is inefficient. The nurse fills in a huge patient document, the 'digitaal ritformulier' (DRF), which contains information that also needs to be shared verbally with the ED nurse. This DRF is printed in the ambulances and scanned in the hospital to make it digital again. It is time consuming, but necessary.

When the ambulance arrives in the hospital with a stable patient and there is no room in the hospital, the ambulance has to wait until the patient is welcome. Moreover, when the ambulance arrives at the hospital, the staff needs to ring a doorbell to announce their visit.

Conclusion

In Figure 17 on page 33 the first phase is colored orange. This means that this phase is not totally flawless. However, the 'flaws' that are happening are human factors and hard to solve with IoT. Therefore this is not an interesting area for VodafoneZiggo to look into.

The next phase is colored orange and green. The protocols used in the reporting room are strict and it seems that no (or at least as little as possible) time is lost. Improving the route calculation system so that it takes into account road constructions and other obstacles might be an interesting design direction. Searching for a solution to make the distribution of the ambulances optimal is possible might be interesting as well.

The third, red colored phase includes most interesting problems that create room for IoT innovations. It became clear that the communication between the ambulance and ED can be improved. The fact that these communication problems are found in this third phase does not necessarily mean that these challenges occur in this third phase only.

Key insight first visit

After the visit in Dordrecht the process was visualized (Figure 16 on page 31) and the problems were mapped out (Figure 17). Both analyses point out that the communication between the ambulance and ED can be improved. Therefore the researcher selected this problem area for further research. The next chapter elaborates on the follow up research.

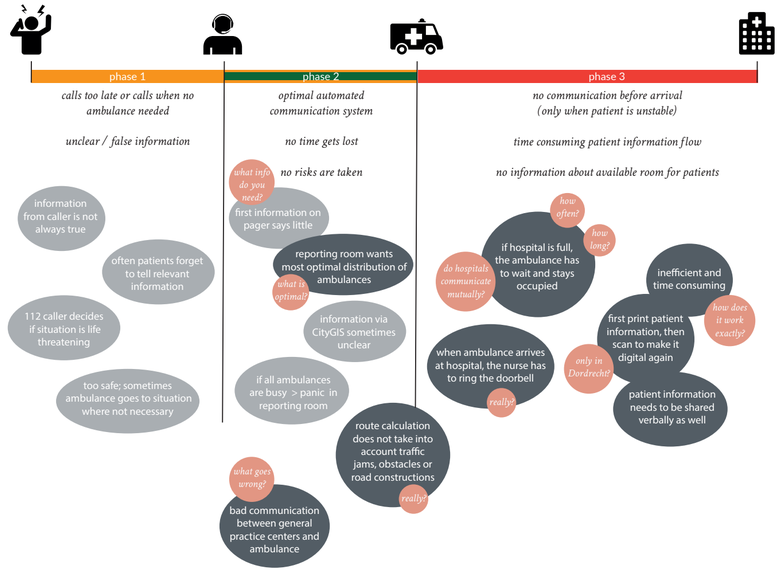


Figure 17. Problems found during first field research in Dordrecht, mapped over three different phases. The dark circles are most interesting for VodafoneZiggo.

FOLLOW UP RESEARCH

With the problems found in Dordrecht (discussed in the previous chapter) more insights were gathered at the ambulance stands in the other regions and at the EMC. These insights are discussed shortly and this chapter includes a concluding summary of the new insights and confirmations.

Haaglanden

Every ambulance region works differently; they use other systems (in the reporting room, but also for example the DRF in the ambulance differs) and the area is different so incidents are variant.

The communication problems found in Dordrecht in phase 3 (Figure 17 on page 33) were not recognized by the interviewee in Haaglanden. The interviewee explained about the 'Acuut Zorgportaal', a system just implemented in Haaglanden which provides information about patient stops of EDs. However, this system works devious. In Appendix F can be found more information about this system.

Bilthoven

In Bilthoven on the other hand, many of the communication problems discussed in the previous chapter were confirmed and new information was gathered. After this visit the researcher decided to fully focus on the ambulance-ED communication and a simple overview of the problems was created (Figure 18) to bring to the next location. As can be seen, the visual includes three issues; inefficient communication about patient stops (set by EDs

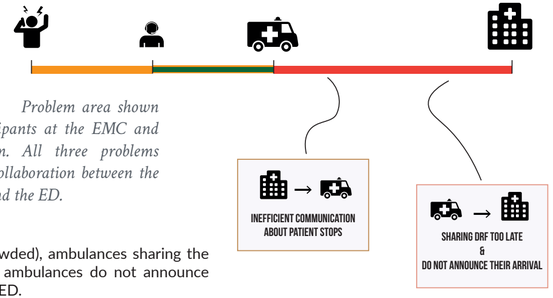


Figure 18. Problem area shown to the participants at the EMC and in Hilversum. All three problems pertain the collaboration between the ambulance and the ED.

when it is too crowded), ambulances sharing the DRF too late and ambulances do not announce their arrival at the ED.

Erasmus MC

Immediately after showing Figure 18 the problems were confirmed again.

'These are exactly the problems we try to deal with. It would be great if you can tackle them'

Another interesting aspect these interviewees mentioned is the fact that there is an unequal distribution of the ambulances arriving at EDs of different hospitals. This is caused by the fact that ambulance staff decides themselves which ED they go to. The result is that several EDs in the region are overcrowded while in other EDs it is way less crowded.

Hilversum

In Hilversum the same approach was used as at the EMC. However, no more new insights were gathered here. The information collection was saturated.

Key insights

So the focus is on communication. An overview of the current way of communicating between ambulance, reporting room and ED is visualized in Figure 19 on page 35. This figure includes in the total process from calling 112 to patient transfer at the ED. On top of the figure a time indication is given by the icons and marking the phases (defined in the field research in Dordrecht) and the explanation is given below.

The communication between reporting room and ambulance in the first stage of the process is going well: ambulances share their real time location with the reporting room to give them overview of all ambulances in the region and the DIA, route and accident information is communicated efficiently.

The numbers in Figure 19 on page 35 point out the inefficiencies:

1. The EDs communicate their patient stops to the reporting room only. Ambulances have no direct insight in patient stops. To find out about patient stops the ambulance staff needs to announce to the reporting room to which ED they are planning to go. When that certain ED has a patient stop, the reporting room employee advises to go to another ED. The reporting room is thus intermediary.

2. Measurements from the monitor are documented manually in the DRF. Moreover, filling in the DRF is done after patient transfer, thus the ED receives the DRF too late.

3. The ED has no insight in arriving ambulances because the ambulance staff does not always announce their arrival to the ED. A delay in patient transfer at the ED can be the result. If they do an announcement (which happens only when the patient is unstable) they share their expected time of arrival via a phone call.

Conclusion

The follow up research gave more elaborate insights in the problems in the communication between the ambulance, ED and reporting room in the total process. Three problems are pointed out, which are again in short:

1. Ambulances have no direct insight in patient stops.
2. The ED receives the DRF too late.
3. The ED has no insight in arriving ambulances.

As can be seen in the visual the inefficiencies happen in phase 2 and 3. These inefficiencies create opportunities to design. Because the focus is on the communication between the ambulance, the reporting room and the ED, the next chapter gives more information about the ED. The work shadowing at the ED of the EMC, at the reporting room in Rotterdam and the day on the ambulance are mentioned afterwards.

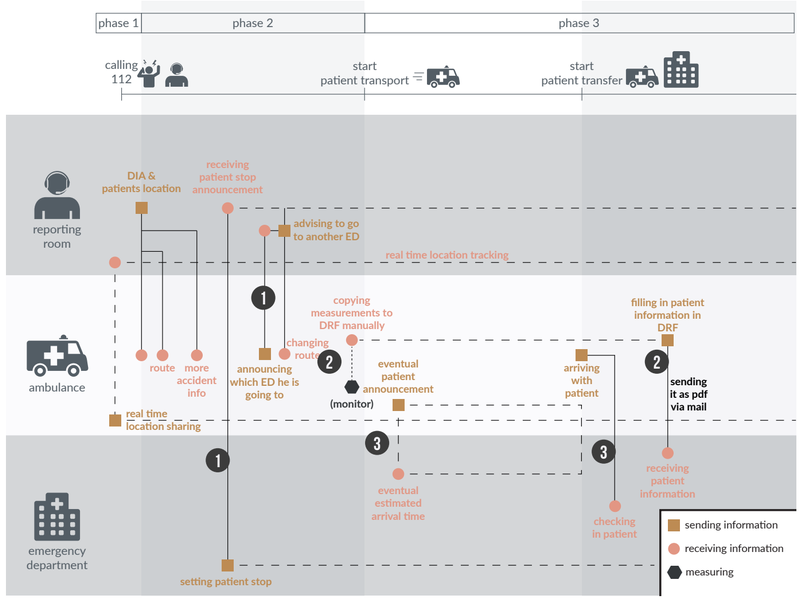


Figure 19. Current way of communication between the reporting room, ambulance staff and the ED. The numbers point out the inefficiencies, which are explained in this chapter.

EMERGENCY DEPARTMENT

General

In The Netherlands there are 132 hospital locations (van der Linden et al., 2013). 95 of them have emergency departments of which 90 are available 24/7 (Volksgezondheidenzorg.info, 2016). On annual basis, about 1,8 million people visit an ED (Volksgezondheidenzorg.info, 2013). On average an ED has 16 beds, ranging from 4 to 28.

The characteristics of the EDs differ greatly. On average about one out of 3 patient arrive by ambulance (van der Linden et al., 2013).

Triage; urgency in treatment

At the emergency department patients arrive unexpected. They can arrive on their own as well as brought by an ambulance. The patients have a different urgency in treatment; the order of arriving is not necessarily the order of treatment. The nurses have to make justified decisions about who needs to be treated first depending on the urge of the case. Therefore they use 'triage', assessing patients into various categories according to the seriousness of the injuries or illness. This makes sure that the most urgent cases are treated first. Thus, it often happens that someone who arrives later at the ED is treated before someone who was already waiting (Mcgroep.com, 2017). A triage nurse estimates the urgency of every case and decides which color code is applicable. The color coding works as explained in Figure 20.

Crowding

Crowding is defined as 'having more patients in the ED than treatment rooms or more patients than the nurses should ideally care for'. Overcrowding is defined as 'dangerously crowded, with an extreme volume of patients in ED treatment areas forcing the ED to operate beyond its capacity'. In 68% of the EDs crowding occurs several times a week or even daily. In 49% of these EDs also overcrowding is happening this often (two or more times a week). In more than half of the EDs crowding occurs mostly between noon and 8:00 PM. Crowding and overcrowding is a nationwide problem according to Dutch ED managers (van der Linden et al., 2013).

Crowding and overcrowding is seen as an ED problem. However, it is actually a hospital-wide problem. If other departments are also crowded people have to stay longer at the ED because they cannot be sent to that next department. Moreover, the increase in emergency admissions has effect on the capacity of the scheduled care (Netwerk Acute Zorg Noordwest, 2017).

Elderly

Nationwide the number of elderly at the ED increases. In 2013 29.1% of the visitors at the ED were people over 65. In 2017 it increased to 33%. This means that the number of elderly at the ED rises with about 1% per year, while the number of 65 plus people in the population increased with 1.3% in those years in total (Netwerk Acute Zorg Noordwest, 2017).

The fact that elderly are going to the ED has consequences for the total care chain. The elderly who come to the ED spend on average more time there than other adults: people from 18 to 40 years old spend in general less than two hours at the ED, while 80 plus people spend in general more than four hours at the ED (Netwerk Acute Zorg Noordwest, 2017).

Number	Name	Colour	Max time
1	Immediate resuscitation	Red	0 minutes
2	Very urgent	Orange	10 minutes
3	Urgent	Yellow	60 minutes
4	Standard	Green	120 minutes
5	Non-urgent	Blue	240 minutes

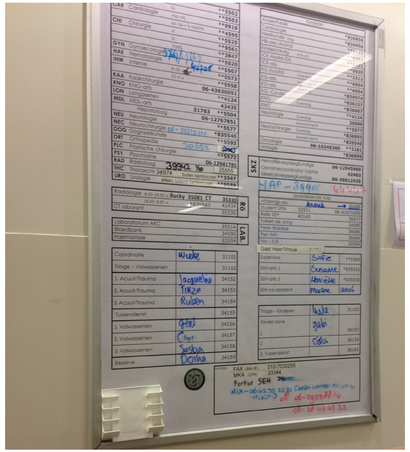
Figure 20. Color coding; the triage nurse estimates the urgency per case. Via these colors, the ED nurses can anticipate on the seriousness of the injuries or illness of the patients in the waiting room.

ED nurse

'In Hix, modules can be added easily but unfortunately we haven't reached the point that we really utilize this option! However, not too much information should be visible in the overview that is shared with the Schipholbord to keep it structured.'

Figure 21. The 'Schipholbord' is a big screen at the ED which gives ED nurses information about the patients in the rooms and the patients in the waiting room.

Figure 22. The responsibility overview shows who is present and who is responsible for what.



VISIT THE ED

A five hours long visit to the emergency department at the EMC gave the researcher practical insights in this world.

Way of working

The ED at the EMC is divided in three parts; children, adults and acute care. Each part has its own 'Schipholbord' (Figure 21). A Schipholbord shows the overview of the patients in the rooms at the ED; who it is, why the patient is there and what medical actions are already applied. This information is filled in (more detailed) via 'Hix' on the computer which stands next to the screen. Hix is the program where all EPDs (electronic patient files) are kept up to date. Also via Hix, the triage nurse defines the urgency of cases and labels the patient with the color coding. This way, the ED nurses know the order of picking up patients from the waiting room. When a room is empty the nurses do not invite a new patient from the waiting room immediately when all patients are coded green. This is because a high urgent patient might come in and it is essential to have a room available then.

During a shift change, all patients are talked over and the nurses distribute the patients they will be responsible for. They read the notes written in the system and the shift starts. The responsibility overview (Figure 22) is updated so everyone knows who is present. The nurses go from one patient to the other and switch their mind between the different cases. They communicate with each other a lot, face to face or via telephone and just use their mind to remember their actions to fill it in later on in Hix.

At the ED the nurses need to do a lot of administration. They wish to reduce or alter steps of data handling, because now documentation takes much time.

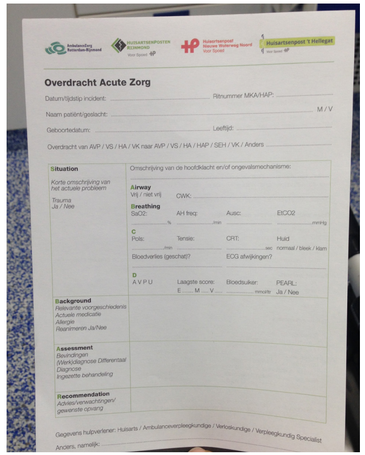
Ambulances

The researcher spoke with different nurses about their experience with ambulance patients. There is a form (one A5 paper) the ambulance staff needs to fill in during the patient transfer to give most important information in one overview. This form is based on the SBAR-method (Figure 23), which is used internationally to support the communication between different care providers. This needs to be done during the verbal patient information share. According to Kathrin Höfer, another graduate student who did research in the ED world, the SBAR-form is too structured and therefore only used in 25% of the cases.

The ED nurses also mentioned that they do not see the DRF from the ambulance. The ED nurses repeat all measurements the ambulance nurse already did. This is because they do not want to take any risks and cannot assume that all observations from the ambulance nurse are correct.

The people working at the ED would like to receive digital real time information about the arrival of an ambulance. Now they only get a phone call with a time indication of when they will arrive with an unstable patient. They need around 10 minutes to prepare, but if the ambulance is delayed they waste time while waiting for the ambulance (sometimes even half an hour). In the case of a stable patient, the ambulance staff does not call in advance. Such unexpected arrivals are not really convenient for the nurses at the ED.

Finally, communication between hospitals does not take place at all. This means that EDs have no insight in the patient stops of other hospitals. If they would have this they can anticipate on the upcoming high pressure.



Overdracht Acute Zorg

Datum/tijd/ddp. incident: Ritnummer MKA/HAP:

Naam patiënt/geslacht: M / V

Geboortedatum: Leeftijd:

Overdracht van AVP / VS / HA / VK naar AVP / VS / HA / HAP / SEH / VK / Anders

Situation — Omschrijving van de hoofdklacht en/of ongevalsmechanisme:

Korte omschrijving van het actuele probleem

Trauma Ja / Nee

Airway — Vrij / niet vrij — OWK:

Breathing — SaO2: — AH freq: — Ausc.: — EtCO2

C — Puls: — Tensie: — ORT: — Huid: normaal / bleek / klam

Bloedverlies (geschat)? — ECG afwijkingen?

D — A V P U — Laagste score: — Bloedsuiker: — PEARL: Ja / Nee

Background — Relevante voorgeschiedenis / Actuele medicatie / Allergie / Reanimeren Ja/Nee

Assessment — Bevindingen / (Werk)diagnose / Differentiaal / Diagnose / Ingezette behandeling

Recommendation — Advies/verwachtingen/ gewenste opvang

Gegevens hulpverlener: Huisarts / Ambulanceverpleegkundige / Verloskundige / Verpleegkundig Roecalist

Anders, namelijk:

Figure 23. *The SBAR-method form that an ambulance nurse needs to fill in during patient transfer.*

Figure 24. *Researcher during field research at the ED.*

Figure 25. *Workplace of a reporting room employee.*

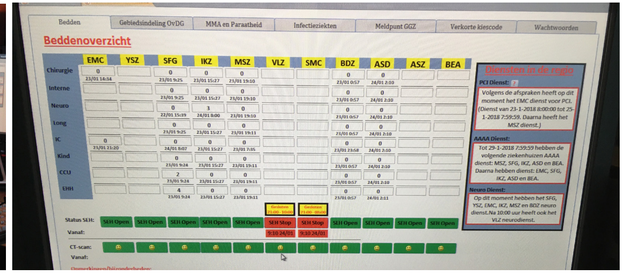


Figure 26. *ED overview; in this case, the VLZ and SMC have a patient stop.*

VISIT THE REPORTING ROOM

A four hours lasting visit to the reporting room in Rotterdam gave the researcher new insights again. A reporting room is divided in two sides: incoming calls and outgoing commands to the ambulance staff. During the visit the researcher looked mainly at the outgoing side of the reporting room, since this is more relevant for this research.

Figure 25 shows the workplace of a reporting room employee; five computer screens, three big screens a telephone and a headset are required to do their job.

The employees at the outgoing side in the reporting room have to do many administrative actions manually. For example, when a new ambulance team calls to announce their shift start, a reporting room employee needs to activate the ambulance in the system manually. From that moment the reporting room employee knows that this vehicle is available. This administration is inefficient and labor-intensive. Documenting an average ride in the system requires 12 actions from the reporting room employee.

It would be way more user friendly if the ambulance and reporting room can register their actions in the same system. Several documentation tasks are done several times. The researcher verified the current way of communication (Figure 19 on page 35) and it was confirmed. The communication should be back and forth between all three parties.

As can be seen in Figure 26 the reporting room has a 'bed capacity overview' of the EDs. However, the experience shows that the EDs never share this information. In the same system the patient stops are added manually after a phone call from the ED and a confirmation via email. After one hour, the stop needs to be removed manually again. The website also shows which hospitals are in charge of specialized care (on the right side of the screen in Figure 26). The ambulance staff can ask the reporting room for this information when needed.

'It would be useful to see at a glance which ED has enough capacity to receive a patient from ambulance.

Johan - ambulance nurse & ED nurse

'I work both as a nurse at the ED and in the ambulance. When I am an ambulance nurse, I don't announce my arrival at the ED because there is a big chance that we won't be accepted.'

Figure 27. Researcher during field research in the ambulance.

AMBULANCE IN PRACTICE

On a Friday evening, an eight hours ride with the ambulance was arranged. The ambulance staff got six calls during the shift, two of them were false alarms.

The ambulance staff does not announce their arrival to the ED. This is on purpose: *'if we announce our arrival by phone and the ED is crowded already, they will reject our request. They will send us to another hospital while it is crowded everywhere. We don't want to carry the patient back and forth.'* The fact that the ambulance staff refuses to do an announcement is difficult for the ED, especially if the waiting room is (over)crowded. The ambulance stretchers need to be available as soon as possible, thus the ED nurses try to arrange a room for these patients, in between the original schedule. This causes chaos.

During the patient transfer the most important information is shared verbally. The ED nurse writes the measurements from the ambulance nurse on his glove to remember them, to be able to compare them with his own measurements; the measurements are done all over again at the ED.

After patient transfer the ambulance nurse fills in the (rest of the) DRF on his iPad. It takes relatively much time (20-30 minutes) and he explained that no one will look at it. It is just for administration. All three parties (reporting room, ambulance and ED) use different systems thus some information is documented three times.

The ambulance staff communicates to the reporting room that the vehicle is available again after filling in the digital patient file. However, it is done slowly; sometimes they take a small break in between. *'If the reporting room really needs us, they will call us.'*

When the waiting time at the ED is more than 10 minutes the ambulance shares this information with the reporting room via the portophone. This way, the reporting room can estimate when they will be available again.

CONCLUSION OF THE FIELD RESEARCH

Problem area

After the field research a clear conclusion can be drawn. Three interesting problems are determined in the communication between the ambulance, ED and reporting room (Figure 28) and explained below.

1. Ambulances have no direct insight in patient stops

EDs set patient stops when departments (including the ED) are overcrowded. The ED communicates this to the reporting room only. This is done via a phone call to the reporting room. The reporting room confirms the patient stop via email and documents this in the system manually. After one hour, he needs to cancel it manually as well. When an ambulance informs the reporting room about the ED they are planning to go to, the reporting room can advise to choose another ED based on the patient stops. This way, the ambulance actually gets the information too late (when he is already on his way to a certain ED with a patient stop) and needs to change his route.

2. The ED receives the DRF too late

The ambulance nurse fills in the DRF after arriving at the ED. It takes about half an hour so there is no time to do it earlier. Because of this, no one will look at it. According to caregivers sharing patient information is a bottleneck. Registrations are not connected to each other and this obstructs further care giving (Marktscan acute zorg, 2017).

3. The ED has no insight in arriving ambulances

The ambulance staff does not communicate that they are on their way to the hospital (except from the moments that they carry an unstable patient). This makes that the ED has no insight in arriving ambulances. Such unexpected arrivals are inconvenient for the nurses at the ED; the ambulance stretchers need to be available as soon as possible, thus the ED nurses try to arrange a room for these patients, in between the original schedule.

Link to literature research

In literature was found that ambulances often arrive too late. The arrival time depends on several phases in the process (Figure 29) which is a never ending circle. In the field research inefficiencies in the communication between ambulance, reporting room and ED were found in phase 2 and 3. By enhancing these, the arrival times might improve due to an increase in efficiency which saves time at the end of the process.

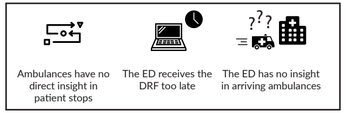


Figure 28. Three main problems.

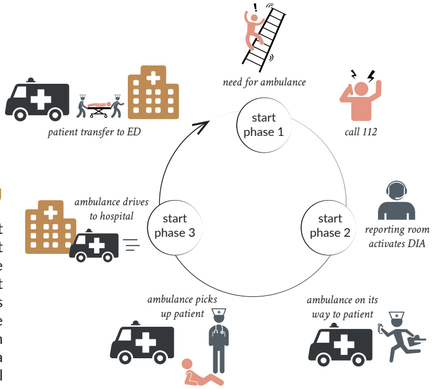


Figure 29. Ambulance process circle; making phase 3 more efficient will have positive influence on the total cycle.

Side note

The researcher visited a referring event focused on the fact that elderly put too much pressure on the ED. Several speakers from different disciplines (ED nurse, ambulance nurse, GP, geriatric doctor) shared their view on this topic. The overall conclusion of this event was that the collaboration and communication between all parties in the acute healthcare should be improved. This was an other clue for the researcher that this project is relevant.

DESIGN GOAL

The literature research and field research formed a clear view on the current situation. In this part of the report the three problems are evaluated and based on that, a problem statement and design goal are formulated. Subquestion 1 was 'what is the current situation for ambulance service in the Netherlands?' and can be answered now.

PROBLEM SELECTION

As concluded after the field research, three problems stand out (discussed in this chapter one by one). However, to solve all three in one concept is way too complex and time consuming for this project. Therefore, a concept to solve one of the three (or a combination) will be developed. This chapter discusses the considerations between the problems. All problems are evaluated relative to each other on two aspects (Figure 30): the problem size and the societal impact that is created when the problem will be solved (in brown), and the relevance for VodafoneZiggo (in pink). This evaluation is discussed below.

1. Ambulances have no direct insight in patient stops

The fact that EDs communicate their patient stops only to the reporting room causes inefficient communication. The ambulance staff calls the reporting room to tell them which ED they want to go to. The reporting room then checks it with the patient stops and if necessary they advise the ambulance to go to an other ED if the certain ED has a stop. This is devious.

By creating an IoT based system to make this more efficient, the reporting room benefits from it because it reduces their tasks. Besides this, 78% of the ambulance staff members agrees that patient stops in hospitals make it difficult to deliver patients at a hospital (Marktscan acute zorg, 2017). The patient stops are not useless, we cannot ignore them. However, 59% of them says that the information provision about the stops is not clear (Marktscan acute zorg, 2017). This can of course be improved; time can be saved and work pressure reduced. However, not much time is saved at the crucial moment solving this inefficiency only; calling the reporting room to get informed about patient stops takes only a few seconds. Therefore the societal impact of a system that makes this communication flow more efficient wont be very big.

For VodafoneZiggo this problem might not be the most interesting one. It can become a complex system for a result with not that much impact. To automate this, the EDs should find a way to measure the waiting lines and care complexity and maybe several other factors to be able to decide on setting patient stops. A simplified version can be a system where the patient stops are still set manually, but communicated immediately to the ambulance staff. This can be combined with solving one of the other two problems.

2. The ED receives the DRF too late

The ambulance nurse needs to fill in a DRF. This file includes all information about the patient, the situation and medical actions performed by the ambulance nurse. At the moment the nurse fills in the DRF after transferring the patient to the ED. During patient transfer all relevant information is also shared verbally and the DRF is in most cases not seen by the ED nurses.

The measurements done by the ambulance nurse are repeated at the ED. This will probably not change; the reason for repetition is a matter of certainty about the condition of the case, they do not want to blindly rely on the conclusions of other nurses. Besides this, the condition of the patient might be changed in time. Therefore solving this problem will relatively have the least societal impact unless the DRF gets a total new function, in such a way that the ambulance nurses do not feel like they waste time by filling it in. However, this will require another very elaborate research.

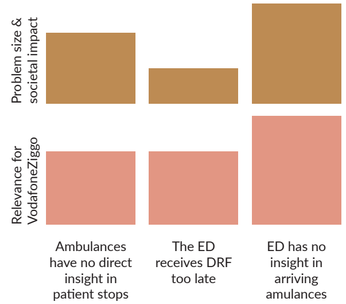


Figure 30. Problem evaluation; all three problems are evaluated on relevance for VodafoneZiggo and its societal impact.

For VodafoneZiggo it would be interesting if this is solved by real time information sharing. The solution has potential to become a new to the world concept and VodafoneZiggo can create competitive advantage this way. However, the fact that every emergency situation is different makes the design complex. Ideally, a whole new system will be designed to make sure the three parties work together way more efficient. During this project this is unfeasible.

3. The ED has no insight in arriving ambulances

Ambulances only announce their arrival by calling the ED when they carry an unstable patient. Unstable means that the patient care needs to be handed over immediately. They share their estimated arrival time and the first information about the condition of the patient via a phone call. At the ED the required room will be prepared and the certain team (around 8 nurses) makes sure they are ready to take over the patient. However, the communicated arrival time is just an estimation. The team wastes time by waiting for an ambulance that might arrive after 10 more minutes.

When carrying a stable person, the ambulance staff does not even call beforehand. When they arrive, the ED needs to take in the ambulance patient in between the patients from the waiting room while the scheme is already complex. Solving this problem can create big societal impact at the ED. Once the ED gets insight in the real time of arrival of all ambulances they can anticipate and be ready at the right moment without wasting time. This was confirmed during the field research at the ED. Creating insight in arrival times of ambulances can help the ED nurses organize their priorities. Finally, by making the phone call unnecessary we reduce actions for the ambulance staff. Another benefit for the ambulance staff is the fact that the system can make sure that EDs cannot refuse ambulances anymore, unless there is set a patient stop.

For VodafoneZiggo this is an interesting design direction. First of all, solving this problem can create relatively the biggest societal impact. Secondly, tracking systems already exist. It is not new to the world, only new to this 'market'. It would be most interesting of the solution can be implemented in devices that are already used.

Conclusion

The concept that will be developed is focused on the fact that the ED has no insight in arriving ambulances. Solving this problem is realistic in this project, most interesting for VodafoneZiggo and will relatively have the biggest societal impact. By creating insight in the arriving ambulances at the ED the nurses can anticipate on these patients and work more efficient. This will help the ambulance staff to become available again earlier and thus save time in the process.

A way to give the ambulance staff insight in patient stops will also be implemented in the concept.

The problem statement and corresponding design goal are formulated as:

Problem statement

The collaboration between reporting room, ambulance staff and EDs is inefficient because:
1. ambulances have no direct insight in patient stops
2. the ED has no insight in arriving ambulances

Design goal

Design an IoT based logistic concept that improves the collaboration between reporting room, ambulance staff, and EDs by giving the ambulance staff direct insight in patient stops and the EDs insight in arriving ambulances.

From now on, phase 1 of the process of ambulance service (calling 112) will not be mentioned anymore because the concept will not change anything in that part by solving the problems from the problem statement.

Research question for this graduation project:

'How can VodafoneZiggo improve the ambulance service with IoT in the Netherlands?'

Subquestion 1:

'What is the current situation for ambulance service in the Netherlands?'

The first part of this research was about answering subquestion 1 (repeated in the brown block above) and sketches the current situation of the ambulance service in the Netherlands based on literature research and field research.

Current situation

At the moment emergency services often arrive too late. Only one out of three ambulances succeeds in meeting the standard (Nos.nl, 2017).

The arrival time depends on several steps in the process. There is a challenge in the end of the process where the collaboration between ambulances, the reporting room and EDs can be enhanced. By doing this, the arrival times might improve due to an increase in efficiency which saves time at the end of the process.

THE CURRENT SITUATION FOR THE AMBULANCE SERVICE

Answering subquestion 1

During field research several communication issues were found. However, solving all of them is not realistic in the certain timespan. Therefore the previous chapter measured the problems on several aspects and the findings were analyzed. This narrowed down the design direction. The problem statement is formulated as follows:

The collaboration between reporting room, ambulance staff and EDs is inefficient because:
1. ambulances have no direct insight in patient stops
2. the ED has no insight in arriving ambulances

The corresponding goal is:

Design an IoT based logistic concept that improves the collaboration between reporting room, ambulance staff, and EDs by giving the ambulance staff direct insight in patient stops and the EDs insight in arriving ambulances.

Next steps

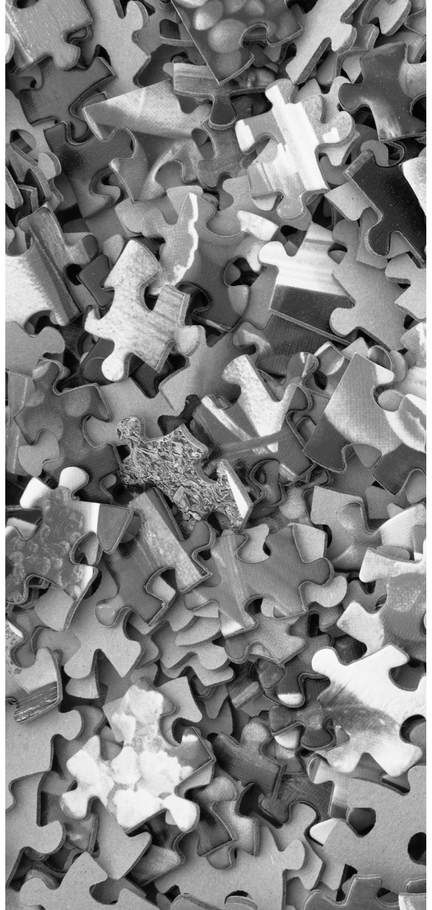
Subquestion 2 is 'what IoT solution can solve the problem(s)?' To answer this question a concept will be developed. In this concept several devices need to communicate with each other. On the one hand, something in the ambulance should be activated to make sure that the ED the ambulance goes to, can receive real time information. On the other hand, in the system should be implemented that the ambulance staff gets direct insight in the patient stops.

*'We experience that the **acute healthcare chain is clogged** which causes long waiting times or the ambulances won't even be accepted.'*

Sandra - team leader ambulance service Rotterdam-Rijnmond

CONCEPT DEVELOPMENT

The concept is an IoT based system where several devices share information. This chapter includes the considerations of this communication system and the final design is explained. The concept is developed via an iterative process (The Interaction Design Foundation, 2018) to keep improving it. User tests are executed to validate the concept and finally, subquestion 2 is answered, which was 'what IoT solution can solve the problem(s)?'.



DECIDING ON SEVERAL ASPECTS OF THE CONCEPT

As visualized in Figure 31 the concept can be developed in different ways. This chapter explains the considerations shown in the visual, divided in the ambulance side of the system and the ED side.

Ambulance side

One simple action in the ambulance is required to activate the system that makes sure that the ambulance shares real time information with the ED they are planning to go to. But who activates the system and which device is used for this? These kind of questions have major influence on the final design of the concept.

Which device is used?

Implementing the system on the iPad for example, has as benefit that all patient information needs to be filled in the same system anyway. However, the DRF is now filled in afterwards. What would make the nurse fill it in earlier?

A new device has the benefit that it can be designed from scratch but the ambulance staff already uses so many devices that it might be better not to add another one.

The ambulance driver now communicates via the keys on his portophone the ambulance status to the reporting room. He presses key 3 when driving from the patients location to the hospital, so the reporting room employees have insight in the status of the ambulance. Because this is already an action for the driver at this moment in the

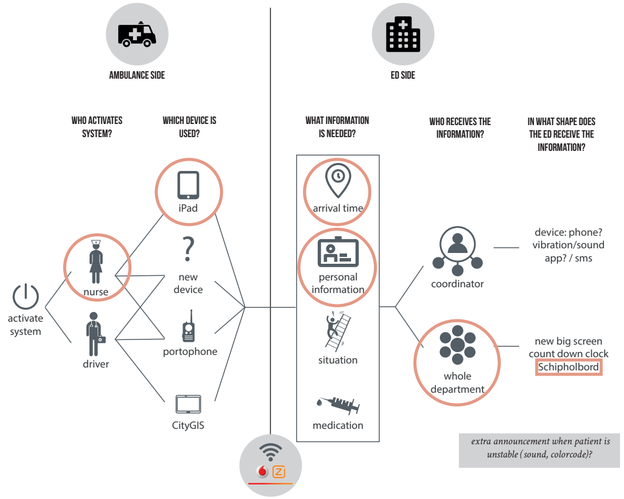


Figure 31. This overview helped the researcher ask questions during the meetings and it therefore helped in making decisions. The pink circles highlight the chosen aspects. In the text is explained why these decisions are made.

Figure 32. This overview shows information about the participants who helped the researcher during concept development.

LOCATION	DATE	EMPLOYMENT PARTICIPANT(S)	CONTACT VIA	USED METHOD
Erasmus MC	Jan 8th 2018	ROAZ-coordinator acute care	previous contact	presenting considerations & interviewing
Ambulance stand Rotterdam	Jan 17th 2018	Team manager ambulance care	reporting room employee	presenting considerations & interviewing
ED EMC	Jan 17th 2018	ED team leader / nurse	previous contact ED	presenting considerations & interviewing

process, it might be efficient to let the system work via the portophone as well. However, adding the extra function to select a hospital and activate the system might be too complex for this limited device.

The CityGIS is also a potential device. The CityGIS is linked to the portophone; when the driver communicates the ambulance status to the reporting room, the CityGIS also shows the output. A benefit of the CityGIS is that this device stays in the vehicle. It would be good if the status can be shared with the reporting room (and with an ED) via the CityGIS as well as via the portophone. A negative aspect of the CityGIS is the fact that it is not a constant factor in the ambulance service. It is a helpful device to get from A to B and to receive information from the reporting room. Every six years this device will be revised and next year that revision takes place.

Who activates the system?

It depends on the device who will activate the new system; the nurse or the driver. It is most argumentative that the patient information and medical data stay close to the nurse. The driver does not have time to fill out questions while driving and if he needs to do it beforehand it might delay the ride.

ED side

When the system is activated in the ambulance information is shared with the ED. The questions are: what information is needed and who needs to receive it? Based on the answers to these questions the ED side of the concept will be designed on a big screen at the ED where every nurse can receive the information, or on a smaller device carried by the coordinator.

When an ambulance transports an unstable patient an extra warning signal might be useful.

Finding the answers

The answers to these questions were found after more meetings (Figure 32). Based on these insights the concept is developed to a final concept and ready for a user test. The decisions are described below.

Decisions

The nurse should activate the system using the DRF (so with the iPad). This is decided based on the considerations and the meeting with the ambulance team manager. A new insight is the fact that DRF already has a function to do a 'patient announcement'. By doing a patient announcement the ambulance nurse fills in some information in the DRF before arriving at the ED. This information is sent ahead so the ED can anticipate on the patient. However, this function is barely used because of several reasons, explained in the next chapter.

The ambulance information should be visible for every nurse at the ED so the Schipholbord is a good device to achieve this.

The more information can be sent ahead, the better. At least real time of arrival, patient information (name, age, gender) and if the patient is known in the hospital are desirable to receive. An ED is obliged to take care of known patients, even if the certain ED set a patient stop.

Two clear goals are defined; creating insight in the arriving ambulances at the ED and creating direct insight in patient stops for the ambulance staff. The final design will include a redesign of the ability to do a patient announcement. The direct stakeholders for this concept are ambulance nurses and ED nurses of all hospitals, but also reporting room employees; some of their tasks can be abolished by the new system. The redesign takes into account the patient stops and several other external factors and will be easier and faster in use than the current patient announcement function. Several already used devices are involved and new connections need to be created. The back-end will be more complex, but the front-end will be way more user friendly than the current system. Not all actions happen in a certain order.

A list of requirements and wishes the concept needs to meet can be found in Appendix G.

CURRENT PATIENT ANNOUNCEMENT NOT USED

The current DRF already has the option to announce the arrival of the ambulance to the ED. Because of the reasons below many ambulance nurses do not use this function.

Activating the current patient announcement takes too much time, so ambulance nurses are often not able to do this; they need to focus on patient care. Three tabs (Figure 33) that include patient information (name, gender etc.), situation, measurements, and ETA need to be filled in before sending the patient announcement to the hospital.

Then, the patient announcement is received by the secretary of an ED via a program called 'Ambuview'. Often, unless the secretary is very observant, the patient announcement is received but not noticed. A patient announcement does not come with a clear sign.

So the current patient announcement function is not really used. This needs to change. To create a base for the concept we zoom in at the total current communication flow and discuss an improved version of it.

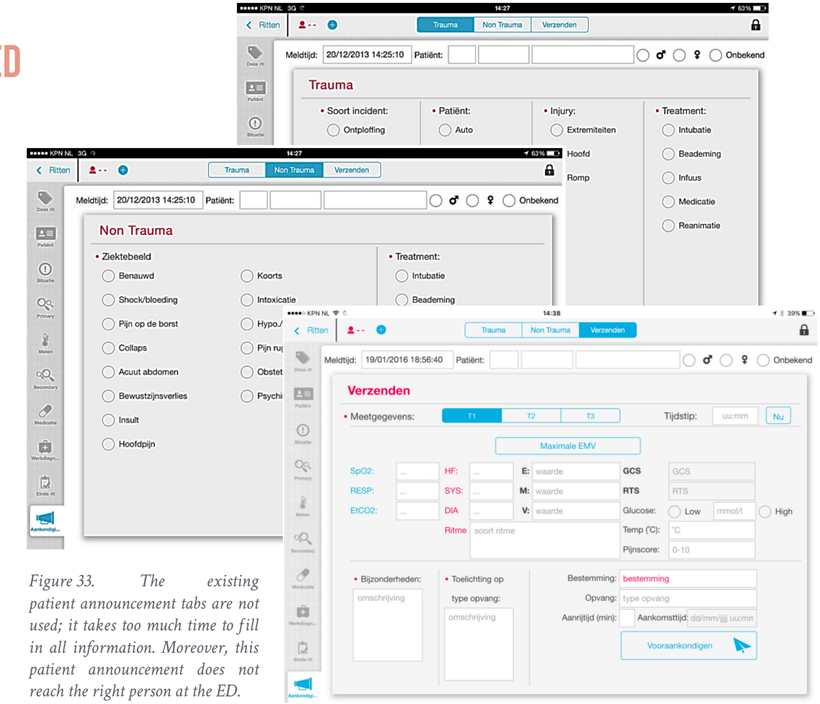


Figure 33. The existing patient announcement tabs are not used; it takes too much time to fill in all information. Moreover, this patient announcement does not reach the right person at the ED.

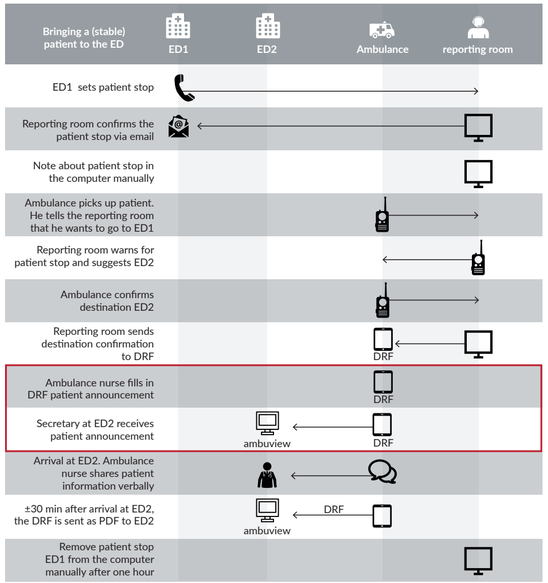


Figure 34. Current communication flow, the steps in the red box are often left out because it takes too much time.

Adjustments in the communication flow

Current communication flow

In Figure 34 the current communication flow is visualized. The scheme starts with a patient stop from ED1 via a phone call. The reporting room confirms this via email and puts it in the system manually.

From the moment that an ambulance picks up a patient, communication via portophone between the reporting room and the ambulance takes place (3 rows in the figure). When it is decided that the ambulance goes to ED2 the reporting room employee sends a confirmation to the DRF. In this confirmation, the name and gender of the patient (if known) is shared as well with the DRF. This information was already gathered in the reporting room during the emergency call. The actions in the red box are usually skipped because filling in the patient announcement tabs takes too much time and it does not reach the right person at the ED. When the ambulance arrives at ED2 the patient information is shared verbally. After all, the ambulance nurse fills in the DRF. This takes about half an hour because many tabs need to be filled in.

The scheme ends with an action in the reporting room; the patient stop from ED1 needs to be removed from the system manually after one hour.

The current flow is devious; a lot of communication now is done verbally and documented manually, so adjustments are required to make sure that the new concept works more efficient. This is the second step to the final concept (the first step was deciding on several aspects of the concept, which was done in the previous chapter).

Future communication flow

Figure 35 shows the improved communication flow (which is immediately the flow of the final concept). As can be seen, many steps are digitized and automated and communicated immediately to more than one other party.

The first step in the figure shows that a patient stop is directly communicated to both the ambulance and reporting room. The system decides to which ED the ambulance goes (explained in the next chapter) and shares this with the certain ED and the reporting room. The reporting room shares the first patient information with the DRF (as they currently do). The ambulance nurse needs to fill in the new patient announcement (also explained in the next chapter). The information is shared with Ambuview, the Schipholbord and the reporting room. After arrival at ED2 the ambulance nurse still shares the patient information verbally and will fill in the DRF which still takes a while because the rest of the DRF will not change in the concept (earlier in the report was mentioned that this will require another elaborate research).

From problems to solution

At the moment the current communication flow is devious. By improving this flow, efficiency in the ambulance service can be achieved. One aspect of improvement is redesigning the patient announcement option in the DRF into an easier to use function. The existing option is not used because it takes too much time and does not reach the right person at the ED. The next chapter elaborates on the final concept.

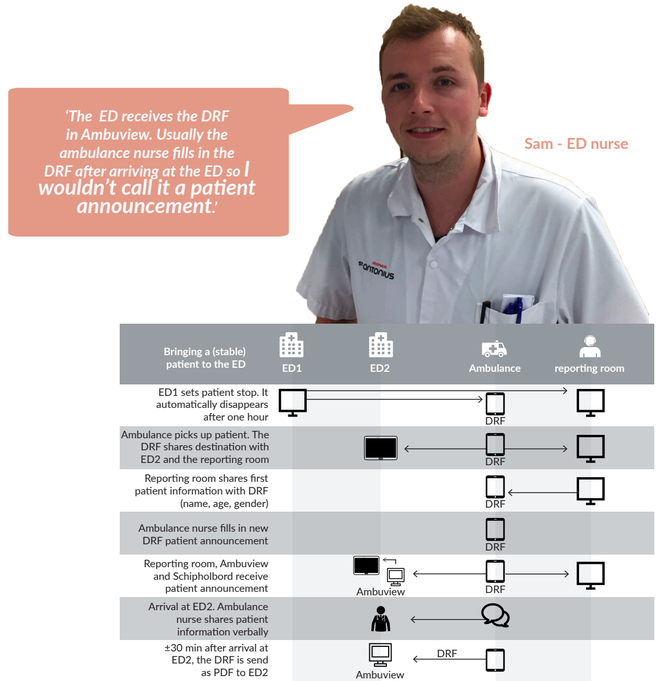


Figure 35. Improved communication flow; many steps are automated and therefore way more efficient than the current communication flow.

FINAL CONCEPT "CommunicAid"

The CommunicAid is a new system that creates direct insight in ED patient stops for the ambulance staff and insight in arriving ambulances at the EDs. In this chapter every detail of the concept will be explained.

All information flows can be found in Figure 36 on page 53. This overview is explained along the way; the corresponding numbers in the visual are mentioned in the text (*like this*). For visual support in this concept explanation, the text sometimes refers to figures further in the report.

Insight in patient stops

In Figure 37 on page 54 the Schipholbord is visualized. This information is visible for the whole ED on the big screen and can be adjusted on a computer next to it via Hix. In the menu on the left side the function to set patient stops digitally ('SEH tijdelijk ontzien') is added (*number 1*). As soon as an ED sets a patient stop, not only the reporting room gets this announcement (Figure 38 on page 54), but also the DRF notifies it and will make sure that the certain hospital is not available anymore (unless the patient in the ambulance needs a specialization which is only available in the hospital that set a patient stop or the patient is know in that certain hospital). One hour after setting the patient stop it will be canceled automatically, so the ED becomes available again (*number 2*). If it is still too crowded, the ED needs to set another patient stop.

Insight arriving ambulances

It starts at the top left of Figure 36 on page 53 where someone calls 112. The reporting room employee activates a DIA (*number 3*) for the most suitable ambulance. He decides which vehicle gets the DIA based on the locations of the empty vehicles. Then the ambulance picks up a patient. Via a low effort menu in the DRF (*number 4*) operated by the ambulance nurse, the system decides which ED is most optimal. The menu includes fields about specialization, where the patient is known, and his preference. These fields are taken into account in suggesting the optimal ED. The corresponding DRF patient announcement screens can be found and are explained on page 55.

In the ROAZ ('Regionaal Overleg Acute Zorgketen') is agreed upon the fact that a patient should be treated in the hospital where he is known, whether there is a patient stop or not. Except for the fields in the menu, the system also takes into account external factors (*number 5*) such as the patient stops set by EDs, the location of the ambulance, other ambulances on their way to an ED and which hospital is responsible for PCI-, AAAA- and neuro service at the moment.

From the moment that the nurse clicks 'vooraankondigen' ('patient announcement') the real time information will be shared with the selected ED (*number 6*) as in Figure 37 on page 54, and with the reporting room (*number 7*) as in Figure 39 on page 54. Arrival time, name, age, gender and eventual specialization, the fact if the patient is known at the certain ED and more information from the DRF are shared with the ED. The reporting room only receives the destination and real arrival time.

As soon as the ambulance arrives at the ED, the announcement disappears from the Schipholbord (*number 8*). When the ambulance is available again, this is announced to the reporting room via the portophone key 5 (*number 9*) just as they already do. From this moment the circle starts over again (*number 10*).

Benefits

As already mentioned, implementing the CommunicAid has benefits for the ambulance staff, the EDs and the reporting room. The new system takes away the option for choices. The ambulance staff has no reason to withhold the ED of their arrival information; this has no negative effect anymore because the ED cannot reject the ambulance via this system. If the ED is too crowded there will be set a patient stop. This will make sure that the ambulance staff cannot select this ED in the DRF anymore.

The reporting room and the ambulance staff benefit from the fact that this system creates direct and digital insight in patient stops for both parties. It reduces the number of phone calls between reporting room and the ambulance staff, but also between ED and the reporting room.

EDs benefit by the fact that ambulances will not show up spontaneously anymore. The nurses can now anticipate on the arriving ambulances.

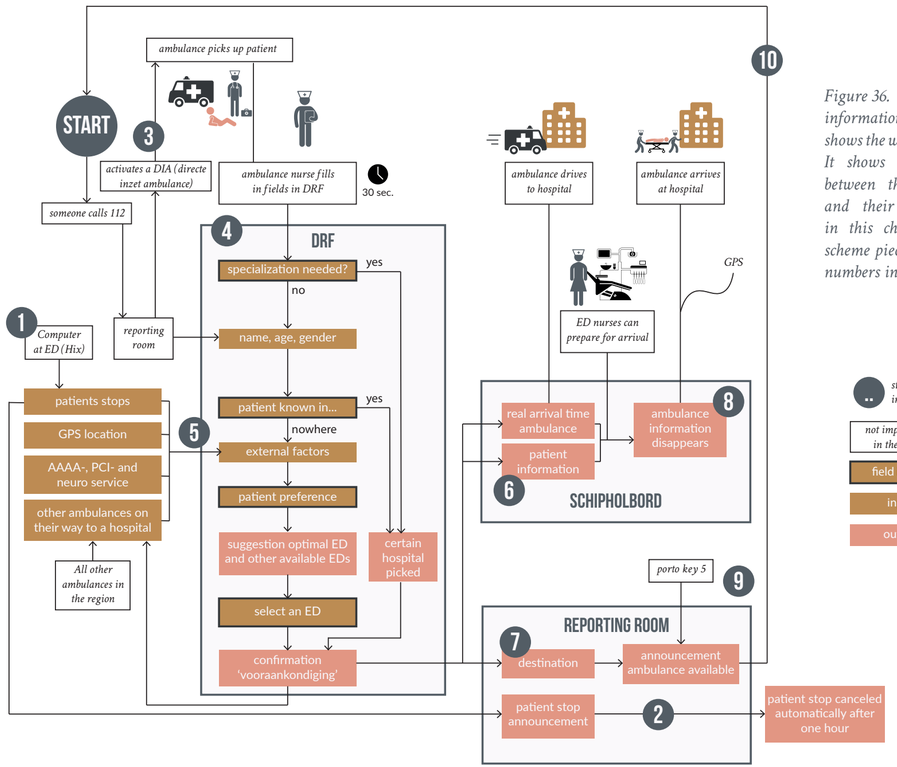


Figure 36. CommunicAid information flow; this overview shows the way the system thinks. It shows the communication between the involved parties and their devices. The text in this chapter explains this scheme piece by piece along the numbers in the figure.

In this example Mr. Janssen will arrive in 11 minutes. He is a PCI patient and is known in the certain hospital so his EPD is available. The nurses at the ED can look up the patient history of Mr. Janssen.

Mrs. van der Wiel will arrive in 14 minutes. The ambulance nurse already shared the first information with the ED.

PCI specialization

patient is known at certain ED so EPD is available

ambulance nurse already filled in some information in the DRF

Ambulances

Janssen, P.L. 74 jr. 11 min PCI

van der Wiel, S. 46 jr. 14 min

SEH tijdelijk ontzien

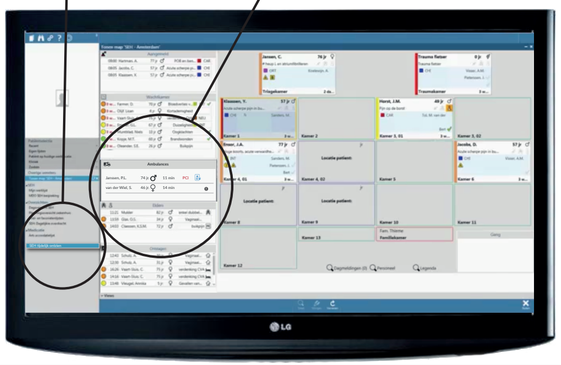


Figure 37. The Schipholbord with new ambulance arrival information pointed out (picture is blurred due to patient information privacy). This screen is visible for the whole ED and can be adjusted in Hix on a computer next to it. In the menu on the left side the function to set patient stops digitally is added. Also a new module is added where ambulance arrival information is visible. The text on page 52 explained this in more detail.

Figure 38. As soon as an ED sets a patient stop, the reporting room gets a pop-up announcement like this. After one hour the patient stop will be canceled automatically. No actions from the reporting room employee are required. The text in this chapter explains this in more detail.

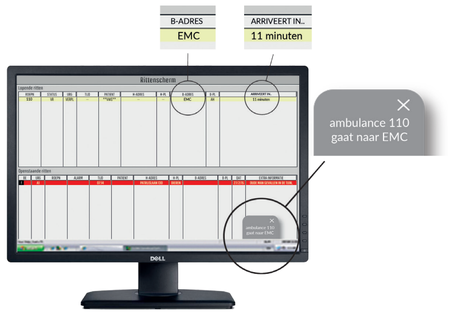


Figure 39. Announcement in reporting room as pop-up about the ED an ambulance goes to. The system reduces the work pressure in the reporting room by automating these actions. However, the reporting room of course needs to continue to exist. Enough tasks remain when implementing the CommunicAid.

DRF screens

Name, age and gender is already filled in because the DRF will be linked to the system in the reporting room. The reporting room gathers this information during the 112 call from the patient. The ambulance nurse only needs to select the right options in the fields (Figure 40). Depending on the selections the nurse needs to fill in one, two or all fields to receive the ED suggestions. For example, in Figure 41 PCI is selected as specialization so the following two fields are not relevant anymore. The system immediately suggests the EMC (responsibility for specialization is rotated between the hospitals that are able to offer it. The MSZ has also PCI specialization but the system also takes into account which ED is scheduled for the PCI service at the moment so it suggests the EMC as most optimal). When no specialization is needed the other fields are still relevant to let the system decide on the most optimal ED (Figure 42).

In about 10% of the cases the patient is not communicative. Then, some information will not be available (source: team leader reporting room Rotterdam-Rijnmond). When this is the case, the situation is probably very urgent so the system will not be used anyway; the ambulance will call the nearest ED to announce the emergency.

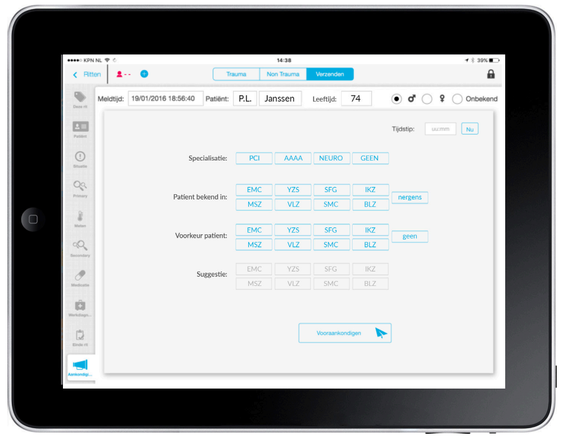


Figure 40. New patient announcement interface. Just a few fields need to be filled in by the ambulance nurse to let the system decide on the most optimal ED to go to.

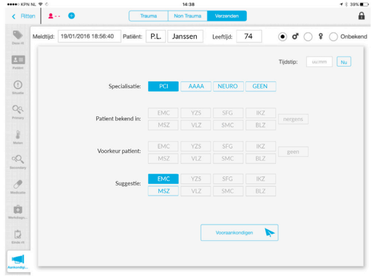


Figure 41. When PCI is needed, there is no need to fill in the other fields; only the PCI-specialized hospitals are available and the EMC is in this case scheduled for PCI service so is suggested as most optimal.

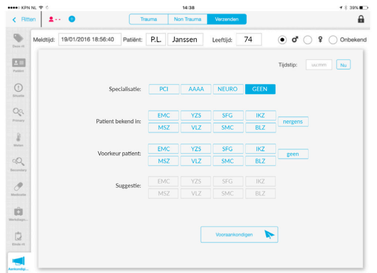


Figure 42. When no specialization is required the other fields need to be filled in before the system gives a suggestion.

How does it work?

To make this new way of communication work, VodafoneZiggo needs to create new IoT connections between the Schipholbord, the ED computer (Hix), the DRF and the reporting room system as Figure 43 shows. At the moment, the black lines already exist: if the current patient announcement function is used the DRF sends this to Ambuview (on the computer at the ED secretary desk). Also, the final PDF with all patient information is received at the ED via Ambuview. Besides, the ED overview is already shared with the Schipholbord. Finally, the reporting room is already able to share the first patient information with the DRF (name, age, gender).

The pink lines represent new connections. The patient announcement and real time of arrival need to be visual at the Schipholbord to inform the whole ED about the arriving ambulances. Therefore, the DRF should share this with Hix, since the overview from Hix is visible at the Schipholbord. This real time information also needs to be shared with the reporting room system.

The patient stops set by the ED via the computer in Hix need to be shared with both the DRF and the reporting room.

VodafoneZiggo's IoT can ensure the connection to share the real time information between the different devices of all parties. No new devices are necessary, the system works with the devices that are already used.

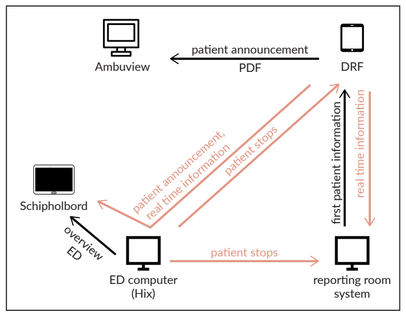


Figure 43. New IoT-connections between the Schipholbord, the ED computer (Hix), the DRF and the reporting room system to let the CommunicAid work.

Scenarios

The scenarios on the following 2 pages visualize the current situation (upper) and the future situation where the CommunicAid is implemented (lower). These are created to highlight the discontinuities in the present, and to show what can be achieved with the CommunicAid. The icon in the upper left corner tells where the certain situation is happening. The diagonal split screens happen at the same time.

The scenarios do not include phase 1 of the process of the ambulance service (calling 112) because the concept does not change anything in that part.

Explanation of the scenarios

The upper scenario on the next two pages explains a situation without the CommunicAid. First of all a patient stop is set by the ED of the SMC hospital. The ED nurse calls the reporting room where this stop will be documented in the computer manually and confirmed via email. After one hour the reporting room employee needs to cancel the patient stop manually. In the future situation the patient stop is set via the computer at the ED (in Hix). This patient stop is communicated to both the reporting room and DRF. After one hour the patient stop is canceled automatically.

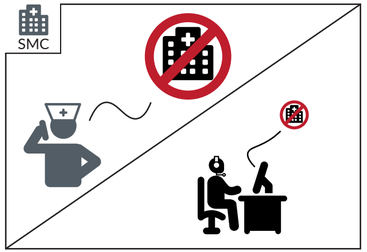
The next step is the same in both scenarios; the ambulance picks up Mr. de Groot after receiving a DIA from the reporting room. In the current situation the ambulance driver contacts the reporting room to announce that they are driving to the SMC with Mr. de Groot. The reporting room employee knows about the patient stop so advises the driver to go to the YSZ. In the future situation the CommunicAid decides based on several factors which ED is the most eligible. In this case, the IKZ is suggested because Mr. de Groot is known in the IKZ. The ambulance nurse confirms this choice and the DRF shares from now on the filled in patient information and real time of arrival with the IKZ ED and the reporting room. This creates the opportunity for the ED nurses to anticipate for the arrival of the ambulance.

In the final stage of the current scenario can be seen that the ambulance arrives at the YSZ while two other ambulances already are waiting for patient transfer. The ambulance thus needs to join the waiting line. In the future situation the system takes into account the ED destination of other ambulances. This prevents long waiting lines. The information disappears from the Schipholbord as soon as the ambulance arrives.

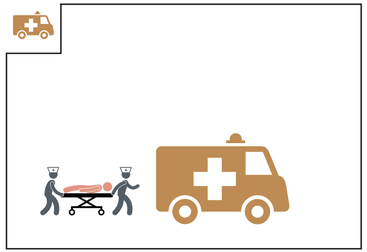
Next steps

After the scenario pages the validation of the concept can be found. This validation is done with all three parties; the ED, the ambulance and the reporting room.

CURRENT SCENARIO

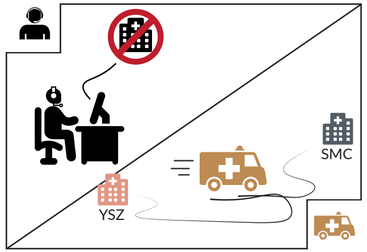


The ED at the SMC sets a patient stop by calling the reporting room. The reporting room employee documents this stop in the computer manually and sends a confirmation via email.

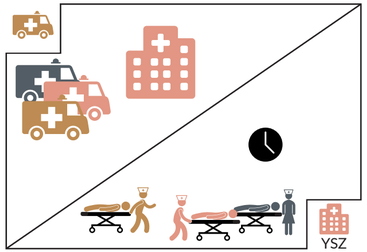


The ambulance picks up Mr. de Groot who needs to go to the ED.

While the ambulance is on its way to the SMC, the driver calls the reporting room to announce their destination.

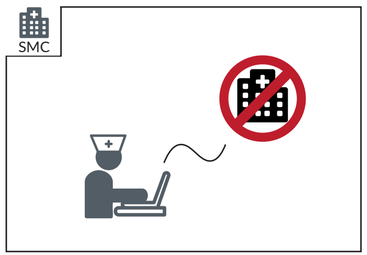


The reporting room employee sees the patient stop of the SMC in the system and suggests the driver to go to the YSZ.

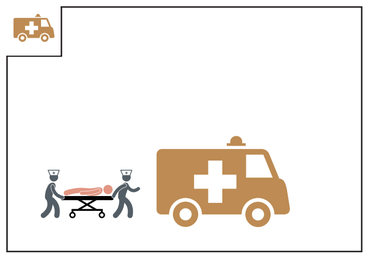


The ambulance arrives at the YSZ. Two other ambulances arrived earlier so Mr. de Groot needs to wait.

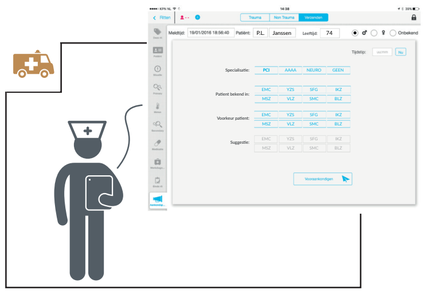
FUTURE SCENARIO



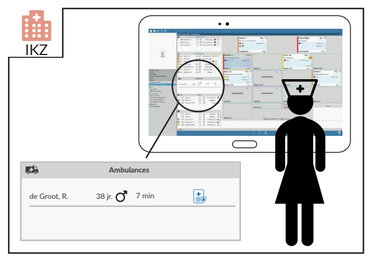
The ED at the SMC sets a patient stop and is therefore the upcoming hour not available in the DRF. The reporting room gets an announcement.



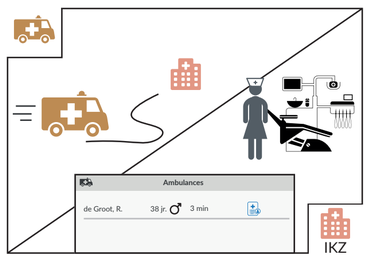
The ambulance picks up Mr. de Groot who needs to go to the ED.



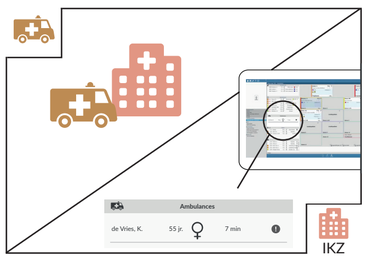
Before driving to the hospital the nurse selects the right fields in the patient announcement tab on the DRF. The system suggest to go to the IKZ because Mr. de Groot is known there. Other EDs without patient stops are also available. He chooses the IKZ and the system is activated.



From now on, the real arrival time of the ambulance is visible at the Schipholbord in the IKZ. Besides name, age and gender, the system also shows that mr. de Groot is known in the EMC, so his EPD is available.



The ambulance is on its way to the hospital while the ED nurse prepares for the arrival. When she is done, she sees that she still has 3 minutes left and decides to check the status of an other patient at the ED.



When the ambulance arrives at the ED the real time information disappears from the Schipholbord. In seven minutes, the next ambulance will arrive so another team needs to get ready to help Mrs. de Vries. Some information from the DRF is already available.

VALIDATION

Participants

To validate the concept, a user test is executed with the ED manager of the EMC, the ambulance team leader in Rotterdam, and the team leader of the reporting room of Rotterdam-Rijnmond (Figure 44) so a participant from all end user parties has been reached (Figure 45). All participants have leading positions, but are still working in the field as well.

Approach

The concept exists of several aspects. During validation the patient announcement function of the concept was tested via a simulation. This simulation is made with 'Invision app' (www.invisionapp.com) and shows the way the system thinks. The participants first got an explanation of the CommunicAid and then they needed to do three exercises. The explanation document and exercises (in Dutch) given to the participants can be found in Appendix H.

The exercises were done with the simulation on an iPad (Figure 46 on page 61, both photos). It investigated whether the working of the system is clear and the interface user friendly.

The Schipholbord was shown on a laptop screen to explain what happens when the patient announcement from the DRF is sent. After every exercise the corresponding Schipholbord information was shown to the participant.

Explaining both sides of the system to all participants is relevant to clearly explain how the system works.

LOCATION	DATE	EMPLOYMENT PARTICIPANT(S)	CONTACT VIA	USED METHOD
ED EMC	Jan 30th 2018	ED manager	ED team leader	user test for validation
Ambulance stand Rotterdam	Feb 1st 2018	Team manager ambulance care	previous contact	user test for validation
Reporting room Rotterdam	Feb 12th 2018	Team leader reporting room	previous contact	user test for validation

Figure 44. This overview shows information about the participants who helped the researcher during concept validation.

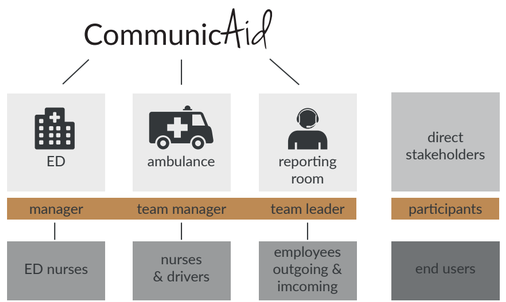
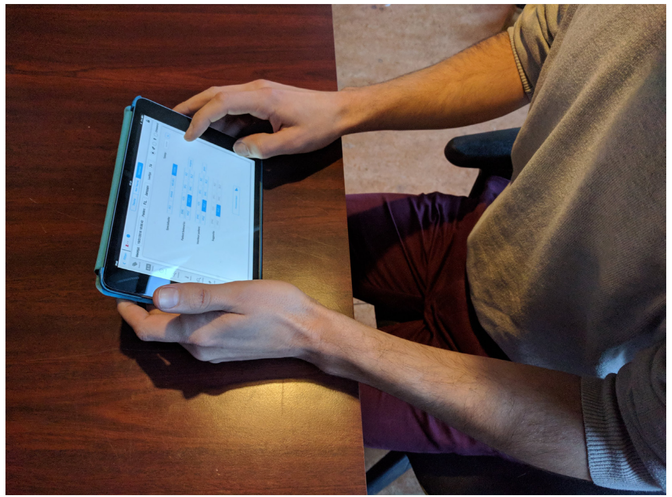


Figure 45. All participants have leading positions, bus are still working in the field as well.



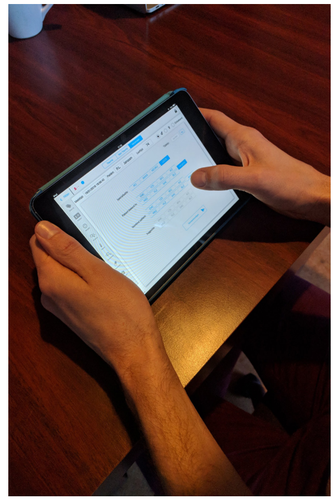


Figure 46. During validation, the concept for the new patient announcement was simulated via the 'Invision app'. As shown in these photos, the simulation imitates how the concept works. The participants did the exercises (Appendix H) via this simulation. The photos show different moments in the exercises.

Output ED side

The ED manager was very enthusiastic about the CommunicAid. He really sees the added value of the concept. *'Creating this insight at the ED will increase the efficiency enormously.'* The ED manager executed the assignments fluently and it seemed that he understood the way the system should work pretty well.

Receiving real time information

He was in doubt about the technical aspects of receiving real time information from ambulances. However, this is nothing to worry about these days, it was just a lack of knowledge on his side.

Automating measurements

Several machines at the ED are already linked to Hix. This way, the ED nurses do not have to put the measurements in the system themselves but it is documented in Hix automatically. For example, the dose of medication administered to the patient is documented automatically. There are plans to do something similar in the ambulance with the monitor and the DRF. This might be an interesting development for the concept and is discussed in the chapter "Recommendations" on page 86.

EPD security

If the EPD can be released directly when the Schipholbord shows that the patient is known in the certain hospital, needs to be checked with the security team. If not, an extra intermediate step is required. For this, further research is required.

Involving Chipsoft in the design

Another doubt was about the connection between the DRF and Hix. His advice was to discuss it with Chipsoft, the company that designed Hix. Creating the link will probably be the biggest expense. In the chapter "Partnership for CommunicAid implementation" on page 72 is Chipsoft discussed as a partner for VodafoneZiggo.

Suggestions for change

BSN number

In the concept the name, age and gender will be sent from the reporting room to the DRF. Instead of these data, the 'BSN number' or 'name and date of birth' are more accurate. With this information the ED can find out if the patient is known in the hospital or not. The participant also explained about 'Vecozo', via which a check on patients insurance is done to find out if an invoice can be sent. This is implemented in Hix and can also be used with the 'BSN number' or 'name and date of birth'. In Appendix I can be found an example of how the patient announcement might look when this change is processed.

Highlighting new module

To make ED nurses aware of the new information on the Schipholbord it might be good to highlight the new module (at least in the beginning). If adding a separate module for the arriving ambulances at the Schipholbord is not possible, the ambulance information can also be added to the heading 'announcements'. For this, further research is required.

Flashing new information

One last thought was to make the new appearing ambulances flash. However, it also need to stop at a certain moment otherwise there is too much chaos going on. This idea needs to be tested first.

'Creating this insight at the ED will ***increase the efficiency enormously****. Several changes might improve the concept. For example, receiving the BSN number of the patient from the reporting room would be more accurate.'*

Peter - ED manager

'Implementing the CommunicAid will definitely ***save time and reduce the work pressure*** *for reporting room employees. A suggestion for improvement is to add the option 'opvang nodig' to make sure that nurses at the ED are actively waiting for the patient.'*

Leo - Ambulance team manager

Output ambulance side

The same version of the concept (without improvements from the ED manager) was used during the validation with the ambulance team manager. The ambulance team manager was also very enthusiastic about the concept. According to him it will definitely save time and it will reduce the work pressure for reporting room employees. The ambulance team manager also executed the assignments fluently. He called the interface '*very user friendly and intuitive*'.

Who is responsible?

He was wondering who was going to control the system. Someone needs to keep the changes up to date.

The fact that the system automatically knows which hospital is responsible for PCI-, AAAA- and Neuro service seems very relevant as well. It saves a lot of time; calling to the reporting room is not necessary anymore. This would be a great addition to the DRF according to the ambulance team manager. But who is responsible? This is discussed in the "Societal impact of the CommunicAid in Rotterdam-Rijnmond" on page 70.

'Specialization patients' skip ED

A small detail he talked about is the specialization. When an ambulance transports a PCI-patient, this patient will skip the ED and will be brought to the CCU (Cardiac Care Unit) immediately. So these ambulances do not have to appear at the Schipholbord. The ambulance side of the system where the ambulance nurse indicates if specialization is required is still relevant to find out to which ED they can bring the patient.

Low effort ambulance nurse

He thinks that in contrast to the current patient announcement option, this new concept will definitely be used by the ambulance staff. Very low effort is required to do the patient announcement with the CommunicAid.

Linking data already works

Linking data (name and date of birth) from the reporting room is already working now so that will not cause problems. Besides this, it is nice that with this system the patient announcement information shared with the ED is also shared with the reporting room.

Suggestion for change

Transferring patient care directly

The ambulance team manager mentioned that it would be useful to add the option that indicates if it is necessary that the care for the patient is transfered directly (a check box 'opvang nodig'), which exists already in the current patient announcement. When checking this box, the ambulance staff can be assured that the ED nurses are actively waiting for them when they arrive. This might ask for an extra warning signal at the ED. In Appendix I is can be found an example of how the patient announcement might look when this change is processed.

Output reporting room

Again, the same version of the concept (without improvements from the ED manager and ambulance team manager) was used during the validation with the team leader of the reporting room. He understood how the system works and was impressed as well. *'In theory this concept works perfectly. However, we need to get all stakeholders on the same page to be able to implement such a system'.* This is discussed more extensively in the chapter "Constraints; dream vs. reality" on page 68.

Overlapping documentation

Currently if an ambulance nurse fills in patient information in the DRF, the reporting room employee has to repeat this action in a different system. The systems still do not talk with each other. This new concept will reduce the workload in the reporting room by creating communication links.

From verbal to digital

Letting the systems talk to each other is very important for the efficiency. At the moment all information is communicated to the reporting room verbally. Communicating this digitally would therefore not get in conflict with privacy issues. The information is shared anyway, so in what way this is done should not matter.

Checking in digitally

At the moment policemen can check in via their portophone. The difference with the ambulance service is that policemen have a personal portophone thus the system knows exactly who checked in. If the DRF can talk with GMS (gemeenschappelijk meldkamer systeem) the ambulance check-in would be a lot easier for both the ambulance and the reporting room. No more verbal communication is required then. This is a suggestion for a next improvement in the ambulance service with IoT.

Threshold

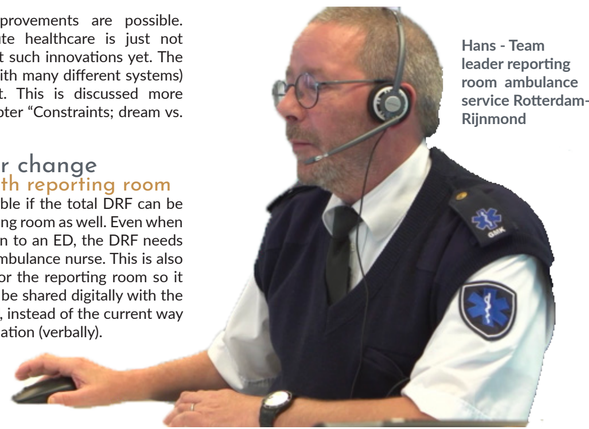
Technically these improvements are possible. However, in the acute healthcare is just not achieved to implement such innovations yet. The complexity (dealing with many different systems) makes it too difficult. This is discussed more extensively in the chapter "Constraints; dream vs. reality" on page 68.

Suggestion for change

Sharing DRF with reporting room

It would be very valuable if the total DRF can be shared with the reporting room as well. Even when the patient is not taken to an ED, the DRF needs to be filled in by the ambulance nurse. This is also relevant information for the reporting room so it would be nice if it can be shared digitally with the reporting room as well, instead of the current way of receiving the information (verbally).

'In theory this concept works perfectly. However, we need to ***get all stakeholders on the same page*** *to be able to implement such a system.'*



Hans - Team leader reporting room ambulance service Rotterdam-Rijnmond

Conclusion

Suggestions for change

During validation several suggestions for change came up. These are summed up shortly in this conclusion.

1. Instead of the 'name, age and gender' data, the 'BSN number' is more accurate to sent from the reporting room to the DRF. In Appendix I can be found how the patient announcement might look when this change is processed.

2. To make ED nurses aware of the new information on the Schipholbord it might be good to highlight the new module. Further research is required to find out if this will be useful.

3. Another thought was to make the new appearing ambulances flash. However, it also need to stop at a certain moment otherwise there is too much chaos going on. This needs to be tested first.

4. It would be useful to add the option to the DRF that indicates if it is necessary that the care for the patient is transfered directly. This way, the ambulance staff can be assured that ED nurses are actively waiting for them. In Appendix I is can be found how the patient announcement might look when this change is processed.

5. It would be very valuable if the total DRF can be shared with the reporting room as well. It includes is relevant information for the reporting room as well so it would be nice if it can be shared digitally.

Further research

Besides the suggestions for change, some aspects need further research. These are discussed in the chapter "Recommendations" on page 86.

Of course, further research costs money. How much it will cost needs to be figured out by the party who will take the lead in the process. More about this can be found in "Implementation", which is the next part of this report.

Constraints

Technically these improvements are possible, as the team leader of the reporting room acknowledged. However, in acute healthcare is just not achieved to implement such innovations yet. The complexity makes it difficult. This is discussed more extensively in the chapter "Constraints; dream vs. reality" on page 68.

Research question for this graduation project:

'How can VodafoneZiggo improve the ambulance service with IoT in the Netherlands?'

Subquestion 2:

'What IoT solution can solve the problems?'

This part of this project was about answering the subquestion 2 (in the brown block above). A concept design is developed and validated.

The problem statement was formulated as:

The collaboration between reporting room, ambulance staff and EDs is inefficient because:
1. ambulances have no direct insight in patient stops
2. the ED has no insight in arriving ambulances

The corresponding goal was:

Design an IoT based logistic concept that improves the collaboration between reporting room, ambulance staff, and EDs by giving the ambulance staff direct insight in patient stops and the EDs insight in arriving ambulances.

"CommunicAid"

AN IOT SOLUTION FOR THE AMBULANCE SERVICE

Answering subquestion 2

To achieve this goal the CommunicAid is developed. This system is based on the current used DRF. In this existing DRF the patient announcement function is not used because it takes too much time and the announcement is received by the secretary at the ED. It seems that it does not reach the right people.

The CommunicAid solves these problems; filling in the fields in the new patient announcement tab will take the ambulance nurse a few seconds and it decides which ED is most eligible to go to. The system takes into account several external factors as well, such as the patient stops set by EDs, the location of the ambulance, other ambulances on their way to an ED and which hospital is responsible for PCI-, AAAA- and neuro service at the moment. From the moment the ambulance nurse clicks 'vooraankondigen' the real time information will be shared with the eligible ED, as well as with the reporting room.

With the CommunicAid patient stops will be set via Hix on the computer at the ED. As soon as an ED does this, not only the reporting room gets this announcement but also the DRF notifies it and will make sure that the certain ED is not available anymore. One hour after setting the patient stop it will be canceled automatically so the ED becomes available again.

IoT is required for the information flows between the different devices. The ambulance needs to share real time information with EDs and the reporting room, and EDs needs to share patient stops with the DRF and the reporting room.

During validation several changes came up to improve the CommunicAid. In general, all three parties were very enthusiastic about the concept.

*'At the moment, the option to send a patient announcement to the ED is not used. **It takes too much time** to fill in all the fields. Besides this, when we send it, we **don't know if it will reach the right person.**'*

Sandra - team leader ambulance service Rotterdam-Rijnmond

Next steps

Subquestion 3 is 'what will be the societal impact of this solution if VodafoneZiggo implements it?' To answer this question the societal impact will be discussed and an implementation plan is created. A final question was 'is this solution scalable?'. The last part of the report also answers this question.

IMPLEMENTATION

This chapter starts with subquestion 3: 'what will be the societal impact of this solution if VodafoneZiggo implements it?' First some constraints are discussed. It seems too complex to implement the CommunicAid in all ambulance regions. Then the societal impact the CommunicAid can make is examined. A choice for partners for VodafoneZiggo, the important stakeholders, the financial support and launch strategy explain the relevant resources before implementation can happen. An answer to subquestion 3 concludes this part of the report.

CONSTRAINTS; DREAM VS. REALITY

Let's take a step back first; why is the acute healthcare still working this inefficiently? Why is something like the CommunicAid not implemented yet? Technically it is all possible but apparently something is standing in the way to make it happen. The researcher asked the three end users of the concept (ambulance, ED and reporting room) questions about this and this chapter includes the answers.

Reality

Parties work in different systems

At the moment all parties work in their own systems that are not able to 'talk' to each other. As simply visualized in Figure 47 (left side) the parties are documenting overlapping information in these three different systems (for example general patient information, situation description, condition of the patient, dosage of administered medication, etc.). This is on the one hand obviously inefficient, but makes it also very complicated to implement innovations in the acute healthcare sector. To make it even more complex, not only all parties work in different systems, also the systems differ per region. This makes it complicated, expensive and actually unrealistic to design a solution that fits every region, unless we start from scratch.

Lack of motivation

It also seems that there is a lack of motivation to take initiative. This might have to do with the fact that the healthcare sector is non profitable. If it were commercial there probably would have been a lot more drive to innovate and make sure that efficiency is achieved because making money is an incentive then. Thus in the healthcare sector the employees do not feel the responsibility to innovate, especially because it is so complex. To get everyone on the same page is already a challenge. 'Everyone' in this case includes the ambulance, the reporting room and the ED, but also the healthcare insurers (the ambulance service sector is financed by health insurers, more about this in the chapter "Financial support" on page 76) and any other party that might be involved. Strict regulations such as the privacy law are big barriers to start the healthcare sector move. These regulations limit the possibilities while in healthcare it is everyones intension to take the best care of people.

Commercial and competitive

The fire brigade in the Netherlands is covered by a ministry. Therefore, this is way better regulated according to the reporting room team leader. Every fire brigade in the Netherlands has the same principles. The ambulance service is commercial and competitive. This competition causes that the ambulance service does not use their budget effectively at all; in the chapter "Financial support" on page 76 is explained that each region gets a certain budget from the health insurers, based on their performance. The regions need to reinvent the wheel because they are not collaborating.

Who is responsible?

It is hard to say who is responsible for purchasing new software for improvement in the acute healthcare. Does the reporting room have to adapt to the ambulance or vice versa? Or is the ED the party that needs to adapt to the others? Or should they team up? For this last suggestion, motivation is probably again the threshold. This is discussed further in the report.

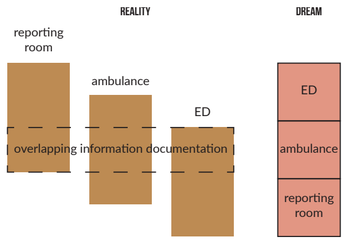


Figure 47. In reality there is overlapping information documentation because the parties work in different systems. The dream is that all parties work in the same system.

Dream

As simply visualized in Figure 47 on page 68 (right side) the dream future vision is having one perfectly working system all acute healthcare parties work with (maybe even the GP and other healthcare parties are involved as well), where every party has a certain level of access to the separate modules of the system. Different parties can add new information to the information that is already in the system. To achieve this, the system should be designed from scratch and be implemented in every region in the Netherlands.

Communication between hospitals should also be implemented in this system; it should be possible to easily look into EPDs of people who are known in other hospitals. For example, Peter broke his arm and in the IKZ (in Rotterdam) several pins are placed to keep everything in the right position. Peter is visiting family in Amsterdam and suddenly his arm hurts, so he visits a hospital in Amsterdam. It would be great if the nurses in Amsterdam can look into Peters EPD to find out what happened before.

CommunicAid as wake up call

The dream situation will not be achieved by implementing the CommunicAid. However, the system should be used as a wake up call: implementing it in the Rotterdam-Rijnmond region should prove that IoT indeed can improve the ambulance service in the Netherlands. Rotterdam-Rijnmond is the most logical choice, because the system is based on the field research where most elaborate research took place in this region.

The beginning of this chapter explained about several obstacles for innovation in the acute healthcare. One of the issues mentioned was the fact that all parties work in different systems. However, the CommunicAid is designed on the different systems that are used in Rotterdam-Rijnmond. Motivation is still an issue though. The next chapter elaborates on the motivational challenge. The competitive situation doesn't change just like that either. By using the CommunicAid as a wake up call, the competitive situation can be tackled. The results of the system need to be promoted in the Netherlands to get a step closer to the dream vision. More about this can be found in the chapter "Launch strategy" on page 78.

Designing the dream system is a very big project and probably takes a long time. The system should be thought through very well and built up from several modules so additional features can be added easily. All end users should be involved in the design phase to share their requirements and wishes.

Conclusion

At the moment, all parties in acute healthcare work in different systems that are not able to 'talk' to each other. Therefore it is hard to implement innovations in this sector. To make it even more complex, also the systems differ per region. Only starting from scratch might be a realistic way to design a solution that fits every region.

It also seems that people in the healthcare sector do not feel the responsibility to innovate, especially because it is so complex. To get everyone on the same page is already a challenge. Besides, the ambulance service is commercial and competitive. The regions are reinventing the wheel because they are not collaborating. Finally, it is very hard to say who is responsible for purchasing new software for improvement.

The dream vision is to have one perfectly working system all acute healthcare parties work with, where every party has a certain level of access to the separate modules of the system. This dream situation will not be achieved by implementing the CommunicAid. The system should be used as a wake up call, to prove that IoT indeed can improve the ambulance service in the Netherlands. The next chapter elaborates on the societal impact of the CommunicAid in Rotterdam-Rijnmond and the first steps to implementation are discussed.

SOCIETAL IMPACT OF THE COMMUNICAID IN ROTTERDAM-RIJNMOND

Objective

In the previous chapter was presumed that the CommunicAid needs to be implemented in the Rotterdam-Rijnmond region as a wake up call in the acute healthcare sector to prove that IoT can have positive impact on society. This corresponds to the fact that VodafoneZiggo wants to contribute positively to the Dutch society and the specific focus in this project on making social impact. Social impact is 'the effect of an activity on the community and well-being of individuals and families' (BusinessDictionarycom, 2017). It is hard to measure how big the social impact of the CommunicAid will be since there has not been done a substantiated pilot yet, but the plausible impact will be discussed in this chapter.

Impact on users

The CommunicAid system is not rocket science; no new technology is invented. It is a system that tracks vehicles real time and processes information to send it to the right party in this cohesion. However, implementing the CommunicAid probably can have positive impact on society: after field research it turned out that 'the simpler the interaction with the system, the better the user can work with it'. The ambulance staff and ED nurses are both dealing with unexpected situations. Therefore the systems they work with should be intuitive and take little effort. The CommunicAid meets these requirements and is able to improve the work flow of the users; with little effort from both the ambulance staff and ED nurses the collaboration between these parties improves. The system also takes away tasks from the reporting room employees.

During the field research and concept development the participants confirmed that the founded problems in collaboration were exactly the ones they are dealing with. For the ambulance nurses communication flows improve with the CommunicAid and the system can save time; when ED nurses are able to anticipate on the arrival of an ambulance it might prevent long waiting times. Therefore, efficiency can be increased. Being able to anticipate on what is going to happen can create rest at the ED.

For the reporting room employees on the outgoing side implementing the CommunicAid can also have positive impact by reducing their workload. Now, many actions are done manually. With the CommunicAid several of these actions are automated. The reporting room employees are still very relevant though. Many tasks are not automated with the concept; they still need to manage the distribution of the ambulances and give each ambulance the task to go to a certain accident (DIA).

Impact on patients

At the moment, it happens that ambulances arrive at the same moment at an ED. A queue of ambulance stretchers arises and the patients have to wait for an available room. The efficiency that will be achieved by the CommunicAid, makes that the ambulance patients do not have to wait (that long) anymore for an available room. This impact might not be mentioned by a patient. If one did not know about this inefficiency the patient will not mention the improvement. He probably expects it to be organized fluently; it is the acute healthcare.

The efficiency automatically makes sure that ambulance is available sooner for the next patient.

Direct or long term?

As earlier explained in the chapter "Creating societal impact" on page 18 activities can have direct impact, but can also have a long term effect (Social Impact Scotland, 2017). The CommunicAid has direct positive impact in Rotterdam-Rijnmond as soon as the system is implemented in this region. The system provides insights for the ED and ambulance staff with the result that their collaboration will be improved immediately.

The CommunicAid can also have long term positive impact in a certain way. The concept will be the start of a major change in acute healthcare as a wake up call.

Implementation

Motivation

In theory, implementing the CommunicAid will have positive social impact. However, in the previous chapter was mentioned that motivation was one of the key problems in innovation in the acute healthcare. People in this sector don't feel the responsibility to innovate. Motivation is needed from all parties to get it off the ground.

To encourage this motivation an independent party needs to manage the project and be the link between all parties an be 'the driving force of the project'. This can for instance be a design agency. This party can fully focus on this project. They can do further research, improve the concept and convince all parties to cooperate and invest. They need to connect all puzzle pieces and make sure the requirements of all different stakeholders are met. In the next chapter is written more about this.

ROAZ

Every region has a ROAZ (regionaal overleg acute zorg). The ROAZ is a consultation where the ambulance service and EDs communicate about the collaboration between the different parties. This should prevent that every party will solve problems on its own and make the region work the same. The ROAZ can be a good opportunity to motivate and persuade the end users to innovate in acute healthcare and provide the plan (namely implementing the CommunicAid) to do so since all end users are attending the ROAZ. More about this can be found in the next chapter as well.

Responsibility after implementation

As remarked by the ambulance team manager during validation, someone needs to control the system; he needs to keep changes up to date. These changes include updating the responsibility for PCI-, AAAA- and Neuro service.

This would not become a full time job. It seems most convenient if someone in the reporting room will be responsible for this. The reporting room employees keep the overview of the responsibility for PCI-, AAAA- and Neuro service already. The system will reduce work pressure in the reporting room. This new task won't outweigh the disappearing tasks.

Conclusion

It is hard to measure the social impact of the CommunicAid since there has not been done a substantiated pilot yet. However, this chapter explained that implementing the CommunicAid can have direct societal impact in the Rotterdam-Rijnmond. The CommunicAid has advantages for all users, patients probable won't mention the improvement.

Motivation is one of the key problems for innovation in acute healthcare. To encourage this motivation, for example a design agency needs to manage the project and be the link between all parties an be 'the driving force of the project'. The ROAZ meeting might be a good opportunity to motivate and persuade the end users about innovation with IoT in the acute healthcare.

After implementation, it seems most argumentative that someone in the reporting room needs to keep changes up to date, such as updating the responsibility for PCI-, AAAA- and Neuro service.

Impact of implementing the "CommunicAid"

Now	vs.	CommunicAid
Ambulance		
Can be rejected by ED, so does not call ED to announce arrival, to prevent this		*Fills in menu to decide on which ED they go to*
Calls reporting room to find out if a certain ED has set a patient stop		*Can see in the system which EDs are available and gets the most eligible ED suggested*
ED		
Stressful situations when ED is crowded and ambulances arrive without announcing		*ED nurses can anticipate on ambulances that are on their way*
Sets patient stop by calling the reporting room		*Sets patient stops digitally, communicating it to both the reporting room and the DRF*
Reporting room		
Processes patient stops manually and communicates them by portophone to the ambulance		*Gets a patient stop announcement which disappears automatically after one hour*
Is called by ambulances about the ED they go to and checks if there is no patient stop		*Gets an announcement about the ED the ambulance goes to*

PARTNERSHIP FOR COMMUNICAID IMPLEMENTATION

VodafoneZiggo's role

VodafoneZiggo is partnering with five cities in the Netherlands with the goal of making them smarter. This partnership makes VodafoneZiggo an argumentative party to provide the IoT-connections for this concept. (A) partner(s) need(s) to join in to develop and deliver the other technical aspects of the concept.

Design agency

This project has been executed on behalf of VodafoneZiggo. As explained, VodafoneZiggo is the company that will deliver the IoT-connections required for the system. However, if VodafoneZiggo wants to put the CommunicAid into practice, an advice is to involve a design agency in the process as 'the driving force of the project' (unless VodafoneZiggo has an in-house design team that can continue this project. But for now, this report talks about the external design agency). VodafoneZiggo is then the initiator of the CommunicAid, but the design agency will take the lead in managing the project and be the link between all parties. The design agency reports to VodafoneZiggo.

Current partners VodafoneZiggo

Several parties are considered as partners for this project since VodafoneZiggo will not build the concept. The researcher talked with a few experts from VodafoneZiggo in this area. These experts suggested several existing partners of the company.

First of all, HP (Hewlett-Packard) seemed an interesting partner. VodafoneZiggo and HP earlier did a project in the acute healthcare together. This project was about sharing patient information. Thus, for HP it should have been interesting if the concept was more focused on this aspect.

Flister is another partner of VodafoneZiggo. This company developed an application that warns car drivers for approaching ambulances. This company exists of only three employees so the task to develop the CommunicAid is probably too big and complex for Flister.

Ascom was mentioned by one of the VodafoneZiggo experts, but according to someone else this company is way too big and international for this project. Moreover, Ascom mainly focuses on screens and information provision within hospitals, so not on communication with external parties.

Companies responsible for currently used systems

Besides these existing partners from VodafoneZiggo in the healthcare industry, the companies that are currently responsible for the systems used in the acute healthcare industry might be even more interesting.

ENAI is a small Dutch company that develops and implements software together with partners that deliver services in the field of security, facility support and welfare (ENAI, 2018). This company is among other things responsible for the systems that are used in the reporting room.

NAVARA is a relatively small Dutch company that created the DRF the ambulance in Rotterdam-Rijnmond and 'Ambuview' which is used at the ED. NAVARA has the goal to improve healthcare process; make it more efficient, faster, more reliable, customer oriented and easier to control. It leads to process improvement, digitalization, communication and functionality. Within healthcare NAVARA is specialized in the domain 'acute healthcare', so the ambulance service, EDs and GPs (NAVARA, 2017).

Chipsoft created Hix, the program used in hospitals for all administrative tasks (Chipsoft.nl, 2018). This party is therefore also interesting to involve in the implementation. During the validation of the concept, the ED manager also advised to involve Chipsoft in the design to realize the connection between the DRF and Hix.

Involving the end users

Of course, the end users need to be involved in the design process as well. The design agency needs to connect all puzzle pieces to meet the requirements of all different stakeholders. This can be achieved by ascertain a group of people with a representative of each party (VodafoneZiggo, the partners, and the end users). These people together will be responsible for the decisions during the project. They need to get together once in a while to make sure the requirements of all parties are met.

As mentioned before, the ROAZ might be a good opportunity to motivate the end users about innovation. The goal in the ROAZ is to form a group of end users that will be involved in the project. VodafoneZiggo and the design agency can prepare this together.

Conclusion

VodafoneZiggo will deliver the IoT-connections that are required for the CommunicAid and an advice is to involve a design agency to take the lead in the project. This design agency reports to VodafoneZiggo since VodafoneZiggo is the initiator of the CommunicAid. Together, they need to convince the partners and end users to join in the project. More about this can be found in the chapter "Financial support" on page 76.

ENAI, NAVARA and Chipsoft developed the current used systems in Rotterdam-Rijnmond. Because the implementation of the CommunicAid will only take place in this region, these parties seem to be the most optimal partners for this project. These companies are responsible for what is used now so that is a good fundamental to build upon.

Figure 48 shows the structure of how the partners are in relation to each other; VodafoneZiggo is the initiator and therefore on top of the pyramid. The design agency manages the project and reports to VodafoneZiggo. VodafoneZiggo is also placed on the same level as ENAI, Chipsoft and NAVARA as supplier of the IoT-connections. The end users need to be involved in the process.

The next chapter is about the stakeholders of the ambulance service in the Netherlands. This information is relevant for the subsequent chapters where the financial support and the launch strategy are discussed.

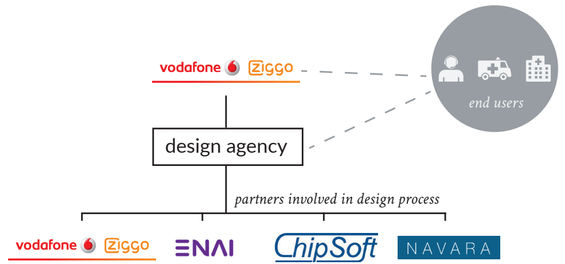


Figure 48. Choice of partners to implement the CommunicAid in the Rotterdam-Rijnmond region.

STAKEHOLDERS OF THE AMBULANCE SERVICE

Before explaining the financial support and the launch strategy, it is important to dive into the complex web of stakeholders of the ambulance service (Figure 49 on page 75).

Someone who is in need of an ambulance is an important stakeholder of the ambulance service. This can be anyone, including the general practitioner (GP) or an obstetrician (calling for their patients). For 112 callers the ambulance service is in the emergency situation the first contact with medical service. This contact is with the reporting room, which is part of the ambulance service. During this first contact it is important to make the patient feel comfortable.

A patient is the most important direct stakeholder of the ambulance service. Patients are the people the service is about. The patient is linked to the one who calls 112, to the ambulance staff (nurse and driver) and to the ED.

The ED as the location to bring the patient to is a direct stakeholder as well. The communication with this party is important to make the process fluently.

In the Netherlands 25 RAVs ('regionale ambulancevoorziening') are working as separate businesses. An RAV is the cooperation between the ambulance service and the ambulance reporting room in a region. The RAV 'AmbulanceZorg Rotterdam-Rijnmond' is a direct stakeholder because the CommunicAid will be implemented here. The AZN is the umbrella organization that connects the RAVs and is therefore good to keep in mind as well. Especially when thinking about the future dream vision where all parties work in the same system.

As mentioned earlier, every region has a ROAZ (regionaal overleg acute zorg). In the ROAZ, healthcare providers work together to improve acute care and make it accessible (Lnaz.nl, n.d.). This should prevent that each party will solve problems on its own and make the region work the same. The parties who attend the ROAZ are hospitals, ambulance service, general practitioners, GGZ, GHOR (Geneeskundige Hulpverleningsorganisatie in de regio) and obstetricians in the certain region. Healthcare insurers and the ROAZ are together working on improvement of information provision.

The ambulance service sector is financed by health insurers. They buy ambulance service for their insured people and give advice to the Dutch ministry of health (VWS) in granting ambulance services licenses. The ministry of health determines the available macro budget for the ambulance service, the number of vehicles and the dispersion of the vehicle stands (Langejan, 2013).

The NZa (Nederlandse Zorgautoriteit) has the task to create a balanced healthcare market and keep it that way. This means that the NZa keeps an eye on healthcare insurers and -providers. They determine rules, budgets and prices for the regulated healthcare industry (Regionaal Ambulance Plan, 2012). The NZa recommends using smart technology as IoT to improve the information provision in acute healthcare. Healthcare insurers and the ROAZ are the primary parties to achieve this (Marktscan acute zorg, 2017). The NZa might be the party that can change the regulations in such way that it once becomes possible to implement the dream vision where all parties work in the same system.

NAVARA, Chipsoft and ENAI are the parties that are responsible for Ambuview, the DRF, Hix and the reporting room system. These stakeholders are also the partners for VodafoneZiggo that will develop the new concept.

After this project, VodafoneZiggo and a to be determined design agency might become important stakeholders for the ambulance service in the Netherlands. The required IoT- connections for the application which makes the ambulance service in the Rotterdam-Rijnmond region more efficient will be provided by VodafoneZiggo. The design agency will manage the project.

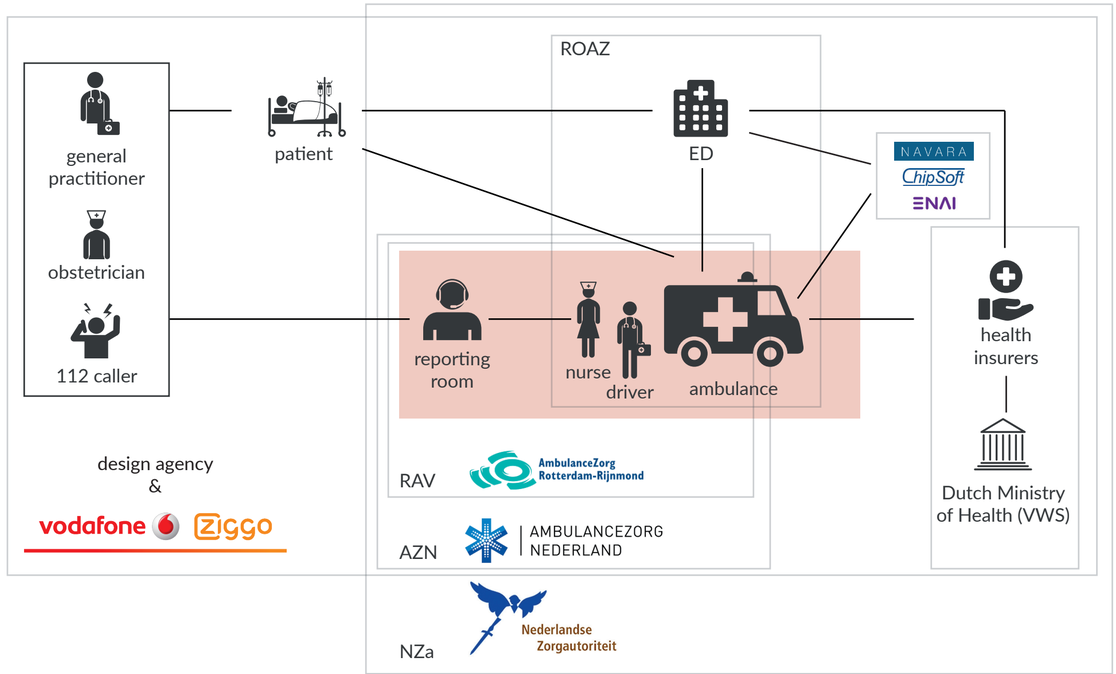


Figure 49. Stakeholders of the ambulance service in the Netherlands.

FINANCIAL SUPPORT

This chapter explains how the system should be financed by the ambulance and reporting room on the one hand, and the ED on the other hand.

As mentioned in the chapter "Constraints; dream vs. reality" on page 68, it is hard to say who is responsible for purchasing new software for improvement. A design agency will take the lead in developing and implementing the concept together with the partners. However, they are not paying of course. Each profiting party (the end users) should invest a share in the CommunicAid. This is explained in the following sub headers.

Ambulance and reporting room

From January 2018 19.2 million euro extra is available for the ambulance service. The extra money is meant for revised labor costs (13.5 million) and more ambulance rides (5.7 million) (Nza.nl, 2017). The CommunicAid will make more ambulance rides possible because fewer delays at the ED will occur with this system.

The ambulance service sector including the reporting room, is financed by healthcare insurers. Based on the performance of the ambulance regions a certain amount of money is supplied per region. The barriers and accessibility of the acute care are only measured in response time of ambulances, and patient stops in hospitals (Marktscan acute zorg, 2017).

Thus, the healthcare insurers are responsible for financing the ambulance service and the share each region gets depends on the performance. In this case, only the Rotterdam-Rijnmond region is going to implement the CommunicAid, so only (a part of) the share of money from the healthcare insurers of this region is available.

By investing in the CommunicAid, the information provision in the acute healthcare in the Rotterdam-Rijnmond region will improve. The different parties will be better informed about each others status which improves their collaboration. Efficiency will be achieved and therefore time will be saved. The effect is that the performance will improve. This is a realistic start of an innovative improvement in collaboration in healthcare.

EDs

Not only the ambulance service needs to invest in the implementation of the CommunicAid. Also the EDs have their share. The EDs are separate parties with their own budget. The EDs of all hospitals in the Rotterdam-Rijnmond region should invest a bit. It might be a challenge to convince them all.

Convincing the parties

VodafoneZiggo and the design agency need to convince the Rotterdam-Rijnmond ambulance service and the EDs to invest in the CommunicAid. This is an important part of the persuading during the ROAZ. This can be achieved by explaining the added value of IoT in the acute healthcare sector extensively. Examples of earlier IoT innovations and the concept of the CommunicAid need to be explained, together with the benefits. Besides, a clear financial overview needs to be made up first.

Costs

Research is done to estimate the order size of the costs for implementing the CommunicAid. Several costs need to be taken into account; prototyping, development, the IoT infrastructure, the software that receives and analyzes data, and the changes that need to be made in the current used systems. According to Klubnikin (2016) IoT software development for a 'medium project' costs around thirty-five thousand dollar (twenty-five thousand euros). It is hard to make an estimation but this project might be comparable with a 'medium project'. Software development costs are only a tip of the iceberg. The conclusion is that a simple IoT project costs at least fifty thousand dollar (Klubnikin, 2016).

How much the total project will costs is hard to say. It is recommended to make up a financial overview beforehand.

Ready business

As earlier explained, the biggest expectation for organizations is to improve efficiency by using IoT. The most commonly seen benefits of implementing IoT are consequently better business insights, reduced costs, and improved employee productivity (Vodafone IoT Barometer 2017/18, 2017). Implementing this system will be an investment that achieves efficiency and finally reduces costs; the ambulance service is able to become a ready business this way.

Conclusion

The design agency will be the connecting party in the project. This party and the partners are not paying for the CommunicAid. Each profiting party (the end users) should invest a share in the CommunicAid. This means that the ambulance service and reporting room should invest a part of the budget they get from the healthcare insurers and the EDs the other part. In what proportion this will be distributed should be investigated by making a financial overview.

The ROAZ might be a good opportunity to convince the profiting parties about innovating in acute healthcare, because all end users are attending the ROAZ.

The order size of an IoT project like this seems achievable. Implementing the CommunicAid will bring the acute healthcare one step closer to becoming a ready business.

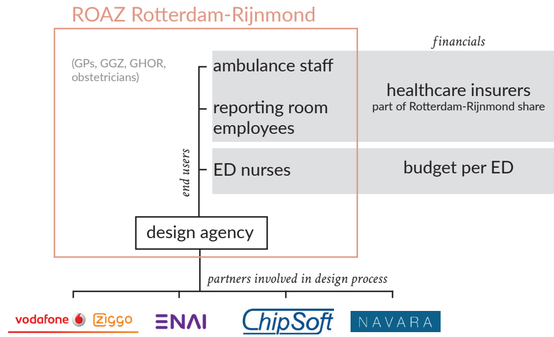


Figure 50. Overview of all involved parties. The design agency is the party that connects all stakeholders. The end users are paying for the CommunicAid.

LAUNCH STRATEGY

Many steps go in advance before the 'dream vision' described on page 69 is achieved. This chapter mainly explains the implementation of the CommunicAid in the Rotterdam-Rijnmond region. This can immediately start after this thesis. The roadmap (Kerr & Phaal, 2015) on page 79 will support this chapter visually to show the steps for implementation of the CommunicAid and roughly the steps to finally fulfill the dream vision. A timeline is placed on the top of the visual to indicate the timespan. A few relevant trends are indicated in the roadmap. Elaborate information about these, and more trends can be found in Appendix J.

Parties on the same page

The first step for VodafoneZiggo should be finding a design agency, followed by accomplishing the partnerships with ENAI, Chipsoft and NAVARA, and pitching the concept in the ROAZ to convince all end users. This convincing needs to be done by explaining the added value of IoT in the acute healthcare sector extensively and the concept of the CommunicAid. A team of people needs to be formed with a representative of each party to make sure all parties have their share in the project.

When all parties are on the same page, the extended user tests can be prepared and executed. First, the concept (and thus the test) should be adjusted based on the validation during this project and afterwards, the test needs to be done with more users to make sure the outcome is valid. Based on these user tests the system development can start. The outcome of the user tests will be applied to the concept. Then, a prototype of the system can be designed, created and tested.

Rotterdam-Rijnmond

Every ambulance region works differently. Rotterdam-Rijnmond is the region where most insights are gathered, and thus a realistic picture of the process is formed. The CommunicAid is mainly based on the findings in the Rotterdam-Rijnmond region. The pilot should therefore be done in this region to finally implement the system here as well.

Introducing the CommunicAid

Before starting a pilot with the prototype the CommunicAid should be introduced to all users (ambulance staff, nurses working at the EDs in all hospitals in Rotterdam-Rijnmond and the reporting room employees in Rotterdam). This can be done by giving a one time workshop to explain the added value of the system and explain how it works. These workshops should be adjusted per party because they all need to operate with another part of the system, but all parties should be informed about the whole system to understand the added value for the total acute healthcare chain.

The organization around the workshop should be thought through very well because the ambulance service, reporting room employment and ED need to be available 24/7. Therefore, the workshop for each party should be offered at least twice. The design agency will be responsible.

Pilot

In the beginning of 2019 the pilot in Rotterdam-Rijnmond should start. For the pilot, the working prototype will be used. Via this pilot more extensive user research can be done. This user research will be more valid than the user research during this thesis project because it can be executed with an actual working system with more participants. After a few months of use, a moment of reflection can deliver feedback on the system. If needed, more improvements can be done to finally implement the final version of the CommunicAid in Rotterdam-Rijnmond at the end of that year.

Future plans

To persevere the innovations in acute healthcare, the pink blocks are added in the roadmap. It all starts with promoting the results of the CommunicAid nationwide. This should encourage the motivation of all acute healthcare parties to apply IoT. The promotion should go hand in hand with presenting a plan to develop the dream system. The NZa is an important target as the party that might be able to change the regulations in such way that it once becomes possible to implement the dream vision. Also the AZN is an important target audience since this party can reach all RAVs.

Developing one system for all acute healthcare parties would be a major improvement in communication flows, collaboration and documentation and is the dream vision. This will probably take much more time to develop because this system should be designed from scratch. The development of this 'dream system' might take 2 to 3 years. Then, investment for the system needs to be arranged. This might be an issue because of the complex structure of involved parties and benefiting parties. The system needs to be tested, (eventually) improved and implemented. The expectation is that this takes another 2 to 3 years.

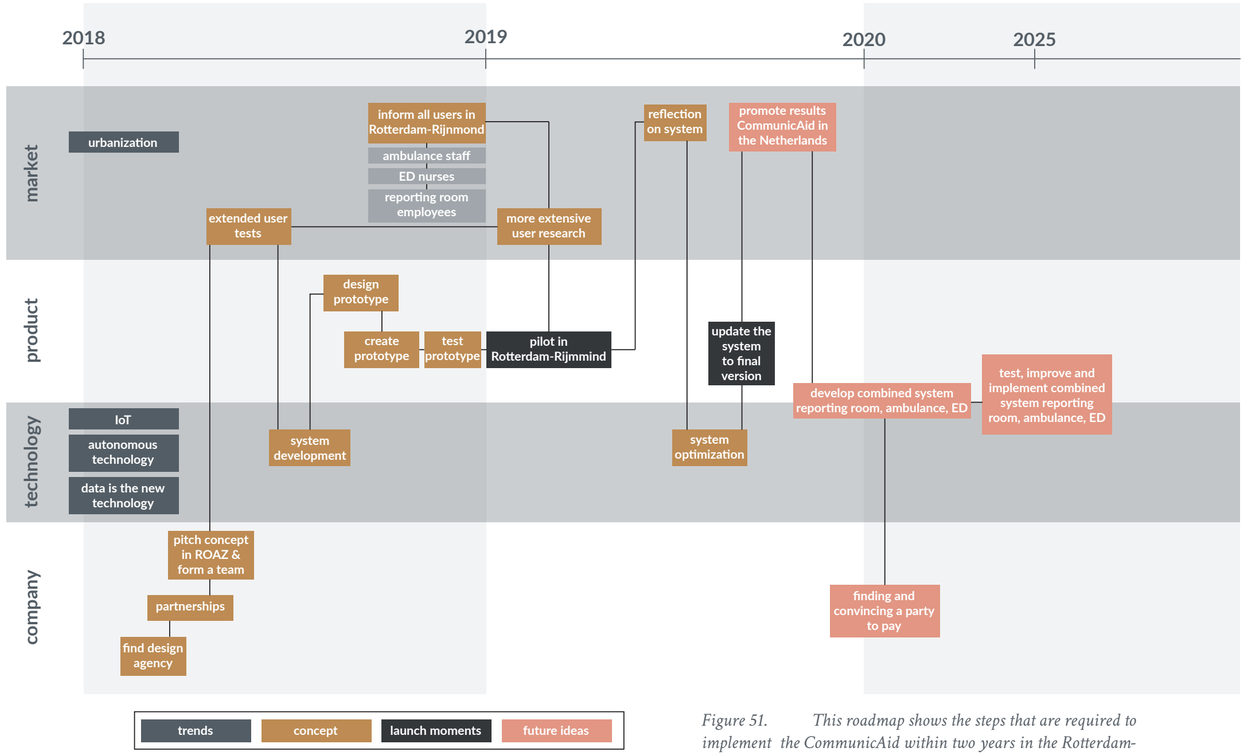


Figure 51. This roadmap shows the steps that are required to implement the CommunicAid within two years in the Rotterdam-Rijnmond region and the follow up steps to work upon the future dream vision to develop one system all parties work with.

Research question for this graduation project:

'How can VodafoneZiggo improve the ambulance service with IoT in the Netherlands?'

Subquestion 3:

'What will be the societal impact of this solution if VodafoneZiggo implements it?'

In the previous part of the report was presumed that the CommunicAid is the IoT solution for the problems in ambulance care. However, implementing the system brings some complications with it. If we compare the dream and the reality, the following constraints have been found: the dream is *'having one perfectly working system all acute healthcare parties work with where every party has a certain level of access to the separate modules of the system'*. In reality however, there is a lack of motivation to take initiative. People in the healthcare sector do not feel the responsibility to innovate. The ambulance service is commercial and competitive. All parties work in their own systems that are not able to 'talk' to each other. This makes it hard to come a step closer to the dream. To make it even more complex, not only all parties work in different systems, also the systems differ between regions. This makes it complicated, expensive and actually unrealistic to design a solution that fits every region, unless we start from scratch.

IMPLEMENTING THE COMMUNICAID

Answering subquestion 3

The final subquestion can be answered:

'Is the solution scalable?'

The CommunicAid should be used as a wake up call. Implementing the system in the Rotterdam-Rijnmond region should prove that IoT indeed can improve the ambulance service in the Netherlands. Rotterdam-Rijnmond is chosen because the system is designed based on the field research where most elaborate research took place in this region. We can assume that the solution is not scalable.

Societal impact

The societal impact of implementing the CommunicAid in the Rotterdam-Rijnmond region will be direct and positive. For the ambulance nurses communication flows improve with the CommunicAid and the system can save time; when ED nurses are able to anticipate on the arrival of an ambulance it might prevent long waiting times. Being able to anticipate on what is going to happen can create rest at the ED. For the reporting room employees implementing the CommunicAid will reduce their workload.

Partnerships & investment

VodafoneZiggo will deliver the IoT-connections required for the system. An advice is to involve a design agency in the design process as 'the driving force of the project'. Next to that, VodafoneZiggo should partner up with ENAI, NAVARA and Chipsoft. These parties seem to be the most optimal partners for this project because they developed the current used systems in Rotterdam-Rijnmond.

Each profiting party should invest a share in the CommunicAid. This means that the ambulance service and reporting room should invest a part of the budget they get from the healthcare insurers and the EDs the other part. Of course they need to be involved in the design process as well. The design agency thus needs to ascertain a group of people with a representative of each party (the partners, and the end users). The ROAZ meeting might be a good opportunity to motivate the end users about innovation with IoT in the acute healthcare.

*'The ambulance service is too **commercial and competitive**. This has led to the fact that every region is working totally different. Implementing one concept everywhere is not possible anymore.'*

Sandra - team leader ambulance service Rotterdam-Rijnmond

CONCLUSION

Since all subquestions are answered now, the final part of the report is concluding the project. It includes a discussion, which states the limitations and implications of the project. Then a conclusion of the total graduation work, the future recommendations and a personal reflection are finalizing this report.

DISCUSSION

Limitations

Few ambulance regions

The field research only has been executed in a few ambulance regions, and the elaborate research only in one region (Rotterdam-Rijnmond). This can be seen as a limitation, especially because all ambulance regions work differently. Most societal impact could be made when the system can be implemented in all regions, preferably as a module of a larger system to harmonize the operations in acute healthcare in the Netherlands. With the executed research cannot be ensured that the system is applicable for all ambulance regions. In the implementation part of this report is explained that the system therefore only will be implemented in one region and should work as a wake up call in the acute healthcare.

Qualitative research only

The research that has been done was only qualitative. To make sure that the findings are valid, quantitative research might have been helpful. This applies for the field research, but also for the concept validation.

Validation

The next limitation in this project is the way of validating the concept. The researcher was, except for the simulation of the DRF, out of reach of making a working prototype. This leads to the fact that the validation of the concept might be questionable. In the chapter “Recommendations” on page 86 is elaborated on an advice for validation.

Approaching suggested partners

It would have been useful to approach the suggested partners, to validate that this suggestion is realistic.

Problem selection

At the end of the field research, three problems were evaluated relative to each other on two aspects; the problem size and the societal impact that is created, and the relevance for VodafoneZiggo. This evaluation might be doubtful. The evaluation is done by logical reasoning, but no further research has been done to find out if the claims are really true.

Time

The limitations mentioned earlier are among other things caused by the time limitation of six months. When more time was taken for this project, for example deeper research or more extensive user tests could have been done.

Concept development phase

The concept development phase started with only one idea that has been developed into the final concept. This might have been a limitation. However, developing the idea was an iterative process so lots of improvements have been applied since the first idea.

During this phase, no input from other people was asked. It might have been helpful to do so. A clear mind of someone else could have added creative aspects to the system.

Convincing end users to invest

As mentioned in the chapter “Financial support” on page 76, it will be a challenge to convince all EDs to invest in the CommunicAid. This also goes for the ambulance service, since the CommunicAid will be implemented as a wake up call in the acute healthcare. It will have direct positive impact in the region, but it is a major project and investment, knowing that a few years later the dream vision might be achieved and thus the CommunicAid won’t be used anymore. The fact that the system can improve the performance and therefore can increase the budget from the healthcare insurers, is not an incentive anymore if the higher goal is to work together nationwide with one dream system and thus one budget. It depends on the size of the investment if it will be reasonable to convince the parties to invest. Besides, it is all about the right mindset.

Use of VodafoneZiggo knowledge

A benefit from doing a graduation project for a company is having access to internal knowledge and experts. During this project, not many of these experts are consulted. This might have been a limitation; if more experts were approached, more of the internal resources might have been used to bring the concept to a higher level.

Implications for..

VodafoneZiggo

For VodafoneZiggo this project probably will not become a business case. The problem is that the ambulance service in the Netherlands is very complex; every region works differently and they all use different systems and devices. The concept fits one ambulance region now. It will be relatively a big project for VodafoneZiggo in relation to the impact it can make. However, this research can be used in B2B marketing as an example case to show what impact IoT can make on society.

Acute healthcare

For the acute healthcare the effect of this project depends on their own initiative. During the field research and concept validation all participants were positively surprised and definitely interested in the solution. However, this project ends here for the researcher and thus the acute healthcare employees should take initiative themselves. At least, this project made them realize again that the current way of working is not optimal.

Further research

The limitations and implications can be resolved by doing further research in the future. What kind of steps this further research includes can be found in the chapter “Recommendations” on page 86.

CONCLUSION

Despite of the limitations and implications mentioned in the discussion, a conclusion can be drawn. This graduation project started with the question 'what is the impact of IoT on society?' This very broad topic is narrowed down to the goal to improve the ambulance service with VodafoneZiggo's IoT. The project was divided in three subquestions. The answers on these can be found in short in this chapter.

1. What is the current situation for ambulance service in the Netherlands?

At the moment, emergency services often arrive too late. Only one out of three ambulances succeeds in meeting the standard (Nos.nl, 2017). The arrival time depends on several steps in the process. There is a challenge in the end of the process where the collaboration between ambulances, the reporting room and EDs can be improved. The focus in this project is on the following two problems found in the field research: ambulances have no direct insight in patient stops and the ED has no insight in arriving ambulances. To solve these problems, the goal is formulated as:

Design an IoT based logistic concept that improves the collaboration between reporting room, ambulance staff, and EDs by giving the ambulance staff direct insight in patient stops and the EDs insight in arriving ambulances.

2. What IoT solution can solve the problems?

The CommunicAid is an IoT based system that improves the communication between the ambulance, the ED and the reporting room. Figure 52 shows in one overview the main characteristics of the concept. The concept is based on the current used DRF. In this DRF the patient announcement function is not used because it takes too much time. Besides this, the patient announcement is received by the secretary at the ED. It seems that it does reach the right person.

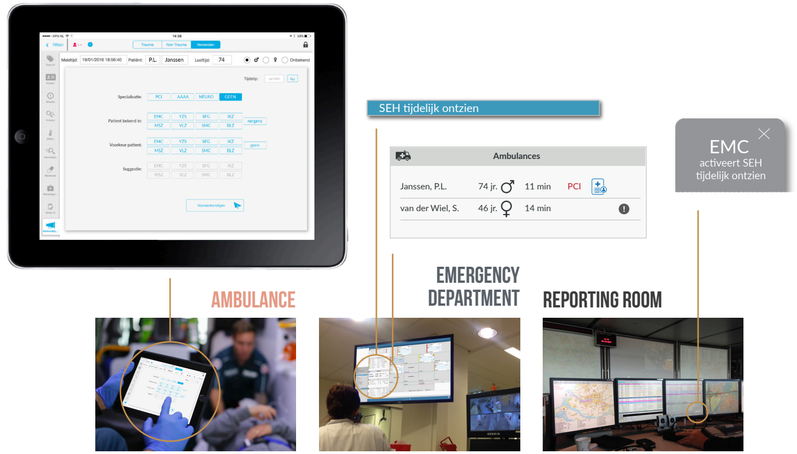


Figure 52. The main characteristics of the concept for each of the involved parties. The systems communicate with each other to improve the collaboration.

With the CommunicAid, the ambulance nurse fills in several fields in the new patient announcement tab which takes only a few seconds. Based on this and several external factors the system decides which ED is most eligible. These external factors are the patient stops set by EDs, the current location of the ambulance, other ambulances on their way to an ED and which hospital is responsible for PCI-, AAAA- and neuro service at the moment. From the moment the ambulance nurse clicks 'vooraankondigen', the real time information will be shared with the eligible ED and the reporting room.

With the CommunicAid, patient stops will be set digitally in Hix on the computer at the ED. As soon as an ED does this, the reporting room gets an announcement and the DRF notifies it and will make sure that the certain hospital is not available anymore. One hour after setting the patient stop it will be canceled automatically, so the ED becomes available again.

IoT is required for the information flows between the different devices. The ambulance needs to share real time information with the ED and the reporting room, and the ED needs to share the patient stops with the DRF and the reporting room.

3. What will be the societal impact of this solution if VodafoneZiggo implements it?

Implementing the system brings some complications with it. In the healthcare sector is a lack of motivation to take initiative. The ambulance service is commercial and competitive. All parties work in their own systems that are not able to 'talk' to each other. To make it even more complex, not only all parties work in different systems, also the systems differ between regions. This makes it complicated, expensive and actually unrealistic to design a solution that fits every region, unless we start from scratch. The final subquestion can be answered:

'Is the solution scalable?'

The system should be used as a wake up call. Implementing the CommunicAid in the Rotterdam-Rijnmond region should prove that IoT indeed can improve the ambulance service in the Netherlands. Rotterdam-Rijnmond is chosen because the system is designed based on the field research, where most elaborate research took place in this region. We can assume that the solution is not scalable.

The societal impact of implementing the CommunicAid in the Rotterdam-Rijnmond region will be direct and positive. For the ambulance nurses communication flows improve with the CommunicAid and the system can save time; when ED nurses can anticipate on the arrival of an ambulance, it might prevent long waiting times. Being able to anticipate on what is going to happen can create rest at the ED. For the reporting room employees implementing the CommunicAid will reduce their workload.

VodafoneZiggo will deliver the IoT-connections required for the system. An advice is to involve a design agency in the design process as 'the driving force of the project'. Next to that, VodafoneZiggo should partner up with ENAI, NAVARA and Chipsoft. These parties seem to be the most optimal partners for this project because they developed the current used systems in Rotterdam-Rijnmond.

Each profiting party should invest a share in the CommunicAid. This means that the ambulance service and reporting room should invest a part of the budget they get from the healthcare insurers and the EDs the other part. Of course they need to be involved in the design process as well. The design agency thus needs to ascertain a group of people with a representative of each party (the partners, and the end users). The ROAZ meeting might be a good opportunity to motivate the end users about innovation with IoT in the acute healthcare.

Final conclusion

This study shows that there are many inefficiencies in the ambulance service in the Netherlands which create a huge amount of possibilities for improvement. However, the problem in the acute healthcare sector is that all parties work in different systems and even the systems differ between regions. This makes it complicated, expensive and actually unrealistic to design a solution that fits every region, unless we start from scratch. The main question was:

'How can VodafoneZiggo improve the ambulance services with IoT in the Netherlands?'

The CommunicAid should work as a wake up call to prove that IoT indeed can improve the ambulance service in the Netherlands by integrating the systems. It should be the start of a major change in the acute healthcare. An important future goal should be to harmonize the operations in acute healthcare in all regions for all involved parties.

VodafoneZiggo can start this big improvement in the ambulance service by supplying the IoT-connections required for the implementation of the CommunicAid.

RECOMMENDATIONS

The goal of this thesis was to improve the ambulance service in the Netherlands with VodafoneZiggo's IoT. After analyzing VodafoneZiggo, reading literature, diving into the context, learning about the people in that context, developing a concept, validating it with the users, and making an implementation plan, a conclusion was drawn in the previous chapter. However, there is still room for further development, improvement and future research. This chapter includes recommendations for several parties based on all insights gained in this project.

Design changes

After validation it turned out that several changes in the design might improve the system. The first recommendation is to change the patient information that will be sent by the reporting room to the DRF (age and gender) to the BSN number of the patient.

Another easy but relevant change is to add the function 'opvang nodig' to the DRF so the ambulance nurse can communicate that he/she expects that the patient care can be transfered directly.

Finally, in the beginning the new ambulance module in the Schipholbord should stand out, so highlighting it might be useful. How this will be done exactly, needs to be investigated first.

It is a recommendation to put these changes in the concept.

Concept validation

The concept needs to be validated more. This can be done via more extensive user tests with a working prototype, as described in the chapter "Launch strategy" on page 78. First, the concept (and therefore the test) should be adjusted based on the validation during this project (the design changes mentioned before need to be processed and tested) and the test needs to be done with more users to make sure the outcome is valid.

Further research

Further research can bring the concept to a higher level. For example, extended research should be done in other hospitals than the EMC. It must be identified for example if each ED uses Hix and has a Schipholbord. If not, then even implementing the system on a small scale brings implications.

During validation, several aspects for further research came up. It needs to be investigated if adding a new module to Hix is possible. If not, the arriving ambulances should be added to the heading 'announcements'.

If the EPD can be released directly when the Schipholbord shows that the patient is known in the certain hospital needs to be checked with the security team. If not, an extra intermediate step is required. For this, further research is required.

More research is recommended to find out if it is a good idea to let new information about an arriving ambulance blink or not. It might become chaotic.

As mentioned as limitation in the chapter "Discussion" on page 82 only qualitative research is done. In future, quantitative research is recommended as well to make sure that the findings are valid in a broader range.

Another recommendation is to extensively research the current DRF. During field research was found that the ED does not look into the DRF at all. Maybe the DRF should get a new function, in such a way that the ambulance nurses do not feel like they waste time by filling it in.

Of course, further research costs money. How much it will cost needs to be figured out first. A financial overview needs to be made up, together with the knowledge of all involved parties.

Future developments

A future version of the system might take into account more (external) factors, for example the amount clinical beds available in hospitals. If the ambulance staff can estimate if a clinical bed is needed, the system can also take this into account. This way, the system can make even a better estimation of the most optimal hospital. However, the list of fields in the patient announcement tab of the DRF should not take too much time.

During validation, the ED manager talked about the fact that several machines at the ED are already linked to Hix. This way, the ED nurses do not have to put the measurements in the system manually but it is documented in Hix automatically. This might be an interesting aspect for the ambulance as well. When this is applied to the monitor, it can send its measurements immediately to the DRF, which saves time for the ambulance nurse when filling in the DRF.

Voice recognition might play a role in a future version of the system. Another interesting feature is making the system self-learning. For example, when a patient already had an ambulance ride, the system recognizes him and can fill in several fields beforehand. The system knows in which hospital the patient is known and his history.

Collaboration ambulance regions

There are already less ambulance regions and this number is still decreasing. Also, several regions work a bit together and 'lend' each others ambulances. However, it is a fact that the regions all work their own way with their own manners and their own systems. For example, the DRF differs per region; in Rotterdam-Rijnmond an iPad is used to document the information in the DRF and it is sent as a PDF to the hospital. In Zuid-Holland zuid the laptop in the vehicle is used for this, they print out the file in the ambulance and the hospital needs to scan it to make it digital again. If they do not work together as a team each region needs to reinvent the wheel. This is also the reason that the CommunicAid cannot be implemented in every region. Competition in this section should not be necessary, they all have the same goal; saving lives. A recommendation to the ambulance regions is thus to collaborate more. Working together with the same (most optimal) system(s) should improve the (efficiency in) the ambulance service.

Collaboration between parties

Not only the different ambulance regions should collaborate more, also the different parties (ambulance, reporting room and EDs) should. All parties now use different systems. This is inefficient because much information is documented more than once and communicated inefficient. When the different parties will work together as a team and use the same system they can add on each others information in one patient file. Every party should get adjusted access to a certain part of the system, so privacy will not be an issue. Maybe even general practitioners or home carers can have (limited) access to the same system to improve the collaboration in the total healthcare. The recommendation is to work upon the dream vision as described in the chapter "Constraints; dream vs. reality" on page 68.

VodafoneZiggo

A recommendation for VodafoneZiggo is definitely to keep innovating in the (acute) healthcare sector. Many improvements can be achieved by applying IoT and many actions that are done manually now can be automated. For example, there is still a lot of communication via telephone or portophone between the different parties that will not be improved by the CommunicAid yet. For example, the reporting room employee still documents manually which driver and nurse start their shift. He notes the start- and end time, the vehicle number and employee numbers. A simple IoT based system can automate it and therefore reduce the work pressure for the reporting room employee.

Another advice to VodafoneZiggo is to inform the world about their IoT skills. This can improve brand loyalty. At the moment, this is communicated only in the B2B market. VodafoneZiggo should also spread the word in the B2C market about the fact that they are working on positive societal impact. If this concept will be implemented some day it can be used as a promotion campaign.

PERSONAL REFLECTION

Project management

Starting my graduation project

My graduation assignment started with the very broad question 'what is the impact of IoT on society?'. I realized that I had to narrow the topic down as soon as possible. The amount of information was overwhelming because of the broad topic. Looking back on this part of my graduation, I feel like I should have talked with people within the company earlier. I read literature about IoT, smart cities, and subtopics of these. This made me run in many different (interesting) directions and at several moments it felt as if I drowned in all the information.

After three weeks I had my first internal meeting, and several following after that. These inspired me and made me think about the emergency services. I think that I would not have found this direction without these internal meetings. When choosing this topic I narrowed down my scope enormously!

Because I started that broad, my kick-off took place 5 weeks after my official starting day. This is late, but it was also necessary; it was impossible to fill in the graduation assignment earlier.

Documentation

While I was almost drowning in literature I immediately started to structure the information. I documented all interesting websites in one place, and saved all interesting papers in labeled digital folders. This helped me to find back all relevant information quickly.

Next to adding structure to my files I started writing as soon as possible. This way, it was clear to see where information gaps existed and thus easy to build up an ongoing story. I immediately made my work 'report ready' which means that I made supporting figures and designed every chapter immediately in the same style. This definitely saved time in the end. Probably not all written parts and all visuals can be found in my final report, however, it helped me to find my way through the process anyway.

Contact with different parties

In the beginning it was hard to get in contact with ambulance regions that were willing to help. I sent out introducing emails with a request to come over for some talking. Some did not answer at all and the few responses I got (after several days) were negative because of the high workload in the acute healthcare sector. Then, I sent the same message to many more regions. I should have done this immediately. My advice to other (graduating) students is to spread the opportunities by contacting as many potential helping parties as soon as possible. Just dare to ask! My personal environment was also helpful. Talk with as many people as possible about your project; I got one contact in the ambulance service via a friend of mine.

What I learned during this project was definitely to persevere; for field research I asked several times if work shadowing was possible with the ambulance staff. I got a lot of negative responses but by mentioning it again and again, I finally met a person who could help me to accomplish this. The experience was very relevant for my research and in addition to that, it was an unforgettable experience.

Gathering insights

After talking with the different ambulance- or ED (related) people, every piece of the puzzle reached the right place. I pitched my insights from previous meetings during the next one and every time, my findings were confirmed. I noticed that each meeting gave me deeper insights but the new information load was every time smaller than in the previous meeting. I felt more eager to learn after each meeting.

I was surprised about the fact that the acute healthcare industry turned out to be this inefficient and competitive.

Planning

Workload distribution

As a graduation student, you are required to make a planning for your assignment. However, this is a rough planning and does not help to create a daily overview. Moreover, this planning is made during the first steps of the project and is therefore not that specific. It will probably change soon after the kick-off. I am a structured person myself and love to keep overview of what I'm doing. I like to work with deadlines and goals. Therefore, I divided my main planning into smaller pieces and made to-do lists per week. It definitely worked for me this way.

Meetings

Another planning aspect which is important to keep in mind is planning meetings with your supervisors. In my case I had a weekly meeting with my company coach. I planned my next progress meetings (with chair and mentor at the TU Delft and company coach via Skype) during the previous one. In general, calendars are flooding, especially when you want to plan a meeting with four people.

I think I defined clear goals for my meetings every time, to make sure that I got relevant feedback and answers to my questions.

Reflection per phase

Figure 53 shows the total design process of this graduation project. It is divided in the three phases that are formed by the subquestions. I reflected on each of these phases separately.

Research phase

As the figure shows the research phase consisted of two diverging moments. Starting with the assignment, the IoT knowledge had to be extended to find an interesting topic. Next to this IoT research I also dived into the world of VodafoneZiggo. Then, I decided that the ambulance service was a good opportunity to design for. Information about this sector needed to be collected. From all the insights a problem statement could be formulated.

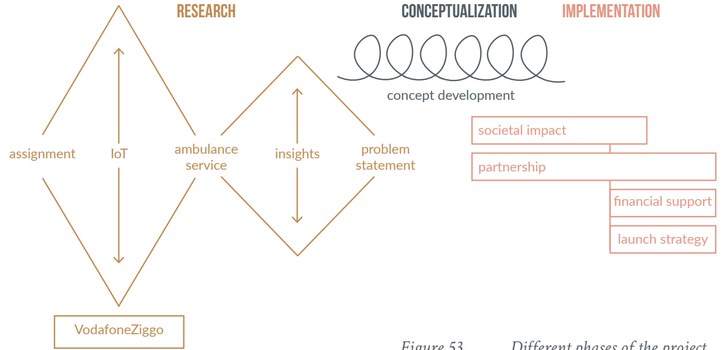


Figure 53. Different phases of the project.

Looking back at my research phase, the first part was hard for me; it started very unstructured due to the broad topic. Many interesting topics came by, so choosing one felt as throwing away many good opportunities. After all, I am happy with my choice to dive into the ambulance service. It is an interesting sector where many improvements can be made.

The research phase took about half of the time of my graduation project. I do not see this as a issue; I do not believe that a good concept can be developed based on a shallow research. The development phase does not have to take much time if you have a clearly defined challenge in an explicit context.

Conceptualization phase

As can be seen in the figure the conceptualization phase overlapped with the research phase. During the research I already thought of interesting solution directions. This is natural, I think. During my concept development I kept in touch with the users. In this way, knowledge gaps were filled up piece by piece. In the conceptualization phase for example, I found an important new insight (the existing patient announcement option).

Looking back on the validation, I wish I would have done more user tests. This was hard to accomplish though; people working in acute healthcare are very busy so it is hard to use their time.

Implementation phase

Again, this phase overlaps with the previous phase. Because I had to wait for an appointment that was really needed for the concept development, I started with the implementation phase. This made me become more conscious about these elements during the concept development.

Working on the implementation plan I was trying to get the puzzle done to implement the CommunicAid in all regions, when I realized that this was impossible. It is too complex with all different parties. Therefore I changed the whole implementation to what it is now. I think that it is a more realistic plan now. However, if I have had more time, I would have improved the implementation plan more. For example, talking with experts within VodafoneZiggo about it, or talking with the recommended partners would help me to bring it to a higher level.

General

SPD

I feel like this project met the SPD learning points. As learned during the courses I applied techniques as market- and company analysis to get an as complete as possible picture of the situation. Sketching scenarios helped to express the idea of the current situation and the idea of the concept. After designing a concept, the implementation plan is worked out with a roadmap with a future vision as leading direction.
Next to these typical SPD values I tried to focus on the human aspect in my project. During field research I really learned a lot about the users and their needs. Unfortunately, it was not allowed to take photos so in this report, I worked with pictures from the internet to communicate the human aspect. In the supportive figures I used icons to communicate my ideas.

The second IDE pillar is business. In the first phase, VodafoneZiggo is analyzed and especially in the final phase, I worked upon a 'business plan'. Finally, the technological aspect comes out in the IoT.

I think that the final solution is very SPD like; the idea itself is not rocket science, but it is in the precise way of doing research to find the underlying problem as an outsider (and as designer). Solving this in a smart way and connecting all puzzle pieces, to meet the requirements of all different stakeholders.

Rubric

Last but not least, sometimes checking the rubric was relevant. It kept me on the right track.