A BUSINESS MODEL FOR TELEMONITORING SERVICES

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Abstract

In the next few decades one of the main problems to deal with in Western Europe is the aging of the population. More people will need healthcare services, while there are fewer people to provide these services. Telehomecare services like telemonitoring can provide a cost-effective means to save valuable healthcare service time by monitoring body functions from a distance. In this paper a business model is presented for implementing telemonitoring. This business model consists of a service domain, technical domain, organisation domain and financial domain. From this business model we can conclude that by using one flexible infrastructure for multiple telemonitoring services, infrastructure costs can be shared among multiple services. A partnership between homecare organization, central contact centre and supplier of monitoring devices and Wireless Sensor Network providers is required for telemonitoring provisioning.

1. Introduction

In the years to come the aging of the population in Western Europe will lead to a dramatic increase in the demand for specialized, and hence costly, healthcare services. For example in the Netherlands we see an increase of people above the age of sixty-five from 14% of the total population in 2005 to 19% percent in 2020 (Central Bureau of Statistics, 2006). On the other hand, within these statistics, an increase in the total healthcare population is not seen. Therefore pressure of healthcare professionals will be expected to rise. One of the chosen solutions to deal with the high costs of this aging population problem is to reduce the housing costs. Elderly people need to stay longer in their own house instead of going to a nursery home. In this context telehomecare services like telemonitoring and teleconsult can provide an outcome. It can help reduce the pressure for the healthcare professionals and increase the independency of the elderly patients. In this context the recent advances in broadband communication, wireless communication can offer affordable healthcare services that have not been fully explored before.

The subject of this paper is which telehomecare services are most viable and how can these services be implemented in such a way that it provides the most added value to the elderly patients and healthcare professionals. Telehomecare service offerings require many different parties to be involved, including for example network operators, medical experts, homecare organisations, central contact centres and service integrators. Implementation of these services is therefore highly complex and requires clear descriptions of services agreements, process descriptions and revenue sharing models. An extra complicating factor in offering these services is that elderly people are not familiar with technologies used within these services and should be introduced to the possibilities of new technologies. Creating business models for telehomecare services can help to get insight in making them commercially viable. In this paper, we propose a business model for telemonitoring services created by following the "Freeband Business Blueprint©"-method as suggested by Haaker et al (2004). For this method, two different creative sessions were held with healthcare- and IT-professionals. The information from these creative sessions combined with a literature study resulted in a business model.

The organization of the paper is as follows. In section 2 a description of business models and its use is given. Section 3 gives an explanation of the method used within our research. Section 4 gives a short summary of the creative sessions held. Section 5 describes the business model as an outcome of the creative sessions and the literature study. In section 6 the conclusions and recommendations are given and section 7 gives an overview of the references used.

2. Business model

Business models can help identifying and understanding the relevant elements in a specific domain and the relationships between these elements according to Osterwalder & Pigneur (2002). There are many different definitions of a business model. Within this paper the definition of Timmer (1998) is used, where a business model is defined as an architecture for the product, service, information flows, including a description of various business actors and their roles, a description of potential benefits for the various actors, and a description of the sources of revenue. Alt & Zimmerman (2001) suggest that there are a few common elements that turn up in definitions of business models which focus on the mission and strategy of the company. In our telemonitoring case we are more interested in how different organisations can work together in delivering a service and how technology can help in fulfilling the mission. Therefore we use the approach of Bouwman (2003) in which also a technology component is added and the focus lies on the customer value. It takes into account how organisation issues, technical and financial arrangements are needed to provide the customer value. The business model consists of four parts: customer value, technology-, organisational- and a financial arrangement.

The most important part of the business model is the determination of the customer value that is offered to the service. The new service should outperform existing services and offer added value comparing the existing services. The benefits of the new service should be higher then the total costs or sacrifices. For the service provisioning different specialised organisations can work together. Organizations are recognizing more and more the flexibility of alliances. Therefore we see organization networks arise. Every organisation within the network has its own goals and reasons why they participate. These goals and reasons should not conflict with each other. There are a lot of factors which have been driving companies into join forces; globalization, technological innovations, deregulation and cost efficiency (Duyster et al 2004). Value chain analyses gained popularity through the writings of Porter (1985) and become a part of the business model. Business requirements as defined within the business model determine the information and communication infrastructure needed for the service provisioning and service management. However, choices made on the techniques used for the infrastructure can have effects on the value proposition and therefore on the business model itself. By describing within the business model which technology will be used, this is taken into account. All choices made on service delivery, technology have effect on the financial costs and benefits. With regard to financial arrangements there are basically three main issues: investments decisions, revenue models and pricing. For the success and viability of the business model it is important that the benefits are higher then the costs for all parties involved. A clear model which takes into account what the partitioning of income, investments, revenues and costs will be should satisfy all the parties.

3. Approach

To get viable business models we used the "Freeband Business Blueprint Method©" (FBBM) as a guiding principle. It is an instrument that can help organisations who want cooperatively develop and offer new innovative mobile ICT services. It can also be suitable for our purpose to get insight in which and how telehomecare services should be implemented. It integrates different techniques, like creative sessions, value webs and Cost-Benefit Analysis into one business model. For our technical domain we added a Modular Product Architecture for identifying functional requirements. The FBBM fits the four parts of the business model and consists of four domains as depicted in Figure 1.

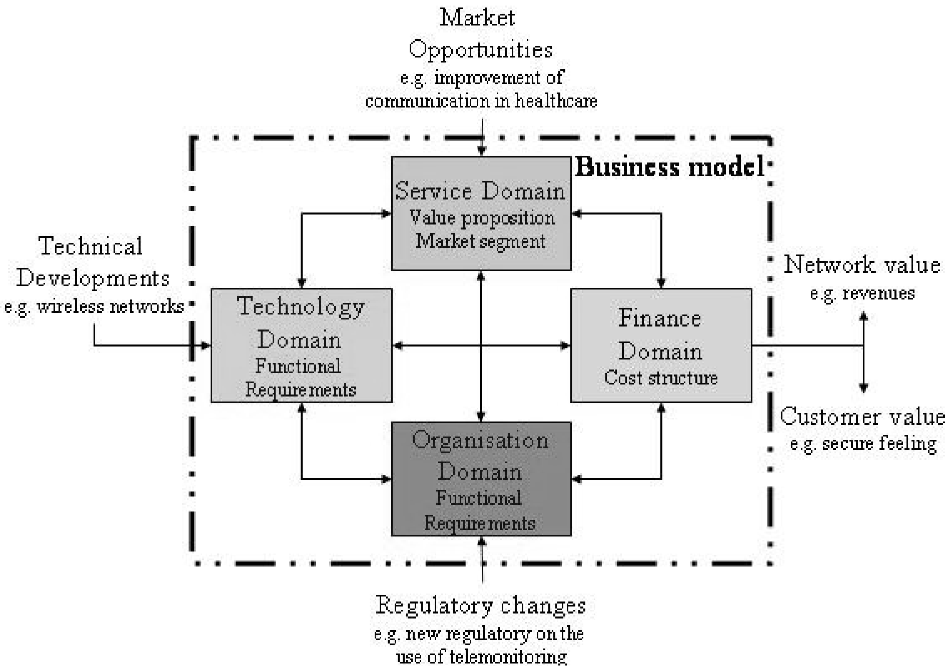

Figure 1: Business model framework

The FFBM proceeds along three steps. The first step is a quick scan which consists of creative sessions with four to six participants. A creative session can be seen as a structured brainstorm session and consist of four domains: problem domain, idea domain, evaluation domain and selection domain. The goal of this creative session is to explore possible business models for telehomecare services. The problem domain is used to set the goal for the creative session. The idea domain is used to generate a lot of different ideas which serve the goal. Within the evaluation domain the ideas are evaluated and only the best ideas are kept. The final selection domain is used to choose a answer to the goal which is can be further developed. In the second step the quick scan of the business model is evaluated and refined by using critical success factors. Further refinements and more details are added in the third step where the business model is evaluated and refined using critical design factors.

4. Creative session

Two separate creative sessions were held within our quick scan. The goal of the first session was defined as: "Which wireless services can help people to let them have a dignity stay for a long period in their own home". It was attended by people of homecare organisation, ICT and healthcare consultancy organisation and a client group delegate. The wireless component of the services was left out in a later stadium of the session. This session resulted in a short description and initial functional requirements of four services to help people living longer in their own homes. Of these four services, telemonitoring was the most important and complex service to implement. It is a service which offers continually monitoring body functions of a patient. It consists of a monitoring device that measures body functions and sent them over to a central contact centre, where the data is analysed. The central contact centre can analyse the measurements, locate the patient and is able to send the right medical expert to the spot if needed. The second service is a relative simple communication service using not only audio communication, but also video. The goal of this service is to increase the social interaction of the person with its environment. For example, elderly people can talk and see their children and grandchildren, if they are less mobile. The third service uses the same technique, only now the video communication is used for consulting doctors, nurses and homecare professionals. The last service is a service that provides access to the home for homecare professionals without having a physical key of the door. This reduces the administration of authorisation and keys.

The second creative session used the conclusions of the first session as an input. The goal of this session was to identify requirements for telemonitoring, teleconsult, key-management service and how different parties can offer these services. This session was attended by an ICT manager of a local hospital, ICT city councillor of the local municipality, employees of a homecare organisation, ICT specialists and a client group delegate. From the conclusion of this session it became clear that homecare organisations can start implementing teleconsult services. Telemonitoring looks a promising service, but further development of the business model was needed from that point on. Within the next session the further development of the business model is presented as an outcome of the creative sessions, literature study and interviews with the working field.

5. Business model for telemonitoring service

In this section we propose a business model for telemonitoring service. The model consists of a service domain, technology domain, organisation domain, and finally, a financial domain. The creative sessions, literature study and interviews were used as an input for this business model.

5.1 Service domain

Telemonitoring can be defined as the use of information technology to monitor patients at a distance. Meystre (2005) suggests that the most promising application for telemonitoring is monitoring chronic illnesses such as cardiopulmonary disease, asthma, and heart failure in the home.

Although telemonitoring is still at an early developmental stage, the possibilities are promising. The main benefits of telemonitoring for the patients can be summarised as:

- Due to telemonitoring, medical experts can get an alarm earlier than without using telemonitoring. This can prevent serious disorders after an emergency.
- Neither patients nor the healthcare professionals need to travel for regular monitoring, comparing to existing monitoring services.
- The idea that medical experts get an alarm in case of an emergency can give patients a safe feeling.

Beside the benefits, also some sacrifices/costs to be made by the patients which come along with the telemonitoring services:

- Extra costs for infrastructure and service.
- Private information on body functions is sent over a public infrastructure and is shared by others.

Monitoring patients can be done in two ways: *active* and *passive* telemonitoring. In active telemonitoring the patient gives explicit permission to make contact with the central contact centre for sending measurements. This can only be the case if the frequency of sending information is relative low. Active telemonitoring has the advantage that privacy sensitive information is only sent with the permission of the patient. In this case the patient does not lose its privacy. If the patient doesn't have a problem in sending body information to a central contact centre passive telemonitoring is possible. In *passive* telemonitoring the measurements are sent without interference of the patient. The main advantage is that in case of an emergency, when the patient cannot explicitly give permission, measurements are sent anyway and an alarm can be triggered. Another advantage is that with a relatively high frequency measurements can be sent to the contact centre without disturbing the patient. To reduce the sacrifice of privacy loss, patients can choose for active telemonitoring, where they decide when private information to medical experts is sent. Important requirement for passive telemonitoring is the security of transport and storage of privacy sensitive information about the patient. If this is taken care of, passive monitoring is preferable due to the higher benefits and therefore it will be used within this business model.

One of the results from the creative sessions is that successful telemonitoring services for a broad public should meet two requirements: they should be both *highly reliable* and *cost-effective*. In an emergency situation telemonitoring can provide up-to-date information, therefore it should be reliable. Not every potential patient will make use of telemonitoring services. In fact, it is more likely that only a relatively small group of patient with a life treating situation will choose for telemonitoring. The total-cost-of-service should be low due to a high adaptation rate by the group of potential clients (Bradford et al 2005). These two requirements seem to conflict. Although high reliability also results in relative low maintenance costs which leads to lower costs. Another conclusion of Bradford et al 2005 indicates that there is a negative correlation between the willingness to use telemedicine and the price to pay for the service.

To give an idea on what kind of telemedicine services can be offered, an overview is given of examples for telemonitoring services within subsection 5.1.1. Within subsection 5.1.2 and 5.1.3 two telemonitoring examples are described.

5.1.1 Telemonitoring services in general

Within table 1 an overview of examples of telemonitoring services is given. For all the services the frequency of the measurements are given, the client group disability, percentage of the total population within the Netherlands (Central Bureau of Statistics 2006) and if the measurements are sent actively of passively by the patient.

Measure	Frequency	Client group disability	% of the total population	Active / Passive
Heartbeat	Continually	Heart disease	1.5%	Passive
Blood pressure	Every day	High blood pressure	9.9%	Active
Long volume	Every day	Asthma and COPD	7.3%	Active
Insulin in blood	Every day	Diabetic	3.1%	Active
Location	On request	Alzheimer	1.8%	
Alarm	When needed	Balance impairment and other geriatric disease	14 %	Passive

Table 1: Examples of measurements of body functions

Telemonitoring with a frequency on daily basis can be performed within the premises of the patient. This service does not require to work outside the premises. Heart rate monitoring, location monitoring and alarm monitoring on the other hand require also the possibility to measure and sent information outside the patient’s premises. Therefore a flexible infrastructure is needed where functionality can be added or left out, depending on the needs of the patient and the needs of measurements.

5.1.2 Telemonitoring for COPD patients

Chronic Obstructive Pulmonary Disease (COPD) is a slowly progressive disease of the airways that is characterized by a gradual loss of lung function. COPD includes chronic bronchitis, chronic obstructive bronchitis, or emphysema, or combinations of these conditions. Within the Netherlands 7.3% of the population has Asthma or COPD (CBS, 2006). The diagnosis of COPD is confirmed by the presence of airway obstruction on testing with Spiro meter. Once COPD has been diagnosed, recognising worsening signs and symptoms of COPD is an important part of managing your illness. Knowing when symptoms are changing is helpful so that treatment and other interventions can begin quickly. A Spiro meter is a simple handheld that can be used within the house of the patient for recognising symptoms. Blowing forcefully into the tube provides a measure of air volume. The measurements can be sent over automatically to a monitoring environment where the measurements are compared with historical information. Important changes generate a trigger.

5.1.3 Telemonitoring for Heart and Vascular disease

A heart attack occurs when the supply of blood and oxygen to an area of heart muscle is blocked. Often, this blockage leads to irregular heartbeat or rhythm that causes a severe decrease in the pumping function of the heart and may bring about sudden death. If the blockage is not treated within a few hours, the affected heart muscle will die and be replaced by scar tissue. Within the Netherlands 1.5% of the population has a hearth or vascular disease (CBS, 2006). The challenge for heart patients is to keep the heartbeat under a certain level.

When a heart attack occurs, immediate reanimation in required. Telemonitoring can not prevent a heart attack, but measuring the heart rhythm can tell the patient if its heartbeat is above a certain threshold and if the heart rhythm is irregular an alarm message can be sent to a monitoring environment where further necessary actions are taken.

5.2 Technological domain

To get a complete image of the functionalities and technology that are needed for telemonitoring service a modular product architecture is used based on a functional refinement tree (Wieringa, 1996). Within this modal decomposition of all functionalities needed in the service is performed. The process of decomposition can be repeated until a level of atomic functions is obtained. The technical infrastructure is also decomposed into smaller atomic technical components in the same way as the functional decomposition. All atomic functions find their implementations within the technical infrastructure. This is reflected by the connection lines between the functions and technologies. In this way a complete overview of functions and implementation of these functions is given. Figure 2 gives the modular product architecture of the telemonitoring service. Only the service delivery functions are described in this architecture. The service management functions, marketing, customer services etc. are not taken into account.

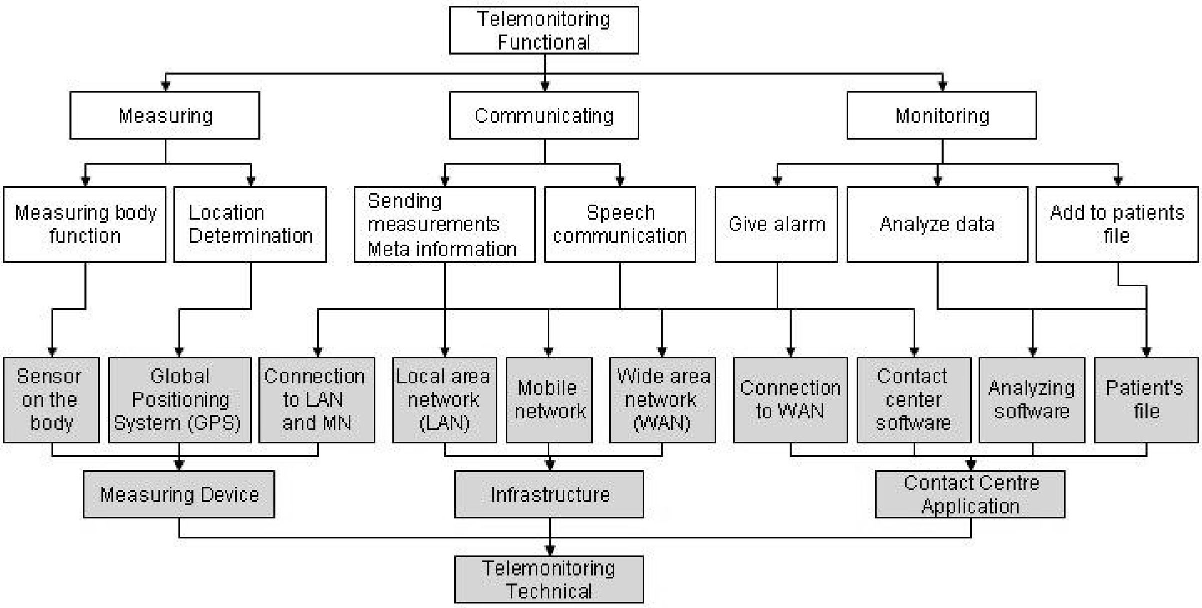

Figure 2: Modular product architecture

All different telemonitoring services mentioned within the previous subsection 5.1.1 have three main functions: measuring, communication and monitoring. Measuring the body functions is where these services all starts. Table 1 indicates which body functions can be measured. Besides measuring the body functions there is a need for location determination for outside the home monitoring. The second function of telemonitoring is communicating between the measuring device and the central contact centre. The central contact centre monitors the patient. Communication consists of sending measurements, speech communication between the patient and the central contact centre when an alarm is given and sending meta-information like alarms, confirmations and cancellations. The last main function is monitoring and consists of storing the measurements within the patient's personal file, analyzing the measurements by comparing it to the information within the patient's file and giving an alarm if a threshold exceeds. Within active monitoring only the measurements are stored when the patient explicitly gives permission to send the data.

Technical implementation of these measurements can be done within a measuring device, using sensors. This can be done by placing sensors on the body of the patient. In the future new technologies like nanotechnology can be expected, which make it possible to measure more body functions within the body (Ferrante 2005). Within this business model they are left out. Location determination outside premises can be done using Global Positioning System (GPS). This gives an indication of the position of the patient with an accuracy of ten meters. Within the premises of the patient a wireless sensor network (WSN) can determine the position. The measuring device also needs a connection for the different communications functions. This connection is on the one hand a connection to a local area network (LAN) within the patient's premises and on the other hand a connection to mobile network (MN) for communication outside the patient's premises. The LAN can be implemented by using the same Wireless Sensor Network of for location determination within the premises, which is a low energy, low cost wireless network suitable within a home environment. Multiple telemonitoring services can be using one WSN. The advantage of this network is that the installation costs are relative low and the body functions can be measured and sent wireless from every place within the network range.

The mobile network needs to have GSM communication for speech communication and General Packet Radio Service (GPRS) or Universal Mobile Telecommunications System (UMTS) for data communication (Wac et al 2005). The choice between GPRS and UMTS depends on the data rate of the measurements needed. GPRS with a bandwidth of 114 Kbps is sufficient for most telemonitoring services, only telemonitoring services which send every couple of seconds a measurement requires UMTS with a minimal bandwidth of 144 Kbps. The local area network and mobile network are connected to a Wide Area Network (WAN). The WAN is used as an infrastructure for the communication to the central contact centre. The implementation of the WAN can be done using a virtual private network (VPN) on top of the Internet (Suomi & Tähkäpää 2003) or in some cases a normal fixed telephone infrastructure is sufficient for telemonitoring services with low data rates (Finkelstein et al 2004).

5.3 Organisation domain

The FFBM suggests creating a value web for modelling the organisational domain. A value web can be seen as a set of actors exchanging things of economic value with each other. An important concept in a value web is a value object. Such an object is a good, a service, a fee or a combination of these, which is of economic value for at least one actor. An actor is an entity perceived by itself and its environment as an independent economic and often legal entity. The goal of an actor is to make profit in case of an enterprise or to increase its economic utility in case of an end-consumer. Actors are related by value exchanges, which express the willingness of actors to exchange objects of economic value with each other (Gordijn & Tan 2003). Figure 3 shows a value web for telemonitoring services.

The two main actors within our business model are the patient and the homecare organisation. The homecare organisation offering care and cure services within home situations to the target group of telemonitoring services, is the natural organisation to offer telemonitoring service. They know the client group and telemonitoring services can be an extension to their current services. In return of the service a fee is requested from the patient.

The medical expert recommends the telemonitoring service if the medical situation requires telemonitoring. To get twenty-four hour monitoring from a distance the homecare organisation uses the service of a central contact centre. Central contact centres already have the infrastructure and the resources for twenty-four hour surveillance. They can enrich their portfolio by telemonitoring for homecare organisations in return of a fee. The contact centre requires telemonitoring software, connection to the patient's files and contact information of medical experts in case of emergencies. An alarm can be given by the contact centre to the medical expert and to the homecare organisation depending of the urgency and needs of the situation. The telemonitoring service makes use of the infrastructure as described in the previous section. The providers of these infrastructures, which are the enablers of the service, are also placed within the value web. The homecare organisation gives a set of minimal requirements for the infrastructure for the specific telemonitoring service. This can consist of a mobile network, Internet connection and/or a normal phone line. Homecare organisations can give advice on providers to be used, but the patients arrange their own infrastructure. The advantage of this is the decrease of the costs for the total telemonitoring service and only infrastructure components needed for the service are used. Moreover, in some cases the patient already has parts of this infrastructure. In that case it is not needed to get an extra connection to that part of the infrastructure. Patients also can choose for using plain old telephone system instead of an Internet connection if the telemonitoring service requirements allow this. The specific infrastructures of the wireless sensor network and the measurement device are provided by the homecare organisation. These are specific equipments that in most cases can not be shared by other services then other telemonitoring services. If the patient wants to stop using the service, these equipments can be taken back by the homecare organisation and reused by a new customer of the homecare organisation.

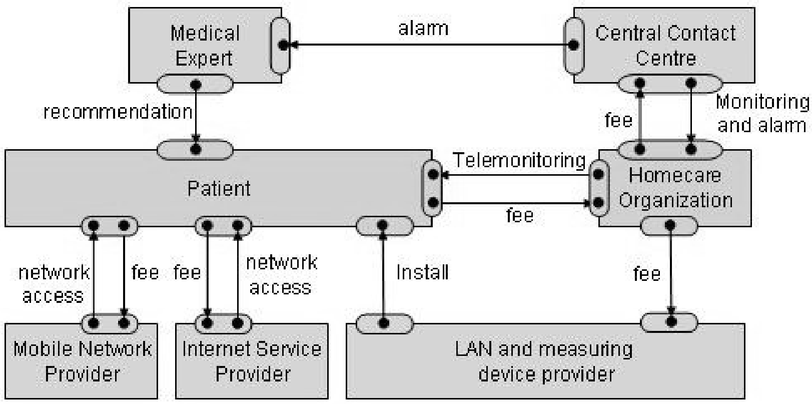

Figure 3: Value web for telemonitoring services

5.4 Financial domain

Financial evaluation of telemedicine applications is required to provide decision makers in healthcare with appropriate information on financial costs and benefits. At the basic level, economic evaluation may include basic cost-benefit analysis (CBA) for all actors involved within the value web. From this analysis decisions can be made on which actors become partners in offering the telemonitoring service and which actors should invest. Partners are organisations that are connected through tight relationships and interdependencies considering risk sharing, solving common problems and acquiring access to complementary knowledge. Only investments decisions and a high level revenue model of the business model are discussed within this section. Pricing model are necessary for the valuation of the organisational network but are left out of this paper; it requires extra market research, and financial cost/benefit analysis which are not performed.

Bradford et al (2005) investigated the willingness to pay for telemedicine, which shows that patients with chronic heart failure and patients with hypertensions are willing to pay for telemedicine. Between 30% and 50% of the hypertension group are willing to pay at least $20 per month for telemonitoring and for the chronicle heart failure patients this is even higher. Assuming these figures will hold within Western-Europe a turnover of approximately 17 million[i] dollar per year within the Netherlands can be expected for only chronicle heart failure patients.

A cost based analyses is performed on a quality level for all the actors within the value web of the previous subsection and resulted in table 2. Two extra actors, insurance companies and government are added to this analysis. Although they don't play a role in the service provisioning nor in the service management, they are indeed a party of interest to invest in telemonitoring. Telemonitoring can prevent health complications, due to adequate and quick actions of medical experts, therefore a reduction in healthcare costs can be realised. Insurance companies and government benefit from this reduction and are logical partners to invest in telemonitoring services.

Actor within the value web	**Benefits**	**Costs**	**Financial invest needed**
Patient	• Prevention of health complications • Monitoring without needing to travel • Safe feeling	• Fee for telemonitoring service • Fees for different network access • Sharing privacy	-
Homecare organisation	• Fee for the service • Customer relation	• Service provisioning costs • Service management costs	Invest in service
Central Contact Centre	• Contract with homecare organisation	• Investments in monitoring equipment • 24 Hour medical surveillance	Invest in monitoring
Medical Expert	• Better and quicker diagnosis • 'On-time' alarm	• Analyse extra medical information	-
Mobile Network Provider	• Extra revenues on data and speech communication	• Minimal extra infrastructure costs	-
Internet Service Provider	• Potential new customers	• Minimal extra infrastructure costs	-
LAN and measuring device provider	• Sell devices • Installation	• Investments in new techniques for the infrastructure and measuring devices	R&D on new measuring techniques
Insurance companies and government	• Prevention of health complications	• Stimulation of telemonitoring projects	Invest in pilots

Table 2: Cost-Benefit analysis for telemonitoring

As we saw, the homecare organisation is the most logical actor to offer these services and by offering these services they can generate new revenues and get a closer relation with the patient. Extra services can be offered to the clients by marketing techniques like cross-selling and up-selling. The central contact centre needs to invest in telemonitoring software and gets its benefits from the contract with the homecare organisations. This is a relative big investment in proportion to the risk been made, there for these investments can only be done in partnership with the homecare organisation. A close relation between these two actors is required to justify the risk for the central contact centre. Another actor which invests in the service is the provider of the measuring device and the wireless sensor network. A partnership with this actor can lead to lower risk of research and development (R&D) costs for the provider due to guaranteed sales of devices and wireless sensor network. Guaranteed sales of devices can result in price reduction for the homecare organisation. Mobile network provider and Internet Service Providers are not necessarily a partner within this service although they are interested parties and can benefit from these services. Their services are used when needed in the specific client situation and no extra investments are needed to offer the services. Table 2 indicates four actors invest in the service. The homecare organisation invests in service delivery, service management, marketing and sales. The central contact centres adjusts it infrastructure for telemonitoring services and creates a connection to the personal medical file. Wireless sensor network and measurement device provider invests in R&D of the devices and infrastructure. Together they can form a partnership. A part of the investments costs can be funded within the pilot phase. Revenues from the service can be shared to ratio of investment between the three partners.

6. Conclusions

In this paper we have proposed business model for telemonitoring services. Concluding from this business model we see that telemonitoring services can provide a cost-effective means to save valuable healthcare service time by monitoring body functions. To implement these services for a broad public they should be secure, reliable, cost effective. The functionality of the service should be flexible and adjustable to the clients needs. A technical infrastructure can be cost effect if it supports multiple telemonitoring services and functionalities can be added and removed. A partnership between homecare organization, central contact centre and supplier of measure devices and LAN infrastructure is required for the services provisioning. Health insurance companies and government can accelerate the time to market of these services by investing in pilot projects.

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[i] The Netherlands counts 16 million inhabitants, of which 1.5% heart patient are (CBS, 2006), of which according to Bradford et al (2005) at least 30% is willing to use and pay 20 dollar for the service.

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