Business Modeling and Value Network Design Case Study for a Tele-Rehabilitation Service

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Abstract. During the last decade, many useful telemedicine pilots have been conducted, however, only a few telemedicine services did actually reach the market and were successfully being deployed. One of the reasons is that costs and benefits are not equally distributed across the organizations of a value network. Value network analysis combined with business modeling right from the beginning of a project may improve the success rate of telemedicine services development and deployment. This paper presents results of this approach used in a case study for Myotel, a wireless rehabilitation service for treatment of chronic work related neck shoulder problems.

1 Introduction

Telemedicine may improve healthcare, both in a qualitative and in a quantitative way. During the last decade many useful technologies have been developed but fail to actually reach the market [4, 17]. Often, telemedicine services are provided by multiple organizations being part of a large value network. In practice, the services innovation is hampered by the fact that costs and benefits of a service innovation are not equally distributed across the network. An organization with only costs and hardly any benefits will not contribute to the innovation. A second roadblock in bringing telemedicine services to the market is the existence of regulations limiting the full power of the telemedicine services [4]. Business modeling is seen as a solution to bring (technological) innovations to successful deployment and several determinants have been identified for success [4, 2, 5]. By using business modeling right from the beginning of a project, the failure rate of telemedicine service innovations may be lowered. This is because such business model designs are expected to be more viable as a result of better alignment with available resources and capabilities as well with their external environments [17]. In this paper, we present a business modeling approach for Myotel, a wireless rehabilitation service for treatment of chronic work related neck shoulder problems. This approach allows for both a qualitative and quantitative analysis needed to engineer a viable value network by allocating activities to organizations such that costs and benefit are sufficiently matched.

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2 Myotel Case Description

The case consists of a so-called myofeedback tele-rehabilitation system that can be used for patients with work related chronic neck shoulder pain. The system monitors muscle relaxation during daily activities via sensors and actuators implemented in a wearable garment, which is connected to a PDA. The system provides continuous feedback when there is too little muscle relaxation. The monitoring data is sent wirelessly – e.g., via a GPRS, UMTS or HSDPA connection – to a back end system, which can be accessed by health care professionals. These health care professionals can use the system for optimizing treatment working more efficiently by saving on face-to-face contact hours with their patients and giving them more personalized feedback as well (Figure 1 gives a high level architectural overview of the system).

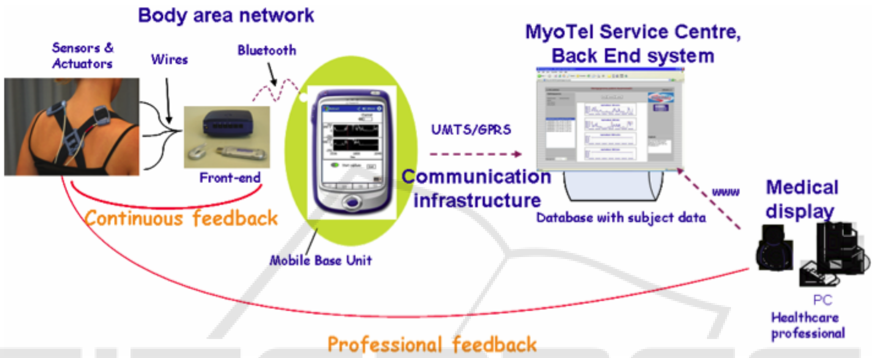

Fig. 1. Myotel system overview.

3 Business Modeling and Telemedicine Services

During the 1970s the business model concept was used for describing IT-related business processes [12, 18]. More recently, the business model concept has been used for analyzing market structures as well as strategic choices related to positioning of organizations within these market structures [16, 8]. A widely used business model definition within this context is that of Chesbrough and Rosenbloom [5] who concisely define a business model as “a blueprint for how a network of organizations co-operates in creating and capturing value from technological innovation”. In our view, it is important to explicitly distinguish the two main types of value to be created: customer value (value delivered from a customer perspective) as well as monetary value (value delivered from a provider perspective). So we define, in similar words, a business model as “a description of the way a company or a network of companies aims to make money and create customer value” [7, 11].
In literature, initially attention has been paid to empirically define business model typologies [8]. In recent years business model research started focusing on exploring business model components and developing descriptive models [11, 15].

Afuah and Tucci [1] see businesses as systems consisting of components (value, revenue sources, price, related activities, implementation, capabilities and sustainability), relationships and interrelated technology. Osterwalder and Pigneur [14] more systematically define four business model components, i.e., product innovation, customer management, infrastructure management and financial aspects. Broens et al. [4] identified five determinant categories that influence implementation of telemedicine interventions: (1) technology, (2) acceptance, (3) financing, (4) organization and (5) policy and legislation. For our case, the technology has been addressed by medical trials proving the medical effectiveness of the Myotel treatment [9]. A recent project focused on the acceptance by conducting Myotel trials in four European countries. Section 4 proposes a business engineering approach addressing the financial in particular the revenue streams and organizational aspects, i.e., value networks and related roles. Section 5 deals with the policy and legislation.

4 Value Chain Engineering using Business Models

We engineered the value chain by addressing the differences between the current traditional treatment and the future treatment of work related chronic neck shoulder pain using the tele-rehabilitation service, using the following three-step approach:

- The first step identifies the main activities needed to provide the service, by defining the role that needs to be played by an actor and a related short description. A certain type of organization or a specific professional with a given set of competences can play a role.
- The second step determines costs related to each role for the current and future situation. This step clarifies the economic impact of tele-rehabilitation services by determining the cost increase or decrease for each activity identified in the first step. From an economic point of view, the implementation of the tele-rehabilitation service makes sense only when the overall cost level of the future situation decreases.
- The third and last step is the "engineering of the business" by allocating activities to existing or to be created organizations. The objective is to create a value network where each organization benefits from the introduction of the tele-rehabilitation, i.e., additional costs must be compensated by additional benefits.

The above-mentioned process requires insights from business model surveys, literature studies, as well as expert interviews. Several cross-organizational workshops are needed to design business models, parameterize quantitative analysis and provide feedback to all parties. The next sections describe the above-mentioned steps needed for the engineering the business needed to viably provide the tele-rehabilitation service.

Step 1: Identification of Main Activities. In order to develop an initial qualitative business model design for the myofeedback tele-rehabilitation service, we organized a half-day workshop for twelve experts within the field of myofeedback and tele-treatments from four European countries in which the service could be offered – The Netherlands, Belgium, Sweden and Germany. Table 1 presents the activities of the main value network roles that will be affected by introducing the tele-rehabilitation service.

Step 2: Quantitative Model. The next step the costs for the activities of per role are determined (see Table 2). We only look at the activities that change when the traditional treatment of neck shoulder is replaced by the new tele-treatment. These activities are presented in italics.

Table 1. Main roles and activities.

Roles	*Activities*
Patient	Gets treated by the myofeedback system
Health care professional	Offers the professional care and guides tele-rehabilitation activities
Tele-rehabilitation service provider	Offers the actual tele-rehabilitation service, including helpdesk, training & certification, public relations,
Hardware provider	Offers hardware, e.g. for communication devices and sensors
Network Provider	Offers mobile communications services
Software developer	Develops the tele-rehabilitation system software
Software platform provider	Offers the tele-rehabilitation software platform
Insurance company	Offers health insurance to patient and absence insurance to employer
Employer	Employs persons who are patient treated by tele-rehabilitation system
Medical research & development organization	Does R&D related to developing training material and certification.

Traditional activity based costing approaches are used to determine costs of the activities. For each activity we determine for each activity the number of times N the activity is carried out and the cost price P per activity. With respect to cost price, we distinguish between investments and yearly costs. The investments are onetime costs for training and education (needed when new employees get involved) and investments for equipment (needed when more devices are needed or old devices are worn out). We consider a period of ten years. The volume and cost tables are part of an Excel spreadsheet that simulates the provisioning of the tele-rehabilitation service in year *i* from 2008 to 2018. Multiplying N_i and P_i gives the overall costs for year I for each activity. The values for N_i are based on an S shaped technology adoption curve. The values for P_i are based on today's market prices that develop over time, i.e., technology prices decline (deflating prices), whereas, e.g., salary costs for professionals increase (inflating prices). This enables Net Present Value calculations over the ten years period as well.

In our study, experts in each country have determined the values for numbers and cost prices for each of the four countries under study. The Excel spreadsheet presents the set of parameters to the experts and provides for instantaneous feedback for what-if analysis. In this way, we obtained a useful tool for evaluating costs and benefits in direct interaction with the experts.

Results of the Quantitative Analysis. The results of the simulation for the Netherlands are presented Fig. **2**. For each year of the ten-year period, the diagram shows how investments and operational costs change due to replacing the traditional treatment by the tele-rehabilitation treatment. The tele-rehabilitation treatment leads to additional investments and operational costs changes for the following activities:

The Service Provider activities require investments in equipment, e.g., garments, sensors and devices for the patient as well as back office equipment. The estimated life time of the back office is three years; the life time for other equipment is set to two years.

- The Service Provider activities require also yearly operational costs to maintain, operate and use software licenses for the above-mentioned ICT.
- The Service Provider activities include investments to train health care professionals in using the equipment. This is a onetime impact, disappearing once all professionals are familiar with using the system. Also the Health Care Professional invests time (equals money) when he or she is being trained.
- The Health Care Professional saves operational costs per patient, because fewer treatments are needed (from nine to four treatments).
- Finally the employer of the patients saves costs due to absence reduction (fewer treatments) and lower productivity losses (because of the treatment).

Table 2. Activities per role.

myofeedback service provider
• *manage tele-rehabilitation service (overhead)*
• *develop tele-rehabilitation market (marketing)*
• *acquire tele-rehabilitation customers*
• *build back office*
• *manage back office*
• *build device service*
• *manage devices needed for treatment*
• *train myofeedback service delivery personnel*
• deliver myofeedback service
• request reimbursement myofeedback treatment
• receive payment for myofeedback service
health care provider
• develop tele-rehabilitation treatment
• *train personnel tele-rehabilitation treatment*
• *diagnose patient*
• *consult patient with traditional treatment*
• *consult patient with tele-rehabilitation treatment*
• request reimbursement treatment
• receive payment for treatment
employer
• *employ traditionally treated employee*
• *employ tele-rehabilitation treated employee*
patient
• *undergo traditional treatment*
• *undergo tele-rehabilitation treatment*

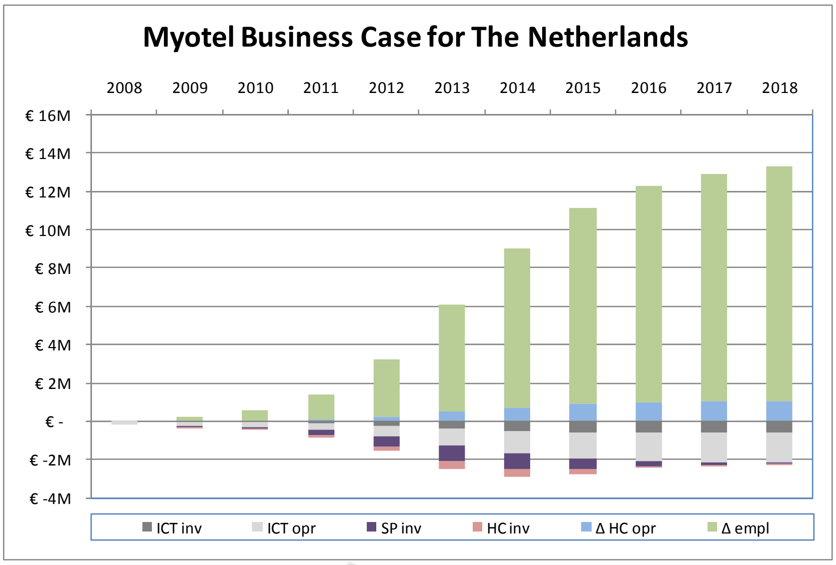

Fig. 2. Results of Myotel in The Netherlands.

Conclusions of the Quantitative Analysis. The cost benefit calculations revealed three critical insights that would be unknown without quantitative business model analysis (the related figures show the calculations for the Dutch market; for the other three countries, similar conclusions can be made):

- The tele-rehabilitation treatment is more expensive than the traditional treatment – mainly due to ICT related investments and operational costs.
- The IT investments are not likely to be compensated by the related labor savings for the Health Care Professional.
- However, the expected absence reduction and productivity increase of employers treated with the myofeedback systems compensates for the above mentioned additional cost.

The results shows that for example in The Netherlands, we may expect that employers obtain the most benefits related to implementing the myofeedback service. Therefore these organizations should be seen as the main potential revenue source when deploying the myofeedback teletreatment service.

Step 3: Value Network Engineering. The final step comprises the allocation of activities to existing or new organizations, part of the entire value network delivering the service to the patients and professionals. These organizations are part of a value network delivering products and services to each other on a commercial basis, i.e., one company pays for the product or service delivered to the other. The roles must be mapped such that each organization is able to cover the costs by payments originating from benefits. The experts mapped most of the roles easily to existing organizations, except for the role of tele-rehabilitation service provider. This role relates to costs (operations and investments) for IT devices and infrastructure that must be financed through the benefits of the employers. From a range of alternatives, the value network presented in was selected as most viable implementation. The employer (or the related insurance company) of employees suffering from chronic neck shoulder problems has an incentive to use the tele-rehabilitation service.

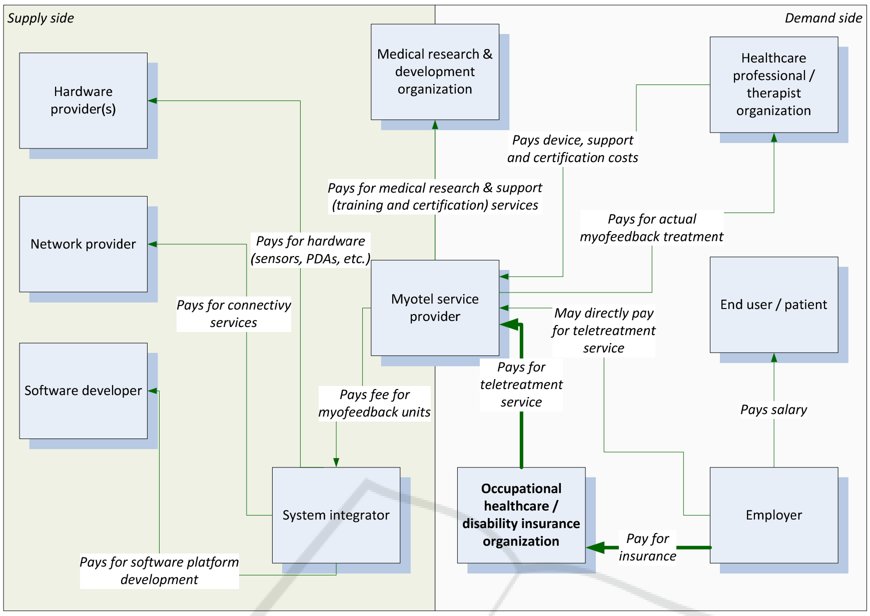

Fig. 3. Value network for Myotel.

5 Regulation

After deriving a viable value network design, we focused on performing a regulatory validation of the design for each of the four countries participating in the research. The main goal was to get insights with respect to the influence of the national healthcare regulation in each of the four participating countries[4]. According to Saltman[3], the influence of national healthcare regulation on the healthcare sector in a country can be divided into two different aspects – policy objectives and managerial mechanisms.

Policy objectives include regulation that is concerned with specific policy goals that influence a broad public, focusing on e.g. providing a healthcare system that is accessible for the whole population or educating citizens about clinical services, pharmaceuticals and a healthy lifestyle.

Managerial mechanisms have a more practical and operational character and target specific regulations that are needed to reach the goals as described in the policy objectives. Saltman et al [3] recognize a number of components that affect healthcare management capabilities and are associated with greater operating efficiency and effectiveness of both human and material resources. The following three main components of managerial mechanisms can be identified:

- State influence – does the government control the healthcare market, is it tax financed or is it dominated by private for profit organizations?

- Licensure and liability – how can be ensured that healthcare professionals meet competence standards and that malpractice will be prevented as well?
- Financial regulation – how does regulation influence the financial structure of the healthcare system?

Because of the practical and operational character of these components and their influence on the operating efficiency and effectiveness of both human and material resources, it is expected that these components have the largest influence on e-health service value networks. Therefore these three components formed the focus of our regulatory validation. Via a workshop with the experts from the four countries as mentioned in Step 1, we discussed the impact of national healthcare regulation in the Netherlands, Germany, Sweden en Belgium on the value network structure that resulted from the previous step.

When analyzing the results from the expert workshop and related expert interviews, we conclude that from the three regulatory elements as identified, the financial element has the most impact on the value network structure. Because reimbursements for e-health services – e.g. teleconsults – are not fully implemented yet, the potential efficiency increases related to the teletetreatment service cannot be fully capitalized yet. Only in the Netherlands and Sweden, recognizes that the work related chronic pain is a work related injury. In both Belgium and Germany only severe injuries are officially recognizes as work related. Because of this, the occupational healthcare can be regarded as a potential revenue source and important value network role only in the Swedish and Dutch value network structures of the teletreatment service. Another critical aspect appeared to be the reimbursement factors: because a Dutch healthcare professional treating neck shoulder problems gets paid for the entire treatment, regardless of the specific treatment, there is an incentive to work more efficiently. In the other three countries, these healthcare professionals are paid per hour. As a result, for them there is no strong financial incentive to work more efficiently.

State influence also impacts the value network structure. Because of the healthcare market in Sweden is highly regulated with relatively independent and autonomous regional healthcare institutes, Swedish government agencies are expected to play an important role in the Swedish teletreatment value network. However, in the other three countries, where state influence is lower, insurance organizations are expected to be important actors in the teletreatment value network structures. The impact of the final component, licensure and liability, was expected to be of less influence on the national value networks of the teletreatment service.

Based on the results related to the regulatory validation, the Dutch and Swedish healthcare markets appeared to be currently the most viable markets for deploying the teletreatment service. In both the Netherlands and Sweden it was possible to include the occupational healthcare role in the value network, which turned out to be a potential revenue source critically important for viably deploying the teletreatment service.

6 Conclusions

In this paper, we described our business model engineering approach to early stage business model and value network development for a tele-rehabilitation service in the R&D deployment phase. We use a three-step approach. First, the main activities that are affected by the introduction of the new treatment are identified. Second, the investments and operational costs for each activity are determined. Finally, the activities are allocated to organizational units such that costs and benefits of the treatment can be matched.

Step 2 and 3 of our method led to critical deployment insights that would otherwise be unknown or learned at a much later phase of the development process. Improving the viability and feasibility of business model and value network designs in an early deployment stage may lead to substantial savings in costs and resources.

The analysis can be augmented by analysis considering the environmental factors like market, technology and regulatory environments.

Although the first results are encouraging, the method and empirical results need to be further validated and the relationships between the qualitative and quantitative analysis as part of the business model action design cycle should be further integrated as well.

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