Deploying a Telerehabilitation Service Innovation: 
An Early Stage Business Model Engineering Approach

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Abstract
The objective of this study was to design a viable business model for commercially deploying a telerehabilitation service innovation in the R&D deployment phase. In the paper the business model engineering approach used to conceptualize the deployment of this telerehabilitation service is described, analyzed and evaluated.

An iterative, multi-method and combined qualitative and quantitative action design approach was used for developing the business model and related value network of the telerehabilitation service. Insights from surveys, desk research, expert interviews, workshops and quantitative modeling were combined to engineer the business model and consequently refine it in three design cycles.

1. Introduction

E-health service innovations promise both quality improvements and higher efficiency. However, the success of these services is mostly limited to the pilot or R&D phase. Despite high end-user satisfaction and attainment of initial objectives in terms of product quality and testing results, most of the innovations never reach the market – apparently, the related business models are not viable [4, 17].

E-health innovations seem to be mostly technology driven instead of being focused on actual value creation [17]. 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 giving business model innovation a priority right from the beginning of a project and developing the business model in iterative loops, the failure rate of e-health 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].

2. Research objective and case description

The objective of this business model engineering case study with action design characteristics [6, 10] was to design a viable business model for deploying a telerehabilitation service innovation – a typical instance of e-health service concepts currently in development. The case consists of a so called myofeedback teletreatment system aimed at patients with 1) chronic neck shoulder pain and 2) whiplashes – directly in the R&D deployment phase of the service innovation project. Earlier medical trials already proved the medical effectiveness of the specific treatment [9]. The myofeedback teletreatment system monitors muscle relaxation (myo stands for muscle) 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 (see Figure 1 for a high level architectural overview of the system).

In the following sections, the three-step business model engineering approach used to design a business model for deploying this telerehabilitation service is described, analyzed and evaluated.

3. Research approach

An iterative, multi-method action design approach [6, 10] was used for developing the business model of the telerehabilitation service based on qualitative as well as quantitative analysis. Insights from business model surveys, literature studies, expert interviews, business model design workshops and quantitative modeling were combined to engineer the business
model and refine and improve it in several design cycles.

Essentially a three-step approach was used to develop a business model for the telerehabilitation service:

1) Design an initial qualitative business model for the telerehabilitation service (based on a qualitative business model analysis framework with survey research and business model design workshop results as empirical data input)
2) Develop a quantitative abstract cost benefit model (based on Step 1 and expert interview validation)
3) Derive a viable value network design (based on Step 1 and 2 and expert interview validation)

After introducing our business model analysis framework that was used for developing an initial qualitative business model for the telerehabilitation service, the results of our multi method, qualitative and quantitative business model engineering approach are being described, following the three steps as mentioned above.

4. Business model literature review

The business model concept plays an important role with respect to deploying e-health service innovations, because it supports structural and logical thinking about designing viable service concepts [3].

4.1 What is a business model?

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 [3, 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].

4.2 Business model components

In literature, initially attention has been paid to empirically defining 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 the following four business model components: product innovation, customer management, infrastructure management and financial aspects. Based on an extensive literature review (see [3, 11]) we defined the following four components – similar to the ones as identified by Osterwalder and Pigneur [14] (see also Figure 2):

- **Service** (description of intended value, delivered value, expected value, perceived value)
- **Technology** (description of technical architecture, service platforms, devices, applications)
- **Organization** (description of actors, roles, interactions, strategies and goals, value activities)
- **Finance** (description of investment sources, cost sources, revenue sources, risk sources, pricing)

The framework as depicted in Figure 2 was used for analyzing the teletreatment service as described in Section 2. Broens et al. [4] identified four determinant categories that influence implementation of telemedicine or teletreatment interventions: (1) technology, (2) acceptance, (3) financing, (4) organization and (5) policy and legislation.

The focus of our research was on two of these critical telemedicine intervention implementation determinants by paying special attention to the following two business model components: the Organization component (with specific attention to the value network and related roles) and Finance component (with a special focus on revenue streams). The other two business model components were already designed and – at least partially – implemented within the R&D phase of the telerehabilitation service innovation project.

4.3 Dynamic business model engineering & validation

Most business model literature has a static and qualitative character and early stage development and validation of business model designs is mostly lacking in practice as well as in literature [11, 13]. In practice,
Business models are dynamic and change continuously because of changes in market, technology, and regulatory environments (think e.g. of the company Nokia: it was founded in 1865 but didn’t make money with producing and selling mobile phones at that time but with manufacturing paper) [11, 3]. Besides, business models could be qualitatively as well as quantitatively developed and tested or validated, not only in the market offering but also already in the implementation and R&D phases of deployment [13, 19]. Starting to think about business model designs only in implementation or, even worse, market phase is common but very risky and costly [13], just like not quantitatively testing business model designs [19].

With our business model engineering method we try to design an initial business model directly in the R&D phase of the innovation process and quantitatively validate it as well in this early deployment phase in order to lower risks, save costs and improve the chances of successful deployment. In this way, the business model can be dynamically improved, adapted and crystallized in the next deployment phases of implementation and market offering [11, 13, 3].

Below, each of our three business model development steps as defined in Section 3 as well as the related results are being discussed.

### 5. Step 1) Designing an initial, qualitative business model

In order to develop an initial qualitative business model design for the myofeedback telerehabilitation service, we surveyed and organized a half day business model design workshop for twelve experts within the field of myofeedback and telerehabilitation from four European countries in which the service could be offered – The Netherlands, Belgium, Sweden and Germany. The method was based on a scientifically tested business model development method [3].

Main question was which business model would be needed for deploying the telerehabilitation service and how the related value and revenue streams would look like.

The experts proposed to offer the myofeedback telerehabilitation service as a fee-based, full service with the health insurance organizations of patients as primary revenue source. These organizations then could reimburse the myofeedback telerehabilitation for their patients. Because of its complexity and high tech character, offering the service in the form of an “off the shelf” product seemed to be less viable according to the experts. Table 1 shows the main value network roles, actors and activities as identified by the experts.

#### Table 1. Main value network roles, actors and activities identified by the experts

<table>
<thead>
<tr>
<th>Roles</th>
<th>Actor</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>End user / patient</td>
<td>Therapist patient</td>
<td>Gets treated by the myofeedback system</td>
</tr>
<tr>
<td>Network provider</td>
<td>Telecom operator</td>
<td>Offers mobile communication services</td>
</tr>
<tr>
<td>Hardware provider (e.g. for communication devices and sensors)</td>
<td>Hardware company</td>
<td>Offers hardware</td>
</tr>
<tr>
<td>Telehabilitation (myofeedback) service provider</td>
<td>(Spin-out) company / independent organization</td>
<td>Offers the actual service (including helpdesk, training &amp; certification, public relations, etc.)</td>
</tr>
<tr>
<td>Health care professional</td>
<td>Therapist organization</td>
<td>Offers the professional care accompanying the activities of the myofeedback service provider</td>
</tr>
<tr>
<td>Software developer</td>
<td>Company</td>
<td>Develops the myofeedback software</td>
</tr>
<tr>
<td>Software platform provider</td>
<td>Company</td>
<td>Offers the myofeedback software platform</td>
</tr>
<tr>
<td>Insurance company</td>
<td>Company</td>
<td>Offers health insurance to end user / patient</td>
</tr>
<tr>
<td>Employer</td>
<td>(Non) commercial organization</td>
<td>Employs the patient</td>
</tr>
<tr>
<td>Medical research &amp; development organization</td>
<td>A (group of) medical institution(s) that support(s) the commercial exploitation of the myofeedback service</td>
<td>Medical research, giving support related to developing training material, certification, etc.</td>
</tr>
</tbody>
</table>

According to the experts, the most crucial role for offering the service would be the telerehabilitation service provider who would offer the service concept to the health care professionals. Besides, the medical research & development organization(s) as well as the software platform provider were expected to be critical because these roles are highly specialized and far more difficult to replace than e.g. a (standard) hardware or network provider. According to the experts, a good cooperation between them would be a prerequisite for viably offering the Myotel service concept in the next stages of the deployment process.
For a complete overview of the proposed value network structure and related roles and revenue streams as proposed by the experts, see Figure 3 and Figure 4.

6. Step 2) Developing a quantitative abstract cost benefit model

Most business model and value network analyses stop at the level described in the previous section without doing any further quantitative validation [3]. Although developed based on the extensive knowledge of experts, in order to get an indication of the viability of the value network design it should be further tested and validated. For this reason, we developed a quantitative analysis model – a so called abstract cost benefit model (ACBM). The model should lead to better insights with respect to the expected benefits and costs related to implementing a new innovation like the telerehabilitation service as described in the previous sections.

6.1 Background of the quantitative model

With the generic telerehabilitation business model design as described in the previous section, an overview was given of the needed value network roles and value exchanges for offering the myofeedback service in a commercial setting.

Based on this qualitative business model analysis, an abstract cost benefit model (ACBM) has been developed which should lead to more insight into the actual viability of the service concept and related value network structure. The model focuses on identifying and calculating the main differences in costs and benefits when comparing traditional treatment of neck shoulder problems and whiplashes with the new myofeedback based teletreatment method. The model abstracts from value network structures: it calculates costs and benefits without predefining specific value network value streams or revenue streams.

Simply stated, the ACBM helps answering the following question: which of the most relevant value network roles will see an increase in costs and which one a decrease in costs related to implementing the new service? This is crucial information for defining the actual money streams (and their heights): when a value network role sees a strong decrease in costs because of implementing the telerehabilitation service, this role may form an important revenue source for the telerehabilitation service provider in order to compensate for the value created by this value role.

6.2 Modeling approach

The modeling principles behind the quantitative model are relatively simple. The basis of the model forms an analysis of the most relevant value network roles in the context of telerehabilitation deployment (see Section 6.3). For each of these stakeholders the most important business processes / activities are defined (see Section 6.4). For each of these activities we then look at the expected volume (N) and related costs of investments, operations and maintenance (P) (see Section 6.5 and 6.6 respectively). For example, investments in IT will recur when the technology is written off.

By multiplying N and P the total costs for each activity are being calculated – C. In summary: C = N * P. N and P are dependent on variables, like market size, hourly rates, etc. These variables are described in Section 6.7 and used for calculating the results as described in Section 6.8.

The related volume estimations are based on an S shaped technology adoption curve over a ten year period. Price developments are also implemented: in the model, prices of technology are declining over time (deflating prices), whereas e.g. salary costs for professionals are increasing (inflating prices). Net Present Value calculations are implemented as well.

By changing the variables in the ACBM as developed in the form of an Excel spreadsheet model, the model automatically recalculates all expected benefits and costs.

In sum, the ACBM was developed by using the following five steps:

A. Identify the primary value network roles.
B. Identify the main activities associated with each of the roles as identified in step A.
C. Determine the costs related to these activities.
D. Determine the volumes of the activities.
E. Calculate the expected benefits and costs.

Each of these steps will be discussed in the following sections.

6.3 A) Identify the primary value network roles

On the basis of interviews with the experts as mentioned in Section 5, four main value network roles for benefit and cost calculations were identified: 1) the myofeedback service provider, 2) the health care provider, 3) the employer and 4) the patient.

The service provider offers the actual myofeedback telerehabilitation service value proposition. Important
activities of this role are e.g. managing the telerehabilitation back office and myofeedback devices as well as developing the service concept. Another important role is that of the health care provider who diagnoses and consults patients. The health care provider performs the actual medical treatment. The employer employs employees who may or may not play the role of telerehabilitation patient.

6.4 B) Identify the main activities associated with each role

Based on a value network role activity analysis, supported by the experts mentioned before, the most important activities for each role as mentioned in the previous step were identified (see Table 2). Because the ACBM focuses on the main differences in costs and benefits between new and traditional treatment, the experts were also asked to identify the activities that are expected to lead to the most substantial cost and benefit changes. These activities are italicized in Table 2 and modeled in the ACBM.

Table 2. Main value network role activities

| myofeedback service provider | • manage telerehabilitation service (overhead)  
| • develop telerehabilitation market (marketing)  
| • acquire telerehabilitation 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 telerehabilitation treatment  
| • train personnel telerehabilitation treatment  
| • diagnose patient  
| • consult patient with traditional treatment  
| • consult patient with telerehabilitation treatment  
| • request reimbursement treatment  
| • receive payment for treatment  |

| employer | • employ traditionally treated employee  
| • employ telerehabilitation treated employee  |

| patient | • undergo traditional treatment  
| • undergo telerehabilitation treatment  |

6.5 C) Determine costs related to the primary value network role activities

In order to perform the activities as identified in the previous section, costs have to be made. These costs have been defined for each of the activities identified and modeled in the ACBM as introduced in Section 6.2. For the model, we made a distinction between investments (like investments in hardware, maintenance, training and education and depreciation) and operational costs (like personnel and housing).

6.6 D) Determine the volumes of the activities

Next to the costs also the volumes related to the activities were identified by the experts, like the number of patients treated, the number of treatments and actively involved health care professionals as well as the number of devices and back offices needed.

6.7 E) Calculate the expected benefits and costs

After the previous four ACBM development steps, the main value network roles and their main activities and related costs and volumes were modeled in a Microsoft Excel spreadsheet over a ten year period – from 2008 to 2018.

For calculating the costs and benefits of the myofeedback telerehabilitation service over this period, a so-called variables cockpit was developed which gives an overview of the most important variables that influence the costs and volumes as mentioned before and based on which the actual benefit and cost calculations can be made. Important variables in this context are e.g. the hourly cost price of a health care professional, the number of therapeutical contacts per treatment, and the myofeedback device costs. The figures for the cockpit variables were determined based on a survey filled in by and a related workshop held with the experts as mentioned before.

For a complete overview of all cockpit variables, see Figure 10. The variables in Figure 10 are successively grouped by general country characteristics, general healthcare professional variables, variables related to traditional and myofeedback telerehabilitation of neck shoulder problems and variables related to traditional and myofeedback telerehabilitation treatment of chronic whiplashes. The last section consists of some specific variables related to the telerehabilitation service provider role.

Based on these variables, the volumes and costs for each of the activities identified were calculated over the period 2008 – 2018 (based on the S shaped technology adoption curve as mentioned before). Because the model was designed in the form of a spreadsheet, the model is very flexible: the effects of changing one or more variables will directly be calculated. Based on a different set of cockpit variables for different countries, the cost delta model can
automatically estimate the expected volumes and costs on a country-by-country level over the period 2008 – 2018. In this way, the APCM formed a useful tool for evaluating a new service innovation and related costs and benefits in direct interaction with field experts.

6.8 Results 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):

1) The cost benefit model showed that the new myofeedback treatment is more expensive compared with traditional treatment – mostly because of IT related investments and operational costs; see also Figure 5.

2) Although the myofeedback treatment is expected to be more efficient compared with the traditional treatment method, the IT investments are not likely to compensate the related labor savings on a health care professional level; see also Figure 6.

3) However, the expected absence reduction and productivity increase of working myofeedback patients does compensate the investments needed on an employer level; see Figure 7 and Figure 8. Therefore, employers should be actively involved and regarded as a crucial value network role and revenue source for the teletreatment service.

In other words, the ACBM falsified the initial value network structure that resulted from step 1) (‘Designing an initial, qualitative business model’) because the myofeedback teletreatment service is not expected to be cheaper than traditional treatment methods. Therefore, there is no incentive for most private healthcare insurance organizations to reimburse myofeedback teletreatments – which was initially expected by the experts. And because the ACBM showed that employers are expected to receive the most benefits related to implementing the myofeedback service, these organizations should be seen as the main potential revenue source when deploying the myofeedback teletreatment service and therefore as a critical value network role as well.

7. Step 3) Derive a viable value network design

Based on the previous two steps the initial value network design was updated in the form of two alternative value network structures.

Because employers (as well as their occupational healthcare / disability insurance organizations) and not the private healthcare insurance organizations seem to profit most from implementing the myofeedback service concept, a revenue model based on payments by employers (or their insurance organizations) seems to be more feasible. A related alternative could be to directly offer the service to employees via the health and safety departments of their employers.

All designed value network structures were validated in the form of eight semi structured expert interviews with organizations that could potentially fulfill critical roles in the value network design (like health care professionals, insurance organizations and potential myofeedback service providers). Based on these validation interviews, the first alternative value network structure (a revenue model based on payments by employers) turned out to be the preferred option, in line with the results of the APCM. One change was proposed by the experts: they proposed to extend the role of the software platform provider in the initial value network structure (see Figure 3) into that of a system integrator which integrates the software as well as hardware components needed for the myofeedback service concept. Because of this change, the myofeedback service provider could focus on the actual delivery of the myofeedback teletreatment service without the need for resources related to handling technical issues. For the resulting value network design of this last business model engineering step, see Figure 9.

Just as the second step in our business model engineering approach, also the third step proved to be valuable with respect to further validate, improve and increase the expected viability of the initially designed business model and related value network structure.

8. Conclusions

In this paper, we described our business model engineering approach to early stage business model and value network development for a myofeedback teletreatment service in the R&D deployment phase. The first results of the method are encouraging: by using the method the viability of the business model and related value network design could be further validated and improved in each of the subsequent development steps.

Therefore we suppose that – also already in early stages of deployment processes – the viability of a business model and value network design can be tested and improved by integrating insights from qualitative and qualitative business model analysis in iterative action design cycles.
The calculation method used abstracted from actual value and revenue stream designs within value network structures. It resulted in an overview of value network roles with the most expected financial benefits and costs related to introducing a new service, which is crucial information for designing viable value network structures.

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: seeing the initial value network structure fully implemented and then fail in the marketplace is a much more expensive and time consuming validation method [13, 19].

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 action design cycle should be further integrated as well. Besides, a more thorough analysis of environmental factors like market, technology and regulatory environments [3, 11, 4] could be included in the method. Especially in the context of e-health service innovations, regulatory environments may have a strong impact on e-health innovation deployment viability, next to technological quality and user acceptance [17, 4].

In order to reach these goals, we plan to apply, validate and further improve the method in future deployment projects.

9. References


Figure 1. The myofeedback teletreatment service

Figure 2. Components of a business model

Figure 3. Initial telerehabilitation service value network structure with value streams

Figure 4. Initial telerehabilitation service value network structure with revenue streams
The cost benefit model showed that the new myofeedback treatment is more expensive compared with traditional treatment – mostly because of ICT related investments and operational costs; the total costs are expected to increase with about € 100 (from ~€400 to ~€ 500) per patient.

A graphical overview of the cost benefit analysis in the Netherlands; showing respectively expected ICT investments and ICT operational costs, service provider and health care professional investments (#1: neck shoulder treatment; #2: whiplash treatment) and the expected operational benefits/costs for health care professionals.

A quantitative overview of the cost benefit analysis for the Netherlands. Compared with Figure 6, now also the maximum employer benefits related to absence reduction and productivity improvement are shown.
Figure 9. Final telerehabilitation service value network structure with revenue streams

Figure 10. An overview of the Myofeedback teletreatment cockpit variables