Collaboration and the Knowledge Economy: Issues, Applications, Case Studies
Paul Cunningham and Miriam Cunningham (Eds)
IOS Press, 2008 Amsterdam
ISBN 978–1–58603–924-0

Business Modelling for eHealth applications in Emergency Medicine Systems

Eric NASS[1], Gerald PÖTZSCH[2], Peter LAING[1], Ivonne SCHWAAR[1]
[1]*Research Institute for Operations Management (FIR) at RWTH Aachen University, Pontdriesch 14/16, 52062 Aachen, Germany*
Tel: +49 241 477 05 - 0, Fax: + 49 241 477 05 – 199,
Email: {Eric.Nass; Peter.Laing; Ivonne Schwaar}@fir.rwth-aachen.de
[2]*PHILIPS Medical Systems, Röntgenstraße 24, 22335 Hamburg, Germany*
Tel: +49 40 5078 - 4150, Fax: +49 40 5078 - 45 47, Email: Gerald.Poetzsch@philips.com

Abstract: In Germany the EMS sector has to face many difficulties in the near future among which the long-ranging shortage of emergency physicians and the constant monetary burden are just the most prominent. The solution to these problems is seen in the development and employment of an eHealth telemetric support system for EMS. The long-term success of such a system is determined by human, organisational and technological factors. Hence an integrated approach for the development of an eHealth system for EMS has to be applied. In this context the paper focuses on the development of an appropriated business model. It examines the methodology for business modelling in the eHealth sector and gives first insights to the market for EMS eHealth services.

Keywords: Telemetric Support System, Emergency Medicine System, eHealth Business Modelling

1. Introduction

In Europe there are mainly two different Emergency Medical Systems (EMS). One is accomplished by paramedic staff and confined to fast transportation of emergency patients to a hospital, the other focusING on emergency physicians and on-site treatment. The first kind of EMS is to be found in the UK or the Netherlands for example where the treatment of patients during transportation is highly standardised and follows strict guidelines.

The German EMS differs fundamentally from this kind of EMS. Emergency physicians play a major role in German emergency aid. Highly qualified physicians already treat patients on-site. This approach led to some serious problems as the number of emergency calls has doubled during the past 10 years, which results in a higher number of required physicians. The proportion of emergency physicians' responses referring to the overall number of primary aid assignments has also raised significantly [1]. Additionally there will be a serious shortage of manpower in the field of EMS especially referring to emergency physicians caused by a lack of qualified personnel. This will lead to a critical situation in primary care if no suitable measures will be taken. By now there is already an alarming shortage of emergency physicians in rural regions of Germany [2]. Moreover, the absence of an appropriate quality control for emergency treatments (due to the lack of standardisation) is a further reason for the need for action in the field of EMS [3].

2. Objectives

This paper discusses a systematic approach for developing an integrated ICT, organisational and business model for a telemetric support system in the field of EMS developed within

the project “Med-on-@ix”. This research project is funded by the Federal Ministry of Economics and Technology (BMWi) and is currently in progress. The project start was in October 2007 and the run time is scheduled for three years.

The objective of this paper is to present instructions for a holistic modelling approach of the system and to highlight the importance of the development of a feasible business model that balances the different interests on an eHealth system in the field of EMS.

3. Project Description

The project “Med-on-@ix” aims the increase in efficiency and quality of emergency medical treatment. As already stated by Fischer et al. [4] quality control and cost-effectiveness in the whole healthcare sector are required by law in Germany. In practice this does not work for lots of fields in medicine, especially not for the emergency medical service. Therefore quality control is a major intend of Med-on-@ix. Efficiency can be obtained by measures leading to a shortening of time a physician has to spend on-site which also leads to a reduction of the number of emergency physicians and mitigates the personnel shortage in EMS. The achievement of these goals will be procured by the development and implementation of a telemedic support system basically consisting of a telemedical competence centre, a data transmission unit and suitable medical apparatus. Emergency patients will receive quick medical aid either by tele-consultation or by the physical presence of an emergency physician who can additionally be supported by a telemedical competence centre. The paramedic staffs are enabled to communicate with emergency physicians, or further specialists, in real-time whereby the Med-on-@ix system facilitates the fast transmission of ECG and pulse oxymetry data for example. Data transmission from the site of emergency to the hospital will lead to a higher level of process integration between primary aid and clinical treatment and shorten the overall medical process. Therefore a quality management adequate and standardised treatment can be provided for the patient. Additionally, the number of cases in which the presence of emergency physicians is required will decline remarkably. The technical development considers compatibility with the electronic health card and the electronic patient record which will probably be established in Germany within the next years. The approach to system development comprises an iterative method with several prototypes.

Besides Med-on-@ix there are several projects in the EU and especially in Germany that deal with telemedicine for different application areas. The EU-funded MobiHealth system allows patients to be fully mobile while there vital parameters are monitored [5]. Patients wear a lightweight monitoring system which measures physical parameters, such as blood pressure or ECG. These measured data are transmitted wirelessly to the patients’ doctor, a hospital or a healthcare call centre. In the TEL LAPPI III project (Finland) local general practitioners (GP) are linked with medical specialists at larger hospitals via videoconferencing technology, digital image transfer and an electronic feedback system [6]. The differences between this projects and Med-on-@ix are obvious: Med-on-@ix is concentrated on mobile emergency-medicine, whereas MobiHealth an TEL LAPPI more or less are geared towards the general connection between several parts of the healthcare system: Patients, GPs and medical specialists.

Particularly in Germany there are also some projects concerning telemedicine in emergency treatment. The most prominent projects are StrokeNET in the city of Berlin and TEMPiS (Telemedicine Pilot Project for Integrative Stroke Care) located in Bavaria which are specialized in the treatment of stroke patients [7] [8]. While StrokeNET also aims on fast transmission of vital parameters form a special equipped MICU to a so called stroke unit (specialized facility in an emergency room) the project TEMPiS focuses on the interconnection of different stroke units. Though Med-on-@ix purposely does not

concentrate on a particular disease pattern but supports all kinds of emergency treatments. In this sense the character of the project is much more extensive.

4. Methodology

4.1 M-O-T Approach

The questions to be answered within the project are complex and cannot be solved by applying methods from a certain subject area such as engineering sciences or economic sciences in isolation. The development of an EMS as complex as Med-on-@ix is intended to be, requires a holistic examination of human, organisational and technical interactions. To guarantee the aspired improvement of working conditions, efficiency and quality of emergency medical aid in Germany, the M-O-T (Mensch-Organisation-Technik, engl. human-organisation-technology) approach is used. Figure 1 illustrates the M-O-T triangle.

Henning et al. describe the M-O-T approach as a methodology to record and solve complex phenomena and problems arising in enterprises [9]. The M-O-T approach utilises methods and models from different subject areas because the continuously increasing support of human labour by technology created numerous interfaces between social, technical and organisational factors. Since these interdisciplinary problems cannot be solved by one scientific area a new approach had to be developed. The success of this approach is well-founded by the combination of methods from social, engineering and economic sciences to develop solutions or models for complex questions. To cover the different fields in question all methods used in the project are based on M-O-T approach.

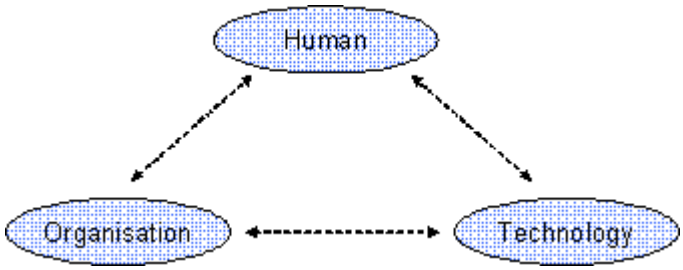

Figure 1: The M-O-T Approach

The main focus of this paper concerns the creation of an appropriate business model that can be located in the M-O-T triangle. Interests of people getting in contact with the telemetric support system, like patients and medical personnel have to be taken into consideration as well as technological potentials arising from the deployment of modern data transmission technology and last but not least adjustments in the medical processes and the organisation of the EMS have to be included. A methodical approach for this is presented in the next section.

4.2 Business Modelling: House of Value Creation

Referring to a study of the eHealth Initiative, most decisive for the long time success of an eHealth service is the presence of a stable business model [10]. A telemetric medical support system for the EMS has to meet many – sometimes opposing – requirements. On the one hand there are the mentioned medical and legal requirements and restrictions while, on the other hand, the economic and organisational aspects are very important, too. Without a benefit for the sponsor of the system there is hardly a chance of being launched onto the market. The balance of the different requirements and the fairly distribution of benefits and efforts among the diverse actors and stakeholders in the EMS has to be assured. To get an

appropriate solution to this difficult problem a systematic and structured procedure has to be used [11].

To overcome the described obstacles the business modelling method "House of Value Creation - HVC", originally developed by the Research Institute for Operations Management at RWTH Aachen University (FIR) for creating business models in the field of internet start-ups, is applied and the necessary extensions are analysed [12].

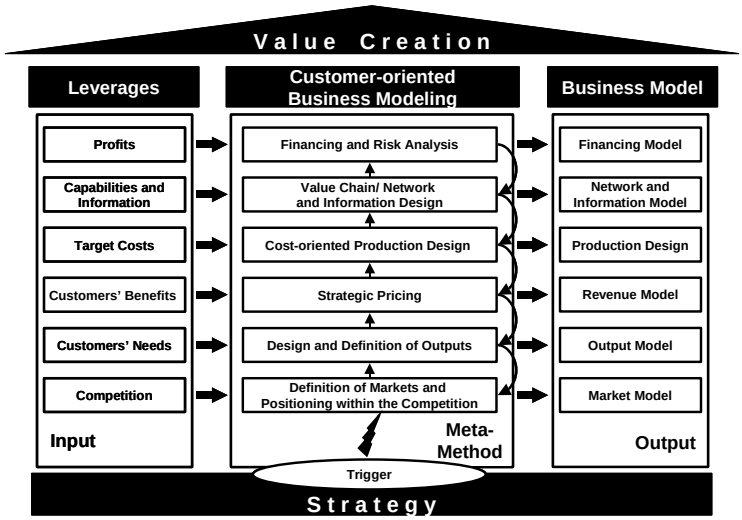

Figure 2: The House of Value Creation – HVC [12]

The HVC consists of 6 layers that correspond to six steps of the method. These steps and the associated questions are as follows (cp. Figure 2):

- Definition of markets and positioning with respect to competition. The first aim in this phase is the determination of possible customer groups in EMS. The initial decision regards the category of services to deal with. Defining the market roles and stakeholders is the first task to be accomplished. The market for medical services is highly restricted; which must be taken into account from the very beginning. Phase output: market model, with a clear identification of relevant market participants, customers and competitors.
- Definition and design of the outputs. The offered services must match the needs of customers addressed. Concerning product design, a well-proven method is the Quality Function Deployment (QFD) [13] [14]. This approach can also be used for service offering as well and a customer-oriented service development can be successfully realized [15]. Needs of the afore defined customers are the basis for this specification. Phase output: output model, with a detailed customer-oriented design of the outputs.
- Strategic pricing. The identification of prices for the planned outputs should be rather the result of strategic positioning than of a cost-oriented approach [16]. Value and benefit streams have to be analysed. This includes cost reductions for health insurances and hospitals as well as more soft factors like qualitative added-value for the medical personnel. Phase output: revenue model, which shows detailed pricing scenarios.
- Cost-oriented production design. The competence centre's services have to be offered below target cost level. Findings from the pricing phase are the main input for the definition of the cost limit. Appropriate service provision structures have to be selected or developed that allow for a profitable operation of the system. Hence, the requirements to the value chain will be detailed. Phase output: service production design, with a detailed description of how the performances have to be achieved.
- Network and information model. In this phase, the definition of core competencies of the competence centre is the basis for the decision of the inclusion of potential partners. Hence the performance structure of the identified potential partners will be thoroughly

analyzed. Additionally the information flows for the operation of the partner network have to be examined. Phase output: network model, selection of the partners within the EMS value chain.

- Financing and risk analysis. According to the findings of a risk analysis, an appropriate funding structure has to be selected. The choice of the kind of legal entity is a crucial factor in the sensitive field of EMS as well. Phase output: financing model

As a meta-method the HVC provides a procedure consisting of a sequence of steps. At each step the corresponding targets have to be fulfilled. If a subordinate target cannot be reached an iterative process should be initiated. The parameters of the previous phase have to be adjusted until the issue is tackled.

5. First Results from 'Med-on-@ix' Project

The analysis of the different market roles and stakeholder in the field of EMS, as first step of HVC, has shown a very specific organisation of the market for primary aid in Germany. Typically there are at least two distinct roles in a market. First, there is a provider of a product or service and second, there is a customer who pays for the offered service that fulfils his or her needs. For an eHealth service, or more precisely a telemetric support system like the one developed in the project, this distinction is not that clear. The first question to be answered is the question of who is the customer. Patients receive a benefit of the eHealth service because of an improved quality of the medical treatment and a saving of time from the first contact with the EMS and the subsequent treatment in the hospital (the latter can be argued, for example, by a faster preparation of an operation because relevant medical information are sooner available). However, the payment for the service is in the duty of the health insurers. This separation of consuming a service and paying for a service does not correspond with the classical definition of a customer. Therefore a third role has to be defined, the role of the financier of the system. Hence there are roughly three major categories of stakeholders: the financier of the telemetric support system, the provider of that system and the customer. The first category consists of the health insurances. In the last instance health insurances have to bear the financial expends related to the emergency treatments of their insurants. Between the insurers and EMS operators there is a public institution that must provide the EMS and has the responsibility to guarantee an appropriate primary care to the citizen in their region. The occurring costs are passed to the insurers.

The second market role is the operator of the medical competence centre. This competence centre could be in the responsibility of the present EMS operator or be supplied by an independent third party. This supplier has to be assigned by the public institution and has to bargain appropriate fees for the service. This bargaining procedure is hampered by the diversity and the fragmented structure of the organisation of EMS in Germany (nearly every local authority has its own EMS).

The third category of stakeholders consists of customers and users of the system: patients, emergency personnel and physicians. They benefit from the offered services but do not pay for it directly. In case of emergency the patients are not in the position to choose if they want to have a telemetrically supported treatment or not. This is the decision of the insurers, they have to decide if their insurants will get the service or not.

Additionally there is a further category of stakeholders, the medical equipment manufacturer and mobile network suppliers. They are suppliers to the system and they are not taken into account in the further discussion because they are not seen as critical stakeholders. Figure 3 illustrates the identified stakeholders in the narrow definition of the market of eHealth services in the field of EMS.

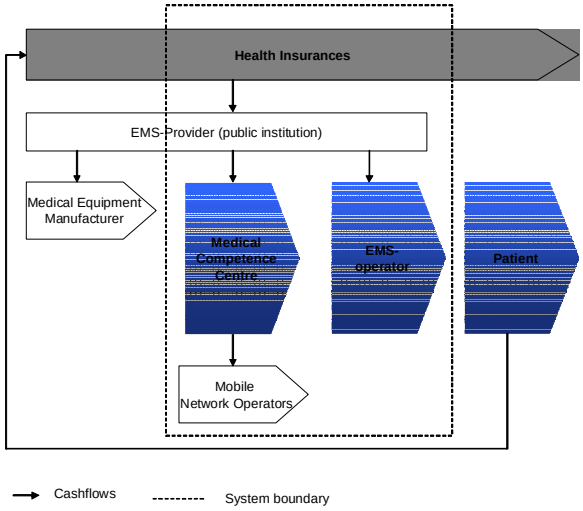

Figure 3: Narrow Market Boundary of Telemetric Support System

A major difficulty for the development of a business model for eHealth services in the EMS sector consists in the differentiation of the roles of the financier and the customer. The interests of these two roles are partly opposed: patients want to have a thorough and professional treatment with high quality standards, the health insurers are also interested in cost cutting. So the introduction of an eHealth system like Med-on-@ix has to get along with this tension. At first sight a telemetric support system will result in higher costs, because of the new infrastructure that has to be built up. On the other hand there are saving potentials by a reduced number of needed emergency physicians. Many assignments can be conducted by non-physicians in cooperation with experts in the competence centre. Key to this savings is the scalability of the support system. Only a supra regional employment of an eHealth system like Med-on-@ix will grant for this kind of savings.

Another critical issue deals with the system boundary. If the field of examination is limited to the original EMS, the monetary effect could stay negative in the long run. But health insurers have to pay for the medical treatment as a whole, from primary aid along the clinical treatment until the rehabilitation phase. A telemetric support system can reduce the time for a treatment of a patient with acute cardiac infarction by transferring all relevant data from the mobile intensive care unit to the hospital for example. Hence an operating theatre and all relevant measures can be prepared while the patient is on the way to the hospital.

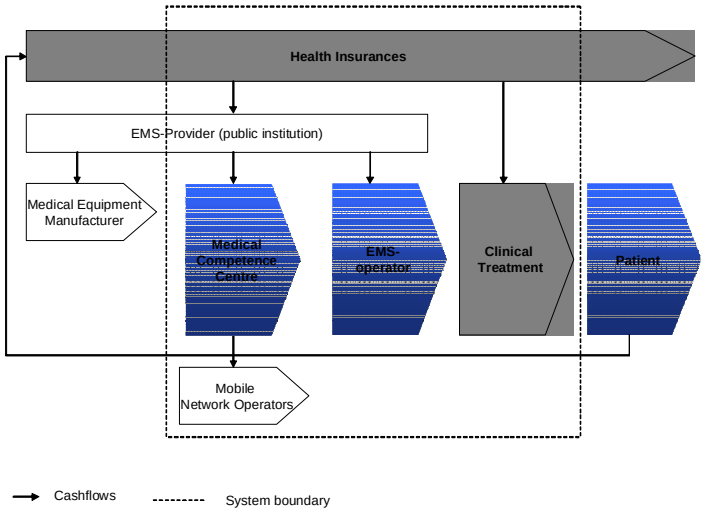

Figure 4: Wider Market Boundary of the Telemetric Support System

Looking at the same market in this wider definition will lead to a better monetary effect from the view of the health insurance companies. Savings in the clinical treatment will exceed the higher costs in the EMS in many cases. The adequate market definition is the basis for an appropriate assessment of the benefit of an eHealth service in the EMS field.

6. Future Work

In order to gain a valid business model the remaining intermediate models have to be generated. Therefore workshops with health insurance representatives are planned. Since the health insurances are the cost-bearers of a future Med-on-@ix system their decision-makers will be involved in the development of the business model from this early state of the project on. Furthermore the results of the legal opinion will provide the basis for decision making about which organisational concept is possible to convert into practice according to the present legal background.

The further technical work includes the performance of mock-up tests. Later-on the complete system of Med-on-@ix will be prototypical implemented in the urban area of Aachen at runtime of the project. During this period of time the concept will be evaluated in regard to the technical quality. In order to ensure the currently best treatment of the patient an emergency physician will also be on-site during the test period. So Aachen will act as a model region for eHealth in EMS and should be an archetype for other regions in Germany as well as in other European countries. Therefore the business model has to be flexible and adaptable to different framework conditions.

7. Conclusions

First results of the HVC demonstrate that the surrounding conditions for EMS are very narrow which has effects on the business modelling. Different legal developments in the field of data security or labour legislation, for example, limit the range of possible services that can be offered. This indeed affects the benefit level of potential customers and their willingness to pay for the service. Because of diverse variables that are yet indefinite it is necessary to operate with different scenarios and to connect these scenarios with probabilities of occurrence. Transition paths between the scenarios can support the eHealth-system-operator to deal with changing conditions. Business models for eHealth solutions have to provide this kind of flexibility to be a sustainable basis for doing business.

The health policy has to provide the general conditions for the establishment of a telemetric support system in the field of EMS. The long term benefit is perfectly obvious because it will contribute to a more efficient and qualitatively better treatment of emergency patients. To face the difficult developments like critical personnel shortage and constant cost pressure in EMS a system like Med-on-@ix will be a milestone. If market forces cannot reduce the different interests of the involved stakeholders to a common denominator; health policy should take into account to set incentives to the stakeholders.

For this reason a major assignment in the near future, besides the technological development, consists in the comprehension of health insurances and health policy representatives.

Acknowledgement

This research is part of the collaboration of the University Hospital Aachen, the University of Aachen (represented by the Centre for Learning and Knowledge Management and Department of Computer Science in Mechanical Engineering (ZLW/IMA), the Institute for Entrepreneurial Cybernetics (IfU), the Research Institute for Operations Management (FIR), Philips Medical Systems and P3 Solutions GmbH.

The project Med-on-@ix (www.medonaix.de) will run until July 2010. It is promoted by the Federal Ministry of Economics and Technology (BMWi) in cooperation with the German Aerospace Center (DLR-Multimedia) as the responsible project execution organisation. The dissemination of project results and the application of developed technologies on field of emergency medical care are ensured by the project consortium.

References

[1] H. Behrendt, R. Schmiedel: Die aktuellen Leistungen des Rettungsdienstes in der Bundesrepublik Deutschland im zeitlichen Vergleich (Teil II). In: Notfall & Rettungsmedizin. Volume 7, Number 1 (2004): pp. 59-70.

[2] S. Rieser, Arbeitsbedingungen schrecken viele ab. In: Dt. Ärzteblatt. 102. Ausgabe, Number 12 (2005): A-797/B-673/C-629.

[3] A. Gries, M. Helm, E. Martin: Zukunft der präklinischen Notfallmedizin in Deutschland. In: Der Anästhesist. Volume 52, Number 8, (2003): pp. 718–724.

[4] M. Fischer, H. Krep, D. Wierich, U. Heister, A. Hoeft, S. Edwards, L.G. Castrillo-Riesgo & T. Krafft, Anästhesiol Intensiv Notfallmed Schmerzther, 38, Georg Thieme Verlag Stuttgart, 2003, pp. 630 – 642

[5] MobiHealth project description. Source: http://www.mobihealth.org, accessed on 03.03.2008.

[6] Lapland Hospital District (ed.): TEL LAPPI III – From technological initialization to the development of services. Source: http://www.lshp.fi/download.aspx?ID=808&GUID=%7B2FCD751A-8502-4FCA-B291-E67BBFF7E1BB%7D, accessed on 03.03.2008.

[7] Stroke NET project description. Source: http://www.strokenet.de, accessed on 03.03.2008.

[8] TEMPiS project description. Source: http://www.tempis.de, accessed on 03.03.2008.

[9] K. Henning, R. Oertel, I. Isenhardt,: Wissen - Innovation - Netzwerke. Wege zur Zukunftsfähigkeit. Berlin 2003.

[10] eHealth Initiative (ed.): 2007 Fourth Annual Survey of Health Information Exchange at the State, Regional, and Community Levels. Source: http://www.ehealthinitiative.org/2007HIESurvey/, accessed on 02.22.2008.

[11] A. Osterwalder, Y. Pigneur: An e-Business Model Ontology for Modeling e-Business. In: Proceedings of the 15th Electronic Commerce Conference “e-Reality: Constructing the e-Economy", Bled (SLO), 17 – 19 Juni 2002. Bled.

[12] T. Forzi, P. Laing: E-Business Modeling, in Albalooshi, F. (Hrsg.), Virtual Education: Cases in Learning Teaching Technologies, IRM Press, Hershey, London, Melbourne & Singapore (2003), pp. 113-138.

[13] T. Pfeiffer, Qualitätsmanagement: Strategien, Methoden, Techniken. Munich 2001.

[14] J. Hoffmann, Entwicklung eines QFD-gestützten Verfahrens zur Produktplanung und -entwicklung für kleine und mittlere Unternehmen, Stuttgart 1996..

[15] J. Saatweber, Kundenorientierung durch Quality Function Deployment, Systematisches Entwickeln von Produkten und Dienstleistungen, Düsseldorf 2007.

[16] T. Forzi, P. Laing, Business Modeling for E-Collaboration Networks. Proceedings of the 2002 Information Resources Management Association International Conference (IRMA 2002), Seattle, WA (USA), May 19th–22nd, pp. 961-963.