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# Identification of Quality Parameters for an E-Health Platform in the Federal State of Thuringia in Germany

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**Abstract**

Many developed countries experience an acute shortage of medical specialists beyond urbanized areas. Specialists and services that are available are usually concentrated in cities apart from the growing number elderly people, who represent the main part of the population in rural areas. These people underlie a growing risk of dementia and live in marginalized isolation apart from specialist support. With the recent development in information and communication technologies, new options for telemedicine and for general knowledge sharing at a distance are becoming increasingly accessible to medical specialists as well as geographically and demographically disadvantaged populations. This paper provides a selected insight into the current state of the art of an E-Health based platform on federal state levels in order to assist medical doctors, nursing services or family members, to communicate with each other. We conclude that such an interconnected platform is highly suitable for the federal state Thuringia in Germany, which is bearing a positive influence on the future of regional health care.

Keywords: Dementia, Demographic changes, E-health, Regional healthcare, Technical process, Telemedicine platform, Thuringia

## 1. Introduction

The elaboration on a telemedicine platform on federal state level is an important part of actual research that helps in providing better healthcare within a regional context. As for the federal state of Thuringia, this development is in its initial project phase and consisting of several individual subprojects for the best-possible establishment of a generic and scalable telemedicine platform (Fincke et al., 2013). This platform shall support especially people underlying demographic changes, symptoms of social isolation and cerebral disorders including dementia in Thuringia (Eib et al., 2014). The urbanization has increased over last decades with the effects of widespread population related losses in rural areas (Gans and Schlömer, 2014). Areas like the Thuringian Forest, Thuringian Slate Mountains, as well as southern, eastern and northern parts of the state suffer economically from the effects of rural-urban migration with subsequent impacts caused due to this situation. This project targets on the improvement of quality of medication by surveying on the implementation of a telemedicine platform in Thuringia and identifying advantages and disadvantages of the usage of such a platform. This study also aims at proofing that telemedicine or E-health services provide more advantages in terms of technical processing as well as patient service. Results show convincing findings about the selection of healthcare provider organisations for regional hospitals in Thuringia. This project compares current technical processes in telemedicine.

## 2. Problem Background

Thuringia consists of an area enclosing 16172.50 km², being inhabited by approximately 2,000,000 people, living mostly in smaller cities. Around 24% of the population live in a cluster with more than 600 inhabitants per square kilometre, which represents 4% of the total area of Thuringia. This small number encloses the biggest towns of Thuringia, namely: Gotha, Erfurt, Weimar, Jena and Gera. However, the northern and south-eastern parts of the state are classified as rural areas due to a population density of less than 25 inhabitants per km².

The population development of Thuringia is characterized by five core processes: decline, aging, heterogeneity, internationalization and individualisation of the population according to the Thuringian ministry for construction, regional development and transport (TMBLV).

The population decline in Thuringia is after the decline in Mecklenburg Vorpommern is the second highest in Germany. The number of inhabitants in Thuringia has decreased by 14.4% in 2011 according to TMBLV. The decline occurred mostly in rural districts with a decrease of 14.55%, and an observed population increase among the cities with 12.43%. Widespread population losses in rural areas such as the Thuringian Forest, Thuringian Slate Mountains, as well as southern, eastern and northern parts of the country were recorded with simultaneous increase in urban areas.

Aging of the population is a distinct phenomenon in Thuringia. The proportion elderly citizens increase with a constant tendency for the next 20 years (TMBLV, 2011). According to the Federal Ministry of the Interior one in three citizens will be older than 65 years in 2030. The consequences of this demographic development represent a challenge especially for the health care sector since the number of people reliant on health care increases with age. This development triggers an increasing number of multi-morbid and degenerative diseases. Moreover, it was observed that particularly in rural areas, the spatial distribution of infrastructure leads to a "regional competition". Due to the concept of general interest, central places like cities become more important especially those which provide access to healthcare facilities. Since the discovery of demographic change impacts, the state government of Thuringia is working on the problem of demographic changes in Thuringia and developing various concepts to counteract its negative effects. As guidelines for a demographically fixed infrastructure in Thuringia, there are certain conditions for economic development; (1) a basic package of essential services, (2) individual regional concepts and (3) a common commitment to the problem. To ensure the sustainability of infrastructure, operational principles such as modernization or the usage of new technologies, solutions or individual ownerships are addressed.

Recently, the use of telemedicine is generally assigned in this context of sustainable health care in the rural areas of Thuringia under the action principle of the use of new technologies. Under the observation of demographic changes, methods need to be elaborated to ensure sustainable health care in rural areas. One option is the use of new technologies such as telemedicine services to improve the medical treatment among spatial distances.

## 3. Problem Statement

One issue that arises during the development of a tele health platform is the creation of a quality ensuring method for the medication of dementia affected patients. Unfortunately, the correct selection of dementia medication represents an ambiguously manageable problem. The quality measure for dementia specifically excludes measurements taken by the specialists on a regular basis, thus precluding the mental condition tele monitoring as a way to meet the dementia goal. To counter this barrier, advocacy in telemedicine is needed so that tele monitoring as a data collection tool is included in quality measures. In order to ensure medically correct treatment using the platform, it is important to identify and verify chosen medical paths on a national level.

## 4. Objectives

The aim of this study is to identify suitable benchmarking processes to outline the benefits of the telemedicine platform especially for treatments of dementia. One goal is to identify measurement parameters to evaluate and compare clinical processes. This will provide supportive steps in the process of decision taking during the development and implementation of a licensed telemedicine platform.

## 5. Methodology

The methods applied in this research enclose the collection and elaboration of topic related literature. Data encompassing telemedicine, tele monitoring and E-health were collected. Most of the articles were taken from “Web of Knowledge and Google Scholar websites”.

Extraction of relevant content was applied previous to analysis. Subsequent to the extraction procedure, articles were related to technical process diagrams in order to facilitate the analysis process. For comparison purposes, a table was created enclosing technical processes, criteria and applications based on telemedicine and without telemedicine basis.

## 6. Results

Our review results in the agreement with North et al. who address the need for quality measure, when treating specific diseases like dementia of diabetes from a distance (North et al., 2014). This also shares the point of view that although tele healthcare appears promising and allows access to populations in rural areas, it lacks in on-site (face to face) treatment (Magann et al., 2014). This technology may provide internationally clinical health care and decrease distance barriers by improving access to medical services that would often not be consistently available in distant rural communities, however, it has not the potential to fully substitute medical doctors. Especially, the condition of the user is highly important and may affect the effectiveness of this tool. Major mental impacts like dementia may impact incompatibility in direct application of this approach. However, previous works on the field of cognitive impairment treatment like dementia show promising results with compliance rates up to 95% (Lee et al., 2000; Lott et al, 2006; Poon et al., 2005; Wang et al.

2014; Harrell et al., 2014). Therefore, we regard telecommunication and information technologies as distant precursors to telemedicine. They allow us to communicate with patients and medical staff. Moreover, we have the ability to exchange clinical parameters, imaging and health informatics data from one site to another. Advantages of telemedicine based on our literature review enclose the following:

A. Cost Effectiveness

Telemedicine directly affects the costs of patient admission per year. If we assume that 10% of 80 patients per month avoid medical transportation, 8 out of 80 patients per month do not require transportation. For calculation purposes, however, we use the likelihood of a patient. This allows us to change the number of patients to 16 for example. To calculate the likelihood ($lh_p$) for one patient, 8 the likelihood of 8 patients (pa) is divided by the total number of patients, which is 80 (PA). Using Eq. 1, the value for the likelihood in this setup is calculated to 0.1, which represents the number of avoided medical transportations by month for a single patient.

$$lh_p = \frac{pa}{PA} \tag{1}$$

B. Avoidance of Community Nurse Visit

A community nurse needs to visit her dementia patients once a week in order to perform a mental performance test. With new self-monitoring service technology, the community nurse would only see her patients once in three months in order to just run an overall check. To calculate the avoided visits, a simple calculation as shown in Eq. 2 is required. One visit ($V_n$) per week ($W_n$) results in 52 visits per year ($V_{Vn}$) and one visit ($V_L$) in every 12 weeks ($W_L$) results in four visits per year ($V_{VL}$). In order to calculate the number of avoided visits, we simply deduct four ($V_{VL}$) visits from 52 ($V_{Vn}$), which is 48 visits. Latter is the number of avoided visits per year ($\frac{A_v}{Y}$).

$$\frac{A_v}{Y} = V_{Vn} - V_{VL} = (V_n \times W_n) - (V_L \times W_L) \tag{2}$$

C. Access

Access refers to the ability of a patient to receive appropriate health care with respect to the time required to be treated. Among the main goal of implementing a telemedicine program, improving access of patient care is considered the most important criteria including geographical and temporal barriers (Henkelman et al., 2000). A telemedicine application may provide care that would otherwise not have been provided, i.e., increase in care. Geographic barriers are a primary factor that limits access to care in rural settings and may be counteracted by telemedicine.

D. Time

Since tele-health increases efficiency of specialists' time, it provides specialists with an opportunity to expand their consulting network. They may need to invest significant time building their referral networks and developing a comfort level among primary care physicians in order to generate new referral cases (Darkins et al., 2008)

E. Technical Properties

Technical issues were greater bandwidth and the impact of the Internet on tele-health (including accompanying security and confidentiality issues). Bandwidth refers to the amount of data that can be transmitted in a fixed amount of time. Thus, greater bandwidth allows more data to be transmitted in less time. As demand and use of bandwidth increase in all areas of telecommunication, associated costs of each individual will decrease. Since other applications use bandwidth, the cost burden on any particular application, including telemedicine, will be reduced. Greater bandwidth enables greater resolution, use of real-time vs. store-forward images, full-motion imaging, and other properties that will expand the technical capacity of telemedicine. The Internet has considerable potential as a medium for tele-consultations, monitoring patient condition, and other unforeseen applications in telemedicine. Use of the Internet for tele-consultations and other telemedicine applications will move these applications into the mainstream of other communications used by physicians and other health care providers, decreasing the need for separate facilities (Young and Ireson, 2003).

F. Patient Satisfaction

Telemedicine developers and other experts concluded that consistently high levels of patient satisfaction demonstrate that further patient satisfaction evaluation is not a priority and that evaluation resources may be spent more wisely on other areas (Jerant et al., 2003). Indeed, telemedicine developers indicate that the effort to complete patient satisfaction forms and the length of the forms may result in the boredom of patient and clinical staff (Leggett et al., 2001).

The overall analysis for the Thuringia telemedicine platform involves eight aspects including:

- Parameters and influencing factors
- Platform targets
- Application scenarios
- Thematic maps
- Actors
- Professional applications
- Functional process models
- Current status of technical process models

Important aspects for the analysis of this project research are the functional process model and current status of technical process model. The functional process model is

a model referring to technical diagram as a Business Process Model and Notation (BPMN) which shows the technical process with the insertion of the telemedicine platform into the current process and modification of a flow chart (Maric et al., 1989). The process diagrams are illustrated as BPMN symbols, which represents a more convenient method to present the flow of data (information) of the technical processes. BPMN models consist of simple diagrams constructed from a limited set of graphical elements. For both, business users and developers, they simplify the understanding of business activities' flow and process.

Functional process models have approximately about ten models of a telemedicine platform and for each of the process models, it includes sub telemedicine process models (Maric et al., 1989). We considered the following process models:

- E-Medication
  i. Regulation
  ii. Delivery / Pickup
  iii. Allocation
  iv. Repeat Prescription
  v. Medication Change
  vi. Medication Information
- Mental Performance Tests
  i. Arrangement
  ii. Implementation
  iii. Documentation
  iv. Visualization
- Care Transition
  i. Planning
  ii. Implementation
- Doctor's Letter
  i. Transmission
  ii. Reception
- Image Findings
  i. Storage
  ii. Inspection
- Laboratory Findings
  i. Storage
  ii. Inspection
- Tele-Cooperation
  i. Contact
  ii. Answer
- Tele-Consultation
  i. Contact
  ii. Communication
- Patient Information
- Employee Information

The mainly important process involved in the project research is E-medication, which is required to be evaluated for the identification of the quality of the Thuringia telemedicine platform in terms of medication aspects. Among the sub technical process of E-medication, only three processes were analysed, which are: allocation of drugs, drug prescription and follow recipe for medication (repeat prescription). These three processes were analysed and compared with the current status of technical process model; the basis technical process of medication for patients suffering from dementia diseases.

The current status of the technical process model is a basic technical process of a normal flow of data for patients suffering dementia disease starting from admission into hospital, recipes and regulation, performance test and consultations. This process does not involve any telemedicine platform and represents a common process or procedure practiced by most of the hospital management systems in Thuringia. To analyse and compare the quality of medication when the telemedicine platform is inserted into the current process, only the process of recipes and regulation gets chosen among the four processes above. Results are shown in Table 1.

A. Allocation of Drugs

The differences between both processes are the introduction of the telemedicine platform plan update allotment, monitoring as well as the national drug ingestion into the technical process. With the new process, caregivers are capable of documenting drug ingestion and saving documentations in medical plan. Thus, any information regarding drug ingestion will be updated into the database system. In future, data will be extracted if it is required for future treatments. By using the former technical process, the efficiency of time usage in terms of allocation of drug is low because the complete processes needs to be repeated from checking medical plan to the last process of drug ingestion.

Moreover, the number of nurses involved in the process of delivering drug information, can be reduced by using a telemedicine platform. This is because data are transferred through the database system. Formerly, nurses involved in this process will be reduced to two specialist nurses, who are responsible in handling the allocation of drugs. For example, two nurses are required to bring the medical plan released by the doctor to the pharmacy department for drug ingestion purpose. However, with the telemedicine platform, only one nurse is required to manage the process by updating the telemedicine database system. Fig. 1 shows the current status of the technical process model for the allocation of drugs.

**Table1**
Technical processes and their own Criteria with and without Telemedicine description.

| Technical Process | Criteria | | With Telemedicine | Without Telemedicine |
|---|---|---|---|---|
| Allocation Of Drugs | **Number of nurses and doctor** | Example: Number of nurses could be reduced from two people to one person in handling drug deliver and prescription. The other nurses could able to look after the other patients. | Yes, able to reduce number of nurses and doctor. | Remain the same |
| | **Time** | Nurses or doctor do not need to manually deliver information of medication plan such as information transfer between drug allocation and pharmacy department. | Able to reduce time of managing medication and increase efficiency in drug prescription | Dragging time is common issue in handling medical plan between medical departments. |
| Follow Recipe for Medication | **Quality of information** | Any data information could be updated into database system and redundant information regarding drug prescription, allocation and medication change could be avoided such as saving patient medical record repeatedly. The data could be access by the nurses and doctor. | Excellent | Moderate |
| Drug Prescription | **Error Rate** | Data or information of medical plan can be analyzed to reduce any errors in medical plan and all the data are well organized | Error of medication can be reduced because telemedicine platform able to update, store, notify and check any changes of medication plan | Unable to reduce error rate |
| | **Time** | Nurses or doctor do not need to manually deliver information of medication plan such as information transfer between drug allocation and pharmacy department. | Able to reduce time of managing medication and increase efficiency in drug prescription | Dragging time is common issue in handling medical plan between medical departments. |
| | **The number of computer / server used** | It is a database system which needs a server for hosting software application under the heavy demand of a network environment so it will be able to share information with each other at different departments in medication. | Require more server/ computer | Require less server/ computer |

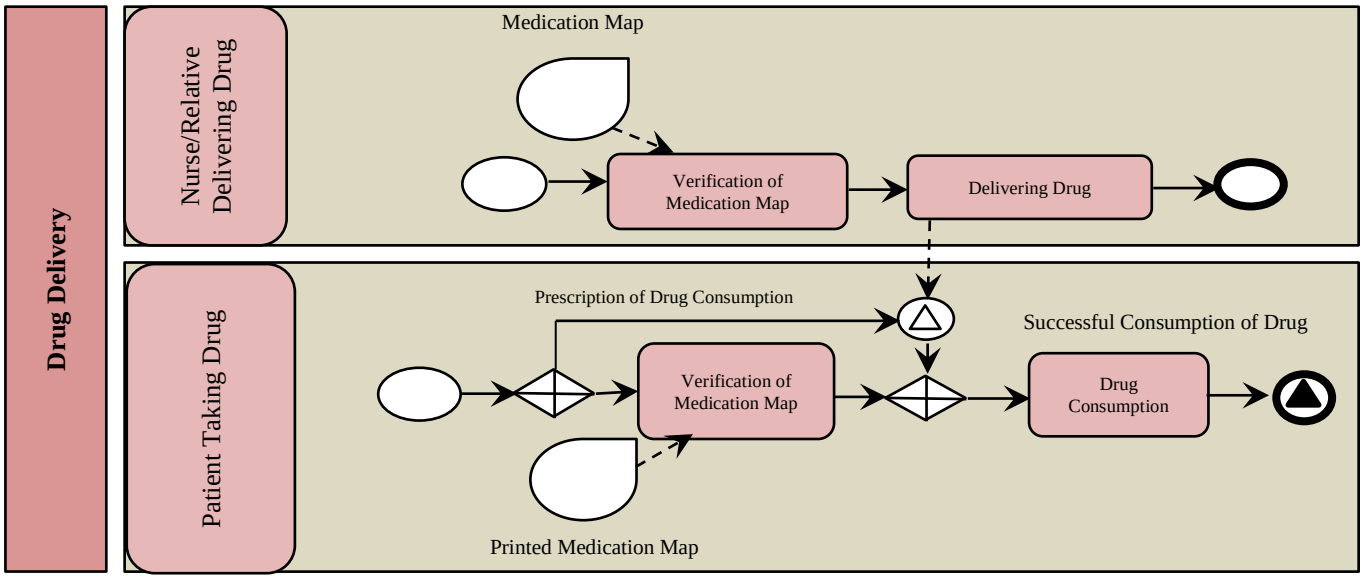


**Fig. 1** Allocation of Drugs of Current Status Technical Process Model.

B. Follow Receipt for Medication

Changes made to the current technical process are for example the process of notification of a licensed medical doctor. The notification is done through a communication request by the medical doctor. The telemedicine platform will update once again based on the medical plan that has been made after prescription. This is important because medical doctors are able to supervise drug prescription delivered to the patient. Thus, improving the quality information of drug prescription is a major concern of telemedicine platforms.

C. Drug Prescription

Telemedicine platforms are able to update medication plans into database systems. This is important in order to test the interaction of medical plans. Any possible interaction will be reported to the physicians, who prescribe the new drug to evaluate the previous interaction so that improvement can be made using the medical plan. Through a telemedicine platform, all data of a new version of a medication plan can be saved into the system to be checked before allocating drugs or printing medical plans to notify caregivers about medication prescriptions. Previously, in the actual technical process, the medical plan could not be checked when transmitted to the next phase of caregiver medication process. This process was affected by errors in transmitting information of one medical plan because the process was previously unable to update changes made in medical plan before.

## 7. Discussion

Telemedicine is widely developing around the world and healthcare in Thuringia is looking forward on implementing a telemedicine platform to treat especially those patients suffering from dementia disease. According to the results obtained, the measures and criteria that had been identified, such as the number of nurses and doctors involved, time, error rates, quality of data information, numbers of computers and servers used as well as patient satisfaction are important to evaluate and identify the quality of medication of a Thuringia telemedicine platform. Expertise in telemedicine platform represents the most important criteria. This encloses the number of nurses, medical doctors and treatment time. According to the results obtained from Table 1, a telemedicine platform is fully able to be used in the role of a nurse and a doctor in their respective field of work. As in the actual technical process, first, two nurses are required to deliver the medical plan released by the doctor to the pharmacy department for drug ingestion purposes. However, with the use of the telemedicine platform, only one single nurse is required to manage the process by updating the telemedicine database system. Therefore, the other nurse is able to manage and look after other dementia patients. Doing so, the ratio of nurses to the number of patients can be reduced. Thus, nurses are able to provide extra care and attention to their respective patients. From the aspect of time, telemedicine shows an ease work of doctors and nurses by reducing transferring time of medical plans to other departments such as the pharmacy department for drug prescription. Another aspect is patient satisfaction, which should be taken into account for a telemedicine platform. The feedback from patients, who are involved in the telemedicine platform should be analysed so that they feel comfortable when dealing with this platform. Some of the patients may experience the telemedicine platform burdening since they prefer to personally meet the doctor and receiving treatment for dementia directly. This possible feedback should be taken into account once the telemedicine platform is done. Questionnaires represent the best way to retrieve feedback from patients once this telemedicine platform project is implemented in Thuringia. Data information of medical plans could be updated by doctors and nurses into the database system. Any redundant information on one and the same medical plan or drug prescription can be eliminated by the database system. Thus the platform shows capability to reduce error rates of data transmission such as wrong drug delivery. Through the database system, we could have high quality of data information because medical data plans need to be continuously updated into the system and can only authorise one person to monitor the database system to ensure the smoothness of database operation and to avoid system hacking by any irresponsible person.

## 8. Conclusion

This survey shows that the implementation of a telemedicine platform has beneficial aspects for the treatment of dementia disease. The platform will be able to reduce the number of nurses or doctors, save time and reduce error rates in data information transmission. However, this requires the increase of the number of servers and computers for the database system. All in all, a telemedicine platform provides several benefits to all including health care parties like management, healthcare stakeholder and the patient, who is representing the highest priority care of a telemedicine platform in Thuringia.

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