ИКТ ДЛЯ ПОЖИЛЫХ: СЕРВИС-ОРИЕНТИРОВАННАЯ АРХИТЕКТУРА СИСТЕМЫ ДЛЯ ДИСТАНЦИОННОГО МОНИТОРИНГА СОСТОЯНИЯ ЗДОРОВЬЯ БОЛЬНЫХ ДИАБЕТОМ

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Проблема старения населения на сегодняшний день особо остро стоит перед развитыми странами. Улучшение качества жизни и медицинского обслуживания приводит к увеличению продолжительности жизни с одной стороны, а также серьезным трудностям, таким как увеличение спроса на медицинское обслуживание, высокие риски развития хронических болезней, повышение затрат на пенсии и здравоохранение, с другой. В такой ситуации ИКТ рассматривается как инновационный подход к решению подобных проблем. С развитием концепций дистанционного медицинского обслуживания появляется все больше и больше частных сервисов и продуктов, которые, при использовании СОА, могут работать вместе для получения эффекта синергии. В данной статье на примере диабета разрабатывается система дистанционного мониторинга состояния здоровья пациента на основе сервис-ориентированной архитектуры, управляемой событиями. Вместе с детальным описанием архитектуры системы и ее преимуществ в статье дается обзор рынка дистанционного медицинского обслуживания, его барьеров и потенциала развития.

Ключевые слова: ИКТ, СОА управляемая событиями, ИКТ для пожилых, дистанционная медицинская помощь, диабет.

Introduction

A major issue currently facing Europe and other developed countries is the population ageing. Life expectancy, for example, in Europe has increased from 55 in 1920 to over 80 today and it is expected to continue to increase [1,2]. It is projected that the number of people aged from 65 to 80 will rise by nearly 40% between 2010 and 2030 [2].

At the same time the demographic dependency ratio (the ratio of the population aged 0 – 14 and over 65 to the population aged between 15 and 64 years) is expected to reach 51% by 2050 [3]. This means that the EU will have four people aged 65 and above for only two people of working age.

These changes in society demographic situation are being driven by a number of factors. On the one hand, those people who were born after the Second World War baby boom are getting old now. And on the other hand, the current demographic situation is not ideal: based on the EU statistics for every woman there are only 1.5 children born while the natural replacement rate that ensures current population size sustainability equals to 2.1 [4].

Key challenges raised by population ageing

Despite the fact that the increase in life continuity is a great achievement for society, it leads to significant social and economical challenges.

Health situation

One problem that is directly connected to population ageing is the problem of chronic diseases. Over 50% of the deaths in the world, ranging from 87% in high income countries to 51% in low income countries are caused by them [5]. World Health Organization projects that by 2030 the number of chronic disease-related deaths will rise to 65% of all deaths worldwide [6] and elder people are even at a greater risk group as they are most likely to have more than one chronic condition. For example, according to a Dutch General Practice, around 79% of ageing people with a chronic health condition has one or more comorbid diseases. A Dutch cancer registry also found that the prevalence of comorbidity among cancer patients ranged from 12% among patients younger than 45 years to 60% among patients of 75 years or elder [7].

Diabetes, lung diseases, several types of cancer and heart disease are main chronic diseases that population faces nowadays [5]. However, recent studies show that, for example, constant control of the diabetes patient's health status leads to significant decrease in mortality and long-term complication prevention [8]. This means that by improving the healthcare system and developing innovative ways for diabetes and other diseases management the whole situation can be changed.

Despite the chronic diseases burden, more elder people prefer to live independently and stay longer at their own homes. But 45% of those aged 75 and elder are impaired in their daily living activities [2]. These social changes require new healthcare models like independent living and remote medical care management.

Economic pressure

Another significant challenge raised by population ageing is economic situation. Together with the growth of elder people population with chronic conditions and drop in workers/retired people ratio the spending on pensions, health and long-term care increase significantly. Expensive medical technologies and high costs for medical care such as ambulances, inpatient or outpatient care, rehabilitation, community health services, medication and etc. change government budget distribution. Health expenditure in Europe has been rising over the past decades, and is expected to continue to increase. According to OECD Health Data 2006, in 1990, health spending accounted for 7% of GDP on average across OECD countries, and reached 8.9% in 2004. It is projected that by 2050 health spending could reach on average 10% of GDP in developed countries [9].

EU actions to tackle the problem

Coping with increased ageing population is one of the key problems that the European society and government have to face in coming years. To prepare for these challenges, effective delivery of health and social care will require reorganization of the care processes and depend more on different technological solutions. Currently European Commission and EU countries governments support research programs and development of the solutions for successful ageing problems resolutions, organize first trials of telehealth and telemedicine systems. Key EU Commission's programs that address ageing population challenges are:

1.The Ambient Assisted Living (AAL) Joint Programme

The AAL joint programme is a new joint research and development (R&D) funding activity implemented by actual 20 European Member States and 3 Associated States with the financial support of the European Community based on article 169 of the EC treaty. The overall objective of the programme is to enhance the quality of life of elder people and strengthen the industrial base in

Europe through the use of Information and Communication Technologies (ICT).

2. i2010 Action Plan on Information and Communications Technology

i2010 is the EU policy framework for the information society and media. It promotes the positive contribution that ICT can make to the economy, society and personal quality of life. Part of the i2010 action plan focuses also on elder people. It has not only the objectives of enabling a better quality of life for senior citizens significant cost-savings in health and social care, but also aims to help creating a strong industrial basis in Europe for ICT and ageing [10].

3. Sixth and Seventh Framework Programme (FP6, FP7)

FP6 and FP7 are the European Union's chief instruments for funding research projects over the period from 2002 to 2006 and from 2007 to 2013 respectively. Among others FP6 and FP7 support researches that are connected to ageing problems resolutions [11, 12].

ICT for successful ageing

As can be seen from the list of key EU Commission initiatives supporting research and development for successful ageing, ICT is considered the needed innovative way that can become part of healthcare and help solve challenges raised by ageing population. According to EU i2010 Action Plan the usage of ICT has great potential for ageing problems resolution while delivering benefits for elder citizens suffering from chronic diseases, companies, European authorities and overall society:

✦ For citizens – a better quality of life and better health through prolonged independent living; active ageing at work ensuring that elder workers with great accumulated knowledge assets and experience can regularly update their competencies; increased social participation, and savings in time and cost for medical care.

✦ For companies – increased market size and market opportunities in the internal market for ICT and ageing in Europe: better skilled and productive workforce and a stronger position in the growing markets worldwide.

✦ For authorities and society at large – cost-reductions, increased efficiencies and better overall quality in health and social care systems, and great accumulated by elder people knowledge and experience assets [10].

Despite the fact that the usage of ICT for ageing problems resolutions has clear potential for many stakeholders the market of ICT for successful ageing is in its' infancy and does not yet fully ensure the availability and take-up of the necessary ICT-enabled solutions [10].

Comparatively low market awareness and visibility, lack of established standards, unsustainable business models and lack of exchange of practical experiences, regulatory and many other barriers lead to the diversity of limited in scale and expensive in cost solutions and slow down market development.

Key barriers

While analyzing and reviewing the first fragmented solutions presented in the market it becomes clear that from a technological point of view significant requirements for the shift to telecare and telemedicine for elderly are established, however, there are still no scalable solutions and products fulfilling entirely the existing needs. There are several reasons that can explain current situation.

Market situation

Plenty of small and mid-size companies develop their own proprietary services, technologies, devices and other telecare solutions for elderly [12]. However lack of awareness among ICT industry, government and final users leads to significant number of expensive test and trial projects. While undergoing the lack of transparency of the applicable rules and regulations and lack of practical experience exchange these companies bare risk of developing telecare solutions for elderly on their own and hardly can support huge investments needed for a shift.

On the other hand, large companies like Microsoft, Intel and others have entered the field not so long ago and only start developing their solutions. However, the promising trend is emerging nowadays: big companies set up alliances and partner with each other to develop telecare solutions that can be widely used to solve existing challenges. For example Continua Alliance, a non-profit, open industry coalition of around 200 healthcare and technology companies that aim to improve the quality of personal healthcare [13]. By joining forces these companies bring investments and knowledge they have, another example comes from Intel and General Electric that in April 2009 announced their healthcare alliance invest in total around 250 million dollars to market and develop home-based health technologies that will help seniors live independently and patients with chronic conditions manage their care from the comfort of their home or wherever they choose [14].

Adoption constraints

Elder people experience problems while facing new technologies. The reasons are most often insufficient motivation, financial means, digital competencies and lack of convenient training. Even basic Internet access is quite limited for the people at this age: only 10% of people over 65 use the Internet regularly compared to 47% for the EU25 on average [15]. Moreover, often products and services are not adapted to meet the specific needs of elder users or are not adequately available, thus limiting their adoption rate.

To tackle this significant problem, research aimed at elder users understanding should be undertaken together with better training and education for seniors on the available solutions.

Regulatory barriers

Lack of common standards, regulations and conformity assessment procedures slow down the process of expansion of telecare and telehealth solutions such as integrated health and social care ICT systems, and assistive technologies. Different social and health care reimbursement schemes, uncertainties about the legal requirements of medical certification for ICT-enabled services, privacy and personal security questions reduce the potential for collective insurance schemes to cover upfront costs for these services and hamper their development and implementation.

Proposed solution

Existing barriers prevent market from fast expansion, but new approaches develop it further. ICT solution proposed in this article connects existing services and products and by gaining synergetic effect helps solving problems of elderly.

Event-driven SOA

To manage their health problems successfully elder and chronically ill people have to constantly monitor various parameters of their health state. For this they utilize a number of services provided by healthcare facilities. Commonly for each service an elder person has to visit a different doctor and a different place.

Current state of ICT makes it possible to automate part of the activities performed by medical staff at hospitals and integrate the provided services bringing them to people's homes in a single solution. The concept of integration of healthcare services being brought to the patient by different providers corresponds to the methodology of service-oriented computing. This methodology comprises a set of tools, technologies and best practices of developing an ICT solution that makes use of various services. Services in ICT sense are defined as discrete pieces of functionality that exist to solve certain business problems. These pieces of code are independent of the programming languages used to develop them or to address them, of communication protocols that invoke them. Services can be easily addressed by any application that utilizes them consuming the data from this application and producing certain output for the invoking application in the end [16]. Such independence of services from the environment enables the service-oriented solution to be agile and scalable with easy adding or removing of functionality.

From another side, the daily routine of chronically ill and elder people consists of a number of simple activities performed in certain sequence. These activities include regular vital signs measurements performance, immediate documentation of measuring results, medication intake and other health-related information. As a rule the activities performed by an elder or chronically ill person are triggered by events occurring during the day including the approach of certain moments in time, changes in health state, initiatives of medical staff. Accordingly, it is possible to describe the typical day of a chronically ill or an elder person as a process that comprises measurement, documentation and communication activities with each activity being started with a certain event and resulting in another event. Furthermore, the resulting events of patient's actions can trigger activities conducted by other participants of a healthcare process. For example, an event indicating an emergency situation on the side of the patient can trigger the process of communication initiated by an emergency unit with further emergency unit dispatch or other kind of intervention.

While taking care of his health, the independent-living patient has to perform vital signs measurements with the use of different measuring devices and document the results making them available to medical staff for further analysis and treatment plan adjusting. The implementation of an ICT solution for elder and chronically ill people makes it possible to automate the communication of data from measuring devices to a single storage place which provides patients with options for sharing the information with others. To ensure that the solution is independent from the devices that are communicating data through, the process of uploading data from devices to a storage place shall employ the service-oriented methodology described above. This way the patient will be able to connect different kinds of measuring devices provided by various producers. All of the connected devices will communicate their data to a single information hub through a standardized set of services. By another set of services it shall be possible to upload the data from the information hub to the patient's personal healthcare record or another data storage place from where the data can be accessed and analyzed by medical staff.

So, from an IT point of view the routine of an elder or chronically ill person involved in a process of independent health state management can be described as an event-driven process with the patient consuming various services on each stage, all of them being integrated into one solution provided for the patient at home. The services utilized in the solution are provided by the devices used by the patient for health state monitoring and by medical facilities that access the patient's data and analyze it. According to this view it is proposed that the solution for elder and chronically ill people shall be developed on the basis of an event-driven SOA.

Diabetes focus

To narrow down the usage area of the proposed solution for the first prototypes it was decided to focus on patients with diabetes as a chronic disease where implementation of an ICT solution can bring the most benefit to suffering people.

Healthcare organizations around the world are paying special attention to the Diabetes disease with the increasing number of diabetes cases in many countries including Europe and United States. The World Health Organization (WHO) estimates that more than 180 million people worldwide have diabetes. This number is likely to more than double by 2030 [16]. Diabetes causes about 5% of all deaths globally each year [17]. According to 2004 data, in Europe 45.4 million people [18] suffer from diabetes mellitus. Since it has been shown that control of diabetes helps to decrease mortality and prevent long-term complications [8] it is important that further innovative developments are made in the area of diabetes management. Such a development can be an implementation of an ICT solution that will automate part of the activities involved in diabetes management process.

Daily routine of diabetes patients includes the need to take into account a lot of details on their health state. This requires frequent measurements of blood sugar level to be performed along with injections, constant control of the weight and special diet [19]. Effective diabetes management also calls for continuous monitoring of the patient's health state by a treatment specialist which requires from the patient a lot of documentation and reporting work.

The issues of diabetes management described above and its high prevalence make diabetes a worth-focusing case for an ICT solution that will help diabetes patients lead their life by reminding them of necessary activities, automatically uploading data on their health state to a storage place, tracking patient's health condition and alerting medical staff on major threats. Diabetes is an incurable disease and thus a patient with diabetes has to receive a lifelong treatment. The ICT solution for people with diabetes will focus especially on elder people with this condition, since they have not only to cope with problems caused by the disease itself, but also with issues brought up by the ageing process.

Usage scenario

The proposed solution will be utilized by its user for easier maintenance of health caring routine including automated documentation of vital signs, reminding of medical activities to be performed, alerting the necessary medical staff in case of emergency situation, and providing interfaces for medical information review.

A typical user of the proposed solution is aged 60 or more and suffers from diabetes. According to the doctor's recommendations patient's vital signs should be constantly monitored.

So, on time when a certain measurement should be performed or a medication should be taken by the patient, a reminder is displayed on his mobile device. When a measurement is performed all the data from the patient's measuring devices is automatically transferred to the mobile device that the patient carries around constantly and that is capable of uploading data to a patient's Personal Health Record system (PHR) for further storage and sharing. Each time the patient takes a medication he registers the intake through the system's interface. Medication intake data entries are stored in the patient's PHR as well.

The patient's doctor, his family and the patient himself can access the PHR anytime and review the patient's medical information. In case of any alerting changes in vital signs the doctor can adjust the treatment plan or schedule an examination. In this case system alerts the patient of the changes in the PHR.

During the day the patient constantly wears a fall detecting device. With its help the body position is being monitored by the system. If the system registers a fall it automatically alerts the emergency unit. The emergency normally tries to contact the patient and dispatches a team if needed. The system also monitors all the data uploaded by the patient's devices for any critical values. In case a peak in vital signs is registered by the system the doctor is automatically notified. His decision then maybe to contact the patient, notify the emergency unit or access the PHR for further review. The same alerting mechanism works if the patient does not perform any activity after a certain critical time since the reminder being sent passes. All the critical times, measurement results values and reminding schedule are derived from the treatment plan which is formed and uploaded by the doctor.

Functional requirements

For the usage scenario described above to be realized in the proposed solution the functionality of the system for independent living with chronic diseases shall include the following functions as a basis.

1. Automated immediate upload of data from measuring devices to an information hub that is constantly carried around by the patient.
2. Translation of all incoming data into the PHR data format and automated upload of patient's data to PHR.
3. Constant monitoring of all patient's data for critical values and alerting of emergency unit and doctor when needed.
4. Reminding the patient on the necessary activities to be performed during the daily routine.
5. Monitoring of patient's reaction to reminders and alerting the doctor if no action is taken for the critical time.
6. Automated retrieval of the reminding schedule, critical waiting times and critical values for each vital sign from the treatment plan formed and uploaded by the doctor.
7. Providing interfaces for the patient's manual documentation of medication intake, automated upload of documented data to PHR.
8. Providing interfaces for PHR review.
9. Providing means of communication among the users of the system including the patient, the doctor, the emergency unit and users with whom patient decides to share his medical records, such as family members.

Architecture description

Based on the functional requirements defined according to the chosen scenario the high-level architecture of the system is defined as the following consisting of 3 parts (see Figure 1):

✦ Presentation or User Interfaces layer

This is the top-most level of the system. The main function of it is to translate user's actions into tasks for the systems, collect the data to be processed on the next application layer of the system, translate results provided by the system into the user-understandable format.

✦ Logic or Application layer

This layer is a core of the system as it is responsible for coordination of the application, processing commands, making logical decisions and evaluations, performing analysis and calculations. It also moves and processes the data between the two surrounding layers.

✦ Data layer

Here the information is stored and retrieved from a database. The information is then passed back to the logic layer for processing and then eventually back to user.

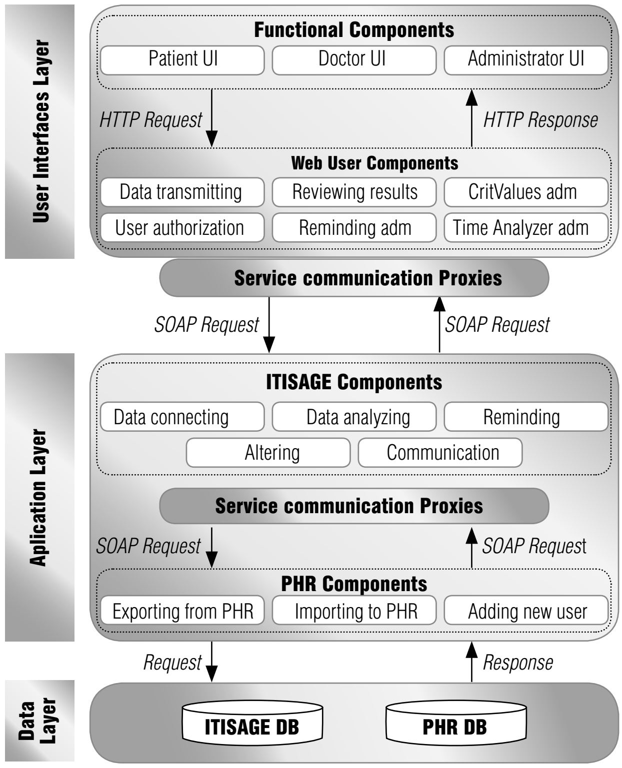

Figure 1. High-level architecture

User interfaces layer

The user interfaces layer is built as a client-server architecture. It consists of the user interfaces browser layer (client side) and web application layer (server side). The client offers the web user interfaces for different groups of system users: Patients, Doctors and Administrators. Client is realized as web pages constructed with the use of HTML, JavaScript, CSS, and JSP and is accessible via web browser on the mobile phone or on PC. The client communicates with the server via HTTP standard in order to provide the users with the full range of functionality.

Web application layer represents the server and consists of six functional components compiled according to the major functions that the user should be able to perform through the corresponding interfaces. These functional components are: user authorization, data transmission, reviewing results, reminding administration, critical values and time analyzer administration. The functional components are connected via Service Communication Proxies with the web services running on the application layer. Service Communication Proxies communicate the data gathered through the user interfaces to the application layer web services and receive the result back via SOAP communication standard.

Application layer

The application layer of the system serves to process all the data transferred between user interfaces and the data storage layer so that the data exchange between these layers would be possible. The functionality of the application layer includes:

✦ calculation and generation of reminders that are to be sent to the user on occasion of necessary medication intake or vital sign measurement;

✦ conversion between data formats provided by user interfaces and supported by PHR;

✦ analysis of all incoming vital signs data for the case of exceeding emergency vital signs thresholds;

✦ generation of alerting messages and calls in case of critical values present in vital signs or emergency button pressed by the patient;

✦ communication of reminding and alerting information to the corresponding contacts through integration with SIP API;

s✦ upport of the system administration process which allows to register new users in the system, retrieve and change information on reminders to be sent, change the information on critical vital signs values;

✦ exporting data to the PHR database and importing data from it;

✦ administration of the user's PHR account.

This functionality is realized on the application layer in the form of web services divided into two groups. The first group provides means for data exchange between different parts of the system and data processing, the other group is working directly with the PHR system writing and reading data from the PHR database as well as supporting PHR user account administration. Each web service has its own network address and can be accessed and used from other parts of the system or other applications. The communication with the web services is carried out via SOAP standard.

As part of its services the application layer contains two data connectors that convert data between devices output data format and PHR data format through an additional data format used by the solution. The application layer also incorporates analyzing components that are run on the server permanently. The time analyzing component does the work of constantly checking with the data generated from the treatment plan for determining the moments when reminders should be sent to a patient, or when an alerting component should be invoked due to patient's non-responsiveness to sent reminders. The data analyzing component compares all vital signs data incoming from the user interfaces layer with its critical values and invokes the work of alerting component if some of patient's vital signs go over the critical thresholds. The reminding and alerting components are invoked by analyzing components and work to gather necessary information either for the patient or the doctor for further communicating this information with the help of communication component. The communication component establishes the connection to communication server and provides the functionality to send reminders and alerts in the form of text messages as well as to connect the patient with the emergency unit in case an emergency button is pressed by the patient.

Data layer

The data layer makes use of two databases containing all the information on the system users. The ITISAGE database temporarily stores the data on user's vital signs collected from the measuring devices and information needed to send proper reminders to the patient. The PHR database serves as a permanent data storage and contains all the information about system users, their vital signs history, their access rights, contact data etc.

Data flow

This data flow in the proposed architecture typically starts with both the patient and the doctor providing data for the system through corresponding user interfaces. The patient is reminded to provide measurement and medication intake data by reminders that are sent to the patient at times defined by the time analyzer based on the information provided by the doctor. The incoming data is translated into an analysis suitable format by one of the data connectors, processed by the data analyzer and converted with the help of the other data connector into a form defined by the PHR system requirements. After conversion the data is submitted into the PHR system with the help of the data importing PHR web service. If the data analyzer notices certain events in the data flow, it invokes the alerting functionality. End-users also perform data-retrieval operations. In this case the data is retrieved from the PHR by the data exporting PHR web service, processed by both data connectors being transformed from a PHR-suitable into the form which can be interpreted by user interfaces.

Implications

The emerging market of independent living and elder care has specific requirements with regards to consumption of electronic and real-world services. Independent living consumers use supportive services to increase their independence which are supplied by a diverse set of providers from different industries and size (SMEs and large enterprise) typically located in the local or regional ecosystem of the consumers. At the same time independent living is a sector that brings together diverse target groups / consumers such as seniors, family, or small service providers with large enterprises from different industries such as retailers, facility managers, care/nursing providers, consumer goods. To enable these stakeholders to collaborate in an Internet of Services environment the previously outlined specific requirements need to be considered. Research into the field of the Internet of Services is still in the early phases of the technology adoption lifecycle, meaning it is mainly used by innovators and early adopters, such as knowledge workers and innovative enterprises. To enlarge the user base and make IoS accessible to a broad audience the chasm between the early adopters and the large mass of mainstream users has to be bridged. Standards for providing, trading, composing and consuming services solutions are being established. The proposed approach to integrate the diverse set of devices in a service oriented fashion will enable an event-driven service oriented architecture thereby pervasiveness can be facilitated by enabling interaction between self-contained components of disparate applications that can be integrated in a "mix and match" fashion based on clear descriptions of the components' interfaces.

Existing technology such as the SAP Netweaver components can provide a technical infrastructure, but a number of operational and organizational questions need to be addressed such as sensitiveness of the domain, potential players of the market i.e. service providers and business models used.

Sensitive domain

As the health of the patient is concerned we are facing the privacy and personal data regulations. For different countries there are quite diverse legal rules and best practices of working with such sensitive data. All these regulations should be taken into consideration while developing the solutions for independent living and health management. On the other hand digitalization of the health care brings the problem if eInclusion. Elder people living distantly could feel the isolation while using independent living solutions. In order to eliminate the lack of personal communication for example teleconferencing services can be used. To make sure that all new solutions and services are bringing value to end user and are developed according to the best practices, regulations and target audience demands peculiarities the certification process should be established.

Services providers

The sensitiveness of the domain as well as the essence of medical care that is mostly managed by government limits the number and type of institutions that could provide independent living and telemedicine type of services. Logically the government bodies are the ones that can support some of the services such as medical care provision. But there is a room also for other players such as large health/nursing services providers that already have all needed certifications to work in the field, insurance companies that can create special elder care insurance plans to support elder users. Currently medical care market is an ecosystem of diverse players already so the independent living and telemedicine market that by the nature similar to it could operate in the same way.

Business models

Different business models could be used in independent living and telecare market. For the end users these services can be fully or partially provided by government. If government covers only part of the cost patient or insurances companies take the burden for the rest of the cost. Service providers can charge their customers for service provision, for infrastructure set up and maintenance etc. To sum up the diversity of the market players as well as products and solutions brings the possibility of the different business models to be used.

Conclusions

The solution proposed in this article considers the implementation of an IT system that deals with the problems of elder and chronically ill people helping them to maintain their daily routine through making use of reminding mechanisms, automation of vital signs documentation, monitoring of health state and alerting the medical staff in case of emergencies. The solution also employs a PHR system as one of its parts which makes it possible for the patient to store and share easily all his medical data with the doctor or other people.

The proposed solution is developed with regards to the principles of service-oriented architecture and event-driven business process models. Implication of these principles gives the solution certain benefits, such as scalability, versatility and portability. The fact that the proposed solution is composed from different services run on a web server makes it possible to add various monitoring devices to the solution, to diverse the activities that are supported by the system, to add other participants of the health caring process as users, all done by developing and implementing new services on the server. In the same way, by removing one services and adding others the system can be easily tailored to the needs of the patient, including the change of chronic disease put in focus. Running the services on the web server and storing user's data in a remote storage place makes the solution easily portable and highly undependable on the user's hardware configuration or physical location.

Considering the focus of the solution being on the supporting life of elder and chronically ill people its actual implementation shall be of great social and economic impact. It is now acknowledged by the governments of all developed countries that improving life of elder and chronically ill people especially with the focus on moving the patients from the hospitals to self-managing their health at home is economically justified. Chronic diseases and old population health problems nowadays already require huge investments. With the share of chronic diseases accountable for deaths growing quickly and population on the whole getting older the amount of investment needed would increase even further in the future. The possibility of elder and chronically ill people to take care of themselves at home can shorten the number of human resources needed for managing health problems of one patient as well as the amount of time spent by the medical staff on each patient. However, for being able to take care of themselves properly elder and chronically ill people needed a supporting system. With the implementation of the solution proposed in this article chronically ill and elder people would receive the necessary support for better independent living and easier coping with their health problems at home.

Potentially the solution can be expanded by other providers developing and implementing new services for the system. Such additional providers may include other health caring facilities, like pharmacies, or non-specialized providers who would like to tailor their products to the needs of senior or chronically ill people, for example, shopping centres. The underlying service-oriented architecture also makes it possible to integrate the proposed solution with other IT solutions implicated in the living process of the users. For example, the solution proposed can be integrated with the hospital's ERP system for easier billing process or with insurance systems.

Therefore, ICT solution proposed in this article connects existing services and products, provides ability to develop new services and products, and by gaining synergetic effect helps solving problems of elderly and chronically ill.■

Литература

1. DG SANCO, DG ECFIN & DG EMPL Healthy ageing: keystone for a sustainable Europe, European Commission, 2007 [Electronic resource]. Access mode: http://ec.europa.eu/health/ph_information/indicators/docs/healthy_ageing_en.pdf (accessed 1 July 2009).
2. European Commission. Communication from the Commission: Ageing well in the Information Society. An i2010 Initiative. Action Plan on Information and Communication Technologies and Ageing, 2007 [Electronic resource]. Access mode: http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0332en01.pdf. (accessed 1 July 2009).
3. European Commission. Communication from the Commission: Green Paper on 'Confronting Demograpahic Change: A New Solidarity Between the Generations', 2005 [Electronic resource]. Access mode: http://ec.europa.eu/employment_social/news/2005/mar/comm2005-94_en.pdf. (accessed 1 July 2009).
4. Levy J. Demographic changes in Europe: Opportunity of threat? // Medical Marketing. – 2007. – №7, p. 287-293.
5. Suhrcke M., Nugent R., Stuckler D., Rocco L. Chronic Disease: An Economic Perspective, Oxford Health Alliance, 2006 [Electronic resource]. Access mode: http://www.oxha.org/knowledge/publications/oxha-chronic-disease-an-economic-perspective.pdf. (accessed 1 July 2009).
6. Mathers C. D., Loncar D. Updated Projections of Global Mortality and Burden of Disease, 2002 – 2030: data Sources, Methods and Results. World Health Organization, Geneva (Evidence and Information for Policy Working Paper), 2005.
7. Gijsen R., Hoeymans N., Schellevis F. G., Ruwaard, D., Satariano, W. A., van den Bos, G. A. Causes and consequences of comorbidity: a review. // Clin. Epidemiol. – 2001. – №54, p. 661 – 674.
8. Azar M., Gabbay R. Web-based management of diabetes through glucose uploads: Has the time come for telemedicine? Review. // Diabetes Research and Clinical Practice. – 2009. – №83, p. 9 – 17.
9. OECD Health Data, 2006 [Electronic resource]. Access mode: http://www.oecd.org/document/30/0,2340, en _2649_7407_12968734_1_1_1_37407,00.html (accessed 20 May 2009).
10. European Commission. Communication from the Commission: "i2010 – A European Information Society for growth and employment", 2005 [Electronic resource]. Access mode: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0229:FIN:EN:PDF (accessed 1 July 2009).

11. European Commission Cordis website [Electronic resource]. Access mode: http://cordis.europa.eu/ (accessed 1 July 2009).
12. ICT & Ageing: European Study on Users, Markets and Technologies. Preliminary findings, 2008 [Electronic resource]. Access mode: http://www.ict-ageing.eu/ict-ageing-website/wp-content/uploads/2008/11/ictageing_vienna_handout_final2.pdf (accessed 1 July 2009).
13. Continua Alliance website [Electronic resource]. Access mode: http://www.continuaalliance.org/about-the-alliance.html (accessed 1 July 2009).
14. GE and Intel to Form Healthcare Alliance. Press-release. [Electronic resource] Access mode: http://www.intel.com/pressroom/archive/releases/20090402corp.htm (accessed 1 July 2009).
15. Eurostat, 2006 Community survey on ICT usage in household and by individuals. [Electronic resource]. Access mode: http://ec.europa.eu/eurostat (accessed 1 July 2009).
16. Mittal K., Kanchanavally S. Pro Apache Beehive. – 2005. – p. 15-25.
17. Diabetes Factsheet. World Health Organization, 2008 [Electronic resource]. Access mode: http://www.who.int/mediacentre/factsheets/fs312/en/index.html (accessed 05 May 2009).
18. The global burden of disease. World Health Organization, 2004 [Electronic resource]. Access mode: http://www.who.int/entity/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf (accessed 15 May 2009).
19. Wallace J. Diabetes daily routine, 2005 [Electronic resource]. Access mode: http://www.iowaonlinejournalism.com/online_journalism/JeffWallace/diabetes3.html (accessed 22 May 2009).
20. Заикина Н., Марухина Е., Сергеева Н. Дистанционная поддержка пожилых // Открытые Системы. – 2009. – №6.