Uptake of mobile ICT health services: has the time come to become commodity?

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***Abstract*— Personalized healthcare (phealth) is a collective term aiming to reflect all modes of patient-centric healthcare delivery via advanced technology means. Personalized health involves the utilization of micro and nanotechnology advances, molecular biology, implantable sensors, textile innovations and mobile information & communication technology (mICT) to create individualized monitoring and treatment plans. pHealth proactively endorses the sense of "one-to-one" communication to elevate healthcare delivery, optimize patient services and ensure seamless from the patient point of view information exchange. Patient awareness, policy planning and technology progress are favoring phealth market penetration, while financing issues, political commitment, and unavailability of technology infrastructures are fundamentally prohibiting its expansion. This paper explores the drivers and barriers to the adoption of phealth delivery schemes, including a discussion on interoperability issues. It also presents case study results.**

I. Introduction

PERSONALIZED HEALTHCARE (phealth) is a collective term aiming to reflect all modes of patient-centric healthcare delivery via advanced technology means. Personalized health involves the utilization of micro and nanotechnology advances, molecular biology, implantable sensors, textile innovations and information & communication technology (ICT) to create individualized monitoring and treatment plans. pHealth proactively endorses the sense of "one-to-one" communication to elevate healthcare delivery, optimize patient services and ensure seamless from the patient point of view information exchange. Patient awareness, policy planning and technology progress are favoring phealth market penetration, while financing issues, political commitment, and unavailability of technology infrastructures are fundamentally prohibiting its expansion.

Personalized healthcare will be achieved through a composite of scientific advances and new technology, and creative uses of information technology and human thought in the practice of medicine. Scientific advances and discoveries, as well as new technological capabilities, will be revolutionary. Innovation in the practice of medicine will be evolutionary. The combination of revolutionary technologies and evolutionary practices form information based medicine and will shape the future of personalized healthcare [1].

Innovative computer and software technologies are deployed to provide vital patient data monitoring and connect clinicians with mobile patients via workstations, wireless devices and the Internet. Technology progresses to produce virtually invisible biosensors, implantable or integrated in the patients clothing or to small, portable devices, which enable continuous vital data transmission and allow the development of personalized treatment plans for the patient.

The concept of prevention prevails now against disease management and treatment plans. As patient-centric processes emerge, the citizens/patients undertake an active role in monitoring their health status, whereas e-wellness evolves to address the rising expectations of the e-health consumers, who are better informed, more demanding, and empowered. The empowered, worried-well, consumers require quality health services on the spot. The drivers are now connectivity, speed and personalization [2].

II. pHealth Service Models

A. pHealth Models of Care

Waves of technology incorporation and scientific discovers, have driven the sector from reliance on direct communication and physician experience, to a higher reliance on technology and community information. The expression "personalized healthcare" has become quite common as basic and clinical medical studies based on the decoding of the human genome continue to progress and social awareness of this trend increases. The idea here is to perform diagnosis and therapy after scientifically determining personal traits [1].

In the frame of the phealth models of care, individual physical characteristics are identified in order to depict the appropriate medical care protocol and associated risks for each person. Personal and family medical history joined with lifestyle and patient empowerment mentality foster the development of personalized pathways of care, which are enabled by research and technology implementation.

Bio-molecular information is explored in order to issue new medications; sensors are getting smaller, smarter, and implantable in order to ubiquitously monitor health state parameters; pervasive computing and data networks are being deployed for the timely information exchange; and the healthcare providers are challenged to keep up with new market and technology trends in order to meet increasing patient needs.

B. Compelling Drivers for Change

The deployment of personalized healthcare models prerequisites research orientation to fulfilling individual patient and carer needs.

The underlying factors for the emergence of new patterns of care include:

Changing trends: The reformulation of current service provision in order to meet patient demand for quality services to be provided anywhere – anytime is necessary, as population grows older and becomes more concerned about the quality and availability of health services

Adding varieties: The increasing demand for quality healthcare services forces the healthcare providers to adopt advanced tools and invest on human capital and infrastructure in order to be competitive in the new information society era. The traditional treatment plans in the traditional nursing areas are insufficient as life rhythms and technology advances lead the patient base to call for novel and sophisticated health products

Improving quality: The availability of information and knowledge accessibility created patient awareness, shaping the demand for service availability and efficacy, expertise deployed for development of medical plans and prevention rather than treatment.

Advancing technology: New technologies introduce highly innovative health products / services creating new needs in patient care and addressing "hidden" needs for specialized medical care.

C. Barriers to Emerging pHealth Adoption, Critical Success Factors & Dependencies

Although theoretically phealth applications effectively address patient needs, actual implementation is still at infancy stage and constrained by numerous factors, "unforeseen" by the research community that provides the new tools and methods for healthcare delivery.

Cost pressure from managed care entities and the lengthy approval processes are prime considerations in bringing a truly breakthrough product rapidly to the market [3]. The healthcare providers focus on healthcare cost containment in the short-run and neglect to examine cost efficacies created by the adoption of new technologies in the long-run, when the high initial investment costs are outranged by more effective patient and internal resources management and/or revenue generation from the provision of added value services.

Even when leadership with vision is overcoming the cost barriers and is budgeting resources so as to shift an organization to adopt new technologies, resistance to change is a common factor that scales down this kind of efforts. The commitment of the whole team (top management, healthcare workers, administrative personnel involved) is essential to the successful implementation of novel applications in the health market.

To this end, awareness and education of the healthcare professionals is also necessary in order to highlight the capabilities generated by the new tools and methods and diminish competitiveness between the traditional practices vs new technologies. Technophobia is often concealed behind reliability in familiar / traditional methods, leading thus to obstructionism behaviours. As a result, the sector in lagging behind in the adoption of novel products and services.

Selecting the right people to be involved is a critical success factor to every project implementation. Especially, when it comes to applying new methods or systems, recruiting people familiar to or interested in new technologies and practices and providing further motives for involvement is essential for the following reasons: a) The participants interested in the new applications are self-motivated and thus, willing to work towards the achievement of the project goals b) Provision of further motives (i.e. know-how transfer, scientific knowledge diffusion, self-esteem, etc) contributes to more active involvement, c) The project participants that are interested in carrying out the project also contribute to effective dissemination of the project outcomes.

Additionally, the commitment of the management of the organizations involved in the project is also a critical success factors as it a) ensures proper allocation of recourses for the effective project implementation, b) support throughout the whole process, c) provision of motives to the participants, d) strong collaboration and dissemination of the results.

III. CURRENT TRENDS

A. The Vision

Specialized health-telematics enterprises aiming at the effective integration of mICT in the health sector and the optimization of the quality of the healthcare services, have started to spring in the recent years in Europe. These are mostly spin-off companies arising from research in academia and industry.

They aim at the commercial deployment of novel technologies generated in the laboratory environments; a particularly interesting area is the vital signs telemonitoring service concept, based on mobile networks and intelligent sensor devices, targeting citizens / patients on the move. This is aligned with the current international trend regarding the provision of healthcare services and in particular chronic disease management, bringing points of care closer to the patients and striving at the wellness of the person and prevention, instead of disease management and treatment plans. These services promote citizen health awareness and patient empowerment.

B. Market frame

1) Service concept

The service concept emerges, as points of care move closer to the patient and the citizen/patient undertakes a more active role in healthcare monitoring and prevention.

The system enables remote monitoring and transmission of the patients vital signs via wearable monitoring devices with mobile transmission capabilities over (locally) BT or Zigbee and (widely) GPRS/3G, WiFi and recently WiMAX. Such a system provides the possibility for doctor-patient ubiquitous communication and support, while the patient is at home, work, vacation (i.e. away from the traditional nursing areas). More than this, it triggers a patient-centric process, focusing on prevention rather than disease management and treatment and initiates patients' active involvement in healthcare.

The need to provide cost-effective healthcare services for continuous telemonitoring of vital signs to remote or on the move patients has been early identified, to bridge the gap in healthcare provision. This gap is created by the inability of healthcare providers to offer continuous monitoring, seamlessly to chronic patients and worried-well citizens.

TABLE I
STAKEHOLDER GROUPS

Stakeholder Groups	Mobinet Value
Private healthcare providers	Expansion of current product /service portfolio Innovation; Leading position; Improved customer care; Provision of services to remote markets
Health care authorities	Long-term: savings on healthcare spending, social care; Short-term: provision of added value healthcare services; prevention of diseases
Public healthcare providers	Long-term: savings on healthcare spending; social care; collaboration and networking; better allocation of resources; Short-term: provision of added value healthcare services; prevention of diseases
Insurance companies	Provision of advanced services to end customers Leading position; Improved customer care; Differentiation from competition
Healthcare associations	Networking; Exchange of scientific view; Ability to extract anonymous statistical data for reference and conduction of studies
Patients - Citizens	Improved care management; User friendly patient record management; Improved quality of life (for carers as well); Wellness & time savings
Athletes	Improved health status monitoring; Based on the above, risk minimization regarding health deterioration incidents in the field; Improved performance without jeopardizing health

2) Stakeholder Groups

3) Business Models

The following business models depict the overall business potential of the service:

1. Joint venture with a remote healthcare centre or a doctor in private practice. The local healthcare centre will be equipped with a portable device. A trained employee (medical auxiliary personnel, nurse, etc.) will be responsible for conducting the signal recording and transmit it to a specialized healthcare provider (private hospital, diagnostic centre) for the provision of diagnosis. This scenario concerns the provision of the service to patients in remote areas in cooperation with local healthcare professionals. For example the Greek topology (isolated islands, small villages away from the cities – hospitals – and not easily accessible by healthcare professionals) favors such a service.

2. Public Healthcare Providers: The rationale is the same as above (of the remote healthcare center). The public healthcare provider may as well provide the service in the manner described above. The savings are obvious for the patients, since the relevant price will be covered by the public insurance organizations. For the public healthcare provider introduction of the service results to provision of healthcare services in isolated areas, elevation of the provided services, and impact on the quality of life. The following scenarios have potential:

a. The Public Healthcare Provider operates the service: The remote healthcare centre will be equipped with portable devices. A trained employee (medical auxiliary personnel, nurse, etc.) will be responsible for conducting the signal recording and transmit it to a specialized healthcare provider (private/public hospital, diagnostic centre) for the provision of diagnosis.

b. Provision of the service to subscribed members: It has a potential, but since we are dealing here with public authorities the organisational issues are more complex. For example, with the new form of the Greek NHS, such scenarios are now possible depending on the decision of a local healthcare authority or public insurance company to provide phealth services.

3. Private Insurance Companies: This model addresses insurance organizations that provide healthcare services as well. The insurance premiums in these cases include provision of primary / secondary healthcare services, homecare, etc. The savings for the patient are more obvious under this model. The cost-effectiveness for the service is also more obvious for the insurance company. Resources previously allocated for homecare (i.e. personnel – nurses and doctors – etc) will be reduced.

4. Provision of the service to subscribed customers. A customer wishing to have an active role in monitoring his/her health status in order to enjoy an enhanced feeling of safety and an elevated quality of life. The newest, emerging business model in the market is about selling devices and service subscriptions directly to the general public and set up a more elaborate and modular service provision infrastructure to meet demand. This model foresees that monitoring devices are sold like mobile phones, together with subscriptions to medical call centres that can receive and diagnose a measurement, keep records of all transactions, even give access to the citizen's desired physician to view and diagnose the data and send recommendations through the service.

This is especially relevant in view of the new, "wellness"

market that is the fastest growing area of health-related expenditure in recent years. Under such circumstances the target population includes everyone, and not only some chronic patient groups or other clinical conditions.

IV. Case Studies

A. The Private-Hospital Project

The Private-Hospital project concerns the provision of the Mobinet telemonitoring services to post-surgery patients and patients with cardiovascular diseases by a well-know private hospital in Athens.

During the project pilot operation phase eight (8) patients were equipped with medical kits, each including three telemonitoring devices, an ECG recorder, a blood-pressure monitor and an oxymeter, as well as a mobile phone. Each patient participating in the pilot operation, following his discharge from the hospital, received a complete kit and training on the use of the devices and the mobile application for data transmission. The patients were then responsible for recording their vital data on a daily basis and sending it to the Mobinet web-center for review and consultation by the hospital specialized staff.

The project never proceeded beyond the pilot operation, as the local medical community perceived this novel service as a strong competitor that would reduce their clientele.

It is a complicated structure, where the cardiologists, external to the hospital, refer their patients for operation, but then fear that they will loose them as customers. The introduction of a personalized monitoring system fear that will push the patients closer to the hospital and that will eventually lead to them loosing them. Thus, they stood against it and the Hospital Medical Management made a quick decision to kill the project so as not to put into turmoil the cooperation with the external cardiologists.

Resistance to change is a common issue faced during the introduction of new methods in all industries. In the healthcare sector in particular, it is common that the medical community shows a negative attitude towards eHealth solutions. Although the project team worked towards the development of a network, where the cardiologists would be actively involved in the monitoring of their patients' health status following hospitalization, the project was eventually terminated.

B. RHA - telemonitoring pilot

The Regional Health Authority - telemonitoring pilot has been designed with the aim to facilitate General Practitioners in completing every-day tasks and providing quality primary healthcare services to citizens. It is being implemented by the health units that operate under the 3rd Regional Healthcare Authority in Greece, covering the Region of Central Macedonia so as to enhance access to specialized healthcare services in remote areas.

The pilot network implementation for the effective health monitoring in remote areas aims at the:

- Provision of advanced healthcare services, regardless of geographical limitations
- Preventive medicine
- Efficient human resources management (for the healthcare providers)
- Scientific personnel facilitation and diffusion of specialized knowledge

The project generates significant social benefits and enables healthcare professionals to allocate their time in an efficient and effective manner, as they are able to manage more patients, since telemonitoring allows the simultaneous monitoring of the health status of multiple patients. Patient management and also, data management for each patient is improved, facilitating medication management and the completion of administrative tasks for the healthcare professionals.

The RHA - telemonitoring pilot concerns interaction between GPs and experts. The 3rd RHM is responsible for the coordination and implementation of health care policies and services in the corresponding geographical region. In the frame of the project implementation, it equipped the health-centers with sets of telemonitoring devices in the five remote areas for the provision of health telematics services.

Early in the project design and planning, several health units expressed interest in participating to the provision of the telemonitoring services in rural areas. Still, those health units operate under different regional healthcare authorities that due to legal and organization complications restricted their participation to the project. As a result the project implementation team faced resistance to change from the selected participants and dealt with it by trying to provide motives, as the provision of anonymous medical data from the project database to the participants, so that the later will be able to present papers in scientific conferences and journals.

C. The telecare center

The Municipality of Trikala has designed a long-term strategic plan for the transformation of the local society, based on the opportunities created by the information society era. To this end, several e-services are planned and are being implemented. Part of this strategic plan is the establishment of a center offering advance health and social care services to the citizens of the region.

The telecare center constitutes a single entry point to health and social services. Medical intervention and social support is provided to all citizens, eliminating discrimination and other social isolation incidents. The citizens receive personalized health services and enjoy advanced community services at the same time. As a result, the telecare center constitutes an efficient channel for the provision of citizen-centric services, strengthening the role of the community public bodies in the society. Thus, the citizens feel safe and confident that the community takes their needs into serious consideration and respond to them.

The Municipality of Trikala has designed a broad strategic plan regarding the implementation of e-services in several fields of activity. To this end, the Municipality of Trikala implements different projects, guided by the common vision, that is the region to be pioneer in applying advance ICT technologies in everyday activities. As a result, the telecare center project is carefully designed and is being implemented by a committed team who puts effort in order to bring advanced technology closer to all citizens. The success of the project lies on its impact on the quality of lives of the end-users that is the citizens and their carers, while enhancing the social profile of the Municipality.

D. *Rural Healthcare*

A pilot study is to assess the performance of the development of a new telecare service for rural areas of Greece featuring a pilot telemetry network has recently reached its mid-life. The network was established in 2008 in 25 remote and isolated rural municipalities of Greece, 10 of them located in islands. The local primary health services were equipped with vital signs telemonitoring devices. At these points the family physicians record the vital signs of the patients with chronic diseases (cardiovascular and respiratory diseases). The data are transmitted through GPRS to a central webserver. Specialized physicians in Athens consult the recorded tests and provide advisory diagnosis to the local physicians.

A retrospective evaluation study was designed to evaluate the initial 6 months (of a 12 months duration planned) of full operational working period of the telecare network. Evaluation criteria measuring the adoption and the outcomes of the implementation of the specific telecare service were based on the recommendations of the WONCAon ICT to Improve Rural Health Care [4].

In total 777 different tele-consultations took place and 2206 logins in the online patients' health records database, with the level of adoption of the telecare services by the local health professionals in everyday practice to vary significantly.

What the study has concluded up to now can be summarized to that the introduction of telecare services for remote communities cannot automatically be a benefit for rural health workers and the communities that they serve. Ongoing support and commitment from all engaged partners is crucial in order to maximise the potential for successful and sustainable telecare services to rural communities.

V. INTEROPERABILITY

pHealth interoperability brings a new challenge to healthcare in that interoperability quality needs to be delivered across many systems and devices from a broad range of implementers. This challenge is of a new dimension at a scale and in a market environment where the management of such processes among stakeholders is not yet in place. The aim of the efforts above is on the "what" needs to be done to deliver systems that will "plug and play" according to the specifications following the example of the IT industry.

Recently a number of coordinated efforts are attempting to overcome this barrier, i.e. lack of interoperability. On the one end the industry has formed open consortia and alliances, such as the IHE, COCIR and Continua, to create interoperability profiles for specific use cases based on international standards. On the other end the European Commicion has taken particular steps to encourage cross-border interoperability, the most prominent the Mandate 403/2007 to CEN/CENELEC/ETSI [5] and the Commission recommendation on cross-border interoperability [6].

A Quality Assurance process reinforcing interoperability may need to include some form of specification or labelling to allow for the easy identification by external parties to the implementation that the quality assurance was effectively and satisfactorily performed. Many such schemes involving or not third party testers have been used in the medical industry.

The most prominent labelling initiative in pHealth is the Continua Health Alliance [7], a group of technology, medical device and health and fitness industry players, committed to empowering consumers and patients world wide, to take an active role in their own care through the use of technology. They recently unveiled their first set of guidelines, based on proven connectivity standards that is hoped will help to increase assurance of interoperability between devices, enabling consumers to share information with care givers and service providers more easily. Manufacturers of products that meet these guidelines are permitted to use the Continua Health Alliance certification logo to promote their products. The logo will clearly identify certified products, making it easy for purchasers to choose products that work together seamlessly.

VI. THE IMPLEMENTATION CONTEXT IMPLICATIONS – CONCLUDING REMARKS

Recent research advances have made possible a viable solution regarding the provision of personalized health services, seamlessly from the patient point of view.

However, patient satisfaction is no longer an easy goal to achieve. Demographics and socio-economic forces endorse the healthcare industry transformation and modernization. Ease of use, system reliability, availability of the service are some of the critical factors that lead to a successful phealth scheme implementation. The attractiveness of the new systems or method reassures active user involvement, and much more importantly leads to user satisfaction and acceptance.

The most important asset in such phealth attempts is the broadly disciplined and highly skilled human capital, consisting of engineers, healthcare professional and

marketers with long-term research experience in the health-telematics field.

Within the commercial context, research outcome should be perceived as the conversion of knowledge and ideas into a benefit, which is for commercial use, while promoting at the same time the public good.

Vidavo in particular aims to bridge the gap between research results and commercial deployment. In theory, the gap is created by the inability of the researchers to timely consider the actual user needs in order to develop products and services addressing those needs. Instead, they provide high technology, transformed in sophisticated products that target highly skilled users, creating new educational and training needs.

In practice, the gap between a successfully working prototype to a successful commercial deployment is widened by the users resistance to change, organizational complexities, financial implications, the sector's dependencies on old fashioned marketing policies, and regulatory vagueness. User attractiveness of the new systems (emerged as the outcome of research activity) is only one attribute that contributes to real implementation success and certainly is not sufficient.

As already discussed in previous paragraphs and depicted in the case studies described, uptaking of phealth is initially limited by the required investment costs. Once the financial obstacles are overcame, phealth uptake is constrained by the organizational complexities of the health sector, the reluctance to change of the health employees, combined with the technophobia of the medical community. Further concerns include the interoperability of the fragmented systems that prevail in the sector and the absence of a concrete legal / regulatory framework.

Still, phealth uptake can be effectively encouraged the strength and qualities of the partnership that attempts to initiate phealth services, the recruitment of the right people, system attractiveness, leading to strong demand, as well as political support and profound socio-economic benefits.

phealth implementation could prove to be a win-win situation for end users, healthcare providers and technology developers in the long-run. The short-term path to implementation still seems sterile, prolonging commercial exploitation life-cycle.

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