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Conference Paper

A new track for technology: Can ICT take care for healthier lifestyles?

22nd European Regional Conference of the International Telecommunications Society (ITS): "Innovative ICT Applications - Emerging Regulatory, Economic and Policy Issues", Budapest, Hungary, 18th-21st September, 2011

Provided in Cooperation with:

International Telecommunications Society (ITS)

Suggested Citation: Baum, Peter (2011) : A new track for technology: Can ICT take care for healthier lifestyles?, 22nd European Regional Conference of the International Telecommunications Society (ITS): "Innovative ICT Applications - Emerging Regulatory, Economic and Policy Issues", Budapest, Hungary, 18th-21st September, 2011, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/52185>

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**22nd European Regional ITS Conference
Budapest, 18-21 September, 2011**

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A new Track for Technology – Can ICT take care for Healthier Lifestyles?

Abstract (150-300 words)

The paper takes a look on potential contribution of Information and Communication Technologies to abate public health challenges caused by demographics and lifestyle. From the current convergence of mhealth, and sport market products emerge targeting normal athletes to control their training in a quantified manner. The resulting feedback and transparency foster a healthier lifestyle. These products and services help overcome limitations to innovation typical to the health care market. The paper is based on research by the European Commission's Institute for Prospective Technological Studies on Integrated Personal Health/Care services.

JEL codes: L86, I19, I29

Keywords

eHealth, Integrated Personal Health/Care services, sport, training, lifestyle related disease, innovation

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Introduction

The demographic structure of the European Union Member States in itself generates manifold health challenges. A plunge in fertility, a surge in life expectancy and migration patterns, has an impact on the coming age structure of the continent, which has been projected to undergo a dramatic change.¹ A declining young generation will have both to cope with working more² and having to bear a heavier financial burden[1]. The change in demographics will affect family composition, social links and ties resulting amongst others in a reduced pool of resources for informal social care.[2] Besides ageing behavioural related disease will increasingly put a burden on societies due to a coming tsunami of conditions resulting from the changes in lifestyle. This paper tries to elaborate how Information and Communication Technologies (ICT) can abate these trends by contributing to overcome one's weaker self³ and motivate behavioural changes beneficial to one's health. The widespread use of sensor and remote monitoring in both health and fitness related applications promises to bring about a change in behaviour towards a more preventive conduct and way of life. Additionally such applications can bridge inhibiting factors regarding an institutionalised uptake of ICT in health care delivery and facilitate a global market. The paper focuses on systemic ramifications related to the field of health. It wants to establish the argument that ICT can contribute to solving public health challenges by tracking behaviour and making the health consequences more transparent, enable collective learning and motivate empowerment of users and patients. ICT are general purpose technologies[3], in the sense of opening up new opportunities rather than offering complete, ready made solutions. ICT are also systemic insofar as their uptake has transformed economic and social practice in many fields of life and have potentially further disruptive impact e.g. on business models, market structures and organisational forms. As a tool eHealth enjoys political support at the European Level both in terms of helping patients and lessening the burden on health care systems.[4]

This paper is based upon findings and scientific evidence gathered by the Information society Unit of the Institute for Prospective Technological Studies to evaluate the impact of Integrated Personal Health/Care services⁴ (IPHS) in addressing the health and/or social care needs of individuals outside of care institutions and supporting the work of care providers in an integrated fashion.[5-7] The overall aim of the research⁵ is to assess techno-economic impacts an uptake of these technologies, determine whether and how this can enable societal change as well as estimate potential market impact from IPHS wide deployment. The research further strives to facilitate an understanding of the actors involved and the involved dynamics. These

¹ Such an ageing society will demand its toll will impact the ability of the EU to respond to the increased burden of an ageing population and to other challenges, e.g. environmental or security related.[1]

² The working age population is expected to decline by 15% between 2008-2060, while the population over 65 is expected to grow significantly.[1]

³ The weaker self manifest as an inner temptation to neglect physical activities and indulge in unhealthy eating habits, it has been labelled metaphorically as an " *inner couch potatoes*".

⁴ Integrated Personal Health/Care Services are defined as Services that "address the health and/or social care needs of individuals outside of care institutions and support the work of care providers in an integrated fashion: a) they can integrate assistance, remote monitoring of chronic diseases, wellness and fitness; b) they are produced as a result of integration of different institutional and information systems. They are personal and possibly personalised in the way they gather, process and communicate data for feed-back or further action and response. " [5]

⁵ Strategic Intelligence Monitor on Personal Health Systems. See: <http://is.jrc.ec.europa.eu/pages/TFS/sps.html>

dynamics manifest themselves not only at market level but also in terms of how they shape the way individuals conduct their lives digitally.

Prevention versus cure to respond to the health challenges

Independently from age factors a global increase in affluence and the associated lifestyle changes has altered human behaviour over the last century and more so in the last decades. We witness a global tsunami of lifestyle related disease, as an unintended consequence of the increased levels of affluence, behavioural change and an abundance of calorically dense, low-fibre and high-glycemic foods⁶. The general population follows a more passive and sedentary lifestyle. Physical activities ceased to be part of daily tasks, a changing rhythm of work leaves less room to conduct or participate in organised sports in a formal manner. Such lack of physical activity and the resulting deficits in fitness take a toll as the obesity crisis continues unabated. Cardiovascular diseases, diabetes and other conditions along a diminished quality of life are the dire consequences. [9, 10] As an unintended consequence of a less burdensome life obesity among both children and adults spiked in developed and developing countries. Childhood obesity statistics worldwide can be considered as disturbing. According to the World Health Organisation nearly 43 million children under the age of five have been overweight globally in 2010[8]. In particular overweight or obese children are exposed to greater risks of poorer health condition in adolescence and in adulthood. Obesity in children has linked to a delay in skills acquisition for obese children and a higher absenteeism at school [11, 12]. Overweight in childhood increases the risk of developing cardiovascular disease or diabetes, related social and mental health problems, which potentially inhibit further education and development of the affected. Suffering from an excess weight problem in childhood is likely to lead eventually to an increased risk of being or remaining obese as an adult, where certain forms of cancer, osteoarthritis, a reduced quality of life and premature death can be added to the list of health concerns. [13]

Such problems demand a shift in health care delivery and a new model of delivery. As stated before these issues represent not only a European concern. In combination with a genetic predisposition a lack of exercise and the changes in diet have sparked a global epidemic in diabetes. The majority of diabetic patients globally suffer from Type II or non-insulin-dependent diabetes mellitus[9, 10]. The international Diabetes Foundation estimated⁷ in 2010 that 8.9% of the adult (20-79 years) EU-27 population⁸ are suffering from diabetes. Most common complications include blindness, heart and blood vessel disease, stroke, kidney failure, amputations, and nerve damage [ibid]. Cardiovascular diseases (CVD) have developed during the same period into a major cause of morbidity and mortality in the general population in the developed world. In nearly all countries of Europe CVD are among the leading causes of death and hospitalization in both sexes. Longer lives and a better success in treatment have increased the cost for treatment and the associated secondary social cost. [14] Trends in both diseases are expected to continue and to worsen. These conditions are life-style-induced; they clinically manifest themselves towards mid-life or at an older age, often after many years of exposure to unhealthy lifestyles and risk factors.

⁶ In the industrialised countries hunger has become a memory. Even a global level famine is decreasing as a phenomena and it is more caused by political or economic circumstances than crop failures became in the last decades. More people die of overweight related conditions than from malnutrition. [8].

⁷ Uniform information does not exist on a global scale. Data on the occurrence of Diabetes is usually collected in special, often regional, surveys and not by routine monitoring, comparison on an international level is further hampered by a lack of a uniform approach to data collection.

⁸ The prevalence ranges from 4.9% in the United Kingdom to 12% in Germany.

Behaviour patterns

These health challenges are shaped by patterns of behaviour. Data on unhealthy behaviour by the market research company Frost & Sullivan indicate widespread unhealthy habits which from a medical point of view could be considered as risk factors for overall healthy lifestyle, including smoking, extensive intake of alcohol, gluttony and poor sleep hygiene.[15-17] According to a recent opinion poll in Europe, a clear majority of Europeans integrate some sort of physical activity into their schedule at least once a week. [18] The decline in organised sport in a formal club or association with a team reflects this tendency⁹. With age the participation rates decrease. Informal ways to exercise are becoming more popular. Participation in sports up to a certain point reflects some social disparities; those in difficult financial situations are less likely or keen to participate in sports, the situation is more severe for children. With health status of the general population in mind, it is disturbing that around one third of the European respondents seldom or never do sports or has some form of physical activity. Time constraints are the most common reasons why the respondents do not integrate sports in their habitual life.[ibid]

Those conditions deriving from certain behaviours can be labelled as civilisation illnesses. Only an active ownership of one's own health can be expected to lead to behavioural change and an increased responsibility for one's own health status. Patient empowerment becomes increasingly important in health policy discourses as a way to support the transformation of how health care is delivered in European Countries. Demographic patterns increase the importance of patient empowerment. Ageing populations is likely to become one of the main economic and social developments shaping the 21st century. Ageing as a trend creates significant market opportunities as well on a global level. Europe's population with a potentially higher demand for care, older or disabled citizens build up a significant market potential. Even more important are the affluence saved during the post war boom years relatively recent marketing terms like "silver market" reflect the importance and purchasing power of the prosperous elderly generation. Developments in Europe are witnessed and can be forecasted comparable to other important markets such as the United States, Japan or China. The European Union has identified accordingly public health as a major societal challenge and included it in the innovation strategy called Europe 2020¹⁰. In this context ICT¹¹ is expected to play a pivotal role to reach the associated ambitious goals. Studies for DG ECFIN has estimated that ageing imply from an economic perspective, a fall in potential growth rates below those levels observed in recent economic downturn. Ageing translates to fiscal challenges, by both side of the budgetary equation, higher expenditure from larger transfer to an older population and by a decline in the ratio of contributors to beneficiaries. In

⁹ Bulgaria (82%), Greece (79%), Hungary (71%), Romania (69%), Italy (67%), Poland (66%) and Latvia (65%) are the countries that show the lowest level in participation in organised sport.

¹⁰ As a pillar of the Europe 2020 strategy the Innovation Union strives to enhance European competitiveness while tackling diverse societal challenges. Of the involved activities in particular related to health is the Pilot Partnership on Active and Healthy Ageing to support the citizens to lead a healthy, active and independent lives while ageing, while easing the burden on public health systems and boosting competitiveness of involved companies.

¹¹ The role of ICT as a tool to enhance care and quality of life for Europe's Citizen in the Europe 2020 Strategy builds upon the previous policy initiatives at European level including but not limited to the eHealth Action Plan, the Lead Market Initiative, the Ambient Assisted Living Joint Programme and a variety of other communications, studies and research projects. At the level of Member States numerous initiatives have mirrored these policies and contributed to a wider knowledge base.

2009 implications of aging in the EU revises common expectations downward: roughly 1.8 % growth on average in Gross Domestic Product instead of 2.4 % annually in the EU in the period to 2060. [1, 19]

ICT related innovations are expected to reach average European citizens in the coming years to improve the quality of their life and wellbeing by changing their behaviour. An increasing popularity in applications for mobile telephones or smart phones is a driving factor, under the label mHealth medical innovations are delivered through smart phones or attached peripheral devices. The medical field is characterised by common barriers for new technology, even harder are product, process or organisational innovations induced by and facilitated through ICT. Innovation should be understood here not as a single new device, but insofar as ideas manifest themselves as an array of novel and related technologies and services which are successfully taken up by the user and the market. Innovation here is not limited to a mere commercialisation, but an uptake and a resulting of a changing social practise. Success on the market is nevertheless the most obvious feature to measure accomplishment of new technology. An uptake of ICT and its related commercial success is systemic in the sense that it changes behaviours, reshapes organisations, allows the reengineering of processes and can result in new social practices¹². ICT facilitates here social innovation. From a policy point of view it becomes important, as the Europe 2020 Strategy has identified an accelerating ageing combined with low participation of elderly in the workforce as a structural weaknesses of Europe¹³. It states that this structural weakness is reinforced by a lack of adequate use of ICT, reluctance to embrace innovation and market barriers.

Overcoming ICT resistance in healthcare or finding a new path

As a tool eHealth¹⁴, and with it mHealth as a subcategory, in general promises to improve the quality of care, increase care efficiency by reducing medical costs. We investigated such applications which allow elderly or chronic ill patients to continue living in their acquainted environment, if possible following their normal patterns of life, work and be part of their community while receiving the most adequate treatment. We consider furthermore ICT as a tool for changing behaviour. A treatment of life style and ageing related conditins greatly profit from preventive activities reather than curative. Clearly such a behavioural change

¹² This paper is aware of the wide field of scientific literature devoted to studying innovation. An accompanying document to the Flagship Initiative Innovation Union uses a broader approach towards and defines innovation as: "*the introduction of new products, processes and services ('product, process and service innovation'); innovations that involve changes in the way business or manufacturing processes are organised ('organisational innovation'); innovation that draws heavily upon knowledge inputs from customers and markets ('user-driven innovation'); changes in the way that firms and other organisations access and exploit knowledge to produce innovations ('open innovation'); and innovations in the way that society organises itself, especially the different ways that the public sector serves the needs of society at large ('social innovation')*".[20]

¹³ Additionally a less dynamic and innovative business environment compared to other parts of the world inhibits growth.

¹⁴ The portmanteau of electronic and health eHealth refers to all sorts of applications of ICT in health care realm, a taxonomy by the eHealth task force supporting the Lead Market Initiative is useful here: 1. Clinical information systems; a) Specialised tools for health professionals within care institutions, b) Tools for primary care and/or for outside the care institutions, 2. Telemedicine and homecare systems and services; 3. Integrated regional/national health information networks and distributed electronic health record systems and associated services; 4. Secondary usage non-clinical systems; a) Systems for health education and health promotion of patients/citizens, b) Specialised systems for researchers and public health data collection and analysis, c) Support systems for clinical processes not used directly by patients or health care professionals.[[21]

consists of avoiding habits detrimental to health and the uptake of beneficial. Public health policy reflects this assessment.

Yet applications and usage of ICT in the medical field face a number of barriers compared to implement the very same technologies in other fields. Non responsiveness and resistance to the implementation of ICT based innovation among physicians and other health care specialists are well documented in scientific literature: Legal issues complicate approval for technology. Additionally the technology performance is often perceived as poor and not adopted to the needs in a health care setting, and legal requirement inhibit an adoption of programmes to the given circumstances. Depending on the organisational form of purchasing agreements are centralised and do not take individual procedures and pace of care units into account. On the other hand insulated and heritage software solutions can lead to fragmentation of software solutions and compatibility issues. Organisational complexity, resistance to change by major stakeholders as well as the lacking of management support, of ICT understanding and of resources can partly explain the resistance against introducing information and communication technology in health care in general[22, 23].

A review of companies active in the market or offering products for the delivery of Integrated Personal Health/Care Services - (including health care providers and pilot projects) further revealed intertwined barriers: They affected as well a wider uptake of remote patient monitoring and treatment and further services. Such barriers apply for further eHealth applications in a medical setting. One example of such barriers is the unclear spread of responsibilities for investment and reimbursement which means that under certain conditions the paying party is not identical with the institutions which financially would benefit from improved prevention,¹⁵ thus impeding IPHS deployment.

Additionally reimbursement issues emerge for health related products. The success of a product depends on the integration into catalogues of benefits compiled by a fragmented landscape of health insurances depending on the institutional setup of the member state. Further the fragmentation of buyers caused by the distinct institutional setup in different regions and countries makes the market less transparent for companies[6, 7]. Out of pocket payments for medical products encounter resistance from insured people, as their contribution to the health care insurances create in some people a feeling of entitlement. In particular SMEs struggle to bring products and services to market, or to expand beyond their initial market. Some market players also encounter resistance from healthcare actors to accept new solutions that have not been proven over a longer period of time. A complex set of responsibilities between social and health care, as well as primary and secondary care can in some countries lead to lack of incentives impeding an uptake: those institutions bearing the cost for a system or service not automatically the same as the ones reaping the benefits. Novel technologies tend to offer only small initial benefits, uncalculated risks and substantial costs. Their main health benefits manifest only with lower cost over a prolonged time, social benefits are harder to measure and can fall out of the criteria for choosing a product.¹⁶ For some of the products offered by actors on the IPHS market, evidence is missing, leading to a vicious circle. Technologies for medical purposes understandably undergo special scrutiny

¹⁵ The financial and administrative burden for providing an simple RMT system or an emergency alarm may lay with the social care

¹⁶ For an instance a telecare alarm triggering a support chain in case of an emergency may prevent hospitalisation, thus it reduces the cost for the health care insurance. The upfront cost for setting up such a system and the maintenance and delivery of the service would be born by the social care service.

which may result in difficulties to obtain approval and certification from health care organisations in EU Member States.

Being used as a tool to support sports, training, and exercise and even track levels of general activity ICT can take a different road to the market. People are less reluctant to purchase products and services related to wellness and sport, out of pocket payments are not a problem here. The very same technologies used in health related applications can cater for the needs normal people active in sports and thus unfolding its potential for customers, companies and society as a whole. At the same time a single set of technologies like ICT in the delivery of care and for the maintenance of wellbeing cannot and should not be considered as a panacea to all the woes related to demographic change, life style related diseases and limitations of public expenditure for health care. The assessment of the impacts and potentials of eHealth in general and IPHS in particular oscillate between two poles. Proponents of the usage and application of ICT in a medical setting enthusiastically herald the repercussions and benefits of a wider uptake of eHealth and, to cite an example, compare ramifications of a wider use of telemedicine to the positive impacts on public health induced by the industrial revolution.[24, 25] Contrary to this positive appraisal other opinions are more critical, a meta study for instance highlights the still rather weak link between postulated advantages and empirically demonstrated benefits of eHealth technologies and cast a shadow of doubt on suggested cost-effectiveness. [24, 25]

At the same time the pitfalls related to medical technology can be avoided by taking the particularities of health care into account. The paper argues that some of the benefits related to the deployment of eHealth and mHealth technologies can be reaped as well if they are popularised in a different fashion. For an instance, vital signals monitoring in a non medical environment has the potential to shape a digital lifestyle and foster health. Additionally is the idea that successful market deployment can trigger user-driven innovation in terms of how technology can be used to encourage more active and less sedentary lifestyle, by adapting to individual needs.

Gnothi Seauton: Know thy self¹⁷

Part of the shift in health care depends on citizens actively reclaiming responsibility for their own health and well-being which is facilitated by ever greater access to information. This can be labelled "patient empowerment", an idea or concept which becomes increasingly important for health policy formulation to support the transformation of health care delivery. It involves the strong connotation that information on health status is available to both the carer and the patient. This involves health literacy defined as the *'degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions'* [26], building the basis to develop such skills needed to perform the activities necessary by their conditions¹⁸.

¹⁷ In context the Greek expression γνῶθι σεαυτόν/ gnothi seauton refers to a mean of self-knowledge through introspection: technology aids by providing quantifiable numbers.

¹⁸ This for instance involves updating adherence-related facts as necessary, such as glucose levels. Additionally it involves regularly execution of a treatment including the acquisition of medication, self-cueing, and self-administering of medications while taking side-effects into account. Last but not least it means incorporating the regimen into the social practise of daily life. It involved social support and instrumental support for adherence.[27] However medical professionals, usually prefer interacting with the monitoring technology directly and avoid empowering patients and minimise measuring mistakes.

ICT offer new ways to hand citizens such information over. Expert systems can support the laymen in conducting medical searches on their symptoms and ICT offer the capability to store and access health related information in the form of Electronic Health Records, which has the potential to become a cornerstone in empowering patients. The chances and perils inherent to patients using the information available are vast. On the positive side patients can use different source for empowerment, and become informed and responsible decisions. On the other side information technologies can lead to a misunderstanding. The online market for medicines attracts dubious business behaviour, as anyone knows owning an email address. Deliberate misinformation and even quackery can be as well facilitated through new means of communication. The field is ripe for new regulation to protect both the patients and the medical practitioners Nevertheless medical or health background information is a prerequisite for an empowered patient to evaluate their own situation, as any behavioural change needs to be rooted in grounded and validated information.

Yet health information is more than just access to medical facts, it is information regarding the patients and on the own health status. Classical paper-based medical records tend to be scattered among different practitioners' and specialists' offices are to be replaced by electronic versions. Such Electronic Health Records (EHR) have been named a decisive element for the success of ICT based services in health care. Yet in particular the storage of sensible information has raised concern and stirred resistance to a widespread use of eHealth services (e.g. in Austria). Either access of patients to their information has been introduced as a new concept or as an incremental improvement to already existing practice. The paper version of patients diary have been owned and physically possessed by the patients themselves in Bulgaria, a digital version of these are offered online and have been accepted as a continuation of an existing habit. [5] We conclude that active ownership of health related information is crucial for the success of patient empowerment.

Patients' empowerment is reinforced by self measuring of vital signals as wells as various biochemical indicator and blood values. Technological progress allows formerly sophisticated test to be performed by an increasing¹⁹ amount of patient independently from health professionals. Additionally the mere fact of measuring something regularly forms a habit; the values of the measurement can reinforce a behaviour change through feedback and comparable through quantifiable numbers. Those users which are able to uptake the habit of regularly measuring vital signs are more likely to comply with a treatment or training plan.

A systematic application of ICT for monitoring vital signals in sports, training and recreational physical activities follows a similar approach. Self-management of training efforts also suggests setting goals based on an ideal individually adjusted training plan. Information is needed on best practise in training. Physical activity is consequently measured to monitor progress to manage the effectiveness and improve quality of the training efforts. Currently measured vital signs include hard values such as weight, pulse rate, blood pressure, training efforts, speed or weight. The tremendous successes in electronics miniaturisation are currently being translated into chips for a rapid chemical analysis of microfluids. This enables chemical analyses of blood hormones as markers of training stress and overtraining or other aspects. With dropping prices such technology are expected to be available for mass sports. Some of the existing systems calculate the calories burned and other factors affected by the physical activity. Other measurements taken include softer or subjective values such as

¹⁹ Labs on a chip and Ambient Assisted Living and other forms of smart homes are expected to increase further the availability and affordability of vital signs monitoring and rapid medical test panels suitable for the laymen.

perceived levels of energy, stress, pain, happiness, or mood affected by training. The usefulness depend on the measurement in itself has been unobtrusively designed and integrates smoothly in the flow of training or conducting an everyday activity, like taking a bike ride to commute. Examples of devices include accelerometers, gyroscopes, or geolocation trackers. The collection, visual display and the automated or peer feedback on the results contribute to further uptake of ICT for fitness applications. In times of the internet peer pressure manifest it self in form of web 2.0 communities, in which athletes share their results. Given the often competitive character of sports, these communities have a stronger leverage to prod participants than other groups.

Tracking efforts and results anywhere: mhealth and sport

The advent of health and fitness related applications for smart phones offer a new way to incentivise people to adopt and more importantly to stick with a healthier lifestyle. Such smart phone based mobile health (or mHealth²⁰) embraces the ubiquitous aspects of being healthy. Early adopters in sports are to be found in particular among those enthusiastic about endurance sports. They have embraced early sensor technologies and evolved as the leading market place for ICT based training support. Wireless telemetry capabilities are employed beyond hospital walls on the track fields. It has become possible to better organise the training, capturing and processing of vital signals and – importantly from a sport medical point of view- to provide feedback on training activities. Classical sport garment and equipment companies, producers of chronographs, consumer electronics and video games are entering the market offering new personal fitness monitoring products or even serious games specific to various sports activities, such as running, cycling or even bowling. It appears that this market moves towards mhealth and wellness applications. Applications and platforms for smart phone altered the dynamics of the ICT market and changed the traditional business models. They promote models based on small payments for downloads while making smart phones and tablet computers central devices. Though Apple has not been not the first company to introduce programmes for smart phones²¹, the company took the lead with its family of smart phones and tablet computers combined with the surge in sale of apps through the unified Apple Apps Store. For many people, mobile phones have already become part of everyday life. The success of smart phones and their ecosystem for downloading apps is linked to their ease of use. This being said, complex hierarchically structured menus can sometimes still be hard to navigate and visibility issues contribute to usability shortcomings for mobile phones and Apps for Smart phones. Age and condition related changes in psychomotor, sensory and cognitive capabilities enhance the demand for usability.[28, 29] The market can be divided into a more restricted market targeted sport professionals with more complex products and a booming consumer market. Additionally under a third category

²⁰ DG Information Society provides a useful definition of mhealth at the following website, our understanding of mhealth is based upon this definition: mHealth is a term that refers to the provision of medical services through the use of portable devices with the capability to create, store, retrieve, and transmit data via mobile communications. In technical terms, small devices are used to monitor patient-related data and actively communicate with a central information system; in most cases, communication takes place either over a mobile telephony or fixed line network (e.g. ADSL) coupled with WiFi. Standing at the crossroads of eHealth, Mobile Devices and Wide Area Networks (WANs), mHealth has found itself in the middle of an explosive growth that these sectors have experienced in the last few years and which is continuing strong, even in the midst of the global recession. http://ec.europa.eu/information_society/newsroom/cf/itemdetail.cfm?item_id=6426&utm_content=tpa-23

²¹ Earlier attempts by the same company of introducing a Personal Digital Assistant platform have not been abandoned in the 1990s.

we increasingly find services targeting corporate clients keen on inducing behavioural change among their employees promoting healthier and more productive lifestyles.

The first group - professional athletes – form as customers a highly competitive market segment, where small improvements can determine success or failure. Training efforts rely more and more on research results of sports medicine, exercise physiology and other science²² increasingly integrating the newest technologies²³. Athletes are early adopters of high tech innovations, such as new composite materials for equipment. Increasingly to improve their performance physiological data is recorded and analysed through remote monitoring or sensors during exercise and recovery Training is increasingly supported by a broader range of algorithms.. In other words the competitive environment of professional athletics functions as a hotbed for new technologies which are useful from an innovation and public health policy point of view.[30, 31]

More and more hobbyists and spare time athletes rely on advanced technical support, and created a distinct market for products targeting them as customers. In mass sports or popular 'early adopters' mimicking the training methods of professionals, they are willing and able to pay high prices for products well ahead of others. Their socio-economic profile makes them technology savvy and demanding customers. They are located somewhere between more average sport practitioners and elite athletes, their choices in training methods and equipment becomes wider and more sophisticated. For this market group a broad variety of tracking devices are available, while endurance sport in itself has become increasingly important in contemporary society and has grown into a significant business opportunity. [ibid.] In particular endurance sports enthusiasts can choose from a wide array of devices and gadgets. Sport garment and shoe manufacturers integrate motion sensors in their products enabling them to be connected to smart phones or advanced digital music players and to record their trainings, navigation system producers or, sport computer producer serve this market with an increasing variety of products.

With the smart phone easily programmable tools has become popular, for which a surge of health, sport and training related apps have become available. The smart phone approach has lowered significantly market entrance barriers for new actors who instead of having to produce and sell new devices can rely on the existing smart phone which can be programmed through an app at a nearly marginal price, so that there is no need for a critical mass of users to bring prices down as was the case before. Independent tinkers without large research and development budgets have access to a tool to use. Athletes and hobby sport enthusiasts alike have a proven track record of been keen on creating new products and establish industries. Windsurfing, snowboarding and skateboarding have emerged from hobbyists' creation²⁴[32]. The health and sport community also welcomes the possibilities created through motion and voice controller like Microsoft's new Kinect. Such sensors survey various points on the body to detect movements and translates these body movements into actions or instructions on the screen, which is additionally equipped with a voice controller. Communities of users are

²² Professional sportsmen rely on a dedicated team of applied sport medical practitioners or athletic trainers to evaluate collected data and to draw conclusions for the improving the performance and trainings.

²³ In the area of professional athletics research institutes and universities tend to be involved to carry out research and engineering, combining different domains of knowledge, such as informatics, mechanical/electrical engineering and medicine.

²⁴ The creative potential within sports may best demonstrated in the evolution of a Polynesian tribal activity like wave surfing to a multi-billion industry. From Riding waves with wooden tools it evolved into such diverse activities as snowboarding, kitesurfing and skateboarding Through recombination of existing technologies new application have sparked, most of these trend sports actually have their roots in hobbyist tinkering around till a new sport is born.

deploying the Kinect capabilities of advanced video conferencing system further for personalised training and feedback by trainers. The first generation of programmes already demonstrate the potential of the sensors²⁵. Features and tasks necessary for home rehabilitation can be performed through adjusted programmes on game consoles. It is important to validate the identity²⁶ of the patient, e.g. by facial recognition and the cameras can record and enable feedback on different aspects of motions by different parts of the body. Similar programmes under development will allow doctors and patients to connect through a social network associated with game consoles and to survey prescribed rehabilitation courses which are graded and assessed according to a schedule. Sensors like the Kintec²⁷ offer an off-the-shelf system and hardware for advanced Ambient Assistance Living and telehealth solutions, which previously had to be developed independently. Such tailor suit solutions made price prohibitive to a broader community of developers. It is an Israel-based Start up called PrimeSense which licenses the controller to Microsoft, thanks to a liberal licensing the sensors is open to a broad variety of purposes including health related experiments and applications.[34]

Corporate fitness and wellness programmes are a further promising area for ICT as a tool for behavioural change. ICT is starting to play a role in the delivery of wellness and training related services capable of delivering feedback and track performance. The accounting and consulting company Deloitte estimates good chances for the fitness industry to establish a new market segment for general corporate fitness programmes. [35] Corporations and public authorities in Europe increasingly provide schemes to keep their employees fit and improve their general well-being, reduce absenteeism and improve productivity. In some European countries tax breaks incentivises companies to contribute to sports activities of their employees. Additionally to the establishment of gyms in office buildings or the reimbursing of membership fees, companies are being offered a broad variety of ICT supported services that nudge people to become physically more active. One example is the Dutch Fitness provider *High five* which targets the market for services catering for the health needs of employees. Additionally to its standard training courses it offers an online repository to manage training efforts and foster healthy lifestyle choices combined with feedback. The British holding Virgin is marketing to corporate customers a health-miles bonus programme as an incentive similar to frequent flyer programmes to encourage employees to increase their level of physical activity. The tracking function happens over a motion detector and a web interface. It is worth noting that the industry focusing on corporate wellness and fitness seems to have remained rather resilient to the economic crisis.

All the above demonstrate that it becomes possible and easier for both the professional athletes and the amateur to record high quality physiological data during exercise and during recovery periods. These new developments are supported by ICTs to open up market opportunities not only by expanding the reach of health related systems to the consumer market as a whole but also to companies and corporations who are increasingly interested in

²⁵ , E.g. *Your Shape: Fitness Evolved* a game offering exercising as part of the gameplay. t.

²⁶ More on the importance of electronic Identity can be found a report by the Institute for Prospective Technological Studies [33]

²⁷ PrimeSense has developed the method behind Kinect and licensed it to Microsoft. The sensor generates a detailed topographic map in 3D by analyzing the deformation in the coded light as it is reflected back from the different objects in the scene. Its components are based on standard electronics already in high-volume production - including standard image complementary metal oxide semiconductor CMOS sensors-, and purportedly offers superior resolution and dynamic range and is most resilient to ambient light.

their employees general health and well-being. Interestingly enough market research conducted by Price Waterhouse Coopers, indicates that consumers who self-reported to be in very good health and shape are the most likely to incorporate an application into their cell phones to monitor their health or training, while consumers with poor self reported health status and/or chronic diseases are the least likely. Here an accumulated advantage or Matthew effect takes place as well, those who already profit from something can increase their benefit through a new tool. Even if technology helps to stay in a better shape, it is as already indicated not a panacea for all social disparities. [36] Games are hoped to reach in particular those children not affected by more classical health education approached to reach them. In general those people affected by a sedentary lifestyle or who feel the need to loose weight are targeted to use such systems to motivate behavioural changes. A distinct set of products for people suffering from inadequate sleeping patterns or insomnia have hit the market. To support the cessation of tobacco or alcohol intake devices, apps and services are emerging, even the support of people in mild form of perceived psychological crisis.

Conclusion

Finding a suitable solution for the demographic and social necessities and harvesting the business opportunities for these looming problems can serve as a prime example of a threefold win situation. It would enable citizens to live a healthier life while improving the sustainability and efficiency of social and health care systems. Finding a way to market ICT for training purposes for many more customers would serve as a way to increase the competitiveness of European companies, not just device producers but also service providers. As a conclusion the paper considers RMT technology used for fitness and training support as an important stepping stone for a wider uptake of IPHS and eHealth in general enabling EU citizens to lead healthy, active and independent lives while ageing. Simply through economies of scales and increased competition a market for sensors and complementary peripheral devices could drive down prices. Yet this is not an argument ultimately decisive for the success of services using vital signals monitoring in medicine out of institutional care.

Networks economics and social network effects play a far more decisive role. Increased acceptance through usage and exchange among peers result in a broader user base accustomed to tracking their signals through training, which may eventually lead to acceptance of the same technologies for medical purposes[37]. One should bear in mind that acceptance can derive not only through personal use, but being familiar with such a technology through some one in the peer group using it. Additionally as state above, the main socio-economic group currently using for sensors and remote monitoring devices in training are middle aged professionals, and affluent people among the baby boomer generation. It is among people in these age groups that the first patients for IPHS will emerge in the future. Consume patterns eventually may disperse among other socio-economic groups.

From a network economics point of view the increase in customers is accompanied by an increase in skills both among clients as well as among developers of technology. Mastering smart phone platforms for a broad variety of purposes becomes common knowledge among programmers and engineers. Social practice of living digitally for staying fit will inspire new products for health care, it can contribute empower patients to take responsibility for their own health. Young users or children can early on adopt habits beneficial to their well being, and continue these during their life. User in the middle of their life become accustomed with mhealth application and will lateron be less reluctant to use them.

In particular ambitious athletes and hobbyist have pushed innovation in new fields; while the humble beginnings in garages of successive revolutions in computing are common knowledge and legendary these days, the impact of enthusiasts in specific sports in creating a multibillion

business is less known.²⁸ [38] At the same time the competitive character of sports pushes scientific research and innovation to the extreme in the race for gaining an additional advantage, these practices trickle down from professionals to elite amateurs and finally reach through popular participation everyday users, to use a much simplified version of diffusion theory.

²⁸ Whether a popularisation of all extreme sports is actually desirable from a public health point of view is a different topic. Their devoted practitioners have spurred many successful businesses, with out these enthusiasts a new sport does not become a mass phenomena.

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