

# Smart Citizens for Healthy Cities

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**Abstract—** On December 10-11, 2014, the inaugural workshop of the IEEE Smart Cities Initiative was organized in Trento. As a part of the workshop labor, a number of working tables were settled on the main domains characterizing the concept of a smart city. This paper reports the outcome of the Health and Well-being working group, a strongly interdisciplinary panel of experts who, starting from the funding notion of health and the present-day challenges, analyzed the ongoing technological trends and related opportunities for new concepts of health delivery and health promotion in the smart community setting.

## I. FOREWORD, THE CONCEPT OF HEALTH

The concept of health is traditionally linked to the idea of a sick body, a damaged organ or pathological physiological functions. Nevertheless, this approach to health has been revealed as being incapable of grasping the complexities comprised in what it means to be healthy. In 1946, the World Health Organization (WHO) [1] defined health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” Since then, health has been conceptualized as including social and psychological aspects. Subsequently, a number of socio-anthropological and human geography studies have highlighted how health is first and foremost a relational process that binds people with their environment via multiple webs [2], [3], [4], [5], [6], [7].

In 1986, the Ottawa Charter confirmed how health is closely related to a variety of socio-economic and environmental determinants.

With regard to environmental health, WHO also approved the Budapest Ministerial Declaration on Environment and Health and the Children’s Environment and Health Action Plan for Europe (CEHAPE), identifying priorities and goals in this field. The Council of Europe Parliamentary Assembly (Recommendation 1863-2009, Environment and health: Better prevention of environment - related health hazards - Council of Europe Parliamentary Assembly) affirmed the

‘primordial role played by civil society and associations working to protect the environment and environmental health in terms not only of sounding the alarm and denouncing health scandals but also of producing preventive strategies and action plans.

A healthy environment is not simply defined by its physical characteristics (for example, somewhere being more or less polluted and therefore more or less healthy) but instead as a space, which offers various affordances in terms of social, practical, economic, affective, and informational opportunities [8], [9], [10], [11], [12], [13], [14]. Courts have shared this all-embracing idea of a healthy environment, both at the national (i.e., the Constitutional Court’s jurisprudence since the 1980s) and supranational level (i.e., European Human Rights Court and European Court of Justice - ECJ). Thus, they are actually close to recognizing the existence of a binding right to a healthy environment, as the ECJ’s jurisprudence has recently demonstrated in relation to the waste crisis in the Campania region [15]. Hence, space is not a mere extension or passive materiality but is an active, lively, historical and political dimension [16], [17], [18], [19] that significantly affects people’s lives and therefore their health [20], [21]. Thus, it is essential to promote multi-sector interventions aimed at population health from the perspective of the “health-in-all policies.” This requires enhancing the use of a shared methodology and tools between policy makers and community stakeholders.

Against this backdrop, smart cities, with their promise to improve the quality of and opportunities available in urban spaces and territories, appear as a very positive advance because, in such a context, the health of citizens should necessarily improve and very tangible positive outcomes would be evident in the short term and especially in the medium/long term.

### A. *Smart City Means Smart Territory*

The crucial question, however, is whether smart cities will be able or not to keep up with their promises and expectations of enriching opportunities for people. Demographic transition and chronic diseases are probably the most serious challenges Europe is facing. In the EU, life expectancy at birth for males is expected to increase by 7.2

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years over the projection period, from 77.6 in 2013 to 84.7 in 2060. For females, life expectancy at birth is projected to increase by 6.0 years, from 83.1 in 2013 to 89.1 in 2060.

Currently, because of the aging demographics and the increasing prevalence of chronic and degenerative conditions, we are now experiencing a growing demand for qualified services that only new models of care will be able to support. In the last 10 years in Italy, life expectancy has increased by approximately 2 years, while the “healthy” life expectancy has decreased by approximately 6 years [22], producing an increased demand for services that the current model of care cannot support in the long term. Smart cities should work against this dynamic, starting from health promotion and risk prevention. The primary focus of a smart city in an aging society should be the prevention of frailty and disability by developing innovative models supported by high-tech services and solutions towards the overarching goal of “smart healthy communities.” On the contrary, frailty is today still mainly measured through clinical criteria, which estimate functional autonomy and do not adequately consider the associated social-health and environmental history. Alternately, knowing how a disease affects one’s functioning enables better planning of services, treatment, and rehabilitation for persons with long-term disabilities or chronic conditions. The International Classification of Functioning, Disability and Health, known more commonly as ICF, is a classification of health and health-related domains. As the functioning and disability of an individual occurs in a context, ICF also includes a list of environmental factors. All 191 WHO Member States in the Fifty-fourth World Health Assembly officially endorsed ICF on 22 May 2001 (resolution WHA 54.21) as the international standard to describe and measure health and disability. The implications of using the ICF include emphasizing the strengths of individuals, enabling individuals to participate more extensively in society through the use of empowerment-oriented interventions aimed at enhancing their abilities, and taking into consideration the environmental and personal factors that might hamper one’s participation.

Technology is one of the enablers for this challenge, which also requires the consideration of business and social innovation. Individuals have been more and more requested to play an active role in the healthcare system and to become better managers of their own health and more active partners in the management of the care with healthcare professionals. Information and communication technology can help create infrastructures and services (e-care), providing citizens with empowering tools to support self-management practices and coordination with caregivers and health professionals through different devices (computer, smartphone, TV, wearable devices, etc.), regardless of their physical location (home, work, holidays) and whenever needed (pervasive e-care). Currently, the smartness strategy has stood out mainly as a standard, or a set of standards, that leads to numerous patterns of dimensions. Multi-dimension schemes adopted by international analysts to test smart characteristics and/or performances have been quite similar. They usually refer to the six dimensions of Economy, Environment, Mobility, Governance, Living and People (the last two particularly concerning health and well-being issues), chosen for the first time in Europe in 2007 [23]. These dimensions, and related markers, are often deemed as the starting point for actions and interventions. This bias carries certain risks. First, because it is based on a fixed pattern rather than on territorial context-specific analysis (i.e., of the real local needs, the strong and weak elements, the different starting points, what has been

finished up to that point etc.), it inspires homogeneous and standardized development pathways unable to capture the specificities of territories. Second, because it is mainly founded on metrics, it leads to a numerical representation of reality. To avoid these risks, it is necessary to switch from a technical to a political approach to smart cities and territories. The first approach, widely supported by dimensions, markers, axes and measurement grids, aims to make the functional structure of cities and territories more efficient, developing mainly technological tools and devices operating within the boundaries of urban areas. The second approach, starting from the identification and selection of needs and the organization of the local resources able to face them, aims to develop integrated and place-based development paths operating, if necessary, beyond the boundaries of urban areas and within medium- and long-term planning. This shift fulfills the requirements of the concept of health, stated at the beginning of this paper, which is understood as a relational process that binds people to their environment. The challenge at stake, in other words, is to think not only about intelligence in the city, in terms of upgrading, efficiency and innovation services, but also and above all about the intelligence of the city, considered the ability to (re)interpret itself on the basis of citizen-centered visions, shared by all the actors (public institutions, private companies, etc.).

Some initiatives – structures, studies and projects – held at both the national and local level could be viewed as an effort towards the declination of the smart city overcoming the predominance of the technological dimension and an attempt to overcome the arrangement of single interventions towards a more integrated urban and territorial planning. The ‘Agency for Digital Italy’ and the ‘National Observatory on Smart Cities’ are the main structures operating at the national level. As for the research, the study on ‘Equal and Sustainable Wellbeing’ by the Italian National Institute of Statistics and the National Council for Economics and Labor can be considered a source of inspiration. At the local level, the Territorial Labs represent an efficient platform to support multi-level governance, able to tailor services directly to citizens. At least three aspects seem necessary to set up a sensitive smart strategy, especially in the specific field of health and well-being: the starting point has to be the local needs (connected, in particular, to current frailties), which will inspire the operational dimensions and the most effective tools. The answers to local needs have to be based on local resources, including the positive experiences that have already produced significant results; the public actor has to strengthen its role of coordination and pilotage, especially with respect to private players. Related metrics must be harmonized on these key elements more than on standardized grids.

## II. SMART CITY AND TECHNOLOGICAL TRENDS

Mobile apps, body area network sensors and personal health management ecosystems have been recognized as essential components of the technological platforms of the next generation of healthcare for their potential to allow citizens to play an active role in the management of their health. Mobile Health has been recently defined as “an emerging and rapidly developing field, which has the potential to play a part in the transformation of healthcare and increase its quality and efficiency.” [24]. Mobile Health applications (smartphone and tablet) can connect to medical devices or sensors (e.g., patches, bracelets, smartwatches, etc.) and provide personal assistance and reminders. Through

the use of sensors directly connected to mobile devices, it is now possible to gather a considerable amount of data regarding not only lifestyle and physiological personal data of citizens but also environmental data (e.g., pollen concentrations and pollution levels). Gathering patient-generated data during everyday life, on one hand, may provide clinicians a richer picture of an individual's health status and, on the other, may enable individuals to engage in managing their own health. The potential of mobile health is therefore related not only to empowering patients but also to a more efficient and sustainable healthcare system in the areas of both prevention and care. To this aim, the variety of sensing equipment available on the market at affordable prices has made user monitoring an accessible task [25, 26], and several solutions have been proposed in the literature to collect and analyze data, as well as to infer the cognitive and physical state of a patient [27]. The most common solutions include the massive use of mobile devices to gather information about motion, such as, for example, the number of walked steps, the walked distance, and, more in general, the physical activity performed by the user throughout the day [28]. This is often achieved with the help of additional wearable sensors that can easily connect via Bluetooth, or other wireless protocols, to a data-collecting unit (mobile, local server, cloud server) to store the acquired pieces of information. If we imagine an infrastructure where every object in the entire environment is smart, following an Internet of Things (IoT) approach [29, 30], then the monitoring process becomes pervasive, making it possible to sense, interpret and eventually react to user actions. Much of the 'big data' that are continuously generated by IoT sensors, devices, systems and services are geo-tagged or geo-located. The WHO, as a unique key enabler of the smarter healthier cities of today and the future [31], recognizes the importance of having robust, intelligent geospatial analytics systems. Thanks to such technologies, although not officially recognized as strictly medical, it is possible to collect data at various scales, from the personal to the environmental level, to provide a complete picture that describes the user in the context he/she moves or lives. The sensing equipment can not only be used for monitoring purposes and self-care management but also be exploited as an active system to assess and possibly improve specific abilities of the user, such as, for example, in the framework of physical and cognitive rehabilitation [32, 33]. This is one of the goals of the European project UNCAP, started January 2015 [34]. The UNCAP project, started from the experience and competences gained over the years by a large network of private and public local actors (Trilogis., Socialit, FBK, Cretenet, University of Trento, Healthcare Trust of the Autonomous Province of Trento-APSS), The local UNCAP consortium is currently collaborating at the European level to provide a unified platform for active aging with the goal of maintaining and fostering the cognitive abilities of elderly patients suffering from mild cognitive impairments. Among the large set of monitoring devices, which include blood and heart rate measurements, as well as localization and tracking, an innovative aspect of the project consists of the gamification of the users' actions. This includes, for example, performing daily activities using a gaming paradigm. An example could be "provided a list of ingredients, use them in the right order to prepare a recipe." The adherence to the rules (in this case, the capability to pick the right ingredient) makes the exercise measurable and makes it possible to understand the elderly's needs and potential. The implementation of these so-called serious games basically refers to the translation of simple yet

effective exercises that involve the physical and/or cognitive sphere that are accomplished using an IT platform able to record, measure, and evaluate the actions taken by the subject.

#### A. Connective technology

Many pilot studies have confirmed that citizen empowerment and community participation have important benefits for achieving better decisions and more effective services and ensuring ownership and sustainability of programs [35]. Empowering the community not only allows for the reduction of health disparities and social exclusion but can also enable the citizens to control many aspects directly influencing their lives that would be impracticable to be performed by a third party. In particular, the introduction of social networks and novel web services allows for the production of knowledge and leveraging of collective intelligence [36], which can significantly help in supporting the citizens with regard to health promotion, disease prevention and therapy self-management. The democratization of mobile technologies allowed pushes this concept even further because it introduces ubiquitous access to information and enables quantified self-tracking [37]. These societal changes have created a significant opportunity to reimagine the healthcare system in order to make it more citizen-centric.

The increased availability of tools has produced a shift in the locus of production and analysis of health information. Patients are becoming healthcare information "prosumers" (producers and consumers). The technology at their disposal allows them to generate personal health and lifestyle information. This information can only be partially shared with healthcare professionals, whose work burdens cannot be increased past a certain degree.

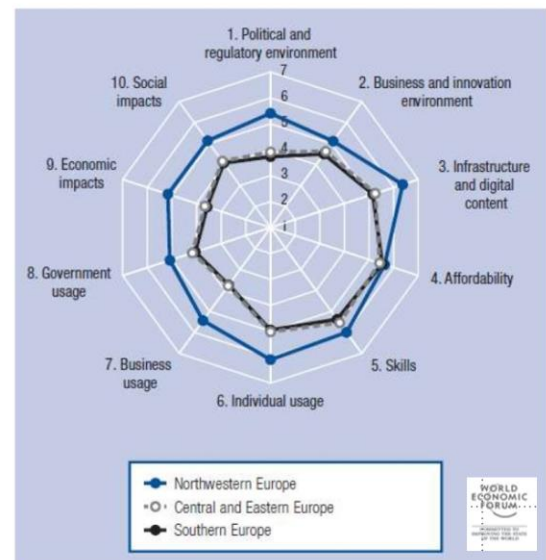


Figure 1. The World Economic Forum Global Information Technology Report 2014 analyzed the digital divide among three European macroregions (Central, Eastern and Southern Europe) along 10 dimensions. A clear lag between western European member states and their counterparts is evident.

Smart Healthy Cities require a reshaping of the role of both citizens and healthcare professionals. Patients need to be educated/supported in the analysis of information that they produce, and healthcare professionals must provide education, counseling and guidance in this process. The engagement of citizens is therefore required to build new forms of

technologically assisted therapeutic alliances between healthcare professionals and institutions but also to create smart networks of citizens to promote peer-to-peer forms of empowerment and experience sharing. The full inclusion of citizens is needed in the definition of services, the monitoring and the evaluation of the proposed solution, and the co-design of technological artifacts. Their inclusion is not only desirable but also actually needed to avoid the design of services or technologies that unintentionally increase the burden of care for citizens and families beyond their actual capability or willingness.

### B. Ethics and Privacy

Smart technologies for health are related to important concerns about ethics, privacy and confidentiality. First, bodily data becomes privatized, given the significant role of corporations as gatekeepers and providers [38]. Second, smart technologies can represent new means of monitoring and disciplining both health workers and patients in terms of regimes of accountability and performance measures [39]. They allow for monitoring patients at a distance, as data about their everyday health condition is collected, stored and managed remotely [40], [41], [42]. This might pose some concerns regarding individual freedoms: for example, people with a history of Driving Under the Influence (DUI) may have their alcohol consumption monitored by means of an ankle bracelet [43].

While smart technologies for health are potentially useful and beneficial, they might be used to constrain the scope and practice of what constitutes citizenship and engagement, limiting people to forms of online and/or mobile participation as a compulsory new practice and politics of responsible online health management. Third, the introduction of smart technologies poses various new challenges for the doctor-patient relationship and clinical practices regarding confidentiality, professional boundaries and privacy [44], [45]. In summary, these technologies involve new regimes of surveillance, time-discipline, audit, accountability measures, and performance-based pay [46]. Therefore, widespread technology implementation should be anticipated by a careful political planning of health data use and limits.

### C. The digital divide

Although the key role of the Internet in the inclusive growth of any region and that it should constitute a common worldwide right have been proven, we still register a gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to the access to this utility [47]. This technological and social gap is referred to as a digital divide, differently characterizing all world countries, which differ markedly with regard to both their opportunities to access information and communication technologies (ICTs) and their use of the Internet for a wide variety of activities. Although a major gap is present between OECD and non-OECD countries [48], a number of barriers remain and are differently spread inside of OECD countries and between regions.

More specifically, computer penetration and Internet access are indeed generally lower for older people than for the young, and overall usage has tended to grow faster in younger age groups. Furthermore, OECD noted significant differences in access across groups from different racial, ethnic and cultural backgrounds, while income and education enlarged these differences. Finally, spatial planning can play an

important role in allowing equity of access as, at present, Internet access in urban areas is greater than in rural areas, and, as a result, urban homes are more connected than rural ones. According to the World Economic Forum Global Information Technology Report 2014 [49], Central, Eastern and Southern European member states continue to lag behind their western European counterparts. As shown in Fig. 1, the gap is apparent for all ten considered pillars, although it seems more pronounced within some, particularly relative to public policy. For this reason, the European Commission is taking actions to improve the use of technologies - and, in particular, of the Internet - among both Public Administrations and citizens. Thus, in light of this action, the Commission has recently adopted the aforementioned document named "Digital Agenda" that represents the EU's strategy to help digital technologies, including the Internet, to deliver sustainable economic growth [50].

At the same time and for the same reason, the Italian Government has created the "Agenzia per l'Italia Digitale (AGID)" [51], an office that has the main task of spreading the use of the Internet to strengthen the relationship between the Public Administration and citizens, especially as far as many public services are concerned.

Moreover, the Italian debate about the Internet is so lively that, October 2014, an ad hoc Parliamentary Commission, chaired by President Laura Boldrini, launched the "Charter of the Internet Rights" [52].

In spite of this consolidated awareness that ICT represents one of the fundamental key channels able to improve sustainability while contributing to the improvement of the quality and efficiency of services, the increasingly strong pressure on cutting the public expenditure strongly collides with the request for increasingly innovative ICT-based services.

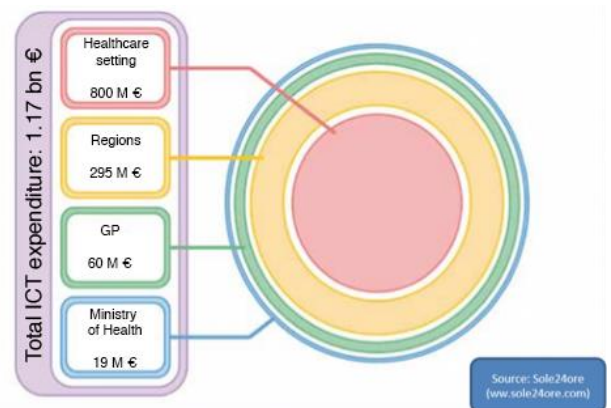


Figure 2. ICT expenditure during the year 2013 as divided among the SSN stakeholders. In order, from top to bottom: Healthcare setting, Regions, General Practitioners, Ministry of Health.

Over the last few years in Italy, little attention has been paid to the digitization of the healthcare system. In 2013, the influential economical Italian newspaper Sole24ore [53] reported on an alarming situation of the total expenditure allocated to the digitization of the Italian Health System. According to this economic review, not only had it not increased compared to the already worrying levels achieved in 2012, but it was further decreased by ~5%, reaching 1.17 billion euros in 2013 (1.1% of public health expenditure, corresponding to €19,72 per inhabitant). Fig. 2 illustrates how the Italian ICT expenditure was divided among the SSN

stakeholders in 2013. In addition to budget constraints, this scarcity of innovation seems to be due to a limited inclination of the health managers towards innovation and actual fragmentation on a regional basis of the healthcare governance system. These factors seem to hinder the realization of backbone infrastructures and the definition of standards that are mandatory for revising and adapting to modern needs of the care systems.

### C. User-centered design

Re-thinking the ensemble of services in the domain of healthcare and prevention involves designing a complex system, and it is necessary to take into account all the interests of the many stakeholders present in this context. This complex system is composed of connections among all the stakeholders' interests and issues, which are dependent on each other and intermingled with technological solutions. However, the citizen, with her/his needs and desires, represents the pivotal center of this system, and all the other stakeholders (such as public institutions, private companies, local communities, et cetera) orbit around it. To design and develop new services that can overcome the problems that the current systems are facing, it is necessary to apply the same iterative cycles of exploration, reflection, implementation and validation that have characterized the recent philosophy of the user-centered design [54]. This novel approach aims to create a better ecosystem, which should lead to a citizen-centered society. In this new ecosystem, all the stakeholders can synergistically work together, improving citizens' well-being and making the user experience of the services more enjoyable. However, to achieve this result, it is crucial that all the entities present in this ecosystem play an active role in redefining their connections in order to establish a new balance. Stakeholders interested in providing services to citizens can support public institutions to create new territorial laboratories, which have to work closely with the citizens, applying the best practices of participatory design. Indeed, it is only by directly involving the citizens that it will be possible to find the best solutions for the entire community. At the same time, involving the community of interest will facilitate the acceptance of changes and increase the awareness about particular issues, which can positively affect the community in order to support spontaneous disease prevention and health promotion. In this process, the technology can play a crucial role in both supporting the multi-entity dialog and in facilitating the delivery of tailored services directly to the citizens.

Born as an evolution and extension of Living Labs, Territorial Labs (TLs) adopt and implement the principles of user-driven open innovation by bringing R&D design and validation activities out of laboratories and into real life. Citizens, businesses, academia and public authorities are engaged in the co-creation of products, processes and services through peer-to-peer interaction in the context of Public/Private/People Partnerships established at the local or regional level [55]. Benefits of the method include improved usability, wider user acceptance, better time to market, lower risk and increased returns on investment. A key element is the construction of partnerships that involve the public administration, industry, SMEs and business/voluntary associations together with traditional R&D actors (universities, research laboratories, etc.) and the essential complement of citizens and citizen groups. Through this new and innovative composition and mechanism of aggregation, Territorial Labs are able to articulate the territorial capital and highlight the resources that are present in a region and are

committed to open innovation. This approach responds well to the bottom-up perspective adopted by the Province of Trento in developing solutions for the citizens, starting from their community and territory. Two main TLs have been implemented in the Trentino territory, namely, SmartCrowds and the Health&Wellbeing Territorial Lab, which are mainly involved with services and applications for Welfare and Health and with a wider range of services based on smartphones.

## III. TRENTO AS SMART TERRITORY

The Autonomous Province of Trento is embracing the idea of becoming one of the first Smart Territories. This requires the concept of a smart city to be extended beyond the boundaries of the urban areas, encompassing valleys and rural mountain regions that characterize the geography of the Province. The aim is to bring all the citizens closer and give people living in small villages in the mountains the same access to the same services, the same quality of life and the same awareness of being part of the territory as people living in towns. The government of Trentino has recently adopted its Research and Innovation Smart Specialization Strategy (RIS3), which includes mechatronics, green and clean environment initiatives, quality of life and agrifood. The RIS3 supports the creation of an inclusive citizen-driven smart territory enabled by technology. Trentino province has been characterized as a promoter of citizen well-being and quality of life. The governance has always been attentive to the needs of its citizens and has long promoted a political and operational strategy aimed at the "quality of life" concept. Such a concept is intended to stimulate not only economic growth as a unique paradigm but also social welfare, sustainable urban interventions and respect for diversity through the realization and the offer of advanced and innovative technological services. As established in the Sphera project [56] and reported in [57], the synergic efforts among different actors and the use of enabling technologies (e.g., ICT, micro and nano-electronics, nanotechnology, advanced materials, and industrial biotechnology) and instruments have produced several different actions to foster this innovative process for the promotion of healthy ICT-based research. Specifically, a few years ago, the EU commission launched the concept of Pre-Commercial Procurement (PCP) to foster public-to-private partnership for technological and social innovation. PCP is an instrument able to empower public authorities to buy technologically innovative solutions that fit their needs before a clear and evident applicative solution is on the market. Public procurers act as first buyers who share with suppliers the benefits and risks of pulling technology from early stages of research to pre-commercial products.

### A. Local eHealth vision and experiences

Given the above premises, healthcare innovation finds a favorable context for its development. The local healthcare service is committed to developing innovative solutions to support advanced models of service management in social and health care provided to the citizens in an integrated manner by multiple agencies and organizations, both public and private. These solutions respond to principles such as usability and transparency, addressing issues of assistance, care, the promotion of well-being and social inclusion. The mission that the provincial health service wants to tackle is the development of an overarching scheme of assistance in which smart hospitals and integrated and inclusive care will

be considered the driving concepts of the innovation in the healthcare sector. The main actions in this direction can be grouped into three intervention priorities: Well-being, Healthcare management and accessibility, and Innovative assistance and care. In 2010, the Trentino health policy maker (Provincial Councillorship for Health and Social Solidarity of the Autonomous Province of Trento) in cooperation with the local healthcare provider (Healthcare Trust of the Autonomous Province of Trento –Azienda Provinciale per i Servizi Sanitari - APSS Trento) developed a formal eHealth plan. This plan provided guidance on how the IT would support the provision of more integrated care to the local citizens in the 2011-2013 period. The overall goal was to share data about citizens and patients among different caregivers and across various points of care. As a general approach, the plan was developed as three steps (Fig. 3). As a first step, the plan enabled data sharing among professionals working inside the APSS organizations (clinicians, technicians, nurses, etc.). According to this implementation, patients receive unified identification within systems, and radiological and laboratory exams are served by means of a main diagnostic IT system on all the operating units, both at the hospital and territory level. During the same period, the hospital rolled-out an evolved web-based solution for patient management that is now accessed by more than 4,500 health care professionals on a daily basis. As a main output, this internal data standardization phase constituted the clinical data repository, a centralized archive for all clinical data produced by all sub-systems. This IT asset consists of 60 million digital documents produced during the interactions of the 530,000 citizens with the local healthcare providers. The second phase was aimed at sharing citizens' and patients' information between internal professionals and primary care professionals (GPs), nursing homes, private outpatient clinics and pharmacies. Connecting all the key actors of territory care is a considerable push for the digitalization of the citizens' experiences with health care providers and their partners. Right now, approximately one million messages (IHE/HL7 standard) per day are processed in the APSS IT systems. An example of the digitalization of services between partners to create value for citizens is related to the pharmaceutical prescriptions. In 2014, more than 3 million prescriptions were performed in a paperless mode (80% of total prescriptions/users). In doing so, thousands of citizens' accesses for merely administrative purposes were avoided, providing a service especially beneficial to people bearing chronic conditions, who need repetitive medications. The third step aimed at sharing information with the citizens. The main IT capability involved here was the web portal, a Personal Health Record (PHR) platform named "Cartella Clinica del Cittadino" (TreC), and other online services that are used by the citizens to access their clinical data via the web. 45,000 authenticated users, who viewed almost 300,000 clinical reports in 2014, now access the TreC healthcare portal. The project has been funded by the Autonomous Province of Trento (Provincia Autonoma di Trento- PAT) and managed jointly with the Fondazione Bruno Kessler (FBK). Relevant stakeholders of the project were included in a steering committee and in a project board, ensuring the active engagement of the key actors, such as the healthcare delivery-organization (APSS), clinicians and patient associations. The basic services were designed, drawing on a need analysis [58] followed by a meeting with patients' associations. Five hundred citizens were selected to test the basic web functions of the system in a Living Lab environment, allowing them to use the system in everyday life. Right now, new paradigms of

chronic patient engagement are under experimentation. Specific modules allow patients to keep a structured diary of condition-specific data and doctors to visualize real-time information through a web-based dashboard and by secure messaging. The pilot studies are being developed via a living lab approach and address primary chronic pathologies such as diabetes, youth asthma, hypertension and oncology [59]. The implementation of innovative services for assistance and care has a great impact on the sustainability and quality of the healthcare system in the Province, with particular attention to the integration between hospital and territory. An example is the Suitcase project [60], which is a Pre-Commercial Procurement that aims at developing innovative services for the elderly involved in the Health&WellBeing Territorial Lab. The effective collaboration among local authorities, health providers and private companies proved to be able to attract European funds. The Trentino health system is currently involved in several European projects designed to provide new technological solutions for the management of care plans and the integration of care with a strong involvement of the patient itself and the surrounding communities. This is the case of Nathcare [61], a project funded by the Alpine Space to create a platform to manage long-term care patients with a transnational vision. Trentino chose the treatment of pregnancy as a case study, proposing a management model that follows the entire care path from conception to weaning. Furthermore, since 2014, three projects involving a local network of research and development with private companies (Trilogis, Socialit), research institutes (FBK, CreateNet, University of Trento) and healthcare Trust (APSS) have been funded by the European commissioner to provide new services for patients and health providers based on indoor/outdoor localization systems (I-Core, I-Locate, UNCAP).

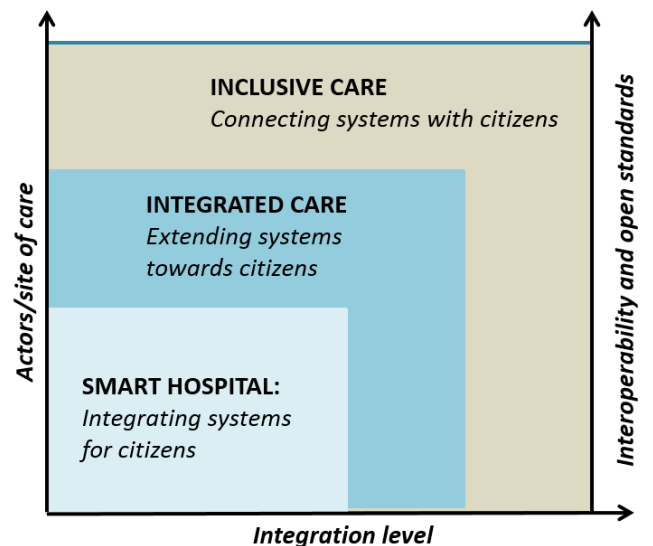


Figure 3. The incremental approach to connected health as adopted in the Province of Trento since 2010 to allow sharing of data about citizens and patients among different caregivers and across various points of care.

#### IV. CONCLUSIONS

By having achieved several important results in the eHealth ecosystem, it should not be overlooked that a new wave of technologies is transforming citizens' and patients' experiences: mobile, social, cloud, wearable sensors and

related information management. Citizens can be constantly connected through multiple technologies that could, if properly leveraged, provide seamless access to public services when necessary. The convergence of the technology above creates a vast range of opportunity in the healthcare space, particularly for those affected by chronic conditions who could access medical information, be constantly connected with a network of formal and informal caregivers and benefit from clinical monitoring tools. Citizens could receive the type of care they really need: preventive care specifically tailored to their own needs and proactive and collaborative care from the different parts of the system as opposed to the current hospital-based reactive/episodic care. For harnessing the value of the new technologies while minimizing the related risks and potential inequalities, the health policy makers and healthcare providers should adopt new models in the governance of information, in the engagement of patients and in the realization and customization of IT infrastructures and services. Table I reports a primary list of key actions needed to make ICT innovation valuable in healthcare and social solidarity.

The primary focus of a Smart City should be the prevention and early detection of frailty, in all its different forms, with the support of high-tech services and solutions, and the realization of “smart health communities.” One relevant aspect of frailty is certainly centered on elderly citizens, but policy for inclusive growth should also give attention to the different risks of social weakness.

TABLE I. KEY ACTION FOR SMART TECHNOLOGY INNOVATION IN HEALTHY COMMUNITIES

<i>Key actions for valuable ICT leverage of social innovation</i>
Data protection and regulatory compliance guidelines in line with (and not against) technology innovation
Support and incentives for the various stakeholders to collaborate in the provision of integrated care
Collaboration in the IT ecosystem to improve usability, data interoperability, standardization of information, and IT competency in the new technologies
Leverage of existing IT capabilities and good practices in the IT ecosystem
Involvement of health/social care professionals and informed citizens in the organizational change and service design
Multidisciplinary system, involving a wide range of social sectors and actors that have in common the aim of disease and frailty prevention
Plan interventions and production of services based on health, environmental and social data

Today's crisis is giving us a chance to concretize processes of inclusion able to respond to the increasingly urgent demand of social equity. Promoting an inclusive society may primarily mean rethinking the “service pact” between citizens and institutions, supported by a systematic assessment of the correlation between the results of policies and interventions applied on several sectors and their impact on the population and individual health. Following discussion and analysis of the Trento Smart City working table on Health and Wellbeing, some methods are the following:

- **Generate new resources** to make citizens and civil society forces feel responsible. The public must gain a

leading role and should not be viewed as a manager or obsessive controller but as a broker of territory. A public policy maker, an expert by experience, should become able to accompany the growth of new responses and promote their autonomy inside of a social market co-constructed and co-managed by public, private, social, active citizens and businesses.

- **Look for collaborators** (rather than users) and be flexible to manage the problems that might arise with them, thus offering some support for people in conditions of vulnerability for which technology alone might not be an answer [62], [63]. New players with needs to be taken into account include neighbors, volunteers, police, managers of commercial activities, etc. Rather than an endless proliferation of social workers, indeed impossible due to the reduction of financial resources, it is mandatory to foster psychosocial care among the actors who everyday manage large numbers of relations with citizens. One of the challenges is to create processes able to increase everyone’s social capital, irrespective of their social and economic class [63]. In fact, one of the problems of the concept of social capital is that it is deeply linked with economic and cultural capital [64].
- **Go towards** the new vulnerable people, who are ashamed to show their weaknesses or unable to express their fragility, in a proactive way instead of awaiting them for a given service.
- **Develop indicators** of need, performance and outcome to improve transparency, provide a comprehensive status of the monitored population and increase access to services;
- **Leverage ITC** to expand the user base and promote health, prevention, and care at home.

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