

# **TOWARDS A CITIZEN-CENTERED INNOVATION SYSTEM FOR EHEALTH**

Annemijn van Gorp  
*The Hague University of Applied Sciences*

## **ABSTRACT**

This study analyzes the mechanisms that underlie ehealth uptake in the Netherlands. Taking a Technological Innovation Systems (TIS) approach, through interviews, observation and document analysis the seven functions of the innovation system for ehealth are analyzed and barriers to system development are identified. The study finds that financial resource mobilization, resistance to change, market formation and to some extent ‘guidance of the search’ are hampering the development of e-health, even though the latter is increasingly taking shape through formation of active networks of health professionals and managers, and ICT professionals. In addition, findings suggest that both organizational and geographical proximity matter in the collaborative development of e-health. It is essential that the mechanisms that hamper the development of ehealth are addressed, if the healthcare system in the Netherlands is to develop towards a truly citizen-centered system. Addressing problems related to financial incentives and business cases, in addition to the creation of stronger inter-organizational networks to spur vision creation and knowledge development and exchange, are means to enhance the functions of the innovation system.

## **KEYWORDS**

e-Health, Technological Innovation System, Geographical Proximity, Organizational Proximity, Citizen-Centeredness

## **1. INTRODUCTION**

A growing number of ehealth applications is available: applications where digital and internet technologies are being used to provide citizens information and services related to healthcare, cure, and prevention. Citizens can download apps from app stores, browse through websites, or buy devices that help the prevention, diagnosis and treatment of illnesses. An increasing amount of information is exchanged between various applications, and between citizen and health professional. In the light of rising health care costs, e-health may enable more

cost-effective health (e.g. Home et al., 2015; Ross et al, 2017), while also positive aspects like patient-empowerment are attributed to e-health.

E-health is becoming a field of interest for many: Large technology companies like Google, Apple, and Amazon have entered the ehealth market. They offer services ranging from online communities, software developer kits, artificial intelligence (AI) applications and cloud storage. Besides the increasing interest in e-health by large global tech companies, telecom operators, large ICT vendors and small software development companies alike are venturing into the e-health business.

Ehealth is also occurring in all domains of healthcare: nursery homes, mental care, care for the disabled, in hospitals and primary care. Working with ehealth is a multidisciplinary endeavor: dialogue between ICT suppliers, policy makers, insurance companies, health professionals and managers, and citizens will lead to customized design, development and implementation. Depending on health domain, organization, vision, users, and many more factors, solutions will be found.

Despite the increasing availability and various benefits of ehealth, in the Netherlands -and many other countries alike- the percentage of citizens using e-health services remains small. For example, in 2017, only approximately 30% of medical specialists provided online access to parts of the medical records (Nictiz, 2017); and 65% of healthcare users did not know whether it was possible to access their medical specialist's records online (Nictiz, 2017). Further, in 2015 only 15% of people was able to ask online for repeat prescriptions (Nictiz, 2015). And while already 19% of people tracked certain physical activity in 2015, only 7% had digital access to information about doctor's visits or treatment (Nictiz, 2015).

Given these developments, this paper aims to identify what kind of mechanisms influence the development of an ehealth system in the Netherlands. It looks into questions like: What mechanisms influence the development of the ehealth system, and what mechanisms are barriers to development? Next, literature regarding adoption and implementation is reviewed.

## **2. EHEALTH IMPLEMENTATION, ADOPTION AND USE**

Research in the field of e-health ranges from studies concerning the potential of emerging technologies such as the rise of wearables (e.g. Piwek et al, 2016) or big data (e.g. Kuo et al., 2014; Liu & Park, 2014), to the evaluation of factors that influence the use of (new) applications (e.g. Garcia-Gomez, 2013, Redfem et al., 2014, Zhang et al, 2015), or adoption by certain target groups such as e.g. the elderly (Bujnowska-Fedak & Pirogowicz, 2014) caretakers (e.g. Sin et al., 2018) or people with certain diseases (e.g. Haberlin et al., 2018). For example, research has found that younger people more frequently use ehealth than older people, and also that multimorbidity is related to more intense ehealth usage (Lupianez-Villanueva et al., 2018).

While many studies focus on application-specific factors that stimulate or impede adoption, some more general barriers to adoption at the individual level have been found as well. These include e.g. insufficient communication from care provider to patient about the service, lack of perceived value of the service to the patient, patients' preference for oral rather than digital communication with care provider, low levels of internet literacy by the patient, lack of availability of devices, etc. (Zhang et al., 2015).

Although individual level adoption studies are valuable, sustainable health innovation asks for a system that enhances value to all stakeholders. Users or patients, health professionals, service providers, and innovators need to work together in the same direction (e.g. Home et al., 2015; Swinkels et al., 2018). Only their collaboration will lead to sustainable use of ehealth (Swinkels et al., 2018): Development tends to happen through co-creation, where various business partners play a role (Uruena et al., 2016). Establishing and maintaining these relationships can be challenging (Devlin et al, 2015), but also due to the networked nature, at times a tension can be observed between embracing innovative co-design and achieving delivery at pace and scale (Devlin et al, 2015), as various parties taking decisions can be time consuming. Also, stakeholder-networking capability is used for attracting new knowledge. Hence, it is considered important for the success and sustainability of projects (Uruena et al., 2016). Thus, we must understand how value is generated at different levels: the individual, organizational, and societal, while taking into account the regulatory systems (Home et al., 2015).

Studies on these higher levels of analysis into adoption and market growth however remain scarce. Nevertheless, a number of studies on implementation and scalability of e-health have been conducted as well (e.g. Dehzad et al., 2014; Devlin et al, 2015; Home et al., 2015). A variety of challenges to successful implementation have been identified, including issues of practical nature such as interoperability and information governance (Dehzad et al, 2014; Devlin et al, 2015) as well as privacy and security problems (Dehzad et al., 2104). Branding and marketing have been found challenging as well (Devlin et al, 2015). In addition, lack of opportunity for finding a sustainable business model of business case was found as a key barrier to market growth (e.g. Dehzad et al, 2014; Oderanti and Li, 2018; Van Gorp, 2016). Part of the problem underlying the generation of sustainable business models regards problems of financial/revenue generating nature due to the absence of funding from insurance companies (Dehzad et al. (2014).

Finally, challenges of organizational and management nature have been found to influence e-health development. Organizational capabilities contribute in transitioning e-health innovation projects from pilots to real implementations (Uruena et al., 2016). Culture in organizations may impede development; conservative culture in the field of health has been found to play a role (Dehzad et al., 2014), but also leadership is important -- visionless development has been found to contribute to lack of development (Dehzad et al., 2014).

### **3. EHEALTH AS AN INNOVATION SYSTEM**

The role of innovation systems has long been focus of research in various sectors of the economy. The notion of innovation systems builds on the idea that technological change comes with changes in the social dimension: behavior of the user, regulation, etc., also viewed as a 'system-level' change. Hence, an innovation system consists of all societal subsystems, actors, and institutions, related to innovation. Innovation systems co-evolve along with technology. (Hekkert et al., 2007).

Traditional innovation system approaches primarily focus on structure. An innovation system consists of all institutions and economic structures that affect technological change (both its direction and the rate at which this change occurs) (Hekkert et al., 2007). This has proven insufficient as they remain limited to comparing structures and fail to analyze the

dynamics of innovation systems. From this it also follows that there is limited focus on individual actions by actors in the innovation system which leads to institutional determinism (e.g. Hekkert et al., 2007).

### **3.1 A Technological Innovation Systems Approach**

TIS highlights how platforms emerge and the role that legitimation processes and the collective dimension play when taking an innovation into the growth phase (Hallingby, 2016). Because this study looks into the emergence of a new innovation system around e-health, the TIS approach fits well. The Innovation Systems approach stems from a combination of institutional theories and evolutionary theories. Its main idea is that innovation and diffusion of technology is both an individual and collective act. It focuses on technology rather than organizations, where technology is the result of collective action of a collective of organizations (Hallingby, 2016). Therefore, the innovation systems approach builds on both firm dynamics and technology characteristics plus adoption mechanisms, that depend on firm and the larger innovation system (Hekkert et al., 2007).

The innovation system relates to “all institutions and economic structures that affect both rate and direction of technological change in society” (Hekkert et al., 2007, p. 415). Thus, the network of institutions and organizations that, through their activities, develop and diffuse technologies. TIS thus emphasizes dynamics rather than structure.

The basic building blocks of (all) innovation systems are actors, institutions (e.g. legislation, technology standards), networks (linkages between organizations) and technology. Technology enables and constrains activities of actors in the innovation system (Hekkert et al., 2011).

While all innovation systems consist of similar components, they function differently. The functioning of the innovation system determines its performance. The following seven functions of innovation systems have been identified in research: 1) entrepreneurial activities, 2) knowledge development; 3) knowledge exchange; 4) guidance of the search; 5) formation of markets; 6) mobilization of resources; 7) counteracting resistance to change.

### **3.2 Collaborative Innovation and the Role of Proximity**

The networked nature of the development of ehealth and innovation was already highlighted before. The TIS approach as such fits the study of the development of ehealth well because it inherently takes into account the role of various stakeholders and their networks in the development (emergence) of a system. Collaborative innovation asks for insight into when organizations collaborate.

Although Innovation Systems literature has traditionally focused on national level systems, the role of local, regional and global systems are also known to have significant impact on national level innovation and market development. In many instances, external contacts outside of a local industry have played a crucial role in innovation processes. In other instances, innovation processes have actually been found to be explicitly regional phenomena, where regional resources and collaborative networks influenced individual organizations' activity. Regions have been found to bring place-specific, contextual knowledge (Asheim & Isaksen, 2002).

Indeed, regional innovation systems theory stresses the role regions play interactive learning and knowledge exchange in innovation processes, which is enabled by geographic proximity.

Global knowledge flows also play a role, through channels such as international R&D collaboration, foreign investments, virtual communities, international conference, etc. Thus, organizations use both global and more local or regional communities; both multinational corporations and SMEs (Martin et al., 2017).

Geographical proximity (has been viewed as a key driver for regional innovation as it enables tacit knowledge transfer, which is more difficult at a global level. However, advances in ICT have made global communication and knowledge transfer much easier. Therefore, Rallet and Torre (1999) pose that organization proximity might be more influential than geographical proximity when it comes to technology transfer.

#### **4. RESEARCH APPROACH**

This study will use the TIS approach to analyze performance of the e-health innovation system in the Netherlands. The TIS approach prescribes five steps to be followed to monitor the development of the emergence of technologies. Step 1 concerns the mapping of structure. Next the phase of development in relation to the state of diffusion is described: pre-development, development, take-off, acceleration or stabilization phase. In the third step the functions of the system and their performance levels are analyzed. As many structures are often not yet in place for emerging technologies, in this step, processes that contribute to the development, diffusion, and use of innovations are described. Finally, the key failures/barriers and handholds for improvements are described. This study will follow these steps, and, given the role of inter-organizational collaboration in the innovation process, the analysis will focus on the role of proximity in the different functions of the TIS.

A variety of data collection methods have been used to gain insight into e-health developments in the Netherlands: interviews, observation, and document analysis. Approximately twenty stakeholders have been interviewed and/or observed in meetings and workshops. Functions of the interviewees vary from managers, to health and (technical) ICT professionals (particularly app developers in the e-health domain). Participants were selected to represent various health sectors, including primary and secondary care, long term care, as well as to represent both small and large health facilities, in order to provide for a wide variety of perspectives.

Given the specific focus on the role of geographical proximity, the study has conducted the interviews in one particular region: the Delft region in the Netherlands. The Delft region was chosen due to the existence of the Delft EHealth Academy – a regional initiative that aims to bring digital health solutions to citizens and health providers in the Delft region. It does so by organizing meetings for stakeholders to share knowledge and skills, discuss possibilities and experiences, etc. Its goals are awareness creation, motivation, knowledge exchange, development of skills, and networking/meeting. Activities are centered around needs of stakeholders. The initiative in Delft is, according to the author's knowledge, one of very few regional initiatives in the Netherlands.

The role of this regional initiative will be researched by interviewing a number of active DEHA participants. These participants will also be interviewed about the role and their perceived needs and benefits obtained from other initiatives.

Interviews took approximately one hour. They were recorded and transcribed. Interviews were analyzed through open coding.

In line with the TIS approach, this study will first identify the structural components of the Dutch e-health system. Next, the phase of development of e-health in the Netherlands will be determined. Then the system functions will be analyzed, including the structural causes for functional barriers.

## **5. RESULTS**

### **5.1 Structural Components of the TIS**

The structure of a TIS consists of actors, institutions, networks, and technological factors. This paragraph describes the changing structure of the health system in the Netherlands, which is leading to the emergence of a new (e-)health system.

The e-health system in the Netherlands consists of a large interconnected network of organizations and institutions. It comprises the ‘traditional’ stakeholders in the field of health as well as new stakeholders. Well-known traditional health organizations include hospitals, clinics, physicians, mental health clinics, etc. Other types of (traditional) stakeholders include knowledge institutes like universities and other higher education institutes. They educate students in health and conduct research. Other traditional players in the traditional value chain of medicine include pharmacies, insurance companies, retailers of medical devices, patient federations, etc.

Government bodies also play a key role in the e-health landscape. At the national level the Department of Health, Welfare and Sport plays a role in promoting e-health. In 2014 the Minister of Health in the Netherlands has announced a number of objectives related to e-health in the areas of 1) digital access to medical information; 2) self-monitoring and measurement; and 3) 24/7 access to a doctor through teleconsulting. By 2019 80% of chronically ill people should have direct access to medical information, including information about medication, vital functions and test results, possibly for use in mobile apps or web-based applications (Schippers, 2014). These goals however were not strict targets.

As a reaction, early February 2017 MKB Nederland (association of small and medium sized companies in the Netherlands) together with VNO-NCW (employers’ organization) and a number of other organizations including health insurance organizations, GGZ (branch organization of mental healthcare providers) and the Dutch Association of Hospitals advised the Dutch Minister to further stimulate ehealth; VNO-NCW and MKB-Nederland indicated that they believe that ‘smart health’ can lead to significant cost savings (VNO-NCW & MKB-Nederland, 2017). The Council for Health and Society also advises the Minister to further stimulate e-health adoption together with health provider and health insurance organizations. In particular, they advocate for the government to develop a so-called “e-health highway” to enable easier and cheaper data exchange, as currently data exchange between different information systems is difficult, and citizens do not have access to their own files.

Further, new apps are typically standalone applications that cannot communicate with existing health information systems.

This standardization problem has arguably received a significant breakthrough recently through the development of ‘MedMij’, a personal (digital) health environment. In March 2018 it was announced that the Department of Health, Welfare and Sport invests in its further development. MedMij should be operational as of 2019. The system will bring together health information for a citizen, which the citizen in turn may or may not share with other health providers. The citizens decides what to do. MedMij is open to ICT providers that need to adhere to certain standards, in order to make information exchange through systems of different ICT vendors possible.

At the municipal level government is involved in ehealth as well, as it is responsible for youth and elderly care. Approaches vary across municipalities. Municipalities increasingly invest in ehealth initiatives to gain a better understanding of its possibilities.

Traditionally, the customer journey through the healthcare system goes from primary, to secondary, to after care. Primary care refers to care that anybody can use without needing formal referral, in which the physical takes a central position. Secondary care refers to those types of health care services that require a referral, such as seeing specialists in the hospital or medical rehabilitation, and certain psychological help. Third line care refers to situations in which the patient needs in-house care – e.g. hospitalization or nursing home. Given the relation between primary and secondary care, networks are often created at the regional level: physicians from certain areas will direct their patients if needed to specialists (secondary care) in their regional hospital. There is no strict demarcation of regions however, e.g. because sometimes if particularly specialized experts (surgeons, specialists) are needed, patients are sent to a hospital or other health facilities further away. This makes collaboration in regions between health providers essential for high quality care.

In addition, citizens are increasingly in charge over their own health because of increased information provision and the possibilities of ehealth, including such developments as MedMij. Citizens make their own choices, which is made possible by the availability of new types of healthcare such as 24/7 availability of doctor consultation services and digital devices that enable self-measurement. The citizen is slowly starting to take a central role in the health care system by increasingly taking care of the organization of health care him or herself.

## 5.2 Phase of Development

The phase of development of the TIS determines to a large extent how the structure and functioning of an innovation system should be built up: when technology is in early phase of development the innovation system has a different structure and certain functions of the systems are then more relevant than others than for a more mature technology (Hekkert et al., 2011). The e-health market, because of its size, with many different (applications of) technologies making up the market, could be argued to be in the development phase, although for different parts different phases could be discerned.

On an aggregate level, the pre-development phase would be too basic – since availability and use of e-health is available beyond just a number of pilots. The development phase is characterized by the availability of commercial applications, which is indeed the case for the Netherlands. However, market growth is still limited, and market saturation is still far away. For example, during interviews physicians express to barely receive requests from patients

about e-health use; and while hospitals are starting to develop their own apps, their application areas are highly scattered, ranging from generic informative ‘how to prepare for surgery’ apps to dermatology apps that are very specific in use and help with diagnosis.

### **5.3 System Functions of the e-Health Innovation System**

#### **5.3.1 Entrepreneurial Experimentation and Production**

A TIS only develops when there is entrepreneurial activity. This activity leads to new technologies and applications through a social learning process. Without experimentation a TIS comes to a standstill (Bergek et al., 2008). Factors indicative of the extent of entrepreneurial experimentation and production are the number of new entrants, the number of different types of applications and the breadth of technologies used (Bergek et al., 2008).

Quite some entrepreneurial experimentation and production already takes place in the Dutch e-health market. Many large and small ehealth app developers exist. Together they have developed hundreds of e-health apps. Nevertheless, large scale uptake of e-health has taken place in only few large health organizations. Much e-health development happens through small development programs, where independent developers make an app, and try to reach consumers through Apple and Google app stores. During interviews many of these developers indicate that trying to sell through app stores does not work well. They have experienced that it is hard to gain customer base because citizens are typically not willing to pay for apps. Therefore often as a next step developers have tried to sell their services to (large) health organizations – who then in turn provide the service to their clients or patients. Although this seems to provide the best business case (in particular the best option for revenue generation), developers experience a lengthy decision process and overall not much interest yet in e-health uptake by large health organizations.

Limited activity by the health organizations, rather than entrepreneurial activity itself, therefore seems a barrier to (sustainable, or continued,) entrepreneurial activity. Entrepreneurial activity itself however is strong in the ehealth market.

#### **5.3.2 Knowledge Development**

The core of a TIS is its knowledge base and the development and diffusion of this knowledge base (Bergek et al., 2008). Factors such as sources of knowledge development and types of knowledge (scientific, technological, market, design knowledge), learning from new applications, and imitations, influence the strength of this function of the TIS (Bergek et al., 2008).

E-health research gains attention in higher education institutes (both ‘regular’ Dutch universities as well as a number of universities of applied sciences) but also at think tanks and other (commercial) research institutes (e.g. Nictiz). The Medical Delta, a network of various stakeholders which stimulates cross boundary research, serves as an example of the perceived importance of technological innovation in health in the Netherlands. An increasing number of publications on e-health is available.

Research studies often times evaluate certain applications or information systems. Such evaluations often concern pilots or fairly new services that have not yet been ‘tried and proven’.

Nevertheless, even though there is interest in the academic and ICT community in the topic, and an increasing knowledge base about the added value of e-health is available, it all concerns very new activity while long term effects of e-health cannot (yet) be tested because it is a young and emerging field. Moreover, given the quick developments in the field, by the time extensive testing has been done, chances are high a new innovation is already outdated – an often heard critique from practitioners when it comes to e-health research in academia. This is problematic to the field of medicine which is largely built on “evidence based” practice. Indeed, in the medical profession the need to test to ensure informed decisions before investing, has often been voiced (see also e.g. Prof. Chavannes, from Leiden UMC, in a recent interview<sup>1</sup>). Also, knowledge development with regard to ehealth could perhaps be argued to happen mostly in academic and technical (developers) communities, and less so in health organizations.

Thus, generally speaking there is no lack of knowledge development. However, possibly we could say that the practice of evidence based medicine at times is incompatible with the often quick to market push of new apps by ICT developers.

### 5.3.3 Knowledge Exchange

Market entry by new companies into an emerging TIS helps the development of so-called positive externalities (Bergek et al., 2008). The entry and activity of new companies supports other functions of the TIS and as such strengthens the TIS. Entrepreneurial experimentation for example helps knowledge development, but also may influence the direction of search and market formation, and legitimize the new TIS (Bergek et al., 2008).

Generally, for the development of a TIS it is important that multiple, and various, types of networks exist: to enable knowledge exchange between science and industry, between users and industry, across geographical borders. Of course, there are national conferences, for both professionals and practitioners. Universities and research institutes organize public lectures etc. An annual national e-health week is organized in January. In addition, regular professional publications like “Healthcare & ICT” (“Zorg & ICT”) magazines are published.

Knowledge exchange is also taking place through the DEHA. It is unique in that it brings together users and health professionals from a particular (Delft) region, as well as to some extent the academic/science community (learning from others). Sessions with end-users (citizens) are held to assess needs and wants; sessions with health providers are held to learn about their problems, experiences, and needs.

Interviewees indicate that generally they find that there are many opportunities for some knowledge exchange (small conferences or networking events). DEHA participants indicate that they generally enjoy being able to hear from experiences of others, and being able to learn from that, or for example to be able to exchange policy documents. The specific regional advantage that is mentioned ranges from: “What works in one place, doesn’t work in another”. “we have to take into account what people in the region find important”, “It shouldn’t be only about sharing ideas and knowledge. You have to be able to do something with it”. “I think that at the end we need to go towards more collaboration. The neighborhood approach, personal empowerment. That’s where you have to collaborate”. However, this collaboration is not only seen as a positive thing: “you need to watch out with sharing, in order to remain a unique player”. Nevertheless, not everybody thinks the local/regional approach is important: “I go to meetings because of the subjects of discussion. Not so much for the network”.

---

<sup>1</sup> See <https://www.hcc.nl/kennis/1221-weinig-onderzoek-naar-resultaten-e-health>

Related to this, a number of professionals from health providers with multiple locations throughout the country indicate that internal collaboration with colleagues from other locations but also sometimes collaboration with other organizations in the same ‘sub-field’ of health care (e.g. mental health) is particularly helpful; more so than regional collaboration with different types of health providers.

Thus, knowledge exchange increasingly takes place. Depending on context and need of the care professional, regional or national level collaboration is preferred.

### **5.3.4 Guidance of the Search**

As Bergek et al. (2008) explain, if a TIS is to develop, various organizations have to enter the system. This means that incentives and pressures must exist that trigger organizations to do so. Guidance of the search thus relates to the existence of a clear vision on how the market will develop (Hekkert et al., 2011). Various organizations together influence this direction of development. The stronger the guidance of the search, the stronger the combined effect of visions, perceptions of opportunities, regulation and policy, demand articulation, among others (Bergek et al., 2008).

A number of interviewed healthcare providers indicate that the direction and pace of the ehealth system is unclear. They indicate that they would like to see more formal guidance and direction. They are waiting for formal policy and targets by the government before making serious moves themselves.

At the same time, a networking organization like DEHA enables the exchange of ideas and thereby guides the development of a vision. A number of interviewees indicates that DEHA indeed gives them guidance as to where e-health is going and how it will affect their practice.

### **5.3.5 Market Formation**

Market formation concerns primarily market size (Hekkert et al., 2011). Question is whether market size forms a barrier for further development of the TIS, and whether current or expected future size are sufficient. In other words, it must be analyzed what drives market formation. A market (the supply side) may not exist yet, but also demand articulation may not yet occur. Further, limited performance, formation of standards, may hamper development of a market (Bergek et al., 2008).

In the Netherlands a large scale ‘e-health market’ does not yet exist. E-health is in its initial stages of development. Many applications are already available, but use is lagging behind. Thus, limited demand articulation keeps the market from growing. Given that e-health entails such a broad array of services, all citizens are potential customers, and thus there is potential for a large market to develop. Although many different subgroups of potential customers could be discerned for the many different ehealth applications that are available, a key problem was found in the purchasing behavior: willingness to pay for apps in app stores is limited. Startups and self-employed developers have experienced the need to sell their services through health providers instead. This however is a lengthy process and limited interest by health providers was found to be a key barrier to the development of sustainable business models. Limited support by insurance companies plays a role in this as well (see also next section).

During interviews indeed often the role of insurance companies was mentioned. Those involved with ehealth development have experienced difficulty in contacting insurance companies about their innovation programs. Further, interviewees refer to the very limited insurance coverage (reimbursements) for ehealth treatment.

Overall, there is significant potential for market formation; supply side is already active, the demand side however it lagging behind, yet a large customer base is potentially available. Institutional changes are needed with regard to insurance companies: both in coverage as well as in their role to support innovation.

### **5.3.6 Resource Mobilization**

Resource mobilization refers to the availability of physical, human, and financial resources (Hekkert et al., 2011). As a TIS evolves, various resources need to be mobilized. And thus, it is important to assess to which extent the TIS is able to mobilize these resources (Bergek et al., 2008).

*Human resources:* education and training programs on the use of e-health in the health care sector -by and large- still need to be developed. Nurses, doctors, etc., do not yet receive this as part of their formal education. Training thus is necessary. Organizations that have started to implement e-health have experienced the need for training at multiple levels: how to use certain software, how to communicate with clients through text rather than F2F, etc. Organizations are figuring out these issues through trial-and-error. Nevertheless, often with limited amount of training employees can start to use e-health. From interviews it was inferred that the culture shift of being willing to work with e-health is the more important hurdle. Incorporation of e-health in formal education programs will of course stimulate a culture of e-health acceptance.

*Financial resources:* although generally increasing start-up capital is available, a key problem is the system through which health care is payed. Health care organizations are paid by insurance companies on the basis of treatment carried out. All activities that patients undergo are according to pre-specified treatments. E-health is barely included in the insurance system (to date this is mostly restricted to blended combination therapy in mental (e-)health). Therefore, doctors do not necessarily have an incentive to start using e-health (except when they can be directed by the hospital because of other certain benefits such as more efficient use of operating rooms).

*Physical resources* refer to complementary assets such as products, services, network infrastructure, etc. Physical resources in the ehealth system do not seem a barrier – e.g. citizens tend to have high quality internet access and typically have devices such as a pc, laptop, tablet or smart phone which they can use for ehealth purposes. Interviewees indicate that there is no single group of people lagging behind with regard to access to this infrastructure, however some people still do lack access. This is possibly more often the case for the elderly although experience also suggests that this is not necessarily the case. To overcome this program some ehealth programs include services including device delivery and rental.

Overall, resource mobilization is not a major hurdle to development of the TIS. However, resource mobilization is not a strong function with room for improvement.

### **5.3.7 Counteracting Resistance to Change and Legitimacy Creation**

This last function relates to social acceptance and compliance with relevant institutions. In other words: for this function to be strong, the new technology has to be considered appropriate and desirable by the relevant stakeholders (Bergek et al., 2008).

When ehealth is implemented in an organization, usually a (small) group of employees with a keen interest in the new technology steps up, and become the first to voluntarily start experimenting or piloting. A number of interviewees indicated that these employees are key in

spreading awareness and enthusing colleagues to start using the new technology as well. In this process, legitimacy is built.

The extent of resistance on the other hand seems to depend on how much impact the new technology has on work processes. For example, when organizations start using online video calling instead of paying house visits to clients, significant resistance has been experienced at times. But as an interviewee indicated, for blended combination therapy in mental healthcare this is much less the case because the face to face contact remains and digital communication is actually perceived as an added value. Nevertheless, overall the level of resistance is a personal matter, and tends to differ across people in an organization.

Overall, at the level of the health professional, experience seems to indicate that resistance to change can be overcome. It seems that at the higher managers or boardroom level the willingness to adopt ehealth is lagging behind.

#### **5.4 Discussion: Barriers to Optimal Performance and Potential Improvements**

A number of barriers to the development of the ehealth system in the Netherlands have been identified. The seven functions of the TIS were analyzed. The following was found:

- Entrepreneurial experimentation and production seem strong. Continued activity however is hampered by the limited possibilities for sustainable revenue models. Health providers are needed in order to be able to reach customers, but limited involvement by health providers constitutes a barrier.
- Knowledge development seems strong, albeit mostly in the scientific and technical communities. Involvement of practitioners (health providers) is lagging.
- Knowledge exchange is increasingly taking place. Proximity plays a key role – both geographical proximity (regional collaboration) and organizational proximity (homogeneity – collaborative development of specific health subdomains) are important.
- Guidance of the search is slowly growing. Limited guidance at times is felt, but a regional organization can play a role in developing a vision and giving direction.
- Market formation is strong on the supply side (app development), but weak on the demand side (citizens directly downloading ehealth, or health providers buying ehealth). More involvement by health organizations could also further stimulate citizens' uptake.
- Resource mobilization varies. Human resources and physical resources are not a hurdle to development of the TIS. Financial resources, in terms of incentive creation for health practitioners, is a problem.
- Counteracting resistance to change/ legitimacy creation is fairly weak. At the work floor legitimation does not have to be a hurdle to development, although it depends on the extent of change in work processes taking place as a result from ehealth introduction. At a higher management or board level, where adoption decisions are made, a more significant hurdle to development is observed. This relates to both the culture of evidence based medicine and the financial incentives.

Prior to the analysis of the seven functions of the TIS, it was also noticed that the structure of the TIS is changing. The development of a digital personal health environment like MedMij suggests that citizens are slowly placed more at the center of the system. A more proactive focus of health providers on digital services will enable them to support patients better (e.g. by recommending certain apps over others, etc.).

A number of potential improvements can be derived from the barriers:

- Incentive creation for health providers is needed. More ehealth coverage by insurance companies and a better understanding (awareness) among health providers of the various benefits of ehealth (including the business case)
- Development of stronger ehealth associations at the regional level (possibly subsidized by insurance companies or government that focus on the connection of different types of health providers)
- Development of stronger ehealth associations that focus on development of ehealth for certain health domains (at the national level), e.g. associations for certain types of specialists to support ehealth development/ knowledge exchange.

## 6 CONCLUSIONS

This paper investigated what mechanisms play a role in the uptake of e-health in the Netherlands by analyzing the seven system performance functions developed by Hekkert et al. (2007, 2011), as well as the role of geographical and organizational proximity.

Recent developments in ehealth indicate that the citizen is increasingly becoming the central player in the healthcare landscape: citizens are taking care of the organization of their own health through increasing digital access to information and opportunities for self-measurement. It is therefore likely that health providers will soon start receiving questions about interpretation of output from digital measurements, logs, and the like. In order to keep up with their patients and clients, it is thus imperative that health providers integrate ehealth in their daily practice so that they can advise them properly.

These developments suggest that it is essential that the mechanisms that hamper the development of ehealth in the Netherlands that were identified in this study are addressed, if the healthcare system in the Netherlands is to develop towards a truly citizen-centered system, and one that keeps up with the digital transformation that is happening elsewhere in society. A number of mechanisms that are hampering the development of ehealth were found. Many of these are related to the limited involvement in ehealth by health providers. In particular, the mechanisms that were found to hamper the development of ehealth are financial resource mobilization, resistance to change, market formation, and to a lesser extent guidance of the search, are hampering the development of ehealth in the Netherlands.

In more practical terms, the underlying aspects to these mechanisms are mostly: limited incentive for health providers in terms of financial incentives/suitable business cases, but also general resistance to change because of cultural aspects: evidence based medicine leaves little room to appreciate various types of benefits stemming from ehealth, as well as seeing the patient at the center of the healthcare system.

To some extent guidance of the search is hampering development, although it is increasingly taking shape through formation of active networks of health professionals and managers, and ICT professionals. With regard to the latter, it was found that both

organizational and geographical proximity matter. Organizational proximity matters: organizations with strong linkages to similar organizations, even when not geographically closely located, were found helpful collaborators in e-health development. Nevertheless, regional proximity plays an important role as well, as e-health asks for collaboration between various organizations in primary, secondary and home care.

Overall, it is important that financial incentives are created if the market is to develop further. The role of insurance companies needs attention by policy makers. Besides the need for financial incentives, health providers' interest in ehealth also asks to be stimulated. More awareness and vision on ehealth (guiding the search) is likely to be beneficial. Recommendations include: 1) establishment of stronger regional networks may help spur vision creation and knowledge exchange; and 2) Stronger networks in general; national or regional - may also help counter resistance to change due to increased awareness of what e-health can do.

The role of networks is key in the diffusion of e-health innovations. Two networks stand out: those with healthcare providers active in various health domains, but that are geographically close (regional networks), or those with healthcare providers from one particular healthcare domain, but possibly geographically dispersed (domain networks).

## REFERENCES

- Asheim, B. and Isaksen, A. (2002). Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Uniquitous' knowledge. *The Journal of Technology Transfer*.
- Autio, E. and Thomas, L.D.W. (2014). Innovation ecosystems: Implications for innovation management. In Dodgson, M., Philips, N. and Gann, D.M. (eds.). *The Oxford Handbook of Innovation Management*.
- Bergek, A., Jacobson, S., Carlsson, B., Lindmark, S. and Rickne, A. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy*, (37), 3, pp. 407-429.
- Boschma, R. and Frenken, K. (2012). The spatial evolution of innovation networks. In: *The handbook of evolutionary Economic Geography*. Edward Elgar. Boschma, R. and Martin, R. (Eds.). Pp. 120-135.
- Bujnowska-Fedak, M.M. and Pirogowicz, I. (2014). Support for e-Health Services Among Elderly Primary Care Patients. *Telemedicine and e-Health*, pp. 696-704.
- Dehzad, F., Hilhorst, C., de Bie, C. and Claassen, E. (2014). Adopting Health Apps, What's Hindering Doctors and Patients? *Health*, Vol. 6, pp. 2204-2217.
- Devlin, A.M., McGee-Lennon, M., O'Donnell, C.A., Bouamrane, M.-M., Agbakoba, R., O'Connor, S., Grieve, E., Finch, T., Wyke, S., Watson, N., Browne, S., and Mair, F.S. (2015). Delivering Digital Health and Well Being at Scale: Lessons Learned during the implementation of the Dallas Program in the United Kingdom. *Journal of the American Medical Informatics Association*, Vol. 23, pp. 48-59.
- Garcia-Gomez, J.M., de la Torre-Diez, I., Vicente, J., Robles, M., Lopez-Coronado, M. and Rodrigues, J.J. (2013). Analysis of Mobile Health Applications for a Broad Spectrum of Consumers: A User Experience Approach. *In Health Informatics Journal*, Vol. 20, No. 1, pp. 74-84.
- Haberlin, C., Moran, J., Broderick, J.M. and O'Donnell, D.M. (2018). Increasing physical activity in cancer survivors using ehealth: A focus group study. *Journal of Clinical Oncology*, [http://ascopubs.org/doi/abs/10.1200/JCO.2018.36.7\\_suppl.107](http://ascopubs.org/doi/abs/10.1200/JCO.2018.36.7_suppl.107).

- Hekkert, M., Negro, S., Heimeriks, G., and Harmsen, R. (2011). *Technological Innovation System Analysis: A Manual for Analysts*. Universiteit Utrecht, Faculty of Geosciences, Copernicus Institute for Sustainable Development and Innovation.
- Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S., Smits, R.E.H.M. (2007). Functions of Innovation Systems: A New Approach for Analysing Technological Change. *Technological Forecasting and Social Change*, Vol. 74, pp. 413-432.
- Home, R., Bell, J.I., Montgomery, J.R., Ravn, M.O. and Tooke, J.E. (2015). A New Social Contract for Medical Innovation. *Comment in The Lancet*, Vol. 385, March 28.
- Knoben, J. and Oerlemans, L.A.G. (2006). Proximity and inter-organizational collaboration: A literature review. *International Journal of Management Reviews*, Vol. 8, No. 2, pp. 71-89.
- Kuo, M-H., Sahama, T., Kushniruk, A.W., Borycki, E.M., Grunwell, D.K. (2014). Health Big Data Analytics: Current Perspectives, Challenges and Potential Solutions. *International Journal of Big Data Intelligence*, Vol. 1, No. 1/2, pp. 114-126.
- Lio, W., and Park, E.K. (2014). Big Data as an e-Health Service. *Computing, Networking and Communications*, pp. 982-988.
- Lupianez-Villanueva, F., Anastasiadou, D., Codagnone, C., Nuno-Solinis, R. and Garcia-Zapirain Sotp, M.B. (2018). Electronic health use in the European Union and the effect of multimorbidity: Cross-sectional survey. *Journal of Medical Internet Research*, Vol. 20, No. 5.
- Martin, R., Aslesen, H.W., Grillitsch, M., and Herstad, S.J. (2017). Regional Innovation Systems and Global Knowledge Flows. *Papers in Innovation Studies: Working Paper*. Paper no. 2017/07.
- Nictiz (2015). Ehealth monitor 2015, available at <https://www.nictiz.nl/programmas/e-health-monitor/ehealth-monitor-2015/>. Last accessed July 6, 2018.
- Nictiz (2017). Ehealth monitor 2017, available at <https://www.nictiz.nl/ehealth/ehealth-monitor/ehealth-monitor-2017>. Last accessed July 6, 2018.
- North, D.C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge, UK: Cambridge University Press.
- Oderanti, F.O. and Li, F. (2018). Commercialization of ehealth innovations in the market of the UK healthcare sector: A framework for a sustainable business model. *Psychology & Marketing*, <https://doi.org/10.1002/mar.21074>.
- Piwek, L., Ellis, D.A., Joinson, A. (2016). The Rise of Consumer Health Wearables : Promises and Barriers. *PLOS Medicine*, pp. 1-9.
- Rallet, A. and Torre, A. (1999). Which Need for Geographical Proximity in Innovation Networks at the Era of Global Economy? *Presented at the 39th Congress of the European Regional Science Association*, August 23-27, Dublin, Ireland.
- Redfem, J., Usherwood, T., Harris, M.F., Rodgers, A., Hayman, N., Panaretto, K., Chow, C., Lau, A.Y., Neubeck, L., Coorey, G., Hersch, F., Heeley, E., Patel, A., Jan, S., Zwar, N., and Peiris, D. (2014). A Randomised Controlled Trial of a Consumer-Focused e-Health Strategy for Cardiovascular Risk Management in Primary Care: the Consumer Navigation of Electronic Cardiovascular Tools Study Protocol. *BMJ Open*, pp. 1-8.
- Ross, J., Stevenson, F., Lau, R. and Murray, E. (2017). Exploring the Challenges of Implementing e-Health: a Protocol for an Update of a Systematic Review of Reviews. *BMJ Open*, pp. 1-5.
- Sin, J., Henderson, C., Spain, D., Cornelius, V., Chen, T., and Gillard, S. (2018). Ehealth interventions for family carers of people with long term illness: A promising approach? *Clinical Psychology Review*, Vol. 60, pp 109-125.
- Swinkels, I.C.S., Huygens, M.W.J., Schoenmakers, T.M., Oude Nijeweme-D'Hollosy, W., Van Velsen, L., Vermeulen, J., Schoone-Harmsen, M., Jansen, Y.J.F.M., Van Schayk, O.C.P., Friele, R. and De Witte, L. (2018). Lessons learned from a living lab on the broad adoption of ehealth in primary health care. *Journal of Medical Internet Research*, Vol. 20, No. 3.

## TOWARDS A CITIZEN-CENTERED INNOVATION SYSTEM FOR EHEALTH

- Thomas, L.D.W. and Autio, E. (2012). Modeling the ecosystem: a meta-synthesis of ecosystem and related literatures. *Paper presented at the DRUID 2012*, CBS, Copenhagen, Denmark.
- Uruena, A., Hidalgo, A., Arenas, A.E. (2016). Identifying capabilities in innovation projects: Evidences from eHealth. *Journal of Business Research*.
- Van Gorp, A.F. (2016). The Promise and Reality of E-Health Adoption: An Analysis of E-Health Business Models and Development Strategies. *Presented at ITS Europe*, Cambridge, UK, September 7-9.
- VNO-NCW & MKB-Nederland (2017). *Vooruit met de Zorg: Beter, Slimmer, Menselijker*. Available at [www.nl-nextlevel.nl](http://www.nl-nextlevel.nl)
- Zhang, X., Yu, P., Yan, J. and Spil, T.A.M. (2015). *BMC Health Services Research*, Vol. 15, No. 71, pp 1-15.