# Risk Perception and Innovative Policy Adoption: A Case of e-Health in Estonia

Bei Jin and So Morikawa

***Abstract*—Nowadays, ICT (Information and Communication Technology) increasingly receive attentions as one innovative solution to realize effective medical service provision. Although the technology, commonly called "e-Health," seems charming in view of relieving the health expenditure burden without sacrificing the well-being of citizens, many countries have showed cautious attitude toward its adoption. In contrast, Estonia had taken e-Health as national strategy to improve their healthcare problems in the early 2000s, hitherto various eHealth services such as e-Prescription and e-Ambulance are provided to support citizens, medical professionals and policymakers. Based on the argument that public perception of "risk" determines the priorities and legislative agendas of regulatory bodies, this research aims to discuss the reason why Estonia adopted eHealth into its health policy relatively smoothly compared with other countries. We suggested that some institutional and social characteristics, such as advanced ICT-ecosystem, an innovative policy friendly media environment, and a relatively abundant opportunities for talented graduates majored in health care technology to work at administrative departments are critical for Estonia to make such achievements.**

***Index Terms*—E-health, Risk perception, ICT, Estonia.**

## I. Introduction

Nowadays, along with the unceasing progress of medical technology, soaring health care expenditure is repressing financial capacity of almost every country, let alone welfare states. Under such circumstance, making full use of limited health care resources is a common concerned issues all around the world. One innovative solution that received increasingly attention is to introduce ICT (Information and Communication Technology) to health care sector, which is commonly called "e-Health".

The critical function of e-Health is to facilitate health care "big data" accumulation and application, by which citizens could know their health condition better, physicians could provide customized health care to every patient without repeating medical test, medical development would be accelerated based on the huge amount of continuous health data, and furthermore, health resource utilization efficiency is also expected to be improved substantially. However, it is not 100% risk-free. One of the most often mentioned problem with e-Health is how would it deal with individual health information privacy, in other words, if e-Health could take full advantage of itself while assures individual health information 100% safe at the same time. The answer is definitely "No", since no technology could prevent such risk so far.

As a result, although e-Health seems charming in view of relieving the health expenditure burden without sacrificing the well-being of citizens, many countries have showed cautious attitude toward its adoption. In this respect, a typical case is Japan. Although Japan is one of the most advanced countries in ICT development, and the government had paid attention to eHealth at early stage, up to now the introduction and utilization of EHR (Electronic Health Record) by medical institutions are still restricted to a very limited extent. By contrast, Estonia, where a national health insurance system was adopted like other welfare states, had taken e-Health as national strategy to improve their healthcare problems in the early 2000s, hitherto various e-Health services such as e-Prescription and e-Ambulance are provided to support citizens, medical professionals and policymakers. Needless to say, there are many perspectives such as sociology, anthropology and politic science to explain the difference between two countries' attitudes toward e-Health. However, this article focuses on one of the critical factors that influence the adoption of e-Health, which was typically called "risk perceptions", that refers to the intuitive risk judgments of the majority of citizens. Since public perception of "risk" determines the priorities and legislative agendas of regulatory bodies, this research aims to discuss the reason why Estonia adopted eHealth into its health policy relatively smoothly compared with other countries including Japan.

In the rest of this article, we shall briefly review some insights obtained from the most cited researches concerning risk as analysis, feelings and politics, then illustrate how Estonia succeeded in introducing its e-Health expansion, followed by our interpretation of the case based on the discussion of prior researches. In the final section we conclude.

## II. Risk as Analysis, Feelings and Politics

As the science and technology achieved great progress since 19th century, there is no doubt that human life had been improved enormously. However, the rapid development of science and technology did not assure human society to enjoy the achievement of ceaseless scientific and technological innovation at ease. On the contrary, the public feel they are exposed to more risks than ever before emerged from these

Manuscript received July 20, 2017; revised October 12, 2017. This work was supported by Ministry of Education, Culture, Sports, Science and Technology Japan under SciREX program.

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doi: 10.18178/ijssh.2017.7.10.903

innovations. This is especially obvious when the administrative departments and legislation bodies discuss whether an innovative policy should be adopted or not, there are always sounds of anxiety and objection from the public, not to mention interest groups, mass media and non-government organizations. In this sense, to appreciate the complex and socially determined nature of the concept "risk" deserves great attention.

According to *Webster's New Twentieth Century Dictionary, 2nd edition*, the dominant conception of "risk" is "the chance of injury, damage, or loss". Moreover, the probabilities and consequences of these undesirable events are assumed to be produced by physical and natural processes in ways that can be objectively quantified by risk assessment. In opposition to this view, many social science researches raise an objection that risk is subjective in nature [1]. For instance, Slovic raised an assumption that risk in the modern world is confronted and dealt with in three fundamental way [2]. The first one is *Risk as feelings*, which means human's fast, instinctive and intuitive reactions to danger. The second way is *Risk as analysis*, which is expected to bring logic, reason and scientific deliberation to bear on hazard management. However, sometimes the first two ways conflict with each other, then the third reality which is called *Risk as politics* comes on the stage, trying to reach a solution to some extent. Among these three ways concerning risk management, the second one has been fully discussed by risk analysis researchers all the time, yet practical experience tells us the development of science and technology itself cannot convince human society to deal with risk logically. Consequently, risk as feelings and politics are expected to open a way between the public, authorities, and experts, paying close attention to the public perception of risk.

Among the most reviewed studies of risk perception, a *Science* article by Slovic is definitely unneglectable [3]. The aims of this paper is to aid *Risk analysis* and policy-making through providing insights of how to understand and anticipate public responses to hazards, as well as through improving the communication among the public, technical experts and policymakers. Despite of various way to understand risk perception, such as geography, sociology, political science and so forth, Slovic focuses on psychological method, which originated in empirical studies of probability assessment, utility assessment and decision-making process. As a result, researches with this method shows that disagreements about risk would not evaporate in the presence of evidence because people's strong initial views influence the way that subsequent information is interpreted and are resistant to change. Besides, Slovic paid attention to the psychometric paradigm, which uses psychophysical scaling and multivariate analysis techniques to produce quantitative representations or "cognitive map" of risk attitudes and perceptions. According to this method, people make quantitative judgement about the desired riskiness of diverse hazards and the desired level of regulation of each. Some typical researches within this method have shown that perceived risk is quantifiable and predictable, and the similarities and differences among groups with regard to risk perceptions are identified to some extent [4], [5]. In addition, other researches complement that voluntariness, along with familiarity, control, catastrophic potential, equity, and level of knowledge do also influence the relation between perceived risk, perceived benefit, and risk acceptance. These factors are correlated with each other, which make factor analysis draw out a small set of higher order factors to show how lay people and experts judge large and diverse sets of hazards.

In the "cognitive map" of risk attitudes and perceptions shown in Table I, factor 1, which was labeled "dread risk", was defined at its high end by perceived lack of control, dread, catastrophic potential, fatal consequences, and the inequitable distribution of risks and benefits. Factor 2 was labeled "unknown risk", which means hazards judged to be unobservable, unknown, new, and delayed in their manifestation of harm. In addition to these two factors, a third factor was also raised by some researchers, which reflects the number of people exposed to the risk. The details of the analyses would not be elaborated here, yet the horizontal factor "dread risk" is pointed out as the most important factor to decide the public's risk perception and attitudes toward various hazards, as well as the regulation strictness expected. By contrast, the experts' perception of risk are found not closely related to any of the factors, thus could explain why the conflicts over risk between the public and experts cannot be eliminated with ease. Similarly, it is because the public's perception and attitude are determined by these kinds of factors as listed in the Table I, those attempts that aim to enlarge the public's understanding of risk by providing relevant quantitative risk estimates could not achieve the expected effect in most cases [3], [6].

TABLE I: THE COGNITIVE MAP OF RISK ATTITUDES AND PERCEPTIONS [3], [6]

| | Low (Dread) | High (Dread) |
|---|---|---|
| High (Unknown) | Caffeine<br>Vaccines | DNA Technology<br>Radioactive Waste<br>Nuclear Weapons Fallout |
| Low (Unknown) | Smoking<br>Alcohol | Nuclear Weapons (War)<br>Coal Mining Accidents<br>Handguns |

Based on insights of the gap between scientific analysis and public perception concerning risk, Slovic examined the complex interplay between *affect* and analysis in risk perception [2]. As the core concept discussed here, affect is defined as the specific quality of "goodness" or "badness" experienced as a feeling state (with or without consciousness), and demarcating a positive or negative quality of a stimulus. In short, affective responses occur rapidly and automatically. Furthermore, it is pointed out that affect plays a central role in two modes of thinking called experiential system and rational system [7]. However, affect depends on characteristics of the individual and the task as well as the interaction between them, which resulted in the affective qualities of a stimulus image being "mapped" in diverse ways, causing different individual constructs his own "affect pool". In practice, people consult or "sense" the affect pool in the process of making judgments, making affect a "mental shortcut" when they confront risk.

As to the risk perception, affect also comes prior to, and directs judgments of risk and benefit. Risk and benefit tend to be positively correlated in reality, while it is found they are negatively correlated in people's mind, including experts. In

other words, people base their judgments of an activity or a technology not only on what they think about it, but also on how they feel about it. Some experiments indicate that providing information about the benefit could change perception of risk and vice versa, and the inverse relationship between perceived risk and benefits increased greatly under time pressure [8]. These findings demonstrate affect influence judgment directly and is not simply a response to a prior analytic evaluation.

Nevertheless, Slovic also admitted affect could mislead people confronting decision-making or risk, otherwise there would have been no need for the rational system of thinking to take a place. One of the scenarios is pointed out that when there are deliberate manipulation of people's affective reactions, such as advertisement and marketing [2]. In addition, researchers try to explain why public polies fail so often from psychoanalytic perspective. For example, supported by the analysis of the problems with patient choice in NHS (National Health Service), it is suggested that public policy are a product of social fantasy, and it is difficult to translate policy into public organizations which have to perform conflicting societal tasks in general [9]. In this sense, affect, not rational analysis, exerts a relatively predominant and negative effect over policy-making.

Besides discussing the *Risk as analysis* and *feelings*, Slovic specifically explores the political and social characteristic of risk [1]. He emphasized that danger is real, but risk is socially constructed, which makes risk perception and assessment inherently subjective. In terms of risk assessment, to arrive at any selection of a measure that policy-makers think more appropriate to reduce the risk depends hugely on a value judgment, thus make defining risk an exercise in power. However, the public's dissatisfaction with risk management is also explained as a failure to appreciate the complex and socially determined nature of the concept "risk".

Moreover, in the same article he pointed out the public is not irrational. Citizens have a broad conception of risk that incorporates considerations such as uncertainty, dread, controllability, and risk to future generations and so forth, which indicates there are legitimate, value-laden issues underlying the multiple dimensions of public risk perceptions. Also, none of these attributes is critical to risk, which make risk analogous to game, as game has also time limit, rule and opponent, while none of them is essential to the concept of a game [10]. By contrast, experts tend to estimate riskiness by probability of harm or expected mortality. Although these findings reveals that the public and experts have different definitions of the concept of "risk", the risk-policy making could not satisfy the public unless various values guide them to percept risk are considered intentionally.

Based on the exploration of the complex and subjective nature of risk, it is revealed that some critical factors such as gender, race, political worldviews, emotional affect and trust are also strongly correlated with risk perception. Among these factors "trust" is particularly important, not only because it correlate with other factors, but also because of its "asymmetry principle" and intricate interplay with a highly democratic political system. Along with the rapid technological and social changes in modern society, powerful interest groups and media create such a hostile atmosphere that the inherently fragile trust among the public, experts, and policymakers could be easily destroyed [1]. This is also exactly the reason why some successful cases like Estonia that has adopted innovative technologies into its public policies and national strategies relatively smoothly and fast, compared with other countries under democratic politics, deserves high attention.

Subsequent research shows how risk perception plays a determinant role in resolving diverse tasks, not to mention the adoption of technology and related innovative policy. King and Slovic investigated the use of affect heuristic in consumer judgments of product innovations such as vaccine strips and solar phone, etc., and the results indicated that consumers' judgments of risks and benefits toward product innovations are inversely related and affectively congruent with evaluations of those innovations [11]. Also, Onwezen and others tried to deepen the understanding of consumers' intentions to buy bio-based products from the perspective of subjective ambivalence, which means aversive feeling that accompanies evaluations containing both negative and positive elements. The results of two studies in six European countries showed that the intention to buy bio-based products is associated with subjective ambivalence, yet it strengthens the association between risks and intentions but not that between benefits and intentions [12]. Moreover, Crettaz von Roton and others analyzed the public attitudes toward nuclear energy in Switzerland after the Fukushima accident. The results showed that public acceptance of nuclear power declined two years after 2011 and a strong and firm opposition to nuclear energy supporting the Federal Council's point of view was also confirmed, which implied the importance of experts and political authorities' understanding about how people think about and respond to risk [13].

Insights of risk as analysis, feelings and politics as reviewed above have been applied to solve various policy problems. For instance, after the terrorist attack 9.11 occurred, Lerner and others discussed how emotion affects the public's responses to risk by using experimental results of a nationally representative sample of Americans. As a result, some prior theories concerning the interplay of affect and risk perception are confirmed, such as anger and fear impose opposite effect on risk judgments and policy preference [14]. Similarly, Weber attempts to use the importance of affect in risk perception and decisions to explain why the noticeable and serious risks of global warming do not evoke strong visceral reactions among the public yet, then call for finding a way to arise the public's crisis consciousness about this long-term risk and to prevent its decrease [15]. In terms of health risks, since perception of health risk exert huge influence on medical decisions and health behavior, Lipkus tries to offer some optimal practices for conveying magnitude of health risks using numeric, verbal and visual formats based on the prior researches, empirical evidence and the like [16].

## III. Case Study: E-health in Estonia

In this section, we illustrate how Estonia succeeded in introducing its e-Health expansion based on the information we collected through site visits in October 2015 and the

workshop which was held at National Graduate Institute of Policy Studies in February 2016, which was also summarized in the report [17]-[19].

### A. e-Government in Estonia

Estonia adopts ICT orientation as its national strategy. Since 1990s, Estonia has experienced rapid ICT development, including the development of Skype, well-known internet communication service utilizing P2P technologies. Based on these R&D resources, many service provision has been done online in Estonia, regardless of whether the services are provided by public or by private entities. As a result, transparent and efficient e-Government and digitalized society have established in the country.

Today, e-Government in Estonia provides online public services including education and medicine. As a basis, 95% of bank transactions are done online as of 2015, and 96% of income-tax are stated online. National surveys are also conducted online and one of their responses rate reaches 66%. Moreover, Estonia is the first country which conducted electronic votes at the national level in February 2007 onwards, and online turnout rate reaches 30.7% in the election in March 2015. Recently, in order to attract entrepreneurs from all over the world, the country introduced e-Residency, which has been effective since December 2014.

### B. Supporting Infrastructures

There are two important infrastructures that support e-Government in Estonia. One is national identification number system and the other is its information exchange network called X-Road. For the national identification number system 11-digit unique identification numbers are issued for all the Estonians when they are born. The first digit indicates sex, following six digits indicate birth year, month and date, and next three digits are given according to the order of the birth on the same day, with the last digit as a check digit. This identification number is broadly used in public services. Since 2002, it has been obligatory for citizens aged 15 year old or higher to own national identification card, and the IC card is utilized not only as identification card, but as health insurance certificate, driver's license and even passport when they travel in EU member countries. In 2007, Mobile-ID, which is the mobile version of the identification card, was introduced, and now Estonians can use their own mobile phones to identify themselves when they apply for public services via online.

The other technological infrastructure that supports e-Government in Estonia is X-Road, which is designed to secure the safety of internet-based information exchange. First, to guarantee confidentiality of information, it is strictly regulated who and under what conditions could get access to the information. Second, to avoid security risks of data concentration, it does not adopt centralized data storage. While data is stored in the original places where it is generated, it is referred temporally when requested. In this sense, X-Road is just a network of information exchange and copies of information are not stored in the system. X-Road is the center of infrastructures of e-Government in Estonia, and it connects around 900 databases and services that public and private entities have including tax administration, public transport, parking charges, elections, police services and so on. With regard to e-Health, nation-wide health-information exchange platform was built to provide e-prescription and e-ambulance services.

### C. e-Health in Estonia

Almost all the citizens in Estonia register medical records from their births to deaths to national health-information exchange platform called Health Information Exchange: HIE. Medical Service Organizations Act oblige all medical institutes to provide statutory medical data to HIE. HIE covers medical information of patients and clinical information of medical institutions nationwide. As medical information of patients, information on allergy, past illnesses, visits to family doctors and hospitals, clinical test results, and referral for seeing specialized doctors are included. In addition, e-prescription, digital images, e-consultation and e-ambulance services are available and healthcare providers and patients can access these information and services anytime. Healthcare providers are allowed to access their patients' information under authorized conditions, while patients access their own medical information through the portal site called My e-health.

When citizens log in to the portal site with their national identification cards or Mobile IDs, they can make reservations for visiting their doctors and check their medical records. Medical records include clinical diagnoses, details of treatments, test results, and vaccination histories. They can also manage not only who can access the information but also their wills on organ donations. Another important function of the portal site is that they can monitor who accessed their medical information and when. Although information access is also monitored by the public entity called eHealth Foundation, citizens can double-check whether their medical information is used in appropriate ways. As of 2015, 99% or prescriptions and more than 90% of diagnoses are electrolyzed in Estonia. 13% of the population use the portal site and its primary purposes are browsing medical records and reservations for seeing their doctors.

### D. Development of e-Health Strategy

E-health services in Estonia illustrated above are stemmed from e-Health strategy 2006-2008. This strategy was launched following establishment of e-Health Foundation in October 2005, digitalization of clinical diagnoses, introduction of e-prescription.

E-health strategy in Estonia was proposed as one of the e-services the government provides online, rather than as a single strategy. One triggering motivation was to meet demands for information sharing among medical institutions in emergency medicine, where patients are often transferred to national level hospitals due to lack of facilities in local level hospitals. Nevertheless, utilization of ICT for medical service provision was already on the agenda around 2000 under the government's ICT-oriented national strategy. In 2000, they started to consider electronic provision of medical services, and as a preparation period ICT-related infrastructure was developed from 2003 to 2005.

One important characteristic of e-Health strategy in Estonia is that it promotes secondary usage of medical information of

citizens accumulated nationwide as medical big data. Researchers and industries are allowed to use anonymous medical data online to develop new applications and services. Ethical consideration are given by review of ethical committee, and criteria and user fees are different depending on the purpose of their usages. Recently, genetic information have also been accumulated and anonymous data is available for research use. Although risks of sharing information remain, attempts to promote secondary usage in Estonia could have a big potential of contribution for progress in medical research and for improvement of diagnoses and treatments.

Two institutional backgrounds of e-Health strategy are worth mentioning. First, service provisions of e-Health is mainly managed by e-Health Foundation, and activities and authorities of development and management of health-information exchange system are regulated by relevant laws. They stipulate the contents and styles of information which should be provided to the system. Second, matured ICT ecosystem is prerequisite to provide e-services, which is not limited to e-Health services. In this sense, as we have already explained above, national identification number system and X-road play important role in keeping provision of e-Health services feasible and sustainable.

## IV. Discussion

As illustrated above, apart from other far more cautious countries, Estonia paid attention to ICT in early 2000 under its ICT-oriented strategy, then spent almost 6 years to prepare for necessary technological infrastructure as well as to establish eHealth foundation. As soon as the technological and institutional bases are set up, Estonia adopted ICT into health policy and developed its national e-Health strategy immediately in 2006. It goes without saying that Estonia confronted the risk of eHealth adoption just as other countries, the question we are concerning is that what made this country's decision about the adoption of such an innovative policy so quickly, and how its citizens accepted the risk that comes with eHealth relatively smoothly without hesitation and anxiety. Based on the discussion of prior research concerning risk perception, we suggests that some institutional and social characteristics are crucial to answer this question.

In the first place, the advanced ICT-ecosystem played a vital role in the establishment of eHealth strategy. Estonia adopts national health insurance system that is similar with other welfare states including Japan. However, in Estonia, the ICT-friendly digital society cultivated from IT development since 1990s, the broad introduced network equipment across the country, the efficient and transparent e-Government providing diverse public service such as e-education, e-bank and e-health supported by the "X-Road" and national health information exchange system, all served to lower the barriers of eHealth adoption, as well as to relive the resistance to eHealth among the public, interest groups and experts. Considering some key factors that determine how laypeople and expert judge risks which was suggested by Slovic, Fischhoff and Lichtenstein (1985), the mature ICT-ecosystem in Estonia is assumed to reduce "unknown risk" of the citizens and experts by making them familiar with ICT and e-public service. As Table II shows below, although eHealth is regarded as "not so dread but some kind of unknown risk" *in general*, in the case of Estonia it could be classified to the third quadrant in which the extent of both "dread" and "unknown" are reduced largely. This is definitely one of the most important reasons keeping Estonia at the forefront of eHealth adoption and provision.

TABLE II: Key of Success in Estonian Case (Based on TABLE I [3], [6])

| | Low (Dread) | High (Dread) |
|---|---|---|
| High (Unknown) | eHealth in general<br>Caffeine<br>Vaccines | DNA Technology<br>Radioactive Waste<br>Nuclear Weapons Fallout |
| Low (Unknown) | eHealth in Estonia<br>Smoking<br>Alcohol | Nuclear Weapons (War)<br>Coal Mining Accidents<br>Handguns |

Furthermore, it is said that affect comes prior to and directs judgments of risk and benefit, which is positively correlated in reality while negatively correlated in people's mind [2]. Based on this fact, it is also proved that providing information about the benefit is able to change people's perception of risk. In this sense, advanced IT-ecosystem that brought huge convenience in Estonia could be considered as positive information which influenced the way citizens perceive the risk of eHealth. In addition, one informant in our site visits, indicates that the mass media in Estonia is friendly to innovative policy including eHealth, which is specifically embodied in the fact that there are relatively few negative news and reports about the risk of ICT or eHealth. Therefore, it could be assumed that such media environment is also conducive to the acceptance and trust building with respect to eHealth adoption among the public.

Lastly, in terms of the social characteristic of risk which make risk perception and assessment inherently subjective, value judgment in the policy-making process concerning the adoption of innovative policy is also unneglectable. In this situation, the value judgment of relevant experts and bureaucrats is crucial. Similarly, Estonia has created a positive atmosphere in this respect. For instance, great efforts have been put to cultivate competent health care technology talents who are expected to master both medicine and information communication technology knowledge, in order to explore new possibilities of eHealth service provision. On the other hand, it is confirmed from our site visits to which referred above that plenty of such graduates have been employed as bureaucrats not only in the Social Welfare and Health Care Department but also in other administrative departments, which indirectly make value judgment advantageous to innovative policy adoption. The same thing could be said of experts in this field, for they are frequently invited to participate in the policy-making process including eHealth. Surrounded by such a friendly media atmosphere suggested above, it is not difficult to understand why Estonia successfully keeps itself at the cutting edge of eHealth adoption and development across the world, however, without arousing anxiety and destroying trust from the public.

## V. Conclusion

In this article, based on the insights provided by the prior researches concerning risk perception, we discussed the possible reason why Estonia successfully adopted ICT into its health policy and established eHealth strategy at early stage. To contrast the difference between Estonia and other countries, we suggested that some institutional and social characteristics, such as advanced ICT-ecosystem, an innovative policy friendly media environment, and a relatively abundant opportunities for talented graduates majored in health care technology to work at administrative departments are critical for Estonia to make such achievements. We expect this research would provide some useful implications to those countries that are struggling to adopt innovative policy in order to resolve their public problems under intense financial pressure. On the other side, wider insights could not be gained unless more sufficient quantitative evidence about the citizens' affect toward eHealth, as well as more details about eHealth policy-making process in Estonia are available. Data collection and analyses in these two aspects would be our research topics for next stage.

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