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ICDS 2017

Forward

The eleventh edition of The International Conference on Digital Society (ICDS 2017) was held in Nice, France, March 19 - 23, 2017.

Nowadays, most of the economic activities and business models are driven by the unprecedented evolution of theories and technologies. The impregnation of these achievements into our society is present everywhere, and it is only question of user education and business models optimization towards a digital society.

Progress in cognitive science, knowledge acquisition, representation, and processing helped to deal with imprecise, uncertain or incomplete information. Management of geographical and temporal information becomes a challenge, in terms of volume, speed, semantic, decision, and delivery.

Information technologies allow optimization in searching an interpreting data, yet special constraints imposed by the digital society require on-demand, ethics, and legal aspects, as well as user privacy and safety.

The event was very competitive in its selection process and very well perceived by the international scientific and industrial communities. As such, it is attracting excellent contributions and active participation from all over the world. We were very pleased to receive a large amount of top quality contributions.

The accepted papers covered a large spectrum of topics related to advanced networking, applications, social networking, security and protection, and systems technologies in a digital society. We believe that the ICDS 2017 contributions offered a panel of solutions to key problems in all areas of digital needs of today's society.

We take here the opportunity to warmly thank all the members of the ICDS 2017 technical program committee as well as the numerous reviewers. The creation of such a broad and high quality conference program would not have been possible without their involvement. We also kindly thank all the authors that dedicated much of their time and efforts to contribute to the ICDS 2017. We truly believe that thanks to all these efforts, the final conference program consists of top quality contributions.

This event could also not have been a reality without the support of many individuals, organizations and sponsors. In addition, we also gratefully thank the members of the ICDS 2017

organizing committee for their help in handling the logistics and for their work that is making this professional meeting a success.

We hope the ICDS 2017 was a successful international forum for the exchange of ideas and results between academia and industry and to promote further progress on the topics of digital society.

We also hope that Nice provided a pleasant environment during the conference and everyone saved some time for exploring this beautiful city.

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Patient Portal Service: An Exploration of Patients' Experience and Perception

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***Abstract*— The New Zealand government is currently implementing electronic health records and encouraging general practices to enroll their patients into a patient portal service. Although literature shows the benefits of such a system for healthcare providers and patients, there is a lack of empirical research around patient's experiences and requirements. This study aims to bring to light these through a survey research of a major patient portal. The survey data reveals issues around lack of consultation around the design, inconsistency in service uptake and lack of training on the use of the service. Overall, it reveals that the current patient portal system is not designed to the patient's expectations.**

Keywords – e-health, New Zealand, patient portals

I. INTRODUCTION

With technological advances, health care services worldwide are moving to deliver e-health services to patients in order to improve the quality of care, reduce operational costs and to manage the substantial amount of data generated. The benefit and value of a patient portal service for healthcare workers has been heavily investigated and studied in literature. A majority of these studies have investigated the use of electronic health records from the perspective of health care professionals due to the significant impact on their day-to-day activities. It is interesting to note that, in an industry where the quality of service is a need, few studies have been conducted to investigate the benefit, functional and non-functional needs of such a system from a patient's perspective. It has often been argued that the use of a patient-centred e-health service allows patients better insights and self-management of their health, including the ability to access their own medical records, immunisation history as well as perform tasks such as requesting repeat prescriptions, booking appointments, direct messaging to GPs or nurses.

This study aims to bring to light patients' perception and experiences with a major patient portal in New Zealand. Questions around perceived usefulness, accessibility, usability and reasons and intentions to continue or discontinue using the service are explored.

II. RELATED WORKS

Around the world, especially in the developed nations, e-health has been promoted to be the most promising tool to bring growth, cost savings and to improve the overall quality, safety and efficiency of delivering health care to patients [1-3]. In a broader sense, the e-health concept has been promoted not only as a technological development, but also a state of mind - a way of thinking, a change in attitude and a commitment to improve healthcare by taking advantage of information and communication technology.

A. Patient Portals

There are many different definitions and terms for a 'patient portal'. Most of the existing literature uses the term 'personal health records' and 'patient portal' interchangeably. In the New Zealand (NZ) context, the term 'patient portal' is defined as a secure online site, provided by general practices (GPs), where patients can access, manage and share their health information and interact with their GP [4-5]

In the NZ context, most GPs utilise the PC-based practice management software called MedTech32. The Patient Portal is tethered to ManageMyHealth which is one of the most popular portal available that is developed by the same company (i.e. MedTech Global). While e-health sites generally provide 'read only' health information, a patient portal provides a secured platform where patients can log-in to view their own personal health information and communicate with their GPs via secure messaging, request repeat prescriptions and book appointments [6].

Patient Portals are expected to meet the 10 e's of e-health [7]: ***Efficiency*** – the portal decreases costs and enhances communication between providers and patients; ***Enhancing quality of care*** – allows healthcare workers to view up-to-date information to provide the best service; ***Evidenced based*** – allows patients to view detailed test results in order to make better decisions; ***Empowerment*** –empowers patients by providing knowledge and access to their own health records; ***Encouragement*** – a partnership is established between patient and provider where patients can contribute towards their own health; ***Education*** – patients can view their medical records and conduct their own investigation on diseases and issues; ***Enabling*** – exchanging and communication via secure messaging; ***Extending*** –enables patients to view their details such as immunisation history while abroad; ***Ethics*** – introduces a new form of healthcare interaction (where new challenges and threats could emerge); ***Equity*** – the portals will be equitable by allowing access to the same service for all classes of people.

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B. Issues with e-health and Patient Portals Provision

An important prerequisite for the success of any online service is to ensure that the customers experience from the system and its interface satisfies both sensory and functional needs. The providers of patient portals and the government concerned must consider such portals an equal to other online services such as e-banking, online education and e-government services where the customer's needs requires a perspective on the design as well as having a deep understanding on the type of users likely to utilise the service [8].

Existing literature has focused on the potential benefits, utility and satisfaction patients can experience from using patient portals to access their health information, interact with their doctors and nurses, and to manage their own health. However, according to [3], patients are the missing piece of the introduction of e-health services and there is a lack of patient involvement in design and implementation of such services to identify what patients' actual needs and requirements are.

Prior research conducted has been primarily from experts' perspectives [9-10]. There have been very few studies conducted to understand how users perceive and utilise patient portals [11]. This demonstrates that there is still little known from the patient's perspective in regards to usability, perceived value and whether the patients have the intention to use/ continue using such portals.

C. Perceived Value, Usability and Use Intention

The importance of involving patients has been emphasized in the discussion [12] as it is the users who must incorporate patient portals into their lives. While there are few studies that have examined patient portals in regards to enrolment, utilisation, and factors that influence or affect the use among patient sub-groups, further research is crucial for understanding the experience and perceptions of patients. It is crucial that the service is usable and of value to patients, regardless of age, gender, ethnicity, education level, and IT competence

Usability assesses how easy the user interface is to use. If a website or system is difficult to use, lacks the necessary information, if people get lost, and/or if the information is hard to digest; people will not use/ discontinue use [13-14]. According to Gu *et al.* [15], poor literacy is a great concern for e-health services due to the technicality and sensitivity of medical information. As health literacy is defined as "the degree to which individuals have the capacity to obtain, process, and understand the basic health information and services needed to make appropriate health decisions" it is of paramount importance that health information on online services must be understandable and managed ethically to a wide range of patients, or the technology revolution will not reach its full potential and provide its benefits to all those using an e-health service.

Usability is defined by the following quality components:

• *Learnability* - How easy is it for users to accomplish basic tasks the first time they encounter the design?

• *Efficiency* - Once users have learned the design, how quickly can they perform tasks?

• *Memorability* - When users return to the design after a period of not using it, how easily can they re-establish proficiency?

• *Errors* (management)- How many errors can users make, how severe are these errors, and how easily can they recover from errors?

• *Satisfaction* - How pleasant is it to use the design?

A key and related component is *utility* which refers to the design's functionality: Does it do what users need? Together, usability and utility determines whether a website or system is useful. Nielsen [13] states that it matters very little if asystem allows you to easily conduct a task that you don't want do to. A system can similarly fail if it can in hypothetical term do what you want but you are unable to, due to its poor interface.

For patients, the value of a patient portal may come from three general areas – reduction in medical costs, improvement in health care efficiency, and enhanced quality of care [16]. With health records, GP notes, lab results, immunisation history and medication list accessible online, it has become much easier for patients to have control and to monitor them [17] In addition, the ability to perform tasks and interact with the GP could lead to an enhanced relationship with the GP. It has been proposed that patient portal services sparks a new age of collaboration between patients and doctors where patients can become more involved and engaged, thus becoming a partner or co-creator of their own health [18].

Perceived usefulness and satisfaction are the two predictors of acceptance and use continuance intention [19]. Patients may have pre-acceptance attitude based on cognitive beliefs which stem from advice from their doctor that the patient portal is useful and valuable. The main focus for patient portals is to encourage new users to enroll and utilise the service as well as retaining the current users. This is important for the success of the initiative and the future of the delivery of health care. The government and providers must ensure that they do not ignore a user's post-acceptance use satisfaction. Feedback and suggestions from patients themselves must be seriously considered as their actual experience and the issues they encounter in use may become a reason that they stop using and prevent others from adopting the service, if not addressed.

III. RESEARCH DESIGN

An online survey questionnaire was created in Qualtrics. There were two levels of recruitment of participants. The first step was to recruit General Practices (GPs) around New Zealand who have a large number of patients enrolled into a patient portal service. The second step involved securing the assistance of the GPs to distribute the online survey to all of their patients, including those who are not enrolled into the patient portal with the aim of getting insights into why certain patients have opted not to enroll for the service.

The first step was contacting the fifteen Primary Health Organisations (PHOs) from across different regions of New Zealand and communicated to them the research brief and invitation to assist in the research. Two PHOs replied with a

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Research Application to be completed due to a high demand of research requests. Both PHOs opted to not take the research proposal further due to other commitments at the time of the research. One PHO responded with interest in the research and agreed to distribute the necessary documents to the GPs in their region. Due to unknown reasons, the correspondence with the contact ceased and no patients from the region ended up participating in the survey.

Due to the time constraints, a contingency recruitment was required. Local GPs in Wellington were contacted directly. This reduced the scope of the research significantly from across New Zealand to a single city. One GP agreed to distribute the necessary documents to only the patients enrolled in the patient portal through its secure messaging service. This reduced the research scope further. Hence, these should be noted as limitations of this research and the survey findings need to be read in this context.

A selection of key findings is presented next.

IV. FINDINGS

The participating GP had 1,900 patients enrolled into the patient portal. A total of 218 patients responded to the survey. Out of these, 195 were completed responses. 64% were females and 36% were males. The key demographics of the participants are older patients (i.e. mean age group of 45-54 years old), where the majority were at least high school graduates with a self-estimated IT competence of moderate to extremely competent.

All respondents were utilising the ManageMyHealth portal service. 70% of the respondents have been enrolled into the service for more than 12 months or more, and close to 50% were accessing the service once every 3 months which coincides with the standard period of 3 months for prescription medication before repeats can be requested or visits to the GP for a check-up.

To understand patients' perception of the service it is important to see if the respondents are still using traditional methods to interact with their doctors. 82% reported that their preference was using phone, 62% said they preferred talking to doctors in person compared to 37% who used the portal secure messaging function. This shows that the patient portal would not necessarily replace traditional methods. Instead it supplements the existing communication channels. Most of the respondents stated that it is much easier to call their GP compared to turning on a machine and logging in to the portal to make an appointment. Some respondents also stated that they prefer the human interaction and getting immediate feedback.

The features most often used according to the respondents are: view lab results (92%), view GP notes (71%), view reports of medical conditions (65%), request repeat prescriptions (61%), booking appointments (52%), and to view immunisation history (49%).

The mean value of each of the four survey items measuring the "Intention to continue using" ranged between 1.33 and 1.41 – i.e. participants "Strongly Agreed" that they have the intention to continue using the patient portal.

Nearly all respondents (98%) reported that they did not receive any training prior to using the service. Only 2% reported receiving written or verbal instructions from their GP. This suggested that training offer was not proactive and nearly all respondents resorted to exploring the system themselves and there was a possibility that they were not using the system as effectively as possible.

When asked if the portal is easy-to-use and reliable, the results were 88% and 89% respectively agreeing and 92% of the respondents agreed that the portal was intuitive enough for them to learn how to use it quickly. The majority of the patients found that the service is using understandable terms that were used consistently throughout the portal.

The feature respondents found the most valuable is 'Requesting repeat prescriptions'. Patient portals should enable patients to conduct tasks in a more convenient manner and thus save them time. 61% of respondents strongly agreed that the service saved them time. 25% somewhat agreed.

Patient portal services allow patients to be more aware of their health and have more control. By allowing patients to keep a diary that doctors can view as well as providing a direct line of communication to the GP and their doctors, existing literature explains that patients can develop better relationships with their GP as a result.

In the survey findings, 23% of the respondents strongly agreed that they have developed a better relationship with their GP. 29% somewhat agreed, whereas 38% neither agreed nor disagreed. 6% somewhat disagreed, and 5% strongly disagreed. It was possible that patients with chronic conditions who required frequent monitoring may find that the service allows for a better relationship compared to patients who do not require or visit their GP very often.

If doctors utilise the service properly, the portal provides an alternative channel through which they can communicate better with their patients which could lead to enhanced relationship over time. However, this might not be the case if the patients still prefer to visit their doctors in person as indicated in the responses to a previous question. This might be the case for older patients who relatively lack confidence in using ICT.

One of the objectives of the patient portal service is to empower the patient. Among the survey respondents, 35% strongly agreed, 35% somewhat agreed, 21% neither agreed nor disagreed, 5% somewhat disagreed, and 4% strongly disagreed. Looking at the type of respondents, especially the frequency of access, it appeared that "casual" users of the service did not perceive any "control" over their health care compared with a patient who used the service on a more regular basis.

In terms of satisfaction with the portal, 87% agreed that ManageMyHealth was easy to use. 56% of the respondents reported to be extremely satisfied with the ManageMyHealth Patient Portal service. 28% were somewhat satisfied, 11% were neutral, 3% were somewhat dissatisfied and only 1% were extremely dissatisfied.

When asked if the patient portal can be improved, about a quarter of the respondents provided suggestions. The suggestions were largely related to user interface issues:

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- Use more layman terms rather than medical terminology/ jargons
- Provide links to external Web resources to find out more about medications and medical terms
- Clearer indication of "new" alerts
- Ability to personalise appearance e.g. colour, theme
- Simplified interface – reduce number of levels and modules to access information
- Needs to be made more usable using mobile devices
- Display statistical information using visual presentations
- Displaying information/results in plain English as opposed to tabulated results

A number of respondents commented that the service was not as intuitive as it could be. The other comments that are worth noting and worthy of further investigation are:

- The patient portal is a useful tool to view certain information but did not have a great impact on their lives in regards to their health
- The portal should allow for shared access to accounts e.g. between spouses
- Should be integrated with other health care systems provided by e.g. hospitals (including A&E) and specialists/ consultants
- Features do not appear to be utilised well enough by the GP e.g. no response in emails, GP notes are lacking
- The service does not explicitly advise what services are available/ unavailable.

V. DISCUSSION AND CONCLUSION

The respondents of this research had a high level of education and self-rated moderate to high IT competence where nearly all had experience in utilising other online services such as online banking, e-government services and using social media applications. It is not surprising that the majority felt they were able to learn how to use the patient portal quickly without any training or guidance.

The general census was that they found the service intuitive to use, the service was easy for the respondents to become skillful, and found it generally easy to get the service to do what they wanted it to do even though there are areas that could do with improvement such as the need for a more user-friendly, mobile-friendly and intuitive user interface as well as use of layman terms and links to complimentary resources.

There were no obvious differences in responses between the respondents who had a lower level of education and rated themselves with lower IT competence. They also generally reported being able to learn to use the service quickly and perform tasks without training or support.

An issue arose from the findings relates to both functional and aesthetic aspects. The respondents noticed that when they received a notification for something "new" to check such as test results or updates to read, the patient portal did not highlight the "new" updates well enough for the users to find once they logged into the service.

The findings in this research positively reflect the convenience that the service provides which has been reported in the literature. Many respondents believe that the portal has saved them time by allowing them to book appointments online, getting notifications and viewing lab results. Some respondents contradicted this however when asked why they did not use a particular feature, specifically booking appointments. The respondents stated that it is much easier to call their GP and they prefer human interaction.

Other issues include the difficulty to book appointments because there were no confirmation messages that appointment requests are put through, appointments made were at times not received by the GP and the inability to view what appointment is available.

In comparison, viewing lab results is the most popular feature used by the respondents. Respondents liked that they could get notification of a lab result through the system instead of getting them through the post. Respondents felt that this feature saved them time and anxiety.

Even though there has been some discussion in the literature about use of patient portals enhancing patient-doctor/ GL relationships, the survey findings did not support this. It is worth noting however that in the literature, keeping journal diaries tend to be utilised by patients with chronic diseases that require daily updates that their doctors can view online, thus allowing both parties to be kept up-to-date. Because this study did not specifically study or identify such patients that required a closer relationship with their doctor, a conclusion cannot be drawn with regard to this.

Perceived usefulness and satisfaction are the two predictors of acceptance and use continuance intention (Bhattacherjee, 2001). The results from the survey items on value and satisfaction were overall positive, reflecting respondents' intention to continuing using the patient portal service they are currently utilising. Nevertheless, a number of issues were highlighted.

Respondents believed that the service lacked clear help and guidance, specifically instructions on how to use features and explanations of medical terms. Addressing these could increase the usability and user-friendliness of the service.

Respondents also comment that the government and providers must ensure that the doctors are actively participating in the portal service by providing meaningful notes on test results that is clear, understandable and concise. For example, a simple "no further action required" comment is valuable to patients who are looking at test results that they are unable to decipher. Respondents recognise that doctors may also need to be trained on the use of the portal to make good use of the tool to interact with patients and to maximise the benefits of the portal service.

Despite the identified issues, overall, the respondents from this research are satisfied with the patient portal they use and intend to continue using the service. However, in order to retain its current users and to encourage new users to utilise the service, the issues identified must be addressed by involving patients in its future developments.

A number of areas for future research on patient portals are identified. The integration of patient portals and other e-health systems should be looked into.

The patient portals are currently only available for those who are 18-years and older. The government and the heath sector should look into having children into the system with

their own records, perhaps under their parents' account. This will allow a parent to access, view and conduct the same administrative tasks for their children's medication and viewing test results. Several respondents also expressed a need to have a shared access to their spouse/ partner's account. There are obviously ethical issues that would need to be understood and ironed out with regard to these suggestions.

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The Use of an IT-based Cognitive Assessment and Training as a part of a Smart City Program

Implications in Educational, Social, and Healthcare Public Services

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***Abstract*—Smart Cities are defined as communities able to improve citizens' quality of life by integrating innovative, technology-based solutions with human potential. This paper aims to evaluate the impact of adopting on a citizenry level a self-administered, online cognitive assessment and training program targeting cognitive health and wellbeing in the process of building a smart community. An implementation of this program across the Peterborough citizenry will be presented, showing the potential outcomes it is intended to produce across the education, social services, workplace, and elderly healthcare sectors. Starting from this pilot study, which is successfully involving Peterborough local communities, possible implementations of the program in other cities' public services will be considered.**

Keywords-Smart cities; social services; cognitive health; cognitive assessment & training.

I. INTRODUCTION

Smart Cities, according to the main common definitions, are communities which unite different types of resources to create innovative, technology-based solutions directed towards the community's development and improvement of people's quality of life [1].

As winner of the World Smart City of the Year 2015 award, the city of Peterborough in the United Kingdom is an example of an implementation of a citizen growth, innovation, skill, and sustainability program.

To achieve this, Peterborough City Council and Opportunity Peterborough created the DNA Peterborough program, focused on the creation of smart business environments, on providing a "Living Data Portal" (offering easily accessible census data, crime statistics and health information), on the improvement of employability chances, and on long-term physical and mental health resilience.

As a part of this project, Peterborough City Council has promoted a partnership program with a science-based company specializing in IT-based solutions for cognitive health. Their intent is to promote and enhance cognitive wellbeing across multiple segments of the population, resulting in related outcomes in academic achievement, employability, business soft skills, quality of life, health, and sustainability.

In Section 2 the MyCognitionED assessment and training program adopted by Peterborough citizenry will be presented. Details about the implementation of the program across different sectors of city and the related objectives will be illustrated in Section 3. The expected outcomes of the program in contributing to the creation of a smart community according to the previously provided definition will be evaluated in Section 4, considering citizens' skills enhancement, social outcomes, and public costs saving. In Section 5 further possible implementation in other local communities will be considered, following the Peterborough example. Finally, in Section 6 a preliminary conclusion on the evaluation of the potential of the presented program will be drawn.

II. THE MYCOGNITIONED PROGRAM

MyCognitionED [3] is a program designed to assess and train individuals' cognitive wellbeing in various educational communities, including schools, universities, social and cultural groups, and life-long learning programs.

It comprises a 15-minute, self-administered, online assessment including a digital version of five of the most validated, traditional, paper-and-pencil, neuropsychological tests, designed to assess five key cognitive domains – attention, processing speed, working memory, episodic memory, and executive function. The assessment provides reports for each user, showing the scores obtained in each of the five domains, the trends of improvement over time for everyone, their position relating to the two dimensions of speed and accuracy, and detailed explanations about what the different scores mean and actions they can take to obtain improvements.

The MyCognitionED program then uses the assessment's scores to create a "recipe" that automatically configures a linked training program. The training application is designed to enhance overall cognition, particularly training those domains that showed the greatest weaknesses more intensely. The training program is totally embedded in an engaging video game, which adapts itself to the user's progress.

The game has an aquatic theme in which players must venture into the ocean to undertake various activities. The activities include exploring underwater worlds populated with a range of fish and sea creatures, seeking out and

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photographing different types of fish, each with specific characteristics. The training works by encouraging the player to undertake repetitive, and increasingly more challenging, tasks that are designed to train a specific cognitive domain.

Each cognitive domain is mainly trained by a specific "loop," with some domains trained using several tasks. The game develops on multiple structural levels. At the basic structural level, there are the loops corresponding to different cognitive tasks, which are organized in dives, so that in each dive the user can experience a set of loops.

The ocean map represents a meta-level of cognition. At the map level, users must organize their dive to both achieve the proposed mission and to discover new areas.

The progress of the players on the map, and so the growth of difficulty in the training game, depends on the coins the players collect during their dives. In this way, the game adapts its difficulty to the level of improvement reached by the player.

The intensity of the training depends on the individual assessment's scores, too, as mentioned above, as the number of loops for each type of task that the user experiences depends on the score obtained in each cognitive domain. In this way, more impaired domains will receive more intensive training. It is generally recommended that users follow the training program for at least eight weeks, playing a minimum of ninety minutes per week, three times a week, to obtain significant improvements.

The program is used in psychiatric populations and in patients having neurodegenerative and various medical conditions [4][5][11][14], as well as in elderly populations and in students of different ages, including those having special educational or learning disabilities/differences (SEND) [7][8][9][13].

The programs are available online and run on the most commonly used web browsers on PC and Mac computers. MyCognitionED is also available as an app for iPad users, and versions for iOS smartphones. Versions of the programs are in development for Android tablets and smartphones.

III. THE PETERBOROUGH PROJECTS

The adoption of the MyCognitionED program as a part of the Peterborough City Council "smart" plan is divided into several projects across various segments of the population. The goal is to grant the entire population access to this time- and cost-saving, digital tool for self-administered assessment and training of their cognitive health.

The pilot stage of the broad project began in 2016 with targeted workshops and with the adoption of the program by large educational and social institutions. The next phase in 2017 will gather early results from the pilot studies and enroll a wider range of schools, families, and institutions for a post pilot study. The shared ambition for the third phase during 2018-2019 is to offer the program to all about 200,000 Peterborough residents, by hosting the program on the Council website, as well as being available in all libraries and on personal devices.

Beginning with the youngest segment of population, the first project involves 13 primary schools and one secondary, with the aim of improving academic outcomes of those children who are struggling in learning mathematics. The solution proposed is to provide pupils with the MyCognitionED assessment and training programs for an initial period of eight weeks, at the end of which the putative improvements shown in cognition will be compared with official mathematics assessments.

This program will be employed in further projects involving teenagers from the Greater Peterborough University Technical College as an assessment and mentoring tool, and the Peterborough City College, a school specialized in providing educational opportunities for students of all ages, backgrounds, and abilities, particularly focusing on study programs and apprenticeships designed to create employment opportunities for 16-19-year-old students.

Early results from a class of year 5 students have shown an average improvement of their overall cognitive score above 5 points, with a higher improvement in episodic memory, executive function, and attention. Full analyses will be performed at the end of the study; however these early results are encouraging and consistent with the valuable improvements in academic outcomes and behavior, which have already been shown with cohorts of students using MyCognitionED [7][8][13].

A broader educational and social project sees the involvement of the MyCognitionED program in the Early Help Services of Peterborough Council, with particular regard to the Connecting Families program for troubled families. As a first step, the project involves six families with children displaying challenging behaviors, who requested an autism spectrum disorder (ASD) assessment or an attention-deficit/hyperactivity disorder (ADHD) assessment.

This first step is planned to be extended to year 6 students planning to take the Scholastic Assessment Test (SAT) and to unemployed adults at the YMCA, with the aim of improving individuals future professional careers and employability opportunities.

With the purpose of developing a venture able to achieve enhancements in cognitive wellbeing and the consequent improvements in quality of personal and professional life across the entire city's population, the training program will be adopted by the business owners and entrepreneurs at the Allia Future Business Center. The Future Business Center will become a referring point to incubate, facilitate, and develop innovative ideas for entrepreneurs who are still at an early stage of their own business. Therefore, they will be provided with a specific version of the training program designed to enhance those cognitive functions that are mainly responsible for management and leadership skills.

Finally, the project also aims to reach the homes of the elderly with targeted, user-friendly IT solutions to improve their independence, by recovering those cognitive functions that are essential for managing everyday life tasks.

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IV. EXPECTED OUTCOMES

A. Skills enhancement

Since it has been adopted in a number of studies involving hundreds of students from primary and secondary schools, the MyCognitionED program is expected to produce in Peterborough analogous outcomes both in cognitive and learning skills. These outcomes include the ability to focus or to recall information, enhancing academic achievement especially in mathematics, English, and science, as well as in behavioral skills, such as self-regulation and inhibition.

An example of the effectiveness of the cognitive training program in students from 11 primary schools is reported in Figure 1, showing the improvement gained by students engaging in the training program for different periods of time [8].

Strong evidence of the relationship between cognitive functions and academic achievement is reported in the literature, and research is starting to investigate the effectiveness of cognitive training on learning, with some positive results [2].

The program is also designed to enhance the basic soft skills necessary for good job performance, including speed and accuracy in accomplishing tasks, stress management, and leadership skills, the basis of which is executive function.

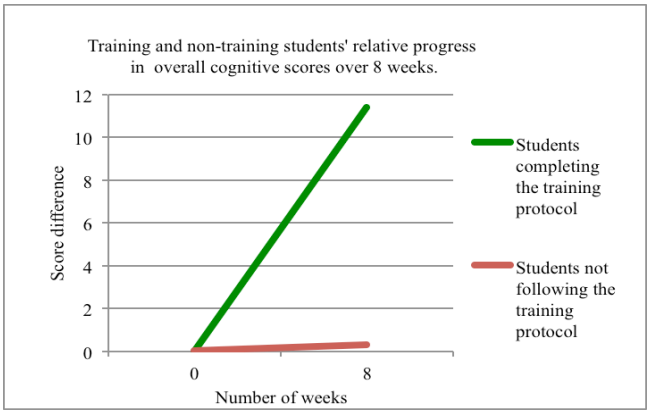

Figure 1. Comparison of improvement in overall cognitive scores between a training and a non-training group of ~50 students.

B. Social outcomes

The main social outcomes expected are related to the employability of the population across different generations and the reduction of the interclass divide.

Recent studies [15][16] have shown that the socioeconomic background of families influences the neuropsychological and cognitive development of children in their early years of life, especially in the domains of executive function and working memory, which are the main ones responsible for both school and work achievement.

Good evidence has been found for the effectiveness of training programs involving troubled families in promoting healthy childhood development, good cognitive functioning, and long-term outcomes into adulthood [17][18]. Recent studies have shown that 46% of troubled families in the United Kingdom have mental health issues, resulting in anti-social behavior and employability issues [19]. The MyCognitionED program is envisioned to reduce the rate of mental health issues and so produce social improvements for specific segments of the population.

C. Cost savings

A cost-benefit analysis has been conducted of the impact of the MyCognitionED program on the annual costs of interventions described above in the different social sectors of health, education, and workplace. The results show that the annual pro rata cost of cognitive deficit in the education sector amounts to roughly £26M ($33M), comprising £17M ($21M) for special educational needs, £4M ($5M) for youth crime, and £5M ($6M) for psychiatric disorders. The cost of poor cognitive health in the working population sector is £154M ($193M) and in the elderly/non-working sector £75M ($94M). It has been assumed that the MyCognitionED program will reduce the cost by 10% for each sector; therefore, the city could realize combined cost savings of about £26M ($33M) per annum [12].

V. EXTENSIONS OF THE PROGRAM IN OTHER COMMUNITIES

Following the example of Peterborough, the MyCognition program will be extended to other communities, in particular those represented by the London Councils, aiming to deliver significant benefits for London residents and to pursue innovation, efficiency, and performance improvement across the capital's public services.

The main goals of these interventions will be to increase educational attainment, to enhance employment possibilities, and to support health and wellbeing across the population. By identifying the underlying causes of moderate learning difficulties, primary school pupils will get the support that they need to improve their educational attainment and life chances. Understanding a child's cognitive strengths and weaknesses would allow effective use of teaching assistants (TAs), which accounts for 13% of education budgets. By reducing the number of TAs needed by 0.5 full-time equivalent in each school, this would save the typical school £9,000 ($11,250) each year.

The program is also aimed to offer support to youth offenders, jobless parents, refugees, asylum seekers, and the elderly segment of the population, since it can be personalized to reflect an individual's needs – job search, skills for life, support for mental health problems, training, mentoring, work placements, or support for creating new businesses or social enterprises.

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VI. CONCLUSION

Analyzing the promising expected outcomes of the Peterborough program, it is possible that his type of cognitive assessment and training intervention will be extended to specific cohorts of other Smart Cities and local communities looking for cost saving solutions for the whole community's cognitive healthcare. This would open a new chapter in the Smart Cities' government, by focusing on the prevention of cognitive issues and their long-term consequences in terms of health, learning, employability, competitiveness, quality of life, and sustainability, which ultimately are the key features of a successful "smart" community. Furthermore, the assessment and training program is implemented in a simple, self-administered software tool, which will be available for every type of device, for people of every age and every background. Therefore, it is expected that this program will play a key role in reducing the inter-generational and inter-class digital divide.

Although the adoption of such cognitive assessment and training programs has been increasing recently in the education and health sectors – especially to target learning difficulties in children and cognitive impairment in the elderly – to date, it is not known to the authors that any similar programs are being implemented elsewhere at the city level. The science-based approach which guides the program presented, together with its universality, easy-availability, user-friendliness, and cost- and time-effectiveness, would seem to make it eligible to be a leading innovation tool for future cities aiming to focus their "smart" agenda on their people's potential and wellbeing.

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The Creation of a Standardized Citizen Health Vocabulary

A Linked Open Data and Semantic Web example

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***Abstract*–The urgency behind this research is twofold. Firstly, the on-going development of an aging society could potentially lead to a 40% workforce reduction in the Dutch public sector, and with insufficient financing in the healthcare sector requires a participatory society in which citizens will need to start taking more responsibility regarding their healthcare. Secondly, we also live in an information society, which keeps developing itself. This brings new and innovative digital opportunities and information services, which potentially makes a participatory society viable. Yet, the development of such opportunities also brings new design requirements since systems world and life-world are converging. Based on an explorative study one of the requirements appeared the creation of clear conditions regarding the comprehensibility, usability and integration of such information technologies. More specifically, this would mean creating digitally accessible and usable terminologies in order for citizens and governmental bodies and professionals to work together for the quality of life. For healthcare this would mean creating so-called a citizen/consumer health vocabulary, a machine-readable standardized list of terms which links ´lay-language´ and the standard terms of professional terminologies.**

Keywords-participatory society; health; vocabularies; Linked Open Data; semantic web.

I. INTRODUCTION

Citizen health vocabularies are created to try to overcome the communication gap between patients and professionals, as the daily life-world of citizens is vastly different from the systems-world of professionals. Professionals use technical terms whilst citizens use lay-language (their own “technical terms”). During face-to-face communication, it is often possible to ask for an explanation of the technical terms used by professionals. However, online this is usually not an option. Online information is formatted in a “one-size-fits-all” package, based on the knowledge and opinions presented. If the patient lacks the means of understanding of technical terms this could lead to faulty associations or misinterpretations [1].

Smith interprets the obstacle described above from two viewpoints, on the one hand there are patients who have difficulty understanding medical terminology and on the other hand, information systems designed specially to recognize, understand and process medical technical terms, have difficulty interpreting lay-language, since patients are generally not involved in the creation of (medical) terminology [5], whilst Dutch citizens themselves indicate that they'd like to be more informed about and more in control of their own medical records [6].

The advancement of technology in recent years, like Open Data, Linked Data and the Semantic Web has allowed us to have access to any information, anywhere, at any given time and make connections with other information / data for more adequate information and analysis. Large (amounts of) databases, websites, digital books, et cetera are all searchable with only a few actions needed.

Most of our searches are performed by known search engines, yet we don’t always get the best results/results we are looking for. Health is an important issue and if necessary citizens want and need qualitative results. A search result may fall short partly because the query is too vague or because the wrong search terms were used. Almost everyone wants to find information that is complete, relevant and reliable in order to rightly participate in realizing the quality of life for themselves and their environment [7].

The digital communication between citizens and professionals has not been optimal up to now. Not professionally trained citizens may find difficulty in reading and understanding medical documents on the Internet and other medical information coming from healthcare professionals. At the same time, there are care-related computer programs, applications, designed to handle only medical terminologies, which have difficulty interpreting expressions of citizens and accompanied care intentions.

The aim of this research is to explore the possibilities of citizen vocabularies and a possible design of a Dutch citizen health vocabulary in combination with semantic web technologies. On the base of the approach were two main aspects. One was an explorative and inventory research of current International initiatives of consumer health vocabularies, among others: the American open access, collaborative (OAC) consumer/citizen health vocabulary (CHV) [1][2] and the Italian Consumer Medical Vocabulary (ICMV) [3][4]. The other was a

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conceptual study enriching patient friendly terms linked to SNOMED terms with the National competence Centre for standardization and eHealth (Nictiz) and the Dutch Patients and Consumer Federation (NPCF).

In Section 3, we provide more context for the Dutch initiative and situation which created an urgency for this research. In Section 4, we reflect on the possibilities for a semantic citizen health vocabulary. In the last section we conclude with some discussion points we intend to continue upon in the research project.

II. CONTEXT

Before we explicate the possibilities for a citizen health vocabulary it is of importance to elaborate on the specific Dutch context in which the research was developed. In the following paragraphs we will emphasize on the development and different design requirements of digital citizens and the main challenges if the 'systems world' and the 'life world' converge in order to realize and manage functionality and participation.

A. The Dutch context

Close to 100% of the population is connected to the Internet and more than 50% of them have access to broadband with speeds that are the highest in European benchmark studies. All people up to 75 years of age use the Internet regularly, mostly daily. Adoption of technology is pervasive, with many intensive users of Twitter and LinkedIn, the most web shops and the most online therapies per capita worldwide.

At the same time the Dutch society is confronted with the transformation of the healthcare and welfare sectors, and moving towards a participatory society where citizens need to take care of themselves more than they have been used to. That transformation is partly due to financial reasons, but partly the consequence of demographics with the effects of an aging society (larger percentage of older people) with a smaller percentage of younger people [8]. The Dutch Ministry of Internal Affairs and Kingdom Relations predict that those compounded developments will cause a 40% reduction of employees in government by 2022 [9][10].

B. Digital citizens

Citizens use digital means to take responsibility for the safety and quality of life in their environment. They may make reports digitally, develop ideas together digitally how to deal best with situations, decide using digital systems and organize the activities involved in maintaining quality and safety in their neighborhood or village. Their digital community systems are connected to all other stakeholders that might be involved in safety and quality of life – they may inform or alarm others to take action.

Citizens in neighborhoods, towns, cities and regions have access to actual and recent data about safety and quality of life of their environment, integrated, analyzed and presented in an understandable way. The use of ICT by citizens in their daily life is fundamentally different from that of professionals: that creates very specific requirements for a digital society. The structural use of digital solutions by citizens means the shift from the 'systems world' of professionals to the 'life world' of people in their day-to-day lives and environment.

That citizens will become a dominant factor in the next phase of the information society is the expected next step in its development. Technology has become personal, prices have come down, communication is effortless which results in the development of integrated information infrastructures *now centered around the citizen*. This may sound self-evident but it is a new development without prior history. We actually have very little notion of the specific requirements that citizens have in their personal lives, even though we have spent years optimizing the usability of individual applications. But that is no longer sufficient and we need to direct our attention to the broader infrastructure supporting a digital nation, where people digitally coordinate their lives, work and activities together in smaller and larger groups. This development is characterized by three new challenges that set it apart from professional information infrastructures [8][9].

C. Main challenges

Quality – people speak their own language. In our own lives we speak our own language. We may suffer from a stroke but not call it CVA ('Cerebro Vascular Accident') or TIA ('Transient Ischaemic Attack'). We talk about money and not 'liquidity'. People use their own language, where professionals need more precise terminology to do their work. For digital solutions to work for citizens, they need to speak the language of people. For health providers in a country that will mean that they - in order to communicate consistently and interoperable with consumers - should use a standardized consumer/citizen health vocabulary in order to realize understandable and usable information [11].

Complexity – diversity requires integration. The growing diversity of digital solutions in the household creates technical challenges, data inconsistencies and information overload. Products and services may be designed to work effectively for a single user, but often not to interoperate with the products and services of other providers. Healthcare apps generally don't integrate their data with other apps. Government services provide individual services, often not integrated or providing a comprehensive overview of all interactions with government.

Scale – networks require effective solutions. People live and grow in groups and networks. That is why

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citizens need to be supported and empowered at a different scale than the individual. Digital solutions need to be effective at the level of groups, neighborhoods, towns, cities, regions and society. Their data need to be interchangeable and consistent and their services scalable and understandable at every level.

By misinformation, patients can for example: misjudge their symptoms, take their medication wrong and could be inadequate to individually maintain a certain level of quality of life for themselves and others. Citizens and health care providers (and other sectors) may experience inadequate digital communication as a problem. But the problem at the moment is mainly present in western countries where there is an aging population, an increase in the use of ICT and less capacities for face-to-face communication, with healthcare providers/professionals.

III. HEALTH VOCABULARY AND SEMANTIC WEB: LESSONS LEARNED

A semantic citizen health vocabulary (CHV) could lead to better understanding of health related issues and more efficient communication of these health related issues to, with and between patients. Moreover, such a vocabulary could also help to enhance search engines and could form the basis for automatic knowledge and advice [8][9]. As Smith and Wicks mention "consumers have gained increased access online to the literature of healthcare professionals, they have also formed their own powerful communities of expertise, and so the very notion of "expertise" has undergone expansion" [12]. There are numerous examples of online platforms in which citizens are able to share questions and answers related to shared interests and illnesses, like 'PatientsLikeMe'. A CHV extends further:

- Recording and standardizing citizen terminology.
- Connecting terminology with systems-world.
- Referring to extra information or explanations.
- Adding qualities.
- Better disclosure and optimizing search results.
- Realizing automatic processing by machines.

Much like creating thesauri or ontologies, CHVs include phases as connecting terminology, structuring accordingly using SKOS (Simple Knowledge Organization System) and RDF (Resource Description Framework) enabling standardized exchange of information and data. Afterwards, a CHV ontology structurally classifies categories, classes, subclasses, instances, individuals, properties creating 'concepts' that are machine-readable and interchangeable. In this way, knowledge domains can be mapped and qualities are defined, which in turn creates the possibilities to defining relations, characteristics and meaning of concepts/terminology [13] from a citizens' point of view.

SNOWMED for instance contains a systemically organized computer processable collection of medical terms (codes, terms, synonyms and definitions) merely used in clinical documentation and reporting, and doesn't match communicating or integrating in services towards citizens.

A possible function of a CHV is increasing the comprehensibility of medical information. An integrated CHV would increase the comprehensibility of for example electronic health records and personal health records, by linking patient-friendly terms with professional terms, as done with the International initiatives. Much like translation applications which are currently build upon CHV's [2].

Another possibility/function of a CHV is supporting the patient by providing the right words for describing their medical history, editing and reading their personal health records and during online consultations. The implementation of a CHV in personal health records ensures that such records are easily understood by the patient. Which in turn gives the patient a betters understanding of, and control over his/her own health. A personal health record is only useful for the patient, provided that the health information and associated tools are understandable and can form a base for action [4].

There are multiple ways to give shape to the concept of CHV. In essence, it's about patient-friendly terms being "linked" to their professional counterparts. This means nothing more than an organized list of data in a machine-readable open file format. Such CHV's are freely available and can be used by computer applications (e.g., search engines and translation applications). Once the patient-friendly terms are collected, this option would be relatively easy to develop. CHV's open a world of possibilities, connecting them using semantic web technologies/linked open data. The added value of linked open data is the ability of machine-readability and usage combining other linked open datasets. It becomes possible to query extensively more data and adding uniform resource identifiers (URI's), unique names, to entities will optimize search results and eventually enriches knowledge and analysis.

IV. CONCLUSION AND DISCUSSION

The development of a CHV is based on research which contains the information needs of the citizens and connecting them digitally with professional information. The challenge is to study/research how people communicate with each other in their own circles/environment, to capture the most common used terms, and then connect these terms with professional standards. Additionally, patient-friendly terms have to be sufficiently consistent: "The feasibility of developing useful CHVs relies on the fundamental question about the stability of lay health language. That is, are the health-related forms, concepts, and relationships familiar to and

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used by citizens sufficiently consistent to allow for the development of a useful vocabulary?" [1].

A Dutch CHV would ideally make more extensive use of semantic web technologies. Moreover, it should include more focus on qualitative applicability in order to generate patient-friendly terms, allowing to generate relations between these terms and with the professional terms. Based on the explorative study of International initiatives it is very important that citizens and patients are actively involved in the creation and attribution of terminology for a CHV [14].

As the resources for developing or translating professional terms are quite restricted an interactive process with a strong co-creation component could help intensify a truly patient-friendly consumer health vocabulary and will ensure the general applicability and sustainability of the vocabulary (Figure 1).

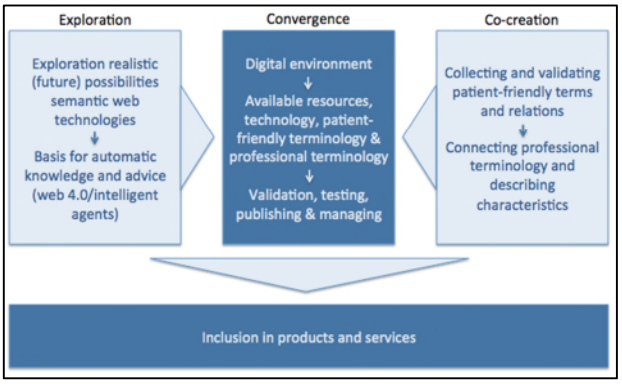

Figure 1. Process patient-friendly citizen health vocabulary

A healthcare vocabulary would give patients more control and possibilities for active participation with ensuring they are equipped and empowered for their quality of life. The design and development process of a digital environment for the collection, validation, linking of terms and relations can start directly. At the same time a further exploration of the realistic future possibilities of semantic web technologies is needed. More specifically, how a short term semantic CHV could be developed and enable automatic knowledge and advice (intelligent agents) in the near future [15]. After this is completed validation is required by domain professionals on the used technology, patient-friendly collection and standards. After a testing phase the CHV could be published and managed. Lastly, the integration in products and services will follow.

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Active Learning in the Museum

Using Technology to Enhance Learning

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***Abstract*—This short paper describes a recent development of an app for use by young student museum visitors. The idea is built on the concept of active learning where students are encouraged to actively engage themselves in the learning process. The app allows students to take photos, make notes, make sound recordings and retrieve online information. All collected information is sent to a server. The students can download the information and make it into a final report from the visit.**

Keywords-active learning; lean startup;museum; app.

I. INTRODUCTION

A museum is a place where objects are stored, preserved and exhibited. The objects are regarded as part of our cultural heritage. To promote understanding and experience, some museums use interaction and technology to make visits more interesting. Still, many museums mainly consist of static exhibitions. Visitors walk around and look at objects on display. Schools use museums as an alternative arena of learning. The challenge is to include the museum in the learning process in a way that enhances learning [1].

University College of Southeast Norway has for some time collaborated with local museums to experiment with technological solutions to enhance visitor experience. The first project was an augmented reality application focusing on deportation of Jews during the Second World War. The second project is described here: A smartphone/tablet app for active learning in the museum.

The rest of the paper is structured as follows. Section II introduces active learning, and a model for active learning in museums. Section III describes the active learning app. Section IV discusses how data from the app can be used to enhance the experience from visiting the museum. Section V presents results from testing the prototype. The last section discusses other application areas, and ideas for further development.

II. ACTIVE LEARNING

According to Weltman [2], active learning is a method of learning in which students are actively or experientially involved in the learning process. To learn, students must do more than just listen: They must read, write, discuss, or be engaged in solving problems [3]. Active learning often involves learning by doing. Creekmore and Deaton [4] argue that learning retention rates from active learning are much higher than from passive learning. The best learning retention rates is made when students are teaching their fellow students. If students are required to present their findings in front of the class after visiting the museum, the learning outcome may be improved.

A. A Model for Active Learning

As part of the project we made a model for active learning. The students collect information in the field (e.g., in the museum), which is later used for reflection. Instead of using a traditional paper notebook, the students use a mobile device with camera (phone or tablet). The technology provides new opportunities to capture information by taking photos, recording voice, writing notes and retrieving online information.

After collecting information, the students can reflect upon their (recorded) observations. This includes asking themselves questions and finding answers. The reflection is important for learning. The result is documented through a report or presentation made by the students, not from scratch, but from the collected data, enhanced with the results of the reflection.

The museum visit is reiterated and not forgotten.

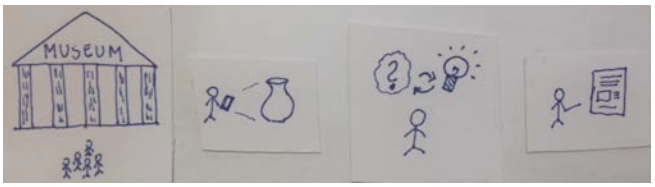

Figure 1. Model for Active Learning

The process is visualized in Figure 1. The students come to the museum, and walk around exhibitions making notes and collecting data with their mobile devices. Back in the classroom they reflect upon the data they collected, and make the report or presentation.

III. THE ACTIVE LEARNING APP

The information is collected by mobile devices (phones or tablets). This simplifies the data collection itself, but also provides opportunities to upload the data to a server. The students can then download the data and embed the data into their report or presentation.

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As part of the project, we developed an Android app as a "proof-of-concept" prototype. The prototype was tested by real users (junior high school students) in real situations (visiting an exhibition). The feedback from the users was used to improve the prototype.

We followed the methodology developed by Eric Ries in his book "Lean Startup Methodology" [5]. His methodology uses a "Build-Measure-Learn" loop to iteratively improve a product. The "Build-Measure-Learn" loop is shown in Figure 2.

The first step of the methodology is to develop what is called a minimum viable product (MVP). The MVP is a prototype with enough functionality to enable a full turn of the "Build-Measure-Learn" loop.

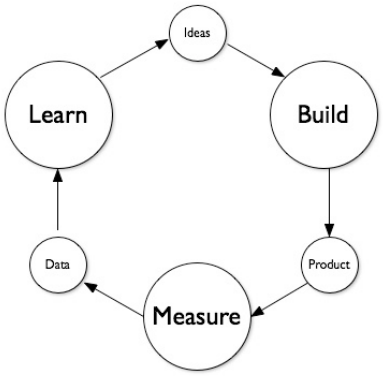

Figure 2. The "Build-Measure-Learn" loop

The "Build-Measure-Learn" loop starts with some ideas about the products. These ideas are developed into a product or a service. Users are asked for feedback. The data is used to learn from the users, which brings new ideas on the table.

The prototype was developed through two iterations with real users (students).

A. *Functionality*

The initial idea was to include four actions initiated by the user (student):

- Retrieving information about an object
- Adding text
- Adding audio
- Adding a photo

All actions upload collected data to a server, where the students can access the data after returning to their homes or school.

Figure 3 shows the main user interface of the app, consisting of four large buttons with both icons and texts to invoke the four different functions described above.

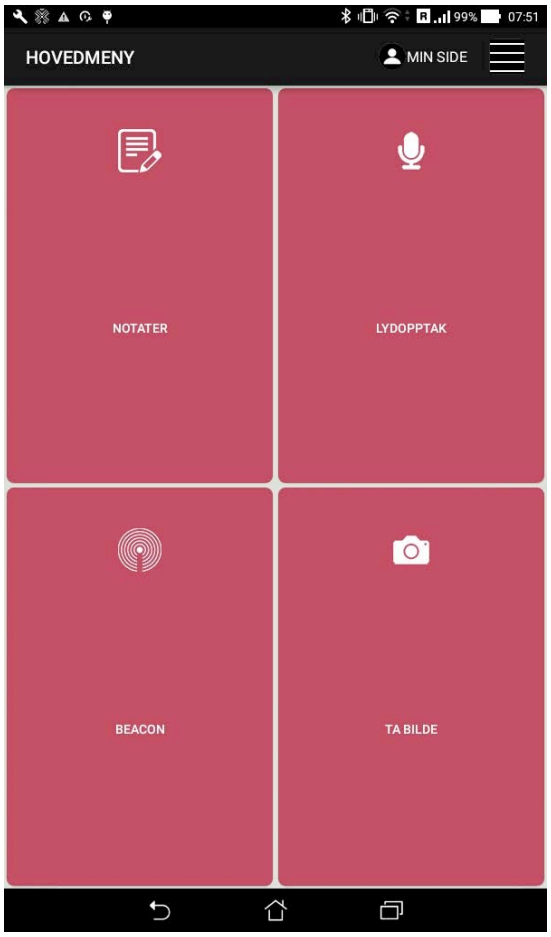

Figure 3. Main user interface

The captions are in Norwegian. The upper left button is used to take notes, the upper right button is used to make a sound recording, the lower left button is used to retrieve information, and the right left button is used to take a photo. *(The text may look small, but this screenshot was made on a tablet, not a phone)*

1) *Retrieving information*

Beacon technology [6] consists of small radio transmitters (beacons) sending messages at regular intervals. The range of the radio transmitters is very short, and can be adjusted. When close enough, the app detects the beacon and retrieves the message. Each message contains an identifier, which identifies the physical transmitter. This identifier can be used by the app to access a service providing information about an object. In our prototype, we associated the identifiers with links to web pages describing the individual objects.

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Figure 4. Two types of beacons

Figure 4 shows a couple of beacons. The one on the left includes a battery and can operate for months without recharging. The one on the right does not have its own power supply, but can be placed in an USB-charger.

2) Adding text

The beacons provide the possibility to retrieve online information about an object. This information is not complete, and does not capture the perceptions and feelings of the user. Therefore, the possibility to add notes is an important function. Standard text input functions are used, and in some smartphones and tablets, this also allows the use of handwriting with a stylus.

3) Adding audio

Audio is a complement to textual input. In many situations, it is easier to just talk to the smartphone or tablet instead of using the built-in keyboard. But audio also provides the unique opportunity to capture sounds emitted by objects. This can be engines, live animals or music instruments.

4) Adding photo

Adding a photo gives the opportunity to capture visual impressions. The value of a photo cannot be underestimated, as it captures details that may not be covered by a textual description.

B. Login

It was also necessary to include an authentication mechanism. Security is not a major concern, but it is necessary to make a connection between the collected data and the user to provide access to the data at a later stage. One of the important ideas in our project is to use the collected data for a report or presentation after returning from the museum. The prototype provides two different kinds of authentication. The traditional method uses a login name and a password. First time users need to register and select a username and password. For this kind of app, most users will be first time users, and the registration procedure will be an obstacle. The alternative method uses Facebook credentials to log in. Facebook provides an application program interface (API) to authenticate users. In this case, users do not have to go through a registration procedure.

Junior high school students testing the app showed a clear preference for using Facebook credentials, since they already have Facebook accounts. The registration procedure was reported as more cumbersome.

IV. FROM APP TO SERVER

Captured data is uploaded to a server. Figures 5 and 6 shows two examples of the user interface. The screen in Figure 5 is used for text input, and the one in Figure 6 for audio input. Both screens include buttons to upload content.

The prototype stores audio and photos as files in the file system, and stores links to these files and text in a database. The database is good for storing structured data in an efficient way, and connects the user id with the content belonging to the user.

Figure 5. Text entry screen

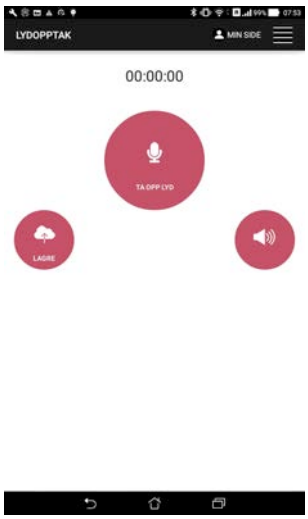

Figure 6. Voice recording screen

V. TESTING

The final prototype was tested by a group of nine junior high school students, four girls and five boys. Their ages were from thirteen to fifteen. All had their own mobile phones (skills). All were Facebook users.

We used a Likert-scale from 1 to 6, where 1 is the lowest and 6 is the highest value. When asked if the functions (buttons) were easy to understand, they all answered 5 or 6. They were also asked about how easy it was to use each function. Again, all answered 5 or 6 for notes, photos, sound, and using beacons. They also answered 5 or 6 for button size and text size. The only question that did not receive only 5 or 6 was the use of colors. One of the respondents gave a 4 for the use of color.

VI. CONCLUSIONS AND FUTURE PLANS

The app itself has been tested with real users in real situations. Improvements were done during an iterative design process.

Even if our prototype app was made with museum visitors in mind, it can be used for a broad range of applications. When students are doing field-work, it can be used to document what is happening, and later be refined into some written record of the event. This approach can be applied to any learning experience, e.g., a car mechanic or a carpenter; the app can help capture data that can later be transformed into knowledge. All of these are learning cycles that consist of information collection, processing, reflection and conceptualization. In many ways, it substitutes the traditional notebook with a more powerful instrument that also allows capturing visual images and sound.

A future version will incorporate ideas from gamification to further encourage students to do more work during their visit. Students will be rewarded when they perform activities, by getting badges or stars. This information may be shared with other students through pop-up messages.

On the server side, it is possible to embed the data directly into a document or presentation. Both Microsoft Word and Microsoft Powerpoint have application program interfaces (API´s) that allow an external program to create documents or presentations, and then fill in content. In this way, the students are relieved of the task of inserting the data themselves, and can spend more time on editing the result.

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Towards Improving Privacy Awareness Regarding Apps' Permissions

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***Abstract*—Empirical studies show that the flow of personal information through mobile apps made devices vulnerable in terms of privacy. Cumbersome and inconvenient representation of privacy notice encourages the user to ignore it and disclose sensitive private information unintentionally. Hence, summarized permissions are presented on mobile devices and users tend to overlook them as well. Rigid structure for using a service and inherited behavior from desktop applications to accept everything are the reasons behind compelling the user to proceed without paying any attention. Complex permission based structure is also a major impediment for consumers that makes it difficult to perceive appropriate consequences of their decisions. We argue that as privacy strongly depends on individual perception, the key to educate and empower users is to providing them with transparency of what is happening on their smartphones. In consequence we suggest a convenient, transparent and proactive approach to help in understanding and deciding upon privacy implications of apps. We propose a scale that has scalability within itself. We implement this method within a tool, named Aware, that presents the summary of what applications are installed on a smartphone, which resources they access, and what are the reasons for that. Moreover, the tool is capable of nudging the user when certain sensitive data is accessed.**

Keywords–Mobile Operating Systems; Mobile Phone Privacy; Control and Management of Privacy.

I. INTRODUCTION

Smartphones are part and parcel of our daily life: we carry them, store all sorts of personal data on them and even sleep right next to them. Gradually, more and more dimensions are being added to smartphones due to adoption of ubiquitous computing in many sectors. They have become a universal interface for many services operating around us. Significant amount of data is required and collected in order to maintain a real time interaction with the surrounding environment. Additionally, commercial incentives play an important role here. It allows the business entities to offer better services through consumer-centric analysis. A diverse revenue stream is generated by this large data pool for numerous businesses and users are benefited by better product recommendations. However, there is a certain trade-off introduced by giving away personal information—risking individual privacy. As installing an app has become a general solution to many of our problems, it has brought a great deal of privacy concerns. It is indeed necessary to look for smart privacy protection, for example the one that preserves good usability while protecting sensitive data.

As opposed to many other concepts, like network latency or power efficiency, privacy is a topic that is fuzzy to address. Keeping aside the technical aspects, decision making is hugely influenced by emotion, feelings and cultural background of individuals [1], which makes privacy a difficult entity to protect. The problem regarding smartphone privacy is two folded. From the technological perspective, we need to overcome lack of knowledge, transparency and simplicity. On the other hand, there are the social, cultural and psychological aspects. Moreover, depending on the person asked, the tolerance threshold will be different. Also time and context both can play vital roles behind personal preferences. Individual tolerance may fluctuate for same piece of information during variable situation and time.

In general, mobile operating systems offer a permission structure for the apps and an app gets access to user data through it [2]. Users are asked for their consents in order to proceed with the app. They are also expected to understand the consequences and make informed decisions, which is in fact very unlikely to be right [3]. Though apps require explicit consents from users, given justifications have proven to be ineffective to initiate privacy-aware behaviour [4]. Decisions are being made with misunderstanding and wrong perception about privacy implications, which lead the user to disclose privacy sensitive information unintentionally [3], [5]. It is quite alarming that the user-consent relies on usual bad practice to press the *Agree* button after scrolling down the list of permissions.

An alternative solution is required to simplify the representation of personal data usage that should have the ability to ease the decision making dilemma by offering a clear and conclusive notification with consequences. We would like to bisect the problem into two parts. First, the permission usage is provided to the user assuming that she possesses proper knowledge to understand it, which is in fact overlooked by majority. It encourages the user to ignore it and carry on without paying attention. We conduct a survey to determine user awareness regarding app permissions. Second, even if we are able to educate users in an easy to understand way, tolerance threshold varies from person to person and is non-quantifiable. We introduce a method for measuring users' preference and implement it within prototype apps in pursuance of nudging toward privacy.

Our contribution to the field has multiple facets. A theoretical method is proposed to quantify individual privacy preference for sensitive data usage on mobile phones. The method is capable of offering a flexible and easily adoptable structure. User convenience and ease of understanding are the prime benefits of it. A tool, named Aware, is introduced which is implemented on both Firefox OS and Android, to provide convenient, proactive and efficient interface for an overview of personal information usage by installed apps. Based on user preference, the app is able to produce nudges in the form of notifications.

The rest of this paper is organized as follows. the problem is outlined through a discussion of related literature in Section 2. A survey was conducted in order to realise the lack of privacy awareness, which is described in section 3. Solution

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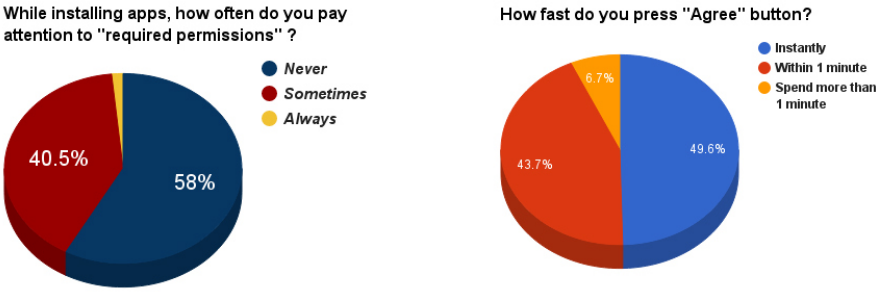

Figure 1. Statistics regarding user behaviour: a survey conducted in Berlin where N=252.

architecture and implementation strategy are described in Sections 4 and 5, respectively. Our prime observations as well as limitations are discussed in Section 6. We concluded with a forecast about future work in Section 7.

II. Related Work

Previous works have ignited several debates within privacy research arena. One of the ongoing debates is whether to introduce more control to user-interface or not [6][7]. Decision making for important private data based on a cumbersome method could result into a complete rejection from the subscribers [3]. Absence of transparency offers difficult hurdle for the user and results into lack of proper attention during decision making process [5]. Misunderstanding and lack of knowledge are often accountable for blindfolded positive consent of a user [3][5].

Privacy-unaware behaviour has the potential to result into passive expenses for the user. In [8], McDonald and Cranor presented a theoretical approach to determine the cost of sacrificing user privacy. They argued about the need for simple and usable transparency for convenient user experience. Jung et al. [9] conducted a survey on different mobile OS users and concluded that an “expectation gap” is present between perceived and actual usage of their agreed permissions. Furthermore, Acquisti and Grossklags [10] pointed out that users are more likely to sacrifice their privacy due to misperceived consequence and lack of sufficient information. Their findings indicate the shortcomings of current methods in order to make informed privacy decisions.

Felt et al. [2] developed Stowaway for investigating permissions on Android apps. They examined 940 apps and reported that one third of them are over privileged. Au et al. [11] developed PScout to analyse Android permissions and found out that 22% of the non-system entries are unnecessary. They went through several versions of Android (from version 2.2 to 4.0) and reported redundancies after examining 75 permissions. Their findings indicate the fact that personal information is being collected without informed consent of the user. Additionally, Rosen et al. [5] pointed out how difficult it can be to understand the privacy implications from an Android interface. They introduced a profile based solution to offer a better understanding by exposing behavioral statistics on privacy issues.

Several research works showed that user behaviour shifts toward positive direction by nudging [12][13]. Nudging is a gentle encouragement to a user for making decisions wisely. Though it does not prohibit users from taking any step, this tiny intervention has proven to be really helpful [14][15]. In case of mobile apps, nudging is also used as reinforcement for privacy preservation [16]. Almuhimedi et al. [17] developed AppOps based on nudging and emphasised on how many times personal data is accessed by apps. Franzen and Aspinall [18] developed PhoneWrap with similar views and proposed ticket based access for controlling permission usage. We developed Aware in a complimentary principle with a focus on spontaneous nudging.

Quantification of privacy aspects has always been challenging. Alohaly and Takabi [4] used Natural Language Processing (NLP) in this regard. Braunstein et al. [19] took user responses during pseudo situations in order to determine individual preferences. In contrast, we propose a flexible scale which is intended to be defined and controlled by users. In our prototype apps, we introduce a method to take user preferences into consideration and produce instantaneous nudges.

III. Survey

We conducted an online survey where participants could take part anonymously. The fundamental goal of this survey was to demonstrate the current scenario regarding privacy-unaware user behaviour. Though it was a subjective test and not a controlled group, the result shown in Fig. 1 depicts lack of cognisance about mobile app privacy. The survey took place during the middle of year 2015. Therefore, responders are expected to be stranger to the latest runtime permission mechanism of Android. Background knowledge of the participants was taken into consideration while selecting two particular group of users.

Within our geographically convenient grasp, we selected two subtle groups of smartphone users in this regard: 1) students from a technical university and 2) employees from an online real estate company. We used Google Form as the medium and English as the language to carry out the survey. A brief introduction in written form was given along with the survey link describing the purpose, background, requirement and motivation behind it. We intended to perform an efficient survey by not conducting an aggravating one. Thus, participants were asked only two precise questions. Moreover, only three options were given to avoid decision making dilemma. Presumably the participants understood the context and answered the questions responsibly.

A. Demography

The survey was conducted in Berlin, Germany and the participants were residing in Berlin when the survey took

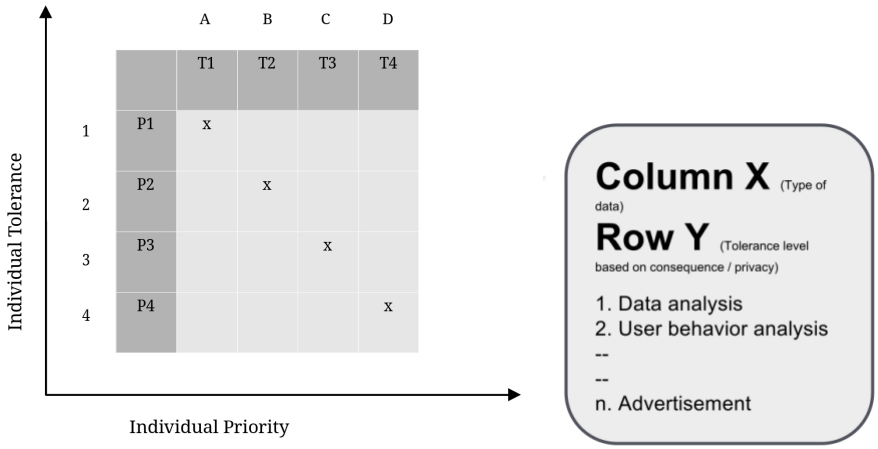

Figure 2. An instance (where columns represent data types / permissions and rows represent tolerance level) and element of the matrix solution.

place. Nonetheless, majority of the participants were expected to be internationally diverse due to the cosmopolitan nature of Berlin. During the first cycle of the survey, invitation was distributed amongst the students of TU Berlin, irrespective of their educational focus. Social media groups were used in this regard for distributing the survey request. The responders were expected to belong to their second cycle of university study. 205 responses were recorded between 08–26 April in 2015.

During the second iteration, a group of employees were requested to take part. They were working for an online real estate company named Lamudi [20]. The employee pool of this company was also internationally divergent (more than 30 different nationalities). Though they were working in different departments, all the employees were anticipated to possess substantial knowledge regarding the context of this survey. Majority of them were involved in app development, website development and data science. Presumably, they were expected to possess sublime knowledge over apps, permissions and privacy impact. Invitation was sent through a group chatting software. 47 responses were recorded between 03–31 May in 2015.

B. Result

We recorded 252 responses in total. Two brief questions were asked:

1) While installing apps, how often do you pay attention to 'required permissions'? Options to answer: Always/Sometimes/Never.
2) How fast do you press *Agree* button? Options to answer: Instantly/Within one minute/Spend more than one minute.

We found only 1.6% responses as *Always* for the first question and 93.1% of the responding participants press *Agree* button within one minute or instantly. Presumably, a significant portion of the survey participants chose 'sometimes' as an answer to the first question. However, the real scenario came out by answering the second question—users hardly spend time to realize the consequences of granting permissions for an app. Despite considering an error margin, the outcome of this survey states that very few users are aware of privacy risks associated with permissions while installing an app.

C. Limitations

The survey had an uncontrolled sample at N=252. Response collection was open for a certain period of time and sample number was not taken into consideration. Also precision was missing form given options. Users could not provide precise answer to the questions. University students and employees of a company running online-based business were presumed to possess sufficient knowledge and information which leaves the possibility of having larger error margin. Regardless of international diversity, the survey lacked participants with broader age range and occupational variety.

Although our findings lack many aspects of a proper survey, a rough conclusion could be drawn from it. Though we chose two slick smartphone user groups, their answers reflected poor privacy awareness. Despite having substantial understanding of apps and permissions, privacy-unaware user behavior was observed in the survey statistics. It is indeed undiniable that broader age range, occupational and geographical diversity would enhance credibility for the survey result.

IV. Solution Architecture

By taking into account how individually defined privacy is, and how blurry the methods are that we can use to ensure respecting it, we believe that the place to start is by improving transparency. To address the aforementioned problems, we propose a theoretical solution which is based on a two dimensional matrix structure. Initially, this method was introduced in our master thesis work.

Let us consider matrix *M (m*n)*, where *m* = number of data types and *n* = number of threshold points for individuals. Depending on the granularity of a scenario, the values of *m* and *n* can be chosen. For instance, permissions are reflected as data types in implemented prototype app which is elaborated in next section. A matrix provides flexibility for the users in two different directions. Moreover, permitting the user to shuffle the columns provides an additional elasticity to the method. It allows to accommodate individually customized and prioritized privacy matrix for each user.

Column: Data types are arranged throughout the columns. Each column is accountable for signifying one particular data type. The rightmost column hosts the most sensitive data

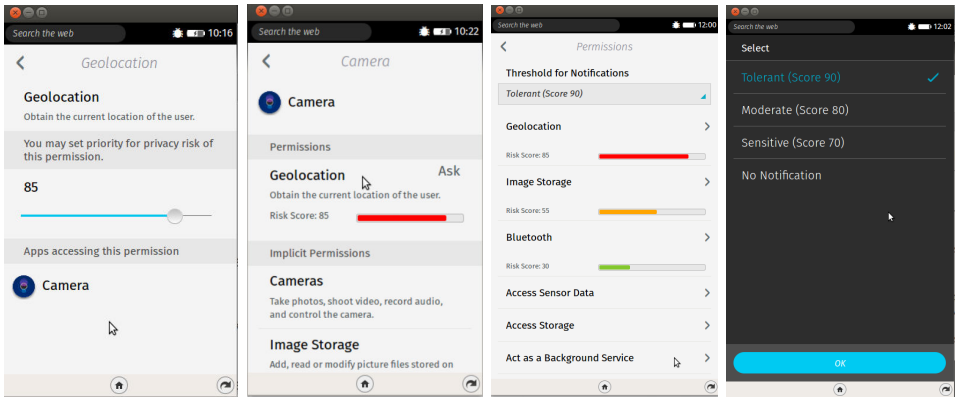

Figure 3. Interface of our prototype app on Firefox OS (from left to right): a) setting the priority for geolocation permission of camera app, b) risk score and risk bar are shown for geolocaiton permission, c) list of permissions is sorted according to user defined priority and d) setting the tolerance threshold for defining frequency of nudging/notifications.

type and the leftmost column hosts the least significant data type. User has the flexibility to rearrange default order of the columns. It allows to emphasise on individual preferences.

Row: The rows denote a personal threshold associated with each column. As the row number increases, tolerance threshold of an individual user regarding privacy decreases. Top most row (or, row 1) denotes that the user is very reluctant about the consequences. On the other hand, the bottom row (or row N) denotes her preference about certain data to be set as the most protected one. It can also be described as follows: the intersection element of the last column and last row indicates the most strict user privacy preference for the most sensitive data type.

Let us elaborate the scenario with an example, as illustrated in Fig. 2, which depicts an instance of the matrix *N (4*4)*. Personal preference of user-data or, personal priority is plotted on X axis. Y axis signifies individual tolerance. For this instance, we have four different data-types which are arranged throughout the columns (A, B, C and D) according to the preference of a user whom we can call Alice. The rightmost column signifies the most sensitive data for her. It should be noted that Alice has the freedom to shuffle the columns for changing her preferences. On the other hand, selection of rows allows to modify her own tolerance level.

Figure 2 also shows an element of the matrix. Besides knowing about data type and default tolerance level, it can describe the expected consequences within convenient description along with appropriate references. This allows the users to go in deeper explanation if they want to. It also allows them to decide upon the clauses more precisely. Moreover, users are able to revoke the settings if they do not want to agree. Suppose, Alice puts [P4, T4] as her privacy preference. This means that her tolerance level belongs to row 4 for the data type placed in column D. From an element of the matrix, Alice is able to explore more about the types of data being shared with service provider. She can also get a better idea about the consequences of sharing such data. Here, Alice has a fine grained decision making opportunity based on her own privacy preference.

It should be added that an extention to this solution has the potential to make room for enhanced decision making opportunity. In addition to partially aggreeable resolution, a temporal consent could reckon another dimension. For example, Alice may decide to put her consent after going throgh a trial period which would facilitate better understanding of any probable repercussion.

This solution is covering only the theoretical aspects of the problem. Dimensions of the matrix depend on the depth of the proposed solution. Value of a matrix element is also subject to specific scenario, which can be taken from a convenient interface. This method is partially realized during implementation. Certainly, there is opportunity to offer finer control. There is room for introducing further granularity to this scale, i.e., denial of certain clause or sub-clause and temporal acceptance. However, this would increase complexity which restrained us from coarse implementation.

V. Prototype Apps

We have implemented prototype apps on two different platforms: Firefox OS and Android. Having system privileges, these prototypes can show a list of installed apps along with the corresponding permissions, describe the reasons and allow users to set their privacy preferences depending on how they perceive the implications. Primarily, the prototype allows the users to take a look into two lists. Installed apps are given in the first one. The list can be sorted based on user-defined privacy risks. User may carry on to discover more details about any installed app. The app details option shows the list of permissions which are being used by that particular app. In the second list, all the permissions are being populated. Users can select one and find out more to be aware of consequences. Moreover, the user may choose to receive notifications for privacy sensitive information usage by other apps.

In order to highlight the privacy-sensitive applications, we introduce *Permission Priority*. It allows a user to prioritize the apps according to perceived consequence. User-defined priority for personal information depicts empowerment over individual privacy. We also introduce smart alert mechanism for certain permission usage. The prototype offers control over notification frequency. The user is in charge to decide on when to get notification and what to be notified about. We also introduce colored *Risk Bar* to improve awareness about consequences instantly through visualization.

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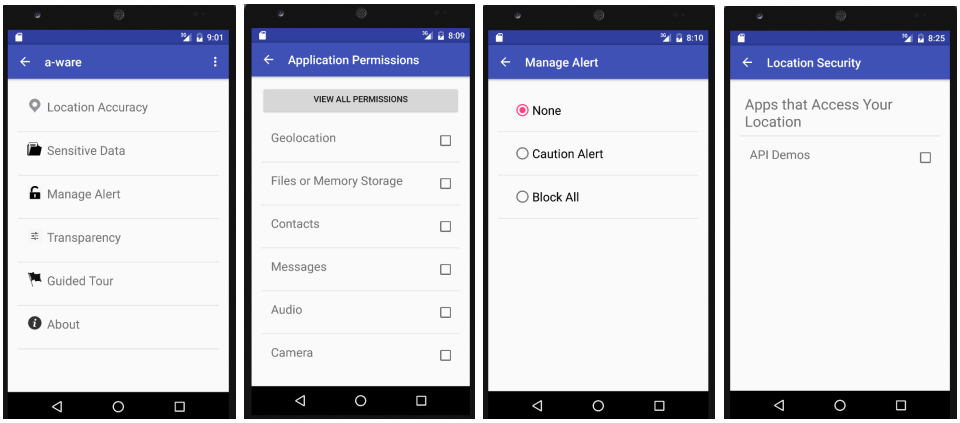

Figure 4. Interface of the prototype app on Android (from left to right): a) starting screen, b) permission list for marking nudging / notification preference, c) managing notification frequency and d) list of apps having permission to access users' location.

A. *Permission Priority*

As shown in Fig. 3 and Fig. 4, Alice can set her priority for a particular data-type which is equivalent to arranging the columns in the matrix solution. It allows to prioritize the apps according to potential risks. Additionally, she can get the summary of data types that are being accessed by an app. Also, an overview of sensitive data usage can be visualized along with their priorities. A colored risk bar helps her to be cautious by highlighting the risky permissions. It improves awareness of the consequences. It also rises curiosity to discover more in order to feel safe. Moreover, the prototype allows to set the frequency of nudges in the form of notifications. The threshold is chosen by the user. This functionality signifies the choice from rows of the matrix solution structure. Thus, Alice can choose "when" and "what" to be notified about.

The purpose of placing permission priority is to introduce a user-defined scale for privacy tolerance. Considering the theoretical matrix solution described in previous section, it symbolizes shuffling the columns through setting priority. In the detail interface of each permission, depicted in Fig. 3, we introduced a *Sliding Bar* with a range from 0 to 100. It has 20 default positions within this range which means the interval between them is 5. This scale signifies individual privacy tolerance for that particular permission. Selection of highest slider value indicates maximum privacy concern of the user.

We considered two constraints to define the scale. First, a flexible enough range is required to resolve decision making dilemma. Secondly, unexpected and fine grained transparency might result into burdensome responsibility. Thus we chose high values and less number of preference taking points in order to present an optimized solution. Chosen values are used to trigger the *notifications or, nudges*. Finally, these values are used to be visualized as the *Privacy Risk Bar*. Persuasive power of data visualization was chosen in order to achieve good practice for privacy preserving behavior. This risk bar offers a visual representation of safety zone and danger zone for privacy implications. User defined *Permission Priority* is also responsible here to define the color code: green, yellow and red zone.

For the prototype on Android, we applied a different approach to take permission priority. Instead of taking values from the range of a sliding bar, check box is placed to take users' preference.

B. *Notifications*

We introduce fine-grained transparency in our implementation. Users can get nudges or, alerts in order to be aware of privacy sensitive information being accessed. Moreover, the control to receive privacy nudges belongs to the user. It depends on the values of *Permission Priority* and user defined threshold. The notification is triggered on extreme risks (permission priority 90 or above) by default. However, users have the option to change the threshold for the notifications in order to control the frequency:

Tolerant Threshold: Notification is triggered when the current application uses a permission having user defined priority more than or equal to 90. The user is expected to receive less amount of alerts.

Moderate Threshold: Notification is triggered when the current app uses a permission having user defined priority more than or equal to 80. The user is expected to receive moderate amount of alerts.

Sensitive Threshold: Notification is triggered when the current app uses a permission having user defined priority more than or equal to 70. The user is expected to receive frequent alerts.

No notification: We understand that nudging can be annoying sometimes for a user. If this option is chosen, no alert will be triggered.

VI. Discussion

Firefox OS provides descriptive and cumbersome representation of privacy policy during the installation of an app [21]. Users are expected to go through lengthy text. It compels a user to ignore and carry on without paying any attention. Lack of knowledge makes the situation even more difficult for users to perceive proper implications. Additionally, individual emotion and judgment can play pivotal roles behind decisions regarding privacy. This is where we identify the requirement of personalized scale for convenient individual decision making. An alternative is required to simplify the representation of privacy policy which should have the ability to ease the decision making dilemma by offering a clear and conclusive

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notification with consequences. In comparison with the current scenario, our prototype app is eligible to offer a solution to the aforementioned problems.

Android offers a much better representation of permission usage on a mobile phone [22]. Considering Android Lollipop (version - 5.1.1) and the previous two versions, a summarized permission list is provided during installation. However, users do not have any other alternative but to accept all of them. This rigid structure encourages a user to proceed without putting further thoughts on privacy implication. The latest version (6.0.1) of Android, Marshmallow, introduced runtime permission structure. In this case, user-consent is required while a user is using the app. It is indeed convenient for the user to understand the permission structure. Our prototype is able to complement the current scenario by adding notification for certain permission usage.

Our observations have pointed out that lack of awareness is a big impediment for preventing invasion of personal data. Additionally, individual privacy remains vulnerable to unintended disclosure due to lack of proper knowledge. Often users remain uninformed about disclosing sensitive information. Misconception regarding consequences is usually responsible for privacy-unaware behavior. Absence of easy to use tools and complex representation of permission usage play pivotal roles behind these bad practices. Sometimes subscribers are compelled to compromise their personal information in order to use certain services. It is hard to convince them to use a proactive approach while only rigid binary options are provided. As a result, users tend to ignore the privacy notice which leads to uninformed decision making and unintentional disclosure of private information. Our two main observations are: (1) individual preference cannot be taken into a stiff framework, and (2) flexible transparency and personalized tolerance scale are required in order to design user friendly tools.

VII. Conclusion

Our prime objective was to help users by keeping them informed about privacy implications. In order to do so, we developed prototype apps capable of nudging. However, user preference was not taken for granted. The prototype allows a user to choose the type and frequency of nudges. As the design of apps relied on a scalable method, it can stretch resilience to accommodate individual preferences. It also allows the user to have personalized scale to determine their preferred boundaries for receiving nudges. We developed two prototype apps named 'Aware' for the Firefox OS and Android. In Aware, the user can assign priorities to each permission in order to define her tolerance threshold. Our implementation depicts proof of concept for the theoretical solution. Both apps are capable of providing privacy overview of a phone. Instant notification relieves the user from worrying about disclosing privacy worthy data. As our implementation work contained privacy threat detection only, we intend to address privacy protection in our future work. Our plan also contains empirical studies to measure usability, effectiveness and to achieve proven viability for the prototypes.

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A Verification Based Flow Space Management Scheme for Multi-Tenant Virtualized Network

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***Abstract*—Cloud services that virtualize existing IT infrastructures at data centers are widely used by governments, universities, and companies. Multi-tenancy is required for data centers to provide a large number of isolated networks to each organization. OpenFlow is a core technology of software defined networking (SDN) and is useful for centrally managing and controlling these networks; however, SDN is used only at the management level. It is desirable to make the flexible features of SDN/OpenFlow available to users' virtual networks. FlowVisor [3] virtualizes multi-tenant OpenFlow networks by coordinating multiple controllers, but it is unable to deal with conflicts of control rules among individual virtual networks. Administrators of each tenant thus need to design the control rules of their networks carefully. This paper describes a verification-based scheme for coordinating multiple tenants' OpenFlow networks. The scheme enables administrators to design each tenant network without having to worry about conflicts with other tenants. It ensures isolation of virtual networks among multiple tenants transparently. It manages the address space overlaps and resolves conflicts in the flow entries.**

Keywords–OpenFlow; Virtualization; Multi-tenant Network.

I. INTRODUCTION

With the development of server virtualization technology, cloud computing services, such as Infrastructure as a Service (IaaS), have become popular. Server virtualization technology virtualizes an organization's IT infrastructure at a data center and provides it through the Internet. In multi-tenant networks, one physical network is divided into many tenant virtual networks. The traffic in each virtual network is isolated from the traffic in other networks. Virtual LAN (VLAN) is a popular virtualization technology. IaaS providers divide one physical network into many layer 2 networks by assigning a VLAN-ID to each tenant virtual network, and the tenant users can then freely construct their own layer 3 network on the allocated tenant virtual network. When the providers of an IaaS cloud using VLAN technology change the configurations of the virtual networks, they need to change the VLAN settings of all the network devices. However, in a cloud environment where the number of virtual networks and virtual machines change rather dynamically, a more flexible virtual network construction and management method is required.

OpenFlow [2], which is a core technology of software-defined networking (SDN) [1], has the features that satisfy these requirements. OpenFlow enables flexible routing control and centralized management of networks by separating the control plane from the data transfer plane. A controller controls the routing of packet forwarding, and the data plane switches transfer packets in accordance with the instruction of the controller. Since this technology has the ability to recognize and rewrite the VLAN-ID of each packet, IaaS providers can aggregate VLAN management functionalities into one controller. The OpenFlow based network architecture also enables flexible virtual network management; however, a tenant network may accidentally disable OpenFlow functionalities when the IaaS provider and user tenants have different control policies. The administrators of each tenant network may thus have difficulty gaining the benefits of OpenFlow, if the provider uses OpenFlow technology to manage its IaaS platform. The idea of coordinating multiple OpenFlow networks on a physical network would enable individual virtual networks to be managed by a single tenant.

FlowVisor [3] is a technique that handles requests from multiple OpenFlow controllers. In FlowVisor, a proxy is placed between the OpenFlow controller and the switches, and it exchanges and manages each tenant's control messages sent between the controllers and switches. This enables OpenFlow switches to be individually controlled by multiple controllers on one physical OpenFlow network. FlowVisor expresses a tenant network space in a way that is called a flow space, and the administrator of each tenant writes flow entries belonging to the allocated flow space definition by using their own controller. This mechanism can be used to construct a plurality of virtual OpenFlow networks, and it enables each tenant controller to control each tenant's virtual network individually. FlowVisor assumes that there is no overlap between flow spaces. When applying it to a multi-tenant network, each tenant network must define its flow entries within the flow space provided by the IaaS provider. This problem becomes more difficult because the flow spaces are not always discrete. In the case of monitoring one tenant's flow space from another flow space it owns, the flow spaces must overlap. The IaaS provider needs to define them very carefully so as not to cause unintended traffic control.

In this research, we propose verification-based OpenFlow network virtualization based on FlowVisor that enables the network to be freely designed by each tenant. To guarantee traffic separation, we propose a conflict management that uses verification of flow space definitions. If a conflict occurs, it can be resolved by rewriting a flow entry. Our approach verifies

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and manages overlapping parts between flow spaces defined by individual tenants, detects conflicts between flow spaces and flow entries, and rewrites the entries to avoid conflict in the FlowVisor. This paper describes the method of flow-space verification among multiple tenants and its implementation. Section II is an overview of OpenFlow/SDN technology. Section III explains the mechanism and problems of FlowVisor. Section IV outlines the proposed virtualization method based on flow entry verification, and Section V describes the method for avoiding flow entry conflicts in more detail. Section VI describes the details of our prototype implementation and its performance evaluation. Section VII discusses our method in relation with other research. Section VIII is a conclusion that mentions future work.

II. OpenFlow/SDN

OpenFlow is a representative architecture of software-defined networking, and it is currently being standardized. It is a next-generation network technology for cloud computing environments. An OpenFlow network consists of an OpenFlow controller responsible for routing control and an OpenFlow switch for transferring packets according to flow entries written by the controller. Hence, it is a centralized control architecture that enables centralized management of networks by separating the traditional network system into a control plane and data plane.

The controller is software, and a pair of matching fields, such as a MAC address, an IP address, a transport number, a VLAN-ID, and actions to be performed on a packet are defined as a flow entry. Flexible routing control is enabled by transferring packets according to flow entries in the switch. If the switch has to be reconfigured in response to a change in the network configuration, the change is applied to all the switches by describing the change settings as new flow entries in the controller. This improves the manageability of the network. The controller and switch are connected by an OpenFlow channel, which is a control network using TCP/IP that is constructed separately from the data network, and they exchange control messages called OpenFlow messages through it. Through OpenFlow messages, the controller controls switches such as for writing the flow entry. In OpenFlow, since the controller controls all the switches and knows the network topology, it is possible for it to control routing flexibly such as through source routing and multi-path forwarding. Virtualizing a physical network by using OpenFlow makes it possible not only to improve the manageability of VLAN-IDs but also to ensure logical division of the network by using the packet headers of layers 1 to 4 that can be specified as a match field. OpenFlow enables its users to create a number of virtual networks beyond the usual limits of VLAN-IDs by dividing up the used address space in advance.

However, the conventional OpenFlow technology has some problems when it comes to virtualizing and controlling the OpenFlow network itself. For example, it is not possible to control each switch individually from multiple controllers in one OpenFlow network, and there is no mechanism to logically divide one OpenFlow network into multiple virtual OpenFlow networks, etc. These problems make it impossible for a tenant to construct and control each controller or devise a virtual OpenFlow network in a multi-tenant data center that provides IaaS.

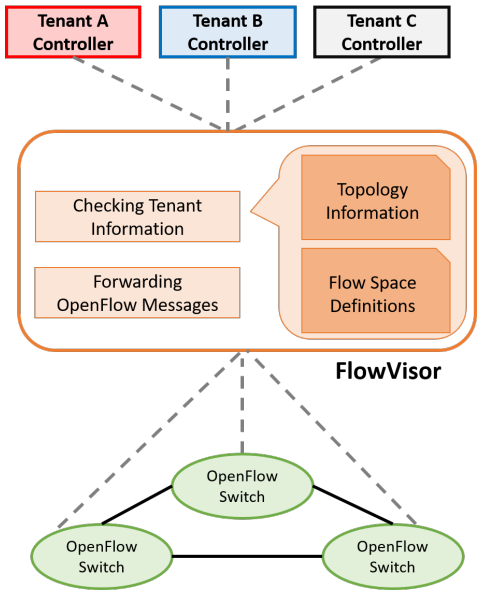

Figure 1. FlowVisor

III. FlowVisor

A FlowVisor is placed in an OpenFlow channel that connects the controller and switches, as shown in the Figure 1. It operates as a proxy that transfers the OpenFlow messages necessary to control the switch from the controller. The administrator of FlowVisor defines the available network space to each tenant as a flow space and presents flow space information to each tenant user in some way. Each tenant user creates flow entries and a controller for writing them in accordance with the network topology and flow space information of the virtual OpenFlow network presented by the FlowVisor administrator. A tenant user can control the tenant network by connecting his controller to FlowVisor.

A. Flow Space

It is necessary for the administrator of FlowVisor to define the available network space in each tenant as a "flow space" in advance. As shown in Table I, a flow space has a slice name indicating the name of the tenant network, a DPID that indicates the OpenFlow switch ID, and a MAC address, IP address, transport number, etc., as an available match field from layer 1 to 4 in a flow entry and priority. In addition, each flow space is based on the premise that the defined network space is independent and has no overlaps. Therefore, there is no mechanism for checking whether flow space conflicts exist in FlowVisor, and hence, the administrator needs to define each flow space carefully.

B. FlowVisor Mechanism

FlowVisor functions as a proxy on the OpenFlow channel and controls the transfer of OpenFlow messages between multiple controllers and switches. This function differs between the case of transferring messages from the switch to the controller, such as when sending Packet-In and Port-Status messages, and the case of forwarding messages from the controller to the switch, such as when sending the Flow-Mod message.

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TABLE I. EXAMPLES OF FLOW SPACE

Slice	DPID	Priority	VLAN	Src MAC	Dst MAC	Src IP	Dst IP	Src TCP	Dst TCP
Tenant A	1	100	50	*	*	*	*	80, 22	*
Tenant B	1	100	50	*	*	10.0.1.0/24	*	80	*
Tenant C	1	100	50	*	*	10.0.2.0/24	*	80	*

First, we describe the messages that are transferred from the switch to the controller. In this case, it is necessary to specify the controller to which the message pertains before transferring the message to it. As an example, a Port-Status message notifying that the physical port state of the switch has changed will affect all the tenant controllers using that port. Accordingly, FlowVisor searches for all target controllers from the topology information of each tenant network and transfers the Port-Status message to all of them. In the case of a Packet-In message, FlowVisor searches the flow space definition to specify which tenant network the packet belongs to and forwards the message to the tenant controller of the corresponding flow space.

Next, we describe the messages that are transferred from the controller to the switch. In this case, FlowVisor refers to the topology information of all the tenant networks; then it transfers the message to the target switch; it performs the same operation on every message. If a tenant user tries to send a message to the switch that does not belong to its own tenant network, the send operation fails and a message transfer error is returned to the controller.

C. FlowVisor Problem

FlowVisor is based on the premises that the flow spaces allocated to each tenant network are independent and the tenant controller sets flow entries within the allocated flow space. If a FlowVisor administrator defines an unintended or incorrect content flow space, an unexpected network control will be executed. In contrast, if IaaS providers want to enable each tenant user to freely design their own tenant network as way of a providing a multi-tenant network, the flow space should be able to be freely defined by each tenant user. There is a problem that unintended traffic control can occur when a flow entry is written that conflicts with the flow space of another tenant. Hence, it is necessary to implement a mechanism that can check for conflicts in flow spaces and flow entries in a multi-tenant network.

Table I shows an example of conflicting flow entries, wherein if tenant user A tries to write a flow entry that prohibits the SSH session such as by sending"*Src TCP = 22, action = DROP*" to the switch with DPID = 1. In Table I, match fields of tenant A are defined as wildcard values " * " with the exception of Src TCP; thus tenant user A can freely use this value. However, if the flow entry such as what is mentioned above is written, it will be applied to all packets that are transferred through this switch with source TCP port number 22. Since all the packets are dropped, all SSH connections are closed even in other tenant networks. In this case, the packet was dropped unintentionally, however, it is possible to rewrite the packet header as a specified action and transfer it in OpenFlow. It is also possible to act in dubious or illegal ways, such as eavesdropping by transferring traffic of other tenants that are not permitted to use a server on their tenant network. In particular, it is also possible to transfer the traffic of other tenants to a server on one' s own tenant network for the purpose of sniffing packets.

If a FlowVisor administrator allows each tenant user to freely design their tenant network and flow space definition, a flow space that has overlaps will cause unintended behavior because the flow entries conflict. This is due to OpenFlow' s ability to flexibly set values such as wildcards about L1-L4 headers in the match field. In the example mentioned above, since tenant user can write a flow entry with wildcards other than the source TCP port number to the switch, he can control the traffic in unassigned flow spaces.

IV. VIRTUALIZATION BASED ON FLOW ENTRY VERIFICATION

We propose a virtualization method for an OpenFlow network that enables a network to be designed for each tenant. In particular, we propose a verification and management system of duplications in the flow space allocated to each tenant and a conflict verification and rewriting method for the flow entries written by tenant controllers. As shown in Figure 2, the verification is implemented in FlowVisor. First, this system verifies and manages the overlapping address spaces in each flow space. A tenant user defines the combination of address spaces that s/he will use in each tenant network as a "flow space", and this system verifies and manages duplications. It is possible to avoid conflicts of flow entries among tenants as much as possible. In addition, when a flow entry in a flow space includes overlappng address spaces with others was written, it checks for a conflict of the flow entry and rewrites the match field to guarantee the separation of traffic between each tenant network. This minimizes the amount of rewriting of flow entries by applying verification and management on the flow space in advance.

Our system uses a new definition of a flow space. It is constructed by restricting the elements and combinations of match fields against the existing definition. It is possible to set arbitrary values for all elements of the OpenFlow match field in the existing definition. In this case, tenant users can write flow entries that cause unintended traffic control when using wildcards. On the other hand, our method restricts tenants to using only a combination of address spaces that have pre-specified range as a match field. We make it so that a tenant user can control only the allocated network and traffic; furthermore, we make it unnecessary to verify fields that are not specified in a practical network.

A. Flow Space Definition

This flow space is different from the definition of FlowVisor in Section III-A. In previous work, a flow space was defined for each switch that the tenant can control; however, here, a new flow space is defined as a combination of address spaces that the tenant can use for one tenant network. A flow space is

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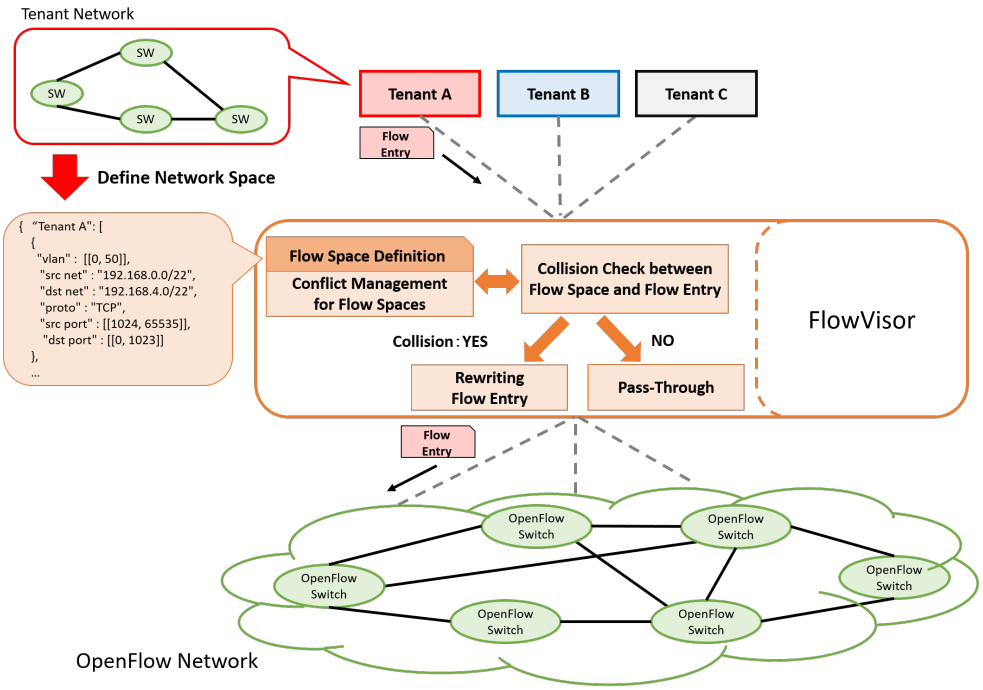

Figure 2. Proposed architecture

composed of multiple rules, where each rule consists of rule IDs, flow space names, and a matching field that is available to the tenant, as shown in Table II. In the matching field, it is possible to set five kinds of header information of L2 to L4 as VLAN ID, Src/Dst IP address and Src/Dst TCP port, which are necessary for network operations. These definitions are described in JSON format, as shown in Figure 3. Each flow space describes a flow space name and a set of flow definitions. A flow definition is described for each element of a match field, and it is defined as conjunctions of fields. Since one flow space is represented by one or more flow definitions, multiple flow definitions are defined as disjunctions to allow flow entries that match any one. Each tenant uses only the combination of address spaces specified in this flow space. Definition example 2 in Table II, which summarizes the examples of Figure 3, shows the following address space:

- VLAN ID = 100, Src IP = 192.168.64.0/20, Dst IP = 192.168.64.0/20, Src TCP = 80
- VLAN ID = 101, Src IP = 192.168.64.0/20, Dst IP = 192.168.64.0/20, Src TCP = 80

The tenant assigned this flow space can control the network by using these two different combinations as a match field of the flow entry. The top row of Table II shows the available address space as the match field, but the upper limit of the VLAN ID is half the original limit of 4096. This is due to securing the independent address space as management space for managing duplications of flow spaces and resolving conflicts in advance. VLAN-IDs are allocated from this management space to the flow space when necessary.

```
{
  "Example 1"    : [
    {
      "vlan" :  [[0, 50]],
      "src net" : "192.168.0.0/22",
      "dst net" : "192.168.4.0/22",
      "proto" : "TCP",
      "src port" : [[1024, 65535]],
      "dst port" : [[0, 1023]]
    },
    {
      "vlan" :  [[0, 50]],
      "src net" : "192.168.4.0/22",
      "dst net" : "192.168.0.0/22",
      "proto" : "TCP",
      "src port" : [[0, 1023]],
      "dst port" : [[1024, 65535]]
    }
  ],
  "Example 2"    : [
    {
      "vlan" : [[100], [101]]
      "src net" : "192.168.64.0/20",
      "dst net" : "192.168.64.0/20",
      "proto" : "TCP",
      "src port" : [[80]],
      "dst port" : [[80]]
    }
  ]
}
```

Figure 3. JSON Format for Flow Space

B. Duplicate Flow Space Verification and Flow Entry

Now let us explain the overlap verification between flow spaces and conflicts of flow entries on the basis of the definition in the previous section. Table III lists examples of flow spaces defined for three tenants A, B, and C. Since the flow space definition of the tenant A at the top row completely includes the flow spaces of the following tenants B and C, flow space A overlaps B and C and is not independent. On the other hand, in the flow spaces of tenants B and C that are independent in Table II, independent values are specified for

TABLE II. FLOW SPACE LIMIT AND DEFINITION EXAMPLES

Rule ID	Space Name	VLAN	Src IP	Dst IP	Src TCP	Dst TCP
1	Maximum usage	0 ∼ 2047	0.0.0.0 ∼ 255.255.255.255	0.0.0.0 ∼ 255.255.255.255	0∼65535	0∼65535
2	Example 1	0 ∼ 50	192.168.0.0/22	192.168.4.0/22	1024 ∼ 65535	0 ∼ 1023
3	Example 1	0 ∼ 50	192.168.4.0/22	192.168.0.0/22	0 ∼ 1023	1024 ∼ 65535
4	Example 2	100, 101	192.168.64.0/20	192.168.64.0/20	80	*

any of the match fields, such as Src IP address. Since only the conjunction of the combination of the address spaces is used as a match field in our definition of the flow space, we can detect for duplications by verifying the inclusion relation for each combination of address spaces.

If the flow spaces have a complete inclusion relation, one must detect and avoid conflicts of flow entries after managing any flow space duplication. In flow spaces such as in Table III, the flow entry at the top of the Table IV written from tenant A' s controller will collide with the flow entries of other tenants. Table IV shows two examples, i.e., one that conflicts with other flow space definitions and another that does not conflict with others. In the example of flow entry at the upper row, the value of Src IP is a wildcard and it is based on the flow space of tenant A. Since it includes the range of flow spaces in other tenants B and C, it conflicts with their flow entries, and their traffic is also controlled by this conflicting flow entry. On the other hand, in the example of the flow entry in the lower row, Src IP = 10.0.0.1, which is an independent value against the flow space of other tenants is set in the match field. This flow entry does not cause a conflict. As mentioned above, we must verify the inclusion relation of the value specified in the match field for each flow space. If the value includes other tenant's flow spaces, it is possible to verify and avoid conflict by extracting a new value from the free independent address space and setting it to a conflicting flow entry.

V. CONFLICT VERIFICATION OF FLOW ENTRY

To avoid conflicts between flow entries, we propose a two-step verification method. The first step involves checking the consistency between the address space defined in the match field of the flow entry and its own flow space. In the second step, for the match field in the flow entry, the part of the wildcard including the value defined in the flow space of the other tenant is automatically expanded into a free independent address. As a result, conflicts due to flow entries using wildcard values are detected and avoided while at the same time different flow entries are prohibited from the defined flow space. These measures guarantee that traffic of the different tenant networks is separated.

A. Consistency Check with Flow Spaces

A consistency check is made of the flow entry in the Flow-Mod message from the tenant controller as to whether the match field deviates from the tenant's flow space definition. The consistency check simply compares the range of the address space for values other than wildcards in the match field to see if they go beyond the range defined in the flow space. If a flow entry with a value beyond that of the flow space definition is written, the Flow-Mod message is discarded and a transmission error for the Flow-Mod message is sent to the tenant controller.

B. Expanding Wildcard Parts

We rewrite the flow entries that passed the consistency check of Section V-A so that the wildcard part of the match field does not conflict with the address space defined in the other flow space. Here, as with the example in Section III-C, we will explain the case of writing a flow entry such as "drop all packets with the source TCP port number 22" from the tenant A controller in Table I. In this case, because the value of the source TCP port is within the flow space first, it passes the consistency check of the Section V-A. Next, all the match fields except for the source TCP port are filled in as wildcards, but these include tenant B's flow space for VLAN-ID and source IP address as well as tenant C's space for the source/destination IP address in Table I. For avoiding conflicts between flow entries, one or more independent values are set for each of these wildcards. The result of rewriting the flow entry using the free address space is shown on the lower row of Table V. Our method rewrites the wildcard part the flow entry so that the match field does not conflict with others and transfers it in a Flow-Mod message. In so doing, it is guaranteed that the flow entry will not incorrectly control the traffic on another tenant network.

VI. IMPLEMENTATION

Our core methods consisted of two flow space conflict verification systems, i.e., the "flow space manager" and "flow translate engine", and we implemented a prototype flow space manager. This section describes the implementation and initial performance evaluation. The flow space manager holds definitions of the given flow space and investigates in advance the flow space where flow entries can collide. Here, the flow space is defined as shown in Figure 3; the manager analyzes it and holds flow definitions for each flow space. At this time, in each flow definition, a flow definition that is a duplicate of one of the other flow spaces in all match fields may cause a conflict.

The flow definition is managed by hashing the source IP address space with the network address of 24 bit prefix as the key. In this case, if the source IP address space of the flow definition is narrower than /24, the network address of the /24 network including it is used as the key. If it is larger than /24, network addresses of all /24 networks are registered as multiple entries.

This manager was implemented in Ruby 2.3, and the initial performance evaluation measured the overhead of flow registration. We measured the change in the time taken from the 1st to 5000th in two cases of 5000 flow spaces that did not contain any conflicts and 5000 flow spaces that completely contained conflicts. The results, as measured by a computer with Intel Core-i7 2.8GHz, 16 GB memory, are shown in Figure 4. The flow spaces where conflicts occurred are slower, but could be processed at a rate of about 0.2 ms per entry. Considering that

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TABLE III. EXAMPLES OF DUPLICATE FLOW SPACES

Rule ID	Space Name	VLAN	Src IP	Dst IP	Src TCP	Dst TCP
1	Tenant A	50	*	*	80, 22	*
2	Tenant B	50	10.0.1.0/24	*	80	*
3	Tenant C	50	10.0.2.0/24	*	80	*

TABLE IV. EXAMPLES OF FLOW ENTRIES IN TABLE III

Entry	Match Field	Action
Conflicting Flow Entry	VLAN ID = 50 Src TCP = 80	Output: port 2
Non-Conflicting Flow Entry	VLAN ID = 50 Src IP = 10.0.0.1 Src TCP = 80	Output: port 2

TABLE V. REWRITING WILDCARD PARTS

Entry	Match Field	Action
Conflicted Flow Entry	Src TCP = 80	DROP
Rewrited Flow Entry	Src TCP = 80 Src IP = 10.0.0.0/24 VLAN ID = 2048	DROP

the flow space registration is relatively infrequent, this result indicates sufficient practical performance. The flow translate engine is currently being implemented; however, it examines only the definitions of target flow spaces, accordingly, the engine searches fewer flow space definitions than in the flow space manager.

VII. Discussion

We proposed an OpenFlow network virtualization scheme that allows each tenant to freely use OpenFlow technology in a multi-tenant network environment. The features of this scheme include virtualization of an OpenFlow network by using conflict management in a flow space abstracting individual tenant networks and conflict verification of each flow entry. The designer of each tenant network can freely design the network configuration by defining the network address field such as the IP address.

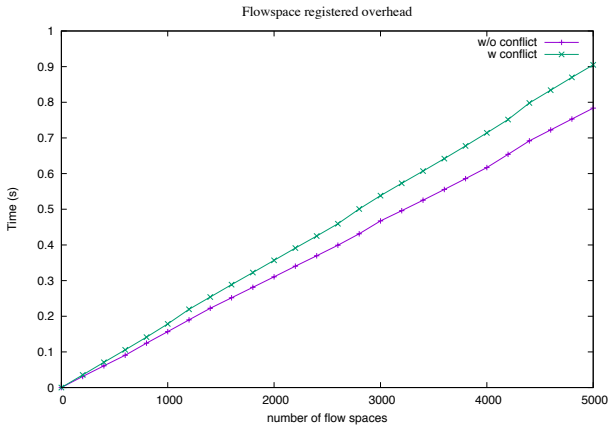

Figure 4. Overhead of Flow Registration

FlowVisor requires that each flow space never overlap; thus, it cannot verify whether conflicts occur between flow spaces. This means that conflict avoidance among flow spaces is left to the operator's responsibility. From this point of view, it seems reasonable to view it as a network partitioning technique rather than a virtualization. Sköldström [4] et al. propose virtualization method that uses FlowVisor as a relay network of a wide area network. They focus on resource management, whereas our research mainly deals with mapping to lower-layer network separation technology such as MPLS. Yamanaka et al.'s [5] virtualization method works by assigning and tagging a specific MAC address for each virtual network at the edge of the network. This method restricts flow definitions to those that can be described by each tenant.

Our method can freely define a virtual network for each tenant and realizes a control that maintains its independence. As a result, based on the design and construction of the established TCP/IP network, users can introduce flexible controls by using OpenFlow technology. Even when the backend of the IT infrastructure of the current organization is moved to the cloud environment, it will be possible to provide both flexible network control and ease of design like that of a conventional network.

VIII. Conclusion

We proposed a virtual network management system that maximizes the ability of OpenFlow virtualization by using verification of the flow space definition. The method enables individual tenant networks to be freely designed in a multi-tenant network environment and ensures isolation among them. This makes it possible for IaaS providers to provide a flexible tenant network in which OpenFlow technology is freely used for and by each tenant user. A preliminary evaluation of a prototype shows that the proposed flow space management has sufficient performance.

Acknowledgment

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A Comparative Study of Cross-Cultural Awareness using Place Oriented Internet Radio

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***Abstract*—Japan is accepting a number of foreign visitors in the trend of cultural diversity; hence, building mutual understanding with who has different cultural background becomes essential nowadays. To provide opportunities for international visitors to grasp better idea about Japanese culture, we proposed Internet radio CCR (Cross-Cultural Radio), which offers place oriented contents including local's talk and international listener's comments. Sequentially, an original measurement CCUS (Cross-Cultural Understanding Scale) was used to evaluate participants' level of cultural awareness, through the fieldwork experiment conducted in Tokyo. A comparative study was designed for Japanese and international participants. The experimental result illustrates that CCR is effective in all dimensions of cross-cultural awareness for international participants, whereas some Japanese participants showed lower CCUS score improvement than internationals. This paper intends to clarify that CCR is more effective for international visitors than Japanese, because of their cultural awareness in the face of "otherness".**

Keywords— comparative study; place orientation; Internet radio; cross-cultural awareness; fieldwork; evaluation.

I. INTRODUCTION

General knowledge of the host culture such as language or values and attitude toward the host culture and its members has been consistently posited to play an important role in influencing effective communication across cultures [1]. Like Damasio [2], who claimed that "culture is a regulator of human life and identity," scholars have attempted to conceptualize their understanding of culture. Although historically it has been regarded as mono-lingual/cultural country, with a drastic increase of foreign visitors [3], Japan is no exception to appreciate cultural diversity. We have to be aware that all foreigners are unique individuals, and we should not generalize them by nationality, race, and religion. Foreigners are visiting Japan for several purposes, such as sightseeing, studying abroad or working. Likewise, depending on their cultural backgrounds, problems they encounter as well as their interests to explore greatly vary, and there will never be a solution applicable for everyone. To propose a way to support foreign individuals, creating new media to provide them the opportunities to know Japanese culture at a deeper level is meaningful from a cross-cultural viewpoint.

Related literature (Yoon [4] and Bramwell [5]) has demonstrated that the effect of motivation and satisfaction is prominent in the decision of tourists to re-visit places. Osti [6] and Pike [7] also pointed out the eagerness of tourists' revisiting in relation to the characteristics of specific places, such as sporting event destinations. In terms of information system, Nakatani [8] and Masuda [9] suggested a recommendation system for tourists, which provides customized tour information depending on user's need, including using smartphone applications. However, there is almost no research of using Internet radio specifically as a tool for raising cross-cultural awareness in Japan, until Ito [10] suggested web-based platform focused on international visitor's behaviors while sightseeing. In this paper, we stretch the concept of previously proposed place oriented Internet radio CCR (Cross-Cultural Radio), which helps foreigners to recognize Japan from a cross-cultural perspective. CCR provides several types of contents, including information from popular tour guidebook, local people's interview, listener's impression and comments of other contents. In addition, we conducted several evaluation experiments in Tokyo to measure the effectiveness of CCR, using criteria called CCUS (Cross-Cultural Understanding Scale), which was also suggested by Ito [11].

The crucial aim of this paper is to analyze the cultural exchange amongst individual experiment participants through the observation of their behaviors, by conducting comparative research for internationals and Japanese.

The paper structure is explained as follows: First, Section II describes a design process of CCR including its concept and system configuration, as well as specific contents architecture. Section III gives a complete set of evaluation experiments conducted in Tokyo for international and Japanese participants. Section IV digs the result into a further behavioral analysis as a comparative study. Lastly, the conclusion and future works are mentioned in Section V.

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II. DESIGN OF CROSS-CULTURAL RADIO

A. Concept

The above-mentioned previous research, particularly Nakatani and Masuda's recommender system for tourists, is designed for usage in a specific place. However, the information they provide to listeners only focuses on tourists' preferences and does not include the cultural perspective of the host country, which promotes cross-cultural understanding amongst international listeners.

Regarding the type of information available, visual material, such as detailed information on smartphones, contributes to a certain extent to obtaining a general idea about a place. Nevertheless, aural information is far superior to visual information to induce listener's flexibility, by allowing them to stretch their imagination regarding what they have heard. Furthermore, aural information can provide direct interaction with the place, including local people's stories or comments from other visitors. This may also be a trigger to increase international listeners' understanding of Japanese culture.

For these reasons, we choose place oriented Internet radio CCR, which Ito has suggested to examine its effectiveness as a sound-focused media. In terms of comparative study, we critically analyze the experimental result with international and Japanese participants. The detailed concept is originally focused on international listeners and is shown in Figure 1.

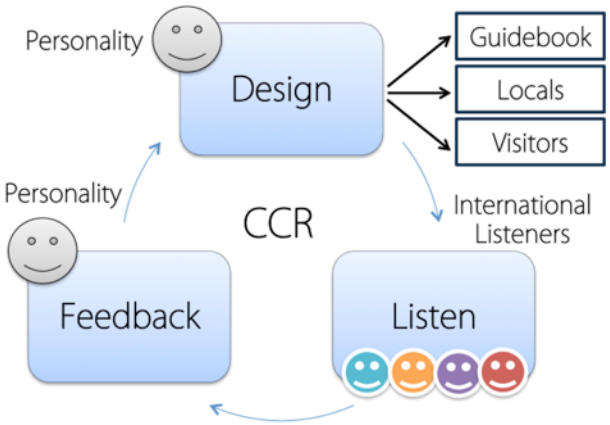

Figure 1. Concept of Cross-Cultural Radio "CCR"

CCR works in three steps. The first step consists in content design for different listeners. The second step is the listening process, which various listeners engage in. The third step is obtaining feedback from listeners, plus revision of the content. To maximize the influence of content, the preferred target of CCR is international visitors who are staying in Japan for a relatively long period of time, from a few months to years, rather than just for a couple of days. The reason of selecting target users is that presumably they are choosing Japan as destinations because they are having stronger aspirations of exploring its culture more than short-term visitors.

B. System

Previous research [12]-[14] has shown that an acceptable duration of content should be approximately 1 to 1 and a half minutes. Several companies produce audio guide players, supporting the delivery of such content as described above.

Once contents in the form of audio clips are prepared, they are stored in the website and linked to clickable icons using JavaScript code. When the listener clicks on an icon, the associated audio clip is played. The website can be accessed [15] or using the QR code shown in Figure 5.

Three types of content are available, such as guidebook (audio clips from the famous tour guidebook), the locals (stories or tips from local people), and visitors (feedback from the listener to be shared with other visitors).

1) Selecting Location

As CCR is designed for various listeners from different cultural backgrounds, the selection of the place, where the content is mapped, is also important. In this research, Asakusa, one of the most famous and popular tourist spots in Tokyo was chosen. The reason is that Asakusa has a rich cultural heritage, such as Japanese traditional temples or shrines, as well as dining venues and souvenir shops that attract many tourists. Besides Asakusa is located in the heart of Tokyo and has great accessibility, which enables us to conduct fieldwork effortlessly.

2) Content "Guidebook"

For guidebook content, several tips of accommodation, introduction of restaurants and explanation of famous architecture or sightseeing object were picked from Lonely Planet Tokyo [16] and recorded using voice synthesis software (Figure 2).

"Needle funeral"
In Senso-ji temple's western garden Awashimado Hall stands, home to an unusual ceremony: the needle funeral. Annually on 8th February, dozens of kimono women gather with monks to perform lasting rites for broken or old sewing needles. Kimono fabric makers and seamstresses express their thanks to the needles by sticking them in a block of soft tofu. Needle funeral reflects ancient animistic Shintoism beliefs, and also marks the end of New Year celebrations.

Figure 2. Example of guidebook content

3) Content "Locals"

For locals content, a couple of interviews with locals were conducted in Japanese and stories related to their daily lives in Asakusa were selected. Each story was translated into English and supplementary explanation about cultural activity was added if needed (Figure 3).

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"Ninja Dojo"
Not so many people know there is a small size amusement park called Hanayashiki in the heart of Tokyo. Here is the story from locals who work in Hanayashiki as a promotion staff.
"We opened Ninja Dojo, where visitors can experience to be a ninja about 1 hour. The entrance is separated from the amusement park, so you don't have to purchase a park ticket to get in. Around 30% of visitors here are foreigners, and ninja is very popular amongst them. Since it's just an hour, it is even possible to put into small group tour." (translated in English, original talk is spoken in Japanese)
Hanayashiki recently started Ninja Dojo, where you can meet real ninja and experience their principles, as well as special martial arts techniques. The interactive tour takes about an hour is available, hence amongst group of international tourists this cultural activity is becoming popular options for tour package.

Figure 3. Example of locals content

4) Contents "Visitors"

After the listeners listened to either guidebook or locals content, they have free discussion about comparison with their own culture. Listener's conversation is recorded and added to the previous two types of contents (Fig. 4). Therefore, this type of content encloses the real voice of listeners, both spoken in English or Japanese.

"Asakusa Jinja"
The proximity of Shintō shrine Asakusa Jinja, behind Senso-ji temple to the northeast, testifies to the coexistence of Japan's two major religions. Asakusa Jinja was built in honor of the brothers who discovered the Can-non statue, and is renowned as a fine example of an architectural style. It's also the epicenter of one of Tokyo's most important festivals, May's San-ja Matsuri, a three-day extravaganza of costumed parades, 100 or so lurching portable shrines what we call Mikoshi, and stripped to the waist Yakuza, kind of Japanese mafia sporting remarkable tattoos.
How did other tourists feel about the story? Listen to them, they are from England and the United States.
"I was just wondering if there are monks there, because monks usually try to be in some kind of solitude. Well, this is very busy."
"We really don't have a specific religion, even though it's Buddhism, or Buddhist, not many people practice it, as people like in the States, as they are like Christianity or specific religion, right?"
"Hmm."
"Japanese are very spiritual, but they are not that religious, if that makes sense."

Figure 4. Example of visitors content

III. EVALUATION EXPERIMENT

A. Method

Fieldwork was conducted for 11 international and 5 Japanese visitors as CCR listeners, using the same scheme to explore how the cycle of CCR works as a set of evaluation experiment. In order to observe various cultural exchanges, we tried to select participants who have diverse cultural backgrounds, as well as their length of stay in Japan. Fieldwork details and participants' attributes are below (Table 1).

TABLE I. FIELDWORK DETAILS AND PARTICIPANTS' ATTRIBUTES

Nationality / Code (xx)	Participants' Attributes		
	Age	***Sex***	***Date / Time***
China (CH1)	25	F	February 1st, 2016 / 16:30 – 18:00
China (CH2)	24	F	February 1st, 2016 / 16:30 – 18:00
Uzbekistan (UZ)	22	M	February 1st, 2016 / 14:00 – 16:00
China (CH3)	28	F	March 14th, 2016 / 11:00 – 13:00
China (CH4)	28	F	March 14th, 2016 / 11:00 – 13:00
Russia (RU1)	28	M	March 19th, 2016 / 13:30 – 15:30
Taiwan (TW1)	20	F	March 19th, 2016 / 16:00 – 17:30
Malaysia (ML)	23	F	March 20th, 2016 / 16:00 – 18:00
Russia (RU2)	27	F	June 11th, 2016 / 15:00 – 17:00
Taiwan (TW2)	27	M	June 26th, 2016 / 11:00 – 13:00
Vietnam (VN)	22	M	August 5th, 2016 / 14:00 – 16:00
Japan (JP1)	22	F	October 15th, 2016 / 12:00 – 14:00
Japan (JP2)	20	F	October 15th, 2016 / 12:00 – 14:00
Japan (JP3)	22	F	October 22nd, 2016 / 10:00 – 12:00
Japan (JP4)	20	M	October 24th, 2016 / 16:00 – 18:00
Japan (JP5)	21	M	October 24th, 2016 / 16:00 – 18:00

However, as for internationals, the nationality distribution is leaning toward Asian countries, which appropriately reflects recent international visitors arrival ratio in Japan [17].

B. Measurement CCUS

To validate the credibility of CCR, an evaluation process with appropriate criteria is essential. Since CCR has a unique concept, inventing a new and suitable measurement tool is more realistic rather than using conventional criteria

without localization. Related literature about measurement design and cross-cultural adjustment are demonstrated by Benson [18], Cui & Awa [19] and Yellen [20] and many other scholars. Sequentially, ten dimensions of cross-cultural understanding have been determined in previous Ito's research, which are mobility, food/diet, flexibility, knowledge, language skills, interaction, awareness of cultural difference, nonverbal communication, respect, and relationship. Since we are conducting a comparative study, some dimensions hold different implication depending on the participants. For instance, to internationals "interaction" means the nature and frequency of interactions with host country (Japanese) individuals, whereas to Japanese participant that involves one's ability to initiate interaction toward any other nationalities, as well as the extent of one's eagerness to communicate with international people, regardless of their language ability.

C. *Instruction*

First, a sheet of paper was distributed to the participants as an experiment instruction. The route of fieldwork and accessible QR code to the website are printed, and they were asked to walk and listen to the content mapped into the route in the numeric order (Figure 5).

Figure 5. Evaluation experiment scenario

Before they started walking, they filled in the self-evaluation form about their current level of cultural understanding, which CCUS 10 dimensions are explained. We observed and took pictures of participants while they are walking, and asked questions to participants for each content such as "what did you think about the place or object, which is explained in the content?" or "do you have any implication or comments compared to your home culture?" (see Figure 6). For Japanese participants, we prepared guidebook contents spoken in Japanese.

Figure 6. Participants engaging in the evaluation experiment in Asakusa

Fieldwork was done either in English or Japanese, depending on participant's language ability. Conversation and route of their walk were recorded (Figure 7) and after they listened to all content, they answered the CCUS form again.

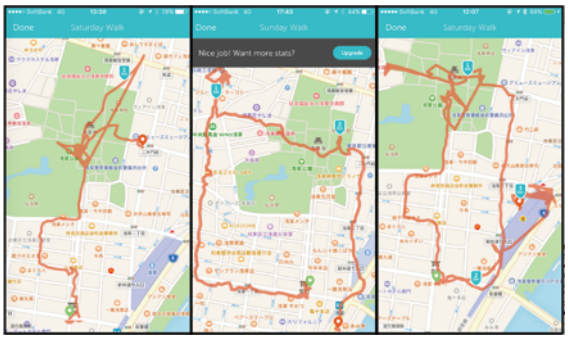

Figure 7. Fieldwork route of participants (excerpts)

D. *Result*

Figure 8 shows the average score of 11 international participants, and Figure 9 shows 5 Japanese participants for each dimension. The green line shows the results prior to the test and the orange line shows the results after the test was finished.

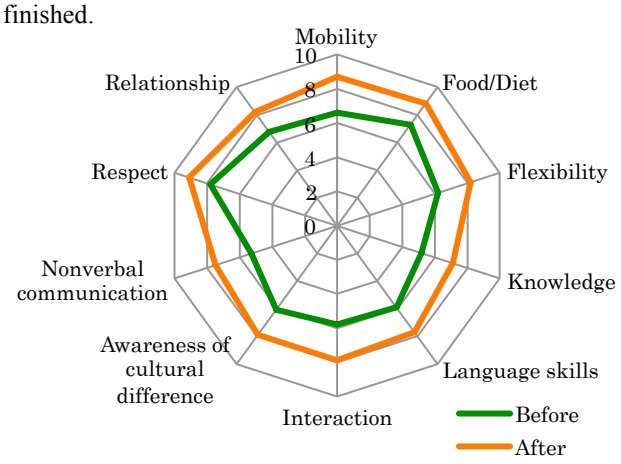

Figure 8. 11 international participants' average CCUS score

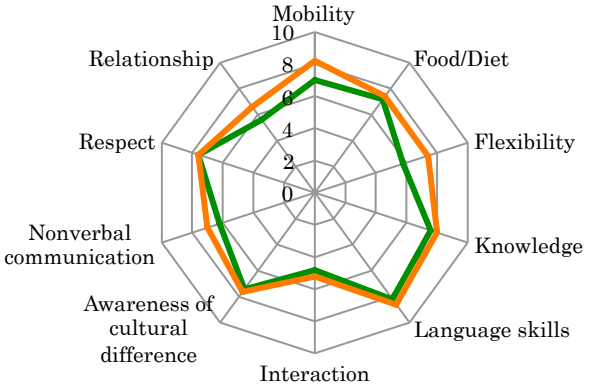

Figure 9. 5 Japanese participants' average CCUS score

As shown in Figure 8, CCR has enriched most aspects of dimensions for 11 international participants. On the other hand, the score improvement of 5 Japanese participants does not seem as much as that of internationals. In addition, Japanese participants recorded much lower score for "Interaction" overall, compared to internationals.

By calculating the area surrounded by green and orange lines, international participants have improved 26% for overall scores. Japanese participants have improved 9%.

IV. Comparative Analysis of Participants' Behavior

Brislin [21] points out that the general approach applicable to all comparative studies is the plausible rival hypothesis analysis which forces the research to examine each and every potential explanation for any data set. In terms of CCR evaluation experiment, the number of participants for the is only 16, therefore conducting additional analysis focused on participant's behavior is more important than discussing their average performance. We chose 4 participants specifically (ML and RU2 for internationals, and JP2 and JP5 for Japanese) as a comparative study samples.

A. Participant ML (Figure 10)

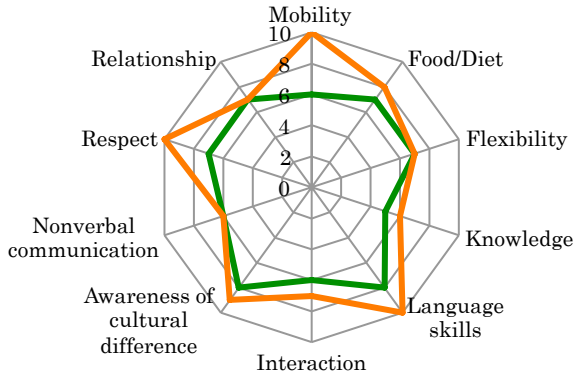

Figure 10. Participant ML's CCUS score

ML is a full-time university student and has been living in Japan for approximately 3 years. Although she speaks fluent Japanese, the fieldwork was conducted in English, as it is still the language she can comfortably communicate with. After she listened to the local's talk about the history of theme park Hanayashiki (refer Figure 3), she found a statue of panda close to the entrance gate. She took a brochure there, read its founding story and learned initially it was established as a botanical garden (Hanayashiki literally means "flower-mansion") then re-opened as a zoo before World War II. She said even though she is interested in watching panda, so far she never had a chance to see one. Presumably, her 3-year stay in Japan made her to recognize herself as a proper resident rather than a temporary visitor, and she might have a mindset of locals more than before. She commented, "I think an audio guide is a lot more interesting than a book, and I also think the local's opinions are more valuable than a tourists." By listening to the local's story, she cultivated the respect and sympathy toward locals, which is demonstrated as an improvement of dimension "Respect" as shown in Figure 10.

B. Participant RU2 (Figure 11)

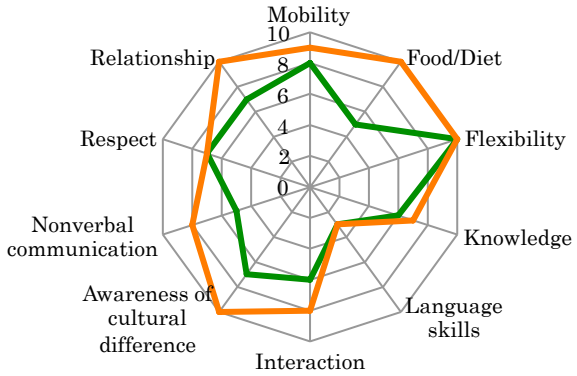

Figure 11. Participant RU2's CCUS score

RU2 is a visiting fellow researcher who has been in Japan around 2 months, and is supposed to stay few years more. This stay is not her first time though: she once visited Jap an about a decade ago for an exchange program, when she was a high school student. After she listened to visitor's comment about range of tourists who are gathering in front of Senso-ji temple, she recalled her first visit and explained her current stay in Japan. "Compared to my previous stay, it (current stay) is totally changed. I can see their normal life like other Japanese people, because I visit not only tourist attractions (but also local places). For me it's much more interesting than visiting touristy place like Asakusa. I want to see the way of people living here, and compare to the life in my country." As she said she is rather interested in knowing daily life setting of Japan not from a temporary

tourist, but from the local's viewpoint. Her mindset certainly has changed compared to her first stay, and now she recognizes herself as a Japan resident, not as a temporary visitor. To make sure whether the contents listening experience has directly contributed to her self-recognition needs more exploration, however her comment above would not be irrelevant to her score improvement of "Relationship" (with local people in this context), "Nonverbal communication" and "Awareness of cultural difference" as shown in Figure 11.

C. Participant JP2 (Figure 12)

JP2 has spent her life mostly in western area of Japan (Tokyo is considered to be in eastern area), and came Tokyo when she becomes a university student. She is in Tokyo for 2 years now, and has few opportunities of visiting Asakusa so far.

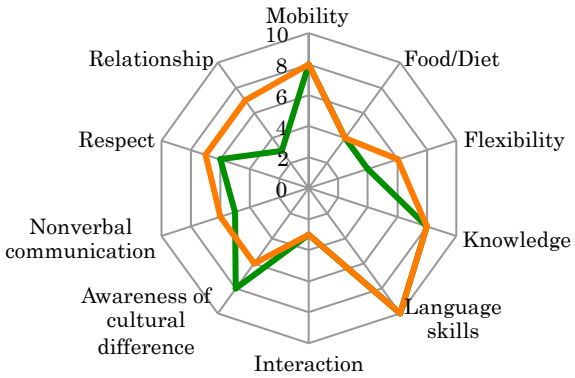

Figure 12. Participant JP2's CCUS score

Through the fieldwork, her overall impression of Asakusa stroll was "very enjoyable" according to her comment. She is from Himeji city, a middle-sized city in the west that is known for Himeji Castle, regarded as the most visited and the finest surviving Japanese castle. She has lived in a walking distance from the UNESCO World Heritage registered site [22], and knows how is being a local surrounded by full of tourists from the world. She continuously compared the city of Himeji to Asakusa, and explained what she feels something in common with Asakusa locals. "Asakusa has Senso-ji, Himeji has Himeji Castle. It must be something memorable for tourists, but for me it is nothing special. It is always there, and I can even see it from my house window. But it doesn't mean Himeji locals are underestimating the Castle, it just resides in our daily life and we are not particularly paying attention to it." As a local person in touristy place, she self-evaluated "Interaction" quite low score compared to other dimensions. However, this might be reflecting her reserved personality well (she was describing herself as very shy and easily get nervous when she encounters with foreigners). To the contrary, as shown in Figure 12 she enhanced "Relationship" well, possibly because she recognized her mindset as a local by Asakusa local's talk, and felt sympathy.

D. Participant JP5 (Figure 13)

JP5 was born and raised in Tokyo. Since he went to high school in Asakusa, the area has always been a familiar place to him.

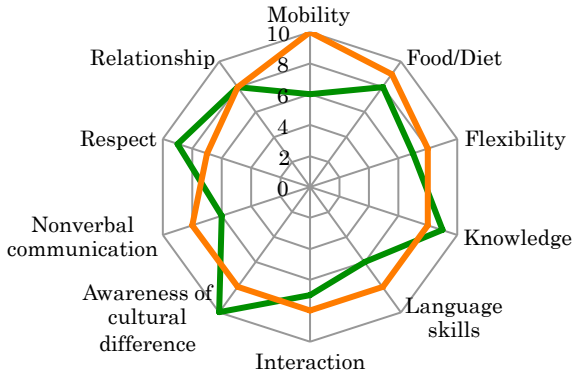

Figure 13. Participant JP5's CCUS score

After he listened to the content about the statues beside Senso-ji's entrance gate, he pointed out there are two signboards there written in English to explain the gate specifically. He noticed the tone of writing was slightly different, one signboard focused on general information such as size, materials and contributors of establishment, while the other explained its history in detail, including the interaction with locals. He found that the former was built by ward office, therefore only official information matters. On the other hand, the latter was built by Senso-ji, which shows they care about its founding story focused on people. Looking at the crowd around the gate taking pictures, he said he is a bit sorry that not so many international visitors seem to pay attention to the signboard, even if they have a chance to know its deeper history right there.

He told the impression of the fieldwork as "a good experience", and said "I came Asakusa countless times since high school, maybe that's why I can look over the surroundings and therefore pay attention to something else from myself, like other internationals' behavior, or just simply other cultures."

According to Zarate [23], the notion of culture occupies a central position within the field of human and social sciences as a whole. Culture is simultaneous action and a state of being, while the representation of "otherness" forms part of the development of individuality. What JP5 implies here is about the encounter with the "other" internationals, and his self-awareness was brought by his experience as a Tokyo local who is already familiar to Asakusa.

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V. DISCUSSION

From both international and Japanese participants' episodes found in behavioral analysis, we assume CCR listening experience contributes to listeners' awareness of cultural aspects to some extent, through the interaction between users. Furthermore, based on the episodes explored, possibly we can relate the 10 CCUS dimensions into four categories of recognition (Figure 14). Hence, observing the CCUS score distribution enables us to roughly categorize each participant's mode of cultural awareness for these four types; recognition of difference between others, recognition about oneself, recognition about Japanese culture itself, or not particularly recognize anything (Not applicable to previous three). This time we observed 11 international and 5 Japanese participants. Adding more participants will validate the effectiveness of this categorization.

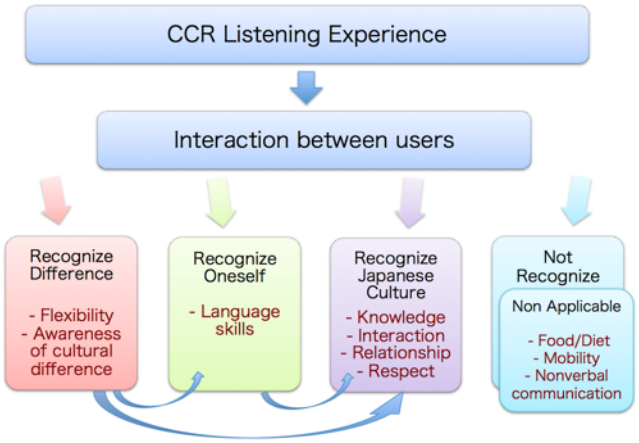

Figure 14. Contribution of CCR listening experience

ML enhanced the dimension "Respect" and "Mobility" at the same level, and thought opinions of local people are more valuable than tourists. She got to know the way of thinking of Japanese local in her 3-year stay in Japan and recognized some part of Japanese culture through real conversation. The reason she enhanced "Mobility" is unknown, and further background exploration is needed, possibly in the form of follow-up interview.

Although RU2's enhancement of "Food and Diet" is still unknown, she improved many dimensions such as interaction, nonverbal communication and awareness of cultural difference. Her inclination to assimilate Japanese locals encouraged her to compare and associate Japanese lifestyle with her Russian background.

Compared to internationals, Japanese participants did not necessarily enhance all dimensions. For instance, JP2's "Awareness of cultural difference" has actually decreased, and JP5's overall score distribution seems a little fluctuated after the fieldwork.

These results might be explained by the difference of mindset toward Japanese culture depending on their nationalities. Holliday [24] points out the recognition toward others would not necessarily occur in the culturally homogeneous setting, however in the face of "otherness" or being surrounded by something (or someone) different from themselves, people tend to realize their cultural identity and thus raise self-awareness. The overall result of CCUS distribution gap between internationals and Japanese supports this argument. In this sense, CCR can be more influential to international listeners than Japanese, because place oriented contents of CCR are designed focusing on Japanese cultural implication and therefore leave stronger impression of "difference" or "otherness" to internationals.

VI. CONCLUSION AND FUTURE STUDIES

In this paper, place oriented Internet radio called CCR, which provides three types of content, "Guidebook", "Locals" and "Visitors" which give listeners ideas about cultural aspects of Japan was explained. To get a profound indication from users and to scale the effectiveness of this media, we used CCUS as criteria specifically designed by Ito to measure the level of cross-cultural awareness.

According to the overall result of evaluation experiment conducted in Tokyo for 11 international and 5 Japanese participants, CCR has reasonably contributed to the enhancement of all dimensions for internationals; nevertheless some Japanese participants decreased the scores. As for average CCUS score, Japanese also showed much smaller improvement than internationals. This is because international participants are surrounded by Japanese cultural implication via place oriented contents, and therefore they could easily conceptualize the concept of "otherness" than Japanese participants from their conversation or other interaction with locals.

For the future work, adding the number of participants for evaluation experiment is needed, not only internationals but also Japanese to backup the argument of comparative study. By adding participants, we will be able to find more clues focused on individual context, which explain the contribution of CCR listening experience toward each participants at a deeper level.

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Strategy for a National Digital Society

Integral approach equipping digital citizens

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***Abstract*– In The Netherlands, an increasing number of projects give experimental form to structural participation of citizens in the design and implementation of local governance and social programs at the local level. The focus on a compact government and diminishing numbers of employees in healthcare and welfare create a participatory society in which citizens become increasingly dependent on digital services. But as of yet, there is no widespread adoption and broad I(C)T infrastructural support equipping digital citizens in their participatory efforts. The participatory society requires citizens to make decisions, coordinate activities and perform tasks benefitting individual and social quality of life. This idea outlines a conceptual design approach identifying and researching a national information architecture and infrastructure supporting and equipping digital citizens in the participatory society of The Netherlands.**

Keywords-participatory society; digital citizens; architecture; infrastructures; digitization.

I. INTRODUCTION

The Dutch national government acknowledges the general challenges and capacities citizens face in an information society. They recognize the importance of digital information on which citizens depend maintaining the quality of life, individually and collectively as a society. But they still ignore the possible benefits of a consistent information architecture that fits the citizens' new participatory role.

When many citizens become more active and equal partners of governmental organizations, they influence and change the dynamics, role and responsibilities of stakeholders in the policy process. Supporting such developments on a national scale requires a new approach to information quality and its ability to answer the requirements of such new policy processes. It poses a new challenge for the Dutch government.

The large-scale use of IT by citizens for health, welfare, safety and governance underpins the quality of life on a national scale [1][2]. Ongoing structural adoption creates an integrated digital society that consists of digital citizens in digital households and requires us to rethink technology, data, information, products and services as seen from the personal environment of citizens.

II. DIGITAL CITIZENS

Increasing adoption and intensifying use of ICT by citizens will result in a convergence of digital services on their households (Figure 1).

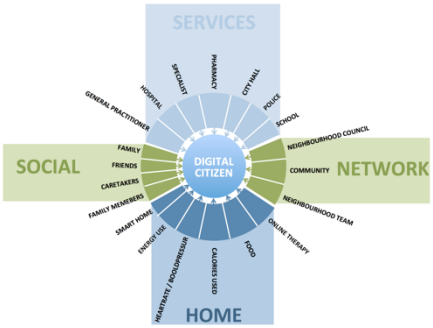

Figure 1. Convergence of services on the individual household.

Citizens that organize their health, governance and public safety individually do so collaborating with other individuals and organizations. Intensifying such collaborative use that binds together different stakeholders by exchanging data and information creates a cohesive digital infrastructure. This development shows that the development of a digital society is entering a new phase that, beyond individual applications, depends on the quality of an ecology of infrastructures, data and services supported by the right regulation, financial retribution and market dynamics. Where these services are a basic requirement for quality of life in society (such as health, governance, education and safety) they will require active support from governments and other stakeholders because its requirements are currently not available.

Citizens will become increasingly dependent on use and quality of the IT infrastructure in their neighborhoods, towns, regions and society. This development will focus attention on citizens as a key driver in the creation of a digital society and with that they become a factor of national importance [3].

A. Staying healthy – digitally

Digital citizens will support their health digitally: they monitor their quality of life and vital health readings, get digital feedback, advice and diagnosis, determine their needs for care, organize their healthcare and welfare

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processes with their social network and volunteers, determine the quality and efficiency of their care process and handle finances. The amount of health data individual patients collect in their home environment is larger than the data that professionals have about them. This personal data will be enriched by publicly available data on the quality of health and illness at the neighborhood, city, regional and national level. From their personal digital environment, they communicate with the different professionals that treat them. To facilitate these activities citizens, use a wide variety of applications, products and services that may be personalized to their needs.

The Dutch Patients and Consumers Federation (NPCF) [4] and the Dutch Council for Health and Care [5] propose, in two different reports, that patients will get their own storage for health-related data. Professional organizations such as hospitals, general practitioners and pharmacies already have their own administrative systems (EPDs or Electronic Patient Data).

This development departs from professional organizations organizing information for their professionals where citizens are participants in professionals' structures and processes. Now the digital infrastructure around patients themselves develops a complexity that requires its own structured storage. It is the first proposal that acknowledges that citizens digitally 'grow up' and proposes they the informal 'life world' of citizens be digitally integrated in the formal 'systems world' of professionals.

B. Living together – digitally

Citizens use digital means to take responsibility for the safety and quality of life in their environment [6]. Today they use Whatsapp groups to share neighborhood observations or develop ideas together in communities supporting the collection, development and planning of collective ambition. Other cities of neighborhoods use participatory budgeting to collective develop ideas and their execution. Such digital community systems increasingly connect different stakeholders that may be involved in safety and quality of life – and inform or alarm others to act.

In the coming years, such solutions will develop further. Citizens in neighborhoods, towns, cities and regions will have access to actual and recent data about safety and quality of life of their environment, integrated, analyzed and presented in an understandable way. Their personal systems – such as cameras for surveillance – may, when needed, be integrated in networks of professional organizations.

When such services are used structurally and strategically cities will need to support the digital life of their citizens. Not only do they need to build up the necessary infrastructure, but also provide the essential information that support the quality of life of their citizens and enables them to know what to do, why to do it, how to do it and when to do it. They need to facilitate the communication between individual citizens and coordinate activities at the level of their neighborhood, city and region. Organizing and providing such information requires an integrated information infrastructure in domains that govern quality of life, such as public health, public safety and security and public governance. To conceptualize and organize such an infrastructure requires an integrated approach – a strategy for a digital society at the national level.

III. INTEGRAL AND MUTLIDISCIPLINAIRY

Citizens are uninterested in organizing information management at levels above their own. It is also not their responsibility. It is governments that carry the responsibility for citizens' and societies' quality of life. In line with the development described above 'information management for citizens' will become a requirement for the societies' quality of life.

Currently no party in society has responsibility for citizens' information management. Healthcare organizations take care of their own data, as do suppliers, insurance companies, the police and insurance companies. Currently governments take responsibility for their own information management. In the coming years, they will become increasingly interested in the quality of the information infrastructure of and for citizens. It is in this vain that we address the concept of 'citizen information management'.

It is information management that acknowledges the specific qualities and challenges that citizens in their own informal and personal lifeworld encounter today and will develop in the coming years. Citizens are 'professionals at being citizens': they use their own language, think and argument in their own way, do things for their own reasons. Those needs are fundamentally different than those of professionals and require their own angle at information managements [7].

Further developing this concept we propose a coherent digital society information architecture - infrastructure, technology, (open) data, services and users. Developing this at a national scale creates three challenges: a new quality, a new scale and a new complexity of an infrastructure shared by all citizens of The Netherlands.

- The new challenge on quality is that of the personal environment of citizens: informal and not professional, emotional and not formal, incidental and not structural, all with an own quality of understanding and reasoning.
- The new challenge on scale is the challenge to create a consistent environment across networks on the different levels of the individual, the household, groups, neighborhoods, cities, regions and countries.
- The new challenge on complexity is organization the exploding diversity of digital services for all

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different stakeholders, such as individual patients, their medical professionals and the healthcare organizations they work with.

Together these challenges create a wicked problem: none of the current stakeholders is able to solve them or is responsible for that. All current players create solutions optimizing their own activities. To enable interoperability previously 'the market' would slowly develop the standards necessary for interoperability or usability, such as the IP standards for internet traffic, the standards for smart home infrastructures or the standards for communication in the healthcare sector. It is a feeble process, often taking decades to develop working standards and sometimes overdeveloping them to the point if becoming unproductive. However, because quality of life in society is a responsibility of the government they may be seen as a stakeholder that might play the role of a catalyst.

IV. DISCUSSION

With the ongoing development of e-health, e-government and e-democracy and the increasing broad and structural adoption of the Internet we foresee that the use of digital tools will result in a coherent layer of digital solutions and services at the national level that support citizens and their collaboration among themselves and with professionals. Citizens' strategic and structural use of ICT will be driving the development of uniform national information architecture. That will consist of a consistent and cohesive ecology of infrastructures, data, services, users, regulation and financing and will have the specific requirements of digital citizens and their households as its vantage point [8][9]. The new and different character of this national infrastructure stems from the challenges on the quality, complexity and scale of an information environment centered on citizens.

One of the first domains this development shows is healthcare. Given the current restructuring of the healthcare and welfare in The Netherlands, the national government is urged to assess the value of an integral vision on the necessity, opportunities and challenges of a more comprehensive national architecture for a digital society. Describing developments in terms of a national infrastructure not only makes it possible see new challenges, but also to identify new markets and services and create inspiration for developers and organizations.

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Emerging Smart World: Technologies, Concerns and Challenges

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***Abstract* – The penetration of smart solutions for ICT industry has revolutionized the outlook of modern society. Technology is in access of humans regardless of their knowledge and expertise level and beyond the social barriers. Advances in mobile communications and web engineering tools have given rise to a new social setup called Smart world. The smart cities support layered architecture abstracting the physical spaces and devices into virtual domains interconnected through ubiquitous infrastructure for information sharing and response systems. Social networking has been a widely accepted platform for communication and information sharing. The information regarding human behavior, requirements, likes and dislikes etc., collected through such networks, can be used for statistical analysis and taking intelligent marketing decisions by analysts and planners. Internet of Things has been the result of wireless sensor networks and intelligent devices. Big data analytics is needed to handle huge amount of data being generated continuously. The smart city projects have been intelligently designed to extract and present information to users through internet. While these new developments are interesting they pose a host of new challenges. Being human centric, the sensitivity and the concerns regarding information propagation and usage have to be carefully handled. We propose services architecture for a ubiquitous smart city built on SOA and cloud computing paradigms. The virtualization by core, essential and extended service layers will be used to address the issues like security, flexible information management, multi-tenant/ multi-dimensional activities, ubiquitous data analysis and presentation for users in normal and emergency situations.**

Keywords- Internet of Things; Internet of Everything; Service Oriented Architecture; Ubiquitous city; Home Area Network; Service Level Agreement

I. INTRODUCTION

Historically, the cities and urbanization of human population was a result of innovative solutions to carry out business, cultural, social, economic or technical activities. For example, rail, roads, trains, automobiles, etc., facilitated communities to flourish in big cities. The driving force in the society today is ICT, having an important role in everyday life for education, business, leisure time, healthcare, entertainment, etc. The innovative growth in technologies has moved the data centers from physical to virtual cloud domain and human interactivity has become boundless due to social media and web based activities. We have smart phones, PDAS, all time available services and smart solutions which have affected our daily activities in all Sections of society.

The concept of global village has engulfed entire society into a virtual reality. As a natural consequence of these developments, smart cities a new vision is rapidly emerging. It is a human centric concept starting with an interface device connecting to a large domain of electronically accessible information useful for interactive decision-making / planning for daily routine to any specialized and data / computation centric professional requirement. The driving forces for smart city development are:

- Resource conservation and optimization
- Peak demand management
- Public safety and emergency services
- Smart transport system
- Smart parking system
- Traffic intelligence sharing and management
- E-tolling for seam less revenue collection

A smart city can be visualized into a layered architecture where physical spaces, buildings, enterprises, transport utilities etc., are abstracted into city systems layer through ICT infrastructure [1]. The multidisciplinary and multi domain connectivity over the internet is used for information sharing, analyzing and decision support systems. The concept of Internet of Things (IOT) coupled with wide adoption of web technologies by communities of users [2] has led to smart solutions manageable through remote connectivity. Internet of Everything (IOE) is the new concept of future development.

Service Oriented Architecture (SOA) has helped in making city systems ubiquitous and pervasive [3]. Smart homes are equipped with intelligent electronic and web aware systems to handle routine matters along with emergency situations. The smart city data contains a variety of information which has to be maintained in big repositories accessible through searching and browsing tools. The service model for systems involved requires features of discovery, security and service engagement through a service level agreement (SLA) [4].

World Health Organization (WHO) reported that half of world population is residing in cities or urban areas. The cities are rapidly becoming crowded and projections show that 60% of world population will be residing in urban areas in 2030 expected to rise to 70% in the year 2050 [1]. The metropolitan managers and municipalities are trying to overhaul their systems for every walk of life to meet the challenges and demands of an intelligent world. Various technologies available in ICT domain are being used for this etc., while portable solutions through mobile devices provide fast and easy access; big data analytics [5] are being developed to intelligently service user requests through cloud services [6]. The proposed solutions provide anytime anywhere connectivity for voice video and text processing.

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Urban mashups combine various data and technologies to enable smart city projects for transport, health, sanitation, tourism, etc. The innovators customize these solutions to meet local cultural and geographical needs of a community [7]. Many model city authorities are releasing open data for interaction with individuals, community organizations and businesses. For this purpose, APIs are developed to enable technologists and developers to interact with open databases [8]. Initially, they are focusing on machine-readable access to static data held by city authorities. To make the systems interactive, transactional APIs are expected to come into play soon. Such APIs will require the properties like atomicity, consistency, isolation and durability (ACID).

In Section 2 we review the related work, followed by technologies and foundations of a smart city in Section 3. The challenges faced by developers are discussed in Section 4. The technical vision of the smart city project for Islamabad, capital of Pakistan, has been presented in Section 5. We conclude the paper in Section 6 emphasizing the requirement of regulation and forensic data management in smart city project.

II. RELATED WORK

Digital cities have evolved with the growth of web applications, broadband networks and information systems providing the knowledge base. The urban environments are highly demanding hence the evolution of smart city concept has become the rapidly developing need of human society. The Home Area Networks (HAN) are common in many cities [9]. They provide all time connectivity and management capability while at home or from a remote location. While it is a luxury for normal citizens it is a big advantage for the aging or handicapped citizens to manage their day to day activities without full time support. Most of them have server based connectivity to the data centers, which pose problems of scalability and interoperability. It is more appropriate to use Wireless Local Area Network (WLAN) and Internet connectivity through WiFi or WiMax support [10].

Smart grid concept is based on three layers of activities, i.e. infrastructure, communications and applications [11]. The metering of various utilities is done through smart meters and grids. Service Oriented Architectures [12] are evolving to take intelligent decisions autonomously to feed the smart grids. Such solutions are scalable and interoperable due to intermediate software layers to provide flexibility in implementation of services across hardware and software platforms. These services can be used to integrate applications with low development costs. The ubiquitous networking and internet enabled devices have promoted developers to provide smart solutions for our day to day activities [13]. Hence, a new name U-cities is often used for smart cities [14]. These services require interoperability, scalability, extendibility and seamless mobility features.

However a number of concerns are yet to be addressed; for example, vulnerability of software services is critical. Some of the weak areas in software deployment may pose serious security problems in smart city projects [15]. A few of these issues are as under:

- Wide exposure of community systems in smart city projects may be a source of malicious activities
- Lack of exhaustive security testing of software components by all the participants
- Lack of emergency response team to handle problems

Intelligent devices can communicate freely generating large amount of data in the wake of new technologies under the Internet of things (IOT) concept [2]. The variation in data collected and its presentation requires multi modal handling through intelligent data presentation services [16]. The data is aggregated, processed for knowledge and event extraction before forwarding to other federating active nodes

III. FOUNDATIONS OF A SMART CITY

A smart city is composed of systems deployed with multiple technologies in hardware and software. The ubiquitous availability of information is expected to improve quality of life by providing knowledge-based data collection and presentation through various devices ranging from cell phone, tablet to laptop [17].

A smart city is capable of monitoring and managing critical resource parameters through ubiquitous services. These parameters may be related to physical domains like airports, bridges, roads, railway stations, subways, sea ports, etc. The aim is to optimize resource utilization, increase efficiency and security [18] [19]. Beside normal operation, disaster management aspects along with service delivery form an important component of a smart city [20]. The software architecture and enabling technologies for smart city projects discussed in various research papers and reports referred have been used to form conceptual outlay presented in Figures 1-3. For this purpose we propose to use agent based model using SOA and ubiquitous cloud services.

Goals	Eco system development, Sustainability, Ubiquitous services, Information management, storage and presentation through APIs, Support Chatting, Audio Visual communication Data recording and navigation tools				
People	E-government, Education, Health, Traffic management, energy management, emergency and security				
Software Services	Community / Social Networking, Data Collection and archiving, Competitive advertising of services and utilities				
Enabling Technologies	Mobility and Network Infrastructure, SOA / Cloud services, Big Data analytics				
City Systems	Communication • Roads • Airports • Railway Stations • Buses • Taxis etc	Residential • Homes • Shopping area • hospitals Community parks	Healthcare • Hospitals • Nursing homes • Pharmacies • Emergency	Utilities • Gas • Water • Electricity	Security • Police • Emergency Response
City Infrastructure	Buildings and spaces, Utilities: Transport, Electric, Networks, Emergency systems....				

Figure 1. Smart City concept

Smart City Abstract Level	Interfaces, Users, Interfaces and other networked sources	GUI, API for Data Visualization
Smart City Support	Transformation of requirements to invoke services model: Deals with security services for accessibility and disposition	Data sharing and analysis
Middleware	Healthcare, Education, Safety, Social Networking and Interoperability	Data Services for storage and retrieval
Interconnectivity	Telecommunications, Informatics, Telephony, Electronics and communication protocols	Data Collection
Data Acquisition through sensor networks	Local connectivity in enterprise, home, office and public systems WiFi, WiMax, Bluetooth, adhoc network, LAN, WAN, WLAN, SCADA and WSN	Data Generation

Figure 2. Functional layout of smart city systems and components

The availability of smart phones and network aware devices has changed the outlook of human society substantially. To lay the foundation of a smart city ubiquitous data management is a core concept. Data is dynamically collected through wireless sensors, meters, personal devices, etc. [21]. Success of a smart city architecture hinges on sustainability under various internal and external factors. The citizens are connected through social networks who share knowledge of common interest [22]. They form digital communities which eventually lead to the smart city concept. Some of the requirements of a smart city are [23] [24]:

a) Development of broadband infrastructure to provide integrated solutions

b) Deployment of embedded systems for data acquisition from smart sensors, activators, etc.

c) Continuous, real time data propagation, management and issuing alerts when required

d) Web based and social network applications providing collaborative data collection and sharing

e) Intelligent sharing of resources and self-decision making capability

Innovative smart home and office management techniques have been used for lights, fans, air-conditioning along with finger print sensors, smart windows, doors, etc. [25]. Home security systems including urgent response in case of fire or medical emergency are the basic community requirements of modern living [26]. The complexity of human behavior in various cross Sections of population require smart solutions which range from intellectuals, workers, children at schools and citizens requiring medical care [27]. Some aged persons require continuous monitoring and healthcare remotely managed from the caring hospital through smart sensors and ubiquitous connectivity. Some of the inputs required for this purpose include:

- Network infrastructure
- Information propagation
- Data management and privacy
- Collective intelligence
- Interoperability
- System safety

The infrastructure requires sensor networks, mobile communications, digital imaging devices and cameras, remote monitoring and servicing, replacement of conventional hardware with innovative new generation of smart devices [28] [29].

IV. SMART CITIES AND THE CHALLENGES

Digital systems and Information Communication Technologies (ICT) are being extensively used in the enterprise systems today. These systems have been implemented using different platforms using different data types and structures. The biggest challenge for developers of smart city is to provide a platform from where these systems can be seamlessly accessed. Distributed object oriented technologies like CORBA, J2EE, COM / DCOM verses Service Oriented Architecture (SOA) are the two main approaches to lay the framework for a smart city. The loose coupling between participating systems under SOA is significant because it allows their interaction without the consideration of software platform and its physical location. SOA has much higher efficiency in integration of information systems hence it is the most favored technology used in the smart cities projects like Berlin, Boston, Toronto, New York and Dubai.

Smart cities combine ICT and Web 2.0 technologies to allow interaction in the society which are above the closed city management domains. Innovative solutions are being designed to improve sustainability and quality of life. The fast moving social systems and job commitment bind the humans to regular schedules with little flexibility. In this situation social networking has brought human society in closer ties and social engagement, often termed as digital society. However, lack of awareness among participating communities regarding security, social issues and potential misuse of information by intruders pose serious problems. For example using e-Healthcare services may require a patient to provide his personal information beyond the basic identity leading to a number of problems. Firstly the user may not be aware of the vulnerability of information and secondly the service provider may mismanage or expose it to other parties leading to security issues. To handle such situations regulatory procedures have to be carefully designed.

The basic issues to be considered for smart city are energy consumption, waste management, pollution, control urban traffic congestion, security, social integration and healthcare especially for elderly population. In the modern cities where the population concentration is increasing, the disaster and emergency handling has assumed great importance [33]. Smart city concept has caught the eye of developers and solution providers and a number of big cities are investing a lot to build smart systems. The ICT experts are working hard to provide widely acceptable solutions to the following issues:

- Smart city should provide ubiquitous services through sustainable, trustworthy and secure model

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- A wide agreement on commercial and service invocation procedures is required
- To overcome institutional resistance particularly in current bureaucratic city management systems [31].
- User friendly discovery, identification and use of services
- Interoperability of services with possibility of reuse, combining into new services and creating mashups [32]
- Information management with suitable measures to avoid misuse [33].
- Customer privacy management with suitable forensic data [36]

Enterprise Resource Planning (ERP) systems are the requirement for building a viable smart city. Figure 3 shows service layers of a smart city using a model ERP system.

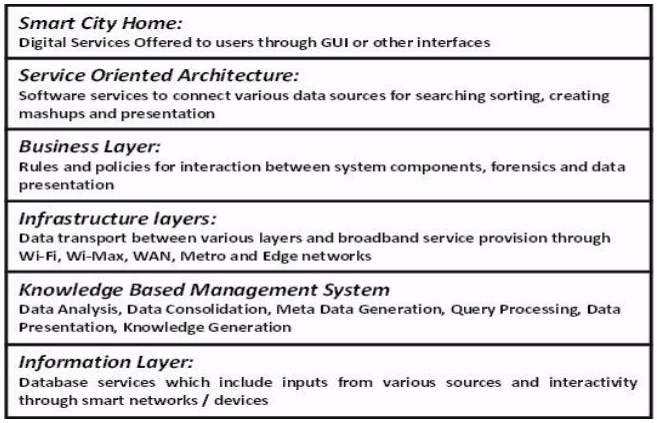

Figure 3. Service layers of a smart city to model an ERP system

The data management in various factions like vehicle registration, resident's registration, Electronic Patient Records (EPR) in hospitals /clinics are not easily accessible with a single window operation [34] [35]. Instead they require institutional verification to access sharable resources. Some methods have to be evolved through a Certificate Authority (CA) at city level to allow access to sharable resources through one level of authentication. So that the smart solutions do not end up with unnecessary delays defeating the purpose of smart solutions. At the same time it is important that suitable forensic data should be generated so that the information misuse may be avoided [36].

V. AGENT BASED MODELLING OF A SMART CITY

Service oriented architecture provides location independence, mobility, scalability and efficient integration of services model. The SOA uses a registry through which the services are offered to the clients under a policy. Ubiquitous intelligent services architecture for smart cities is built using agent based modeling techniques feeding the federated and abstracted cloud servers [3]. The web based Service Oriented Architecture is used to knit the dynamic requirements of clients with the dynamic databases. In a smart city agent-based modeling methodology is used to simulate behavior of people, business, weather, traffic, etc., Agents exhibit features like autonomy, heterogeneity, reactive or proactive behavior. They enjoy bounded rationality, instructiveness, mobility and capability to adapt to dynamic variations of data, environments along with taking suitable decisions under a policy. Development strategy for smart city project components using SOA is presented as under. We conclude the Section with a smart city model proposed

A. Requirements of a smart city

The smart city projects are being built by using ICT and Web 2.0 tools. Some of the requirements for purpose are:

- Information mobility
- Knowledge sharing and sustainable life cycle
- Collaboration between participating systems.

B. Smart City Data Flow model

Typical data flow model in a U-city can be visualized as under:

- Registry management for services offered
- Data acquisition, analysis and presentation
- Data sharing through interactive tools
- Data archiving and security management
- Data transport across various domains
- Data collection and aggregation
- Data acquisition classification and recording

C. Technologies available Cloud and SOA

NIST has defined Cloud computing as a model to enable ubiquitous, convenient, on demand network access to shared resource pool that can be rapidly provisioned and released with minimum overheads [37]. The virtualization of resources has led to the IaaS, PaaS, SaaS etc., as the building blocks. SOA is based on enterprise system approach, the benefits offered include:

- Language neutral integration
- Component reuse
- Organizational agility
- Layered system approach for system integration, i.e., abstraction, loose coupling, encapsulation through clear / unambiguous interface specifications

While both the Cloud and SOA approaches have an overlap they are different in many ways for example:

- SOA is fundamentally enterprise integration technique making system integration easier
- SOA offers language neutral software layers
- Cloud computing covers the entire stack of hardware through presentation layer. SOA is often used for software services within cloud framework
- Cloud computing offers many IT functions as commodities and are less costly
- SOA can be pursued independently or concurrently with cloud to complement each other

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D. SOA for a model smart city - Our Proposal

We propose a service based smart city architecture; the services are classified into core, essential and extended services. Our proposal is shown in Figure 4. A smart city must provide healthcare services in a manner that data regarding all major infirmaries and hospitals with specialties is available online. Any city council registered person can visit a doctor online by booking an appointment and getting his medical advice. He can also arrange an appointment and physically visit the doctors in case physical examination / assistance is required. In the prior case, general practitioner (GP) can order prescribed medicine for the patient, which gets delivered automatically.

Figure 4. Proposed service based smart city model

We propose education services such that the users, i.e., the habitants can find out catchment areas, consult teachers and view progress of their children online, see which of the schools are doing better. This would pose a requirement on the city council of smart city to provide such interfaces for healthcare and education services. Moreover, council would also require managing basic amenities of life such as electricity, water management and providing an interface where the users would be able to make use of such services. We propose a component based architecture in such a way that a mobile interface as well as a web interface is provided through responsive web system that interacts with services that are launched. A block diagram is shown in Figure 5.

Once core services are provided in a smart city application, essential services including traffic management, complaints and waste management will be considered. The travelers can find out, which traffic routes are facing congestion at a certain time? Similarly traffic may be managed avoiding places of congestion in an automated manner. Another aspect of this service is to provide interface for geo-tagging where incidents could be automatically reported. Complaints management would also be supported in a manner that an automatic complaint registered is to be provided with a comprehensive tracking system. This system would also provide task management system such that the remedy providing sectors can view the complaint, take action and log their results.

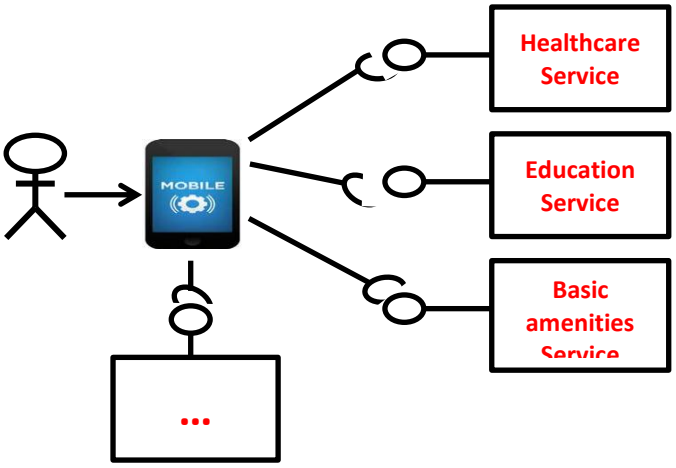

Figure 5. Component-based architecture of proposed services

Finally, a set of services called extended services include security provision with the help of monitoring through cameras. The system would allow the users to log issues and see what safety measures are there in all parts of the smart city. We also propose a set of revenue services, which allow payment of utility bills such system and service providers use same frontend. This set also includes interfaces for social services such as hiring of taxis, booking of places in hotels etc. Our proposal would also provide a set of services where users would also be able to choose from a range of services. Figure 6 shows a conceptual view of the ubiquitous services architecture for a model Smart city.

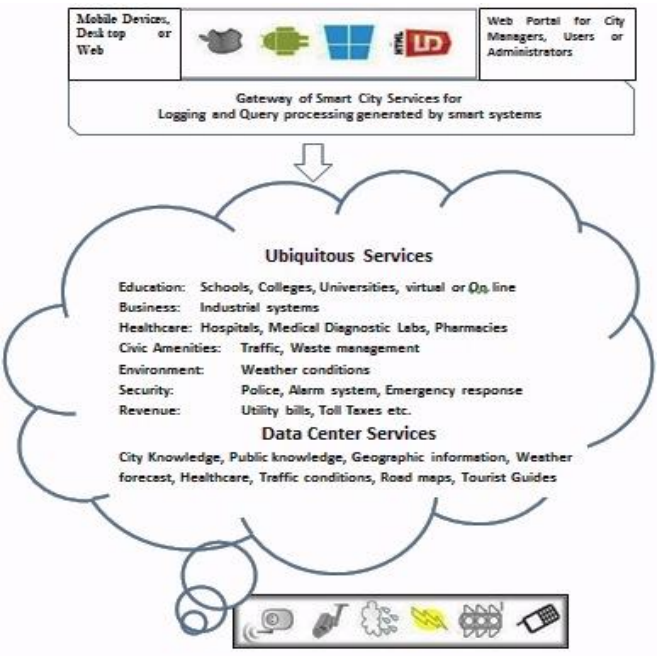

Figure 6. Smart city model with ubiquitous services architecture

We plan to develop a prototype of smart city project for Islamabad, Pakistan to exploit the initiatives taken for IT infrastructure of the country. Some of the Sections we will cover initially include:

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- e-Government
- e-Healthcare
- e-Utility services and revenue collection
- e-Disaster management
- e-Education
- e-Traffic management
- e-Municipal management and civic services

A mobile application ISPAK will be developed to access the smart city, Islamabad through an internet aware device. The session will start with city information and important announcements. For example a request for blood donation may be displayed to catch immediate attention.

Our approach is to develop a software framework at Bahria University, to demonstrate the functionality and then proceed for full scope development. For this purpose the government departments and software developers will be invited to deliberate SLA to provide inputs for data sharing and aggregation, security, availability and other important issues. On the technology side we will use the SOA and ubiquitous cloud services as shown in Figure 6.

VI. CONCLUSION

The implementations of smart city projects have energy saving in operational and capital investment. The SOA will support management and maintenance of city systems and activities in a widely acceptable perspective. To have a good impact of smart solutions the system integration in service-oriented architecture will allow information access and secure data exchange with forensic data bypassing the legacy protocols. The smart city projects are expected to increase productivity as the human interactivity with them has become ubiquitous and boundless. They are accessible through mobile applications available on mobile devices as well as through conventional Internet access through LANs.

The issue of integrating ICT solutions for technical and non-technical communities of users across various live activities is of prime importance in a smart city project. The privacy and regulatory mechanisms required in various factions may be significantly different. For example healthcare, smart grid or traffic management may have very different logistics to handle. Hence, bureaucratic, privacy and regulatory challenges for disparate services to be presented to various communities in service oriented architecture has to be addressed to meet the expectations of end users.

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An Extended UTAUT2 Model for e-Government Project Evaluation

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***Abstract*—Recently the Greek Government has devoted significant effort to streamlining business processes using ICT to better manage public administration resources. To this end, public sector services are designed so that they are accessed through single points, while increasing transparency and reducing cycle time for executing processes and disseminating information to civil and other agencies. To control the services provided by state agencies and to improve them continuously, it seems essential that they are continuously evaluated by users. This paper focuses on the field of e-government and more precisely describes an evaluation method for investigating the success of an e-government project. Specifically, a technology adoption model is proposed, which focuses on the specific characteristics of users for the on-line services of an Independent Authority. The model is essentially based on the framework of the Unified Theory of Acceptance and the Use of Technology (UTAUT2) model, which has been enhanced with four additional criteria.**

Keywords-e-government; evaluation model; unified theory of acceptance and use of technology.

I. INTRODUCTION

E-government is defined by the European Union (EU) Commission as the use of information and communication technologies in public administrations combined with organizational change and new skills in order to improve public services and democratic processes and strengthen support to public policies [1]. Interaction between e-services; provided by the government to stakeholders; may be classified into four key models, depending on who is involved. These models are: government-to-citizen /customer (G2C), government-to-employees (G2E), government-to-government (G2G) and government-to-business (G2B) [2][3]. The goal is to improve public services and streamline business processes to support public policies. Through e-government methods, civil service authorities may offer easier access to public information, upgrade operations to facilitate citizen interaction, increase productivity and competitiveness, combat corruption, facilitate decision-making and promote active participation of citizens, by empowering them. In order to achieve this, the supply management of goods and services must be improved. The implementation of an e-government project can have many benefits, despite the high risk of the project failing due to various factors, such as user resistance to change and their insufficient expertise [4]-[6].

For successful implementation of the e-government services and applications, criteria - such as time, cost, quality, satisfaction of e-government stakeholders and fulfillment of functional requirements - are deemed critical. E-government success means successful ICT implementation in government units in order to rebuild government processes and provide e-government services. It also means effective and efficient use of e-government by all government stakeholders (citizens, businesses and other government agencies) [7]. User acceptance is one of the main issues involved in e-government projects; however, other issues (such as reengineering of work processes, policy changes and management commitment) need also be considered. In addition, convenience, citizen empowerment, exclusivity, choice and cost saving are parameters of utmost importance and relevance for web-based services.

From a citizen's perspective, availability and accessibility are the two critical requirements that must be met for adopting an e-government project. Services must be delivered to them in the easiest and fastest way and be available 24/7. This enables citizens to process transactions at any time, even outside government office hours [8].

Therefore, the evaluation of an e-government project from the citizens' perspective is indispensable, since its success depends on their acceptance. This can be achieved by applying an evaluation model to it. Through evaluation, government agencies understand more easily what factors influence the citizens in adopting such projects. With systematic evaluation, state agencies promptly understand the users' expectations and improve their services, making them friendlier and safer.

A large number of governments throughout Europe have viewed the economic crisis as an opportunity for them to speed up the implementation of their e-government services, with the aim of improving efficiency and effectiveness, increasing savings on public administration operations and enhancing trust-building with citizens. In this context, and in Greece in particular, the necessity for public services to use e-government became evident and imperative, so it may have a positive direct or indirect impact on economic recovery at this difficult point in time. This paper focuses on the field of e-government services; more precisely, on evaluating the G2C services provided by the information system of the Greek Ombudsman, an Independent Authority in Greece,

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and on identifying the factors which facilitate or hinder users in using the e-government IS. The evaluation model used is based on the framework of the extended Unified Theory of Acceptance and the Use of Technology (UTAUT2) model, and has been enhanced by four additional criteria to achieve more insightful results. This study provides useful insights into the motivations underlying the user's intention to use e-government services in developing countries and helps gain a better understanding of the factors that influence the user to adopt such systems.

This paper is structure as follows: In Section II, the relevant theories and the background research are described, along with the main point that this research aims to achieve. In Section III, the case study is presented, and the developed research model and hypotheses are proposed. In Section IV, the study results are presented and analyzed. Finally, in Section V, the conclusions of the study and the future projects are discussed.

II. BACKGROUND

There are several models and theories in the literature aiming at studying the success of an e-government project based on user acceptance. Many studies focus on examining the various factors that might influence the decision of users/citizens to adopt and use such systems. Earlier evaluation models focused on behavioral intention and attitude of the users towards the use of technology, using as main criteria the perceived usefulness and perceived ease of use [9][10]. Because of the enormous development and evolution of digital technology, these models had to be extended to give more accurate results, by adding new factors (criteria) for evaluation.

As noted in recent literature, many research studies have proved that factors - such as demographic characteristics, social influence, trust, risk perception, quality of information, user characteristics and user satisfaction - may be instrumental in adopting e-government services [11]-[14]. Also, the national culture of the population may influence the citizens' intention to use government-offered digital services [15]-[18]. Hence, new integrated models that combine independent and dependent variables have emerged, which use variables such as gender, age, experience and the willingness to use in an attempt to examine whether they significantly affect digital technology use [19]-[21].

Among the most widely accepted evaluation models for e-government services are the following: the Technology Acceptance Model (TAM) [22] and its expanded versions models TAM2 [23] and TAM 3 [24]; the Information System Success Model (IS Success Model) [25] and its refined version [26]; the Unified Theory of Acceptance and Use of Technology (UTAUT) [27] and its extended Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) [28]; the Integrated Success Model (ISM) [29]; the Model for Mandatory Use of Technologies (MMUST) [30]; and the Diffusion of Innovations Model (DOI) [31].

To investigate and analyze factors that influence the adoption and use of an e-government project, researchers have most often adopted various forms of the TAM and UTAUT models. For instance, the TAM has been extended with the self-efficacy measure, to evaluate the use of an e-government website and more specifically, to investigate and understand the fundamental factors that influence the citizens' continued intention to use it. The results of the analysis reveal that TAM, together with computer self-efficacy, can be applied to better understand the citizens' continuous intention to use e-government websites [32].

Furthermore, the use of an amended version of the UTAUT model in the adoption of e-government services has been investigated in Kuwait and it was found that performance expectancy, effort expectancy and peer influence determine the students' behavioral intention for use. Moreover, facilitating conditions and behavioral intentions determine the students' use of e-government services [33].

In addition, the UTAUT model has been used to explore the citizens' behavioral intention to adopt e-government services and the factors affecting e-government adoption in Qatar. The findings indicate that there is a significant positive relationship between performance expectancy, effort expectancy, social influence and behavioral intention to use e-government services for the citizens of Qatar [34][35].

A model that is essentially a blend of TAM, TAM2 and DOI has been used in Greece, along with trust and perceived risk as factors, for describing teachers' behavioral intentions to adopt e-government services. The research findings revealed that cognitive and intrinsic factors have significant effects on the intention to use e-government websites. Out of both attitudinal (trust and perceived risk) and operational variables (compatibility, advantage and job relevance), it is the second set that had a significant effect on the users' intention [36].

A more recent study aims at investigating citizen behavior and the role of Citizen Service Centers in e-government adoption in Greece. Since trust and culture cannot be considered with TAM, an extended UTAUT model was deemed more suitable. The findings revealed that performance expectancy, effort expectancy, trust of intermediary, trust of the government, trust of the internet and finally, social influence are key drivers, influencing directly or indirectly the users' intention. In addition, all the demographic variables that were included in the study (age, gender, educational level and internet experience) were found to be related to the adoption of e-government in Greece [37].

To examine the perspective of trust towards e-government initiatives in a study in Sri Lanka, trustworthiness was included as an additional construct to TAM. The results showed that the model is well suited to investigate the adoption and use of e-government services from the perspective of trustworthiness [38].

Among a multitude of models, researchers face difficulties in finding the most appropriate and suitable model for the evaluation of e-government systems that would improve their adoption by the end users. That is because the users' behavioral intention is determined by factors that may vary along with the situation studied, such as groups in different cultures, level of use and interaction, money constraints, and time [12][37][39][40]. In fact, many

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authors propose the UTAUT model as an ideal choice for e-government evaluation because it offers a better understanding of the factors which determine the citizens' intention to adopt [33][41][42] .

Based on previous studies, although the UTAUT model seems appropriate to evaluate the adoption of e-government in Greece, there are factors that have not been explored and have a direct impact on the Behavioral Intention of the Greek citizens. Recent studies by the Hellenic Statistical Authority and the Greek Information Society show that there are many factors in Greece that may affect the citizens' intention to adopt e-government systems, including digital technology culture, social influence, face-to-face interaction, gender, age, etc. In light of these - and in view of analyzing the influence of social and demographic characteristics, profession, user satisfaction, privacy and continuous usage on the adoption of an e-government service in Greece - an in-depth study must be conducted using an enhanced adoption model. In what follows, an extended version of the UTAUT2 model was used, which was enriched with four additional criteria, as determinants of user behavioral intention.

III. CASE STUDY

A. The Independent Authority of the Greek Ombudsman

The Greek Ombudsman is an Independent Authority sanctioned by the Constitution, which provides its services to the public free of charge. The Authority mediates between public administration and citizens to help citizens exercise their rights effectively. As a mediator, the Greek Ombudsman makes recommendations and submits proposals to the public administration (ministries, regions and municipalities, social insurance funds, tax offices, hospitals, schools and universities, prisons, the police, public utility companies and organizations). Additionally, the Authority's mission is to safeguard and promote children's rights; to promote equal treatment and fight discrimination based on race, ethnicity, religious or belief, disability, age or sexual orientation; and to monitor and promote the application of equal opportunities and treatment between men and women in matters of employment, as well as in matters of access of men and women to goods and services [43][44]. Anyone facing a problem with a Greek public service, anywhere in Greece or abroad, can submit a complaint to the Greek Ombudsman, regardless of their nationality.

From the beginning of its operation, the Authority had a modern IT system installed. This was updated in 2009 to capitalize on modern technology, by improving its services to the citizens. The new Integrated Information System (IIS) aimed at providing a more effective and efficient operation for citizens, employees and stakeholders, by promoting the automation of the Authority's processes to cope with the increased workload created by the citizens. To facilitate and expedite the services offered to complainants on its website, besides general information about the Ombudsman, the system enables a secure two-way communication between the Authority and the users. An on-line form is available to submit a complaint [45]. Through this process, complainants are able to monitor their complaint and receive updates about its progress. Thus, each complainant is able to submit complaints and send additional information regarding his/her case electronically.

B. Evaluation Model Selection

Given the diversity of the Authority's complainants (Greek and foreign citizens, refugees, children, prisoners), it is hypothesized that complainant behavior on using the Authority's website is affected by demographic characteristics (gender, age, nationality), culture, friends or relatives, habits and their skill/experience in using IT services. Also, other parameters might determine the users' behavioral intention for the Authority's website. Thus, it was decided to examine the following factors: user privacy, satisfaction, profession and continuous usage [46].

User privacy: A wide variety of users use the Authority's services (Greek or foreign citizens, children, disabled people, immigrants, refugees). Hence, the level of trust between the users and the Authority may be crucial, since it is widely recognized as very important that the user feels safe and protected when registering personal data. Private data protection is an important issue in the evolving relationship between digital technology and the legal right to privacy when collecting and sharing data. The need for state computerization has led to a greater demand for personal information from citizens. Concerns about privacy arise when sensitive personal data are collected and stored in digital form. These concerns relate to how these data are collected, stored, modified, transmitted, become available (open data) and connected. There is a specific legal and regulatory framework on data protection in place, based on a European Commission regulation [47].

User satisfaction: A satisfactory project offers users the ability to complete their tasks successfully. By asking them to reply if they are satisfied by a service, it can provide a measure of all the parties' contribution to the overall user experience, such as ease of use, navigation and design.

User profession: Through this factor, one can specify the types of users, in terms of occupation, who consider the e-government service friendlier due to the same occupation.

Continuous usage: This factor determines whether users would be willing to use the services at a future time. The more satisfied they are by the e-government services the more likely it is that they may use them.

Figure 1 shows a conceptual model that was created by extending the traditional UTAUT2 model with these four additional criteria. Gender, age and experience are factors, which are already included in the UTAUT2 model, and, as has been determined, have a direct impact on behavioral intention towards e-government services [48] and play an important role to the evaluation of the Authority's e-services.

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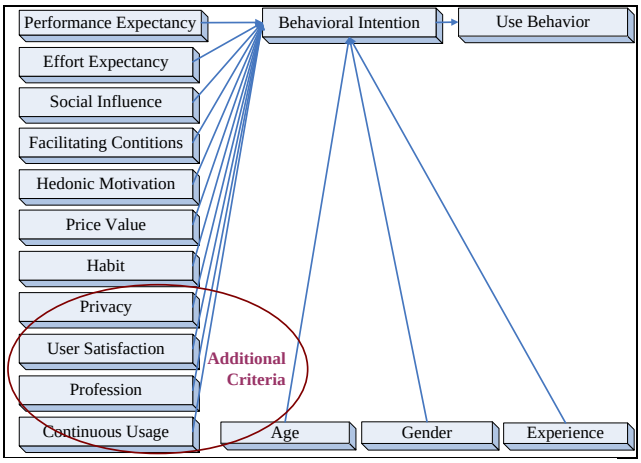

Figure 1. The proposed evaluation model.

C. Research Hypotheses

To improve the quality of the results, we focused on several hypotheses between these variables and behavioral intention:

H1: Age: Younger people are more inclined to use e-government services compared to older ones.

H2: Gender: Gender plays an important role in influencing behavioral intention and how an individual perceives the usefulness of e-government services.

H3: Experience: There is a significant positive relationship between internet experience and behavioral intention in the use of e-government services.

H4: Privacy: Privacy determines the influence of behavioral intention and moderates individual behavior towards e-government services.

H5: User satisfaction: User satisfaction can affect the user's behavioral intention and how an individual perceives the usefulness of e-government services.

H6: Profession: Profession may possibly moderate the individual's influence on behavioral intention to use e-government services.

H7: Continuous Usage: The continuous use of electronic services and internet positively affects the intention of a person to use e-government services.

D. Method – Data Collection

To this end and in view of enabling users to provide their feedback in a smooth and effective manner, a questionnaire was created in April 2015 and was posted online for completion on a voluntary basis. To maintain confidentiality, individuals responded anonymously. For the purpose of speed and convenience, we chose the method of multiple choice questions. Likert's five-point scale was chosen for the answers. With this scale, the respondent indicated the degree of his/her agreement or disagreement to the questions. The questionnaire was developed through free online software, specialized for specific routing, supplementing and monitoring on-line forms-questionnaires [49]. After data submission by users, the software stored the collected information in a special database, which was processed by the researcher (collector).

The questionnaire was divided into two main parts. The first part contained the individual elements of the user associated with the factors of gender, age and profession, as well as three additional questions related to the original topic. The second part contained general questions referring to applying factors for evaluating the model. The individual factors are presented as follows:

Performance Expectancy: The degree to which a person believes that using the system will help them benefit professionally.

Effort Expectancy: The degree of convenience associated with the use of the system.

Social Influence: The extent to which an individual perceives that important others (family and friends) believe they should use the new system.

Facilitating Conditions: The degree to which a person believes there is an organizational and technical infrastructure in place to support their use of the system.

Price Value: The pricing method based on the perceived value of the new system was intended.

Hedonic Motivation: Pleasure or happiness from the use of a technology may play an important role in determining its adoption.

Habit: The degree of influence of habit through behavioral intention**.**

Experience: The acquired experience of someone when using technology.

Additional Factor 1 – Privacy: The degree of safety through behavioral intention for technology use.

Additional Factor 2 - User Satisfaction: How pleased the user is with the technology.

Additional Factor 3 - Continuous Usage: The intention of the user to continue using the technology.

IV. RESULTS

Table 1 depicts the descriptive statistical data (percentage) of this study, obtained through the survey of 97 users/total respondents to the Authority's online system.

TABLE I. CHARACTERISTICS OF STUDY SUBJECTS N=97

Characteristics	%	Characteristics	%	Characteristics	%
		Effort Expectancy		***Hedonic Motivation***	
		Not at all	1	Not at all	1
		Slightly	5	Slightly	7
Gender		Moderately	24	Moderately	35
Male	43	Very	48	Very	38
Female	57	Extremely	22	Extremely	19
		Performance Expectancy		***Habit***	
		Not at all	0	Not at all	5
Age		Slightly	3	Slightly	8
Up to 18	1	Moderately	16	Moderately	27
19-29	21	Very	43	Very	38
30-39	31	Extremely	38	Extremely	22
40-49	36	***Social Influence***		***User Satisfaction***	
50-59	6	Not at all	5	Not at all	1
		Slightly	8	Slightly	5
		Moderately	31	Moderately	30
Experience		Very	34	Very	51
Not at all	0	Extremely	22	Extremely	13
Slightly	4	***Facilitating Conditions***		***Privacy***	

Moderately	17	Not at all	0	Not at all	12
Very	43	Slightly	4	Slightly	14
Extremely	36	Moderately	17	Moderately	26
		Very	52	Very	28
		Extremely	27	Extremely	20
Profession		***Price Value***		***Continuous Usage***	
Private Employee	44	Not at all	0	Not at all	0
Public Servant	23	Slightly	5	Slightly	7
Freelancer	12	Moderately	28	Moderately	24
Unemployed	8	Very	39	Very	42
Else	13	Extremely	28	Extremely	27

These are the main findings of the study:

- Gender has no specific impact. The difference in percentage is relatively small and does not display preference of a specific gender group of users.
- Age shows strong impact between the ages of 19 to 49. If these percentages are associated with the "experience" rates, it is concluded that experience is very high among these groups.
- Most respondents were private employees, as they believed that e-government services help them save time and money. The next high percentage of public servant users considered that e-government services were closer to their job and workplace.
- The majority of respondents positively accepted the system and believed that the Authority's online services help increase performance. Only a small percentage considered that the objective was not achieved. It is worth mentioning that a significant percentage (16%) had a "moderate" stance towards the Authority's website and web services, which questions the need for further improvement.
- Most of respondents believed that the website was comprehensible and well organized, provided clear information material to guide users and, to a large extent, met the needs of its users. Again, there was a high percentage of users (24%), who described the degree of the Authority's "ease of use" as "moderate", which means that the Authority must examine certain details that will enrich the content and image of the website.
- According to the factor of "social influence", 34% of users considered that using the Authority's web services enhanced their status in their social system. Furthermore, they would recommend the Authority's web services to other people.
- Referring to facility conditions, over half of the respondents believed that the Authority's website facilitated citizens, and that the information provided was accurate and compatible with other technologies they use.
- In relation to "price value", 39% of users believed that using the online services significantly decreased cost and considered that the cost for providing the services was mostly justified.
- As to "hedonic motivation", while citizens were "very" satisfied with the navigation environment on the Authority's website and felt satisfaction with the use of electronic services, 35% had a "moderate" view on this. This rate may mean that users might not have the required free time to navigate through the Authority's website. Alternatively, the content of the offered services may not correspond to their interests or they may not have yet identified the benefits that they may gain from the use of e-governance.
- Regarding the users' "habit", most of them felt very familiar to website navigation and they considered it very important to expand its use through mobile equipment.
- The "user satisfaction" from the Authority's website and the perceived usefulness of the e-services provided were significant. The users appeared "very" satisfied with the overall service system, which indicates a positive view for the service and obviously reinforces the attitude that they will continue using it in the future.
- Concerning "citizen privacy" and the "sensitive data protection", users seemed to have a more "moderate" view associated with the security of the e-services when a complaint was submitted to the Authority.
- 69% of the respondents were positive to the factor of "continuous usage" and only 24% continued to have "moderate" intent to use.

V. CONCLUSIONS

An e-government project was evaluated to extract descriptive statistical data and to deal with any problems regarding specific features of an e-government system. The study aimed at producing better products and services, as well as at enhancing the existing situation and the intention of the end users. By increasing the productivity and effectiveness, the project evolves towards quality and success. This study used a specific evaluation framework/model (an extended UTAUT2) to evaluate the design and effectiveness of an e-government project owned by an independent Greek Authority - specifically, the Greek Ombudsman service. The study also made an initial attempt towards understanding the adoption of on-line web services from the users' perspective.

The proposed model proved to be a well-fitted model, which fully met the evaluation requirements of the Authority's online services. Amongst the adoption factors considered, performance expectancy, effort expectancy, facilitating conditions, age, Internet experience, profession, privacy and continuous usage had a significant impact on user behavior for use. On the contrary, factors such as gender, social influence and hedonic motivation did not seem significant predictors of behavioral use.

The results show that the above-mentioned e-government project largely covers the success criteria of people saving time and money. User satisfaction - through their navigation on the Authority's website, the convenience of the services offered, but also the familiar and secure environment offered by the specific website- was the driving force and seemed to meet initial expectations and

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needs. The respondents' answers showed that citizens consider the system beneficial with regard to the e-services and consequently encouraged e-government adoption. It is worth mentioning that most of the website users assessed positively the usability of the system, as well as the security offered to them and had a positive attitude towards encouraging others to use it. However, formal statistical methods must be implemented so as to examine the significance of the factors considered. The results of this study should only be considered as indications of factor significance.

Finally, user satisfaction increases the intention for future use of the system. This puts an extra key to the concept of success of this project and is related to the sustainability of the Independent Authority's website. Moreover, the success of the project is characterized by its complete acceptance by the complainants and end users, through the satisfaction of their initial expectations, the cost savings and the protection of their personal data. The fact that the specific Authority project and the practices implemented are considered successful encourages administrators to further enhance the functional and technical design of system.

The findings of this study can be further extended to cover more e-government projects in the Greek Public Administration.

A future research study may be undertaken, which would expand on this one, by thoroughly and extensively analyzing additional crucial independent variables which may affect the citizens' intention to use e-government services.

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