Designing Transportation Services Based on HCD

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Abstract. A "Social System" enabled by ICT, such as Intelligent Transportation System affects society itself as well as users' behavior. When designing these systems, an approach of having users or citizens in the center of the system is most crucial to derive planned use of the system. In this study, examples of social systems in the fields of transportation and e-government are first reviewed to reveal the history and issues, and then defined the definition of a "social system." A case example is made on ITS in regard with obtaining higher quality in use by employing Human-centered Design. The necessity of broadening conventional HCD methodologies is further discussed.

Keywords: Human-centered Design, social system, Intelligent Transportation System, ITS, ISO13407, e-government, policy making process.

1 Introduction

Human-centered Design or HCD approach with process models and various methodologies is already well implemented in the fields of product and interactive system design. An international standard on HCD, ISO 13407[1], has been effective and it requires to iterate four steps throughout the system development processes. The four steps denotes to 1) specify the context of use, 2) specify user and organizational requirements, 3) produce design solutions, and 4) evaluate designs against user requirements. These four steps are well used for designing user interface for embedded system development[2], but ISO 13407 does not limit its coverage only to product and UI design. In fact it only states "interactive systems" and leaves room for any kind of "system" that has interaction with users.

When looking at some public infrastructures, the government and related bodies have started working on how to place the users at the center of consideration, in response to the criticism on wasting public resources in constructing roads. This move is motivated to ensure accountability for public works and effectiveness of the system. In the case of road administration, which is operated by national and local governments and recently-privatized highway companies, started annually publishing performance and achievement reports to state and check against their annual goals set by projects[3]. In the case of Intelligent Transportation System or ITS which is operated by the government and highway companies with innovative technologies introduced by automobile and ICT industries, they are trying to shift their motivation from

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"utilizing innovation by ITS"[4][5] to enabling "human-oriented ITS"[6]. In the case of e-government in Japan, like the case in U.K., the human-centered approach started from the criticism of relatively small number of use compared to the large amount of budget allocated [7][8].

Administrators of those systems seek for measures to meet user needs and improve effectiveness for allocating resources while the requirement for accountability and limitation for the resources are also taken into consideration, but in Japan's case, well established Human-centered design approach is not yet fully utilized.

2 Examples towards User-Centered Policy Making

2.1 e-Government

In the case of U.K., the problem of delay in passport issuance occurred in 1999 when the authorities launched a new computer system to issue more secure passport, resulting in a significant period of delay in processing[9]. National Audit Office analyzed that it was partly caused by lack of communication between staff in operation and the public. Later, Identity & Passport Service (IPS) started issuing post-implementation assessment reports on its five key projects[10]. In the report, IPS declares the cancellation of developing the second-generation online application of passports (EPA2) projects "on the grounds that it was no longer viable due to rising costs and too short a period to recover the investment."

The Government of Japan has been working on e-Japan and u-Japan initiatives[11]. Policies include the development and installation of an e-government system for online applications. In FY2007, while approximately 13,000 out of 14,000 total applications, or about 92%, were able to be processed online; however, merely 20.5% of the actual applications were done by online, which shows some increase from 11.3% in FY2005[12]. However, online passport service has been suspended by the ministry since February 2007[13] because of the extremely small number of users due to the complicated procedures required for the application.

Responding to the inefficient e-Government in Japan, the Cabinet Office inaugurated a committee consisting of two subcommittees to establish usability and security guidelines for developing e-government system[14]. This committee aims to publish two guidelines that shall be followed by e-Government system developers and the clients, in this case the government.

2.2 Road Administrations

The Government of Japan has started reorganizing their activities in terms of "user-oriented" or "user-centered." In the case of infrastructure of road administration, in 2003 the government implemented publishing performance/achievement annual reports by admitting that their management policies had been mostly targeted at meeting the growing demand as well as post-WW2 recovery[3]. The annual reports aim to realize the process of reflecting users' needs to road administration. Executing and disclosing the cost benefit analysis in the project planning process are required since 2003 as well. A web survey on road user's satisfaction has been conducted every year since 2002[15]. Each survey drew approximately 20,000 respondents with a

questionnaire of 5-point rating scale on users' satisfaction on roads, such as "most used roads", "highways the respondent used", "traffic flow and congestions on most used roads", and so on. It is the first consecutive survey on road users' satisfaction, however, an in-depth investigation on quality in use or the structure of users' satisfaction was not conducted.

As is the case of the e-government, roads are built and managed mostly by the government and are subject to the criticism of "cost-efficiency." Questions are raised if the government(s) failed to properly forecast demand for the road systems.

Demand forecasting framework has been established in the field of transportation engineering. Author's earlier work was in regard with improving accuracy of micro-economic choice models to describe transportation behavior[16]. Yai et.[17] estimated the effectiveness of ways to describe demand with cases by analyzing the structure of citizens attitudes to demand forecast. Not only these works, numerous models have been introduced, however the demand forecasting framework is closely linked with the policy making process by the government[18] leaving little room to introduce new process or framework.

2.3 Intelligent Transportation System

ITS or Intelligent Transport System is a system that manage transportation behavior of users and roads with innovative ICT. It started as a national project in 1995 in cooperation with ministries, industries and academia[19]. It is illustrated as implementation and penetration of ETC (Electronic Toll Collecting system) terminals, car navigation and VICS (Vehicle Information and Communication System).

A concept of ITS was often discussed in early age of its implementation. But the discussion was limited to the scheme of the system that involved hardware and software, but not users in 1999. Ogawa[20] pointed out the necessity of drawing and sharing the overall picture of the ITS from the perspective of developing a large computer system, employing the failed example of integrating banking systems at the merger of the newly created Mizuho Financial Group, Inc.

The development of ITS was first focused on the implementation of infrastructures, and then moved to the IT utilization of technologies including the dissemination of in-vehicle units[21]. However, the development of ITS in Japan has been affected by legacy systems of each ministry and agency involved, namely the three systems of "VICS: Vehicle Information and Communication System," "ETC: Electronic Toll Collection System" and "AHC: Advanced Cruise-assist Highway System."

Yamada[22] described the three systems, VICS, ETC and AHS in relation with the common platform "SMART WAY." In his description, ITS is composed of the infrastructure "SMARTWAY," automobiles "Smart Cars" and telecommunication tools "Smart Gateway." A figure[23] is referred to describe the structure of ITS, highlighting the SMARTWAY as a common platform for those three systems. The platform consists of three layers: hardware, software and data base.

ITS is a social system with various technologies incorporated. The system has been considered as a bundle of technologies and the services that utilize these technologies. A cross-organizational party, ITS Japan has conducted a survey to draw future scenarios of the implementation of ITS services[24]. The scenarios, written by experts of the technologies, are based on the progress of development of each technology.

Needless to say that ITS is a large system growing further with innovative technologies; there are always users or "human" involved in the system, making the perspective of users inevitable. As such system, ITS has been expected to provide more various services than ETC and VICS that are widely well known by general users. The importance of user-oriented approach to the development of ITS has been repeatedly argued, however very few research can be found.

3 Developing a Social System

3.1 Defining a Social System

Defining a social system aims to apply HCD process as it is applied to UI design and computer system design. Moreover it broadens the application of HCD from merely the UI of software to laws and regulations that control the society, which does not require computer software.

In this context, the feature of a social system can be described as a system:

- which has interaction feature with users,
- with which laws, rules and regulations are closely involved,
- of which stakeholders include public body,
- which provides services to meet needs by society, and
- which consists of two or more sub-systems.

In this definition, social system includes e-government, various transportation systems, and more over laws, rules and regulations provided by public body.

3.2 ITS as a Social System

To follow the definition above, Intelligent Transportation System can be described as:

- users of ITS are citizen drivers,
- relevant legal provisions on traffic, wireless communication, highway involve in ITS,
- four ministries as well as private sector involve in ITS, and
- ITS directly affects citizens' transportation behavior.

In Japan, the most provided services of ITS are ETC and VICS. ETC has been operated only for collecting tolls on expressways, while VICS provides vehicles with real-time traffic information. ETC terminals have been prevailed to be currently 27,000,000 vehicles in total equipped with the terminal, or roughly 50% of registered vehicles. And 5.4 million vehicles/day or 76.4% of all the vehicles that go through the toll gates are ETC-equipped. The government is now extending its service fields from the toll gates of expressways to towns by revising relevant laws that prohibited private sector from installing and using ETC system.

Cases expected by the government[19] are as follows:

- Harbor: to simplify the boarding procedures,
- Shopping malls: to provide shopping information,
- Parking lots: to collect charge,
- Gas stations: to collect gas charge,

- Taxi bay: to allocate cabs, and
- Drive-through restaurants: to collect food and drink charge.

3.3 Development of ITS

These cases mentioned above require transmitting more information to the data center and service providers.

In the case of ITS in Japan, so-called "system architecture" (Figure 1) was published in 1996. This system architecture consists of nine areas of projects; each is composed of "user services" in hierarchical manner. In addition, requirements of each project or the system of ITS are defined as 172 "user services." Here a system concept is described from a bundle of projects, in other words, the projects are not planned under the system concept of ITS.

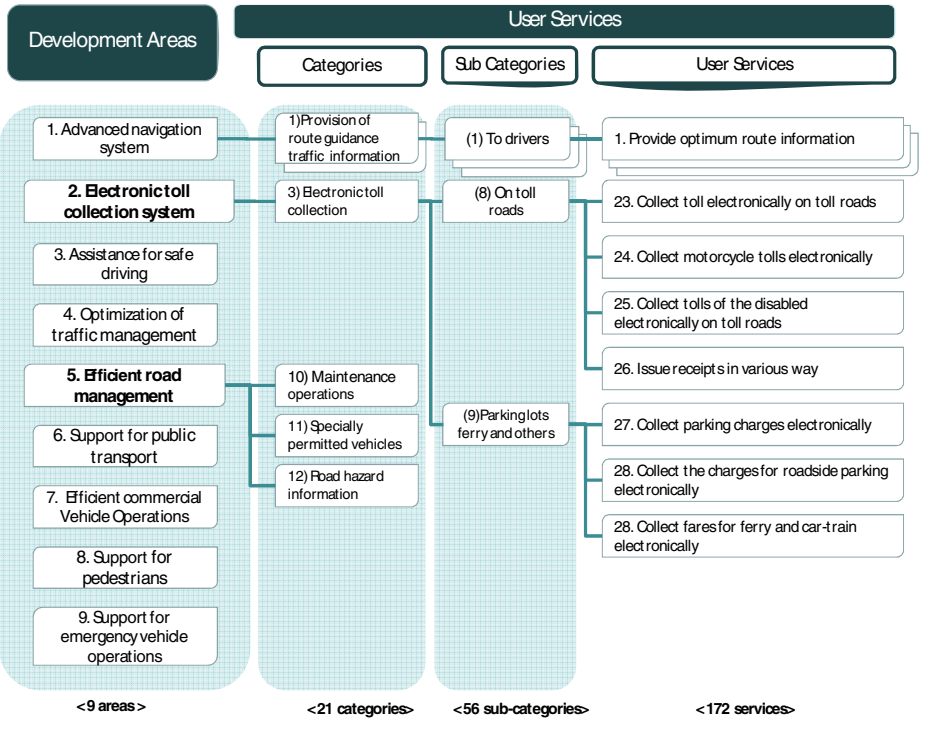

Fig. 1. User services determined in the "System Architecture of ITS"[19] consists of nine areas with 21 categories, 56 sub-categories and 172 user services. In the case of ETC, it consists of seven services, two sub-categories and one category.

Figure 3 denotes a simplified diagram of the development process of a system. To realize a particular system, concept of the system shall be first drawn to enable breaking down to the projects or subsystems. For each project, designing concept, planning, then implementation shall be executed before operation. The control over the system is thus the system concept that is drawn prior to projects configuration.

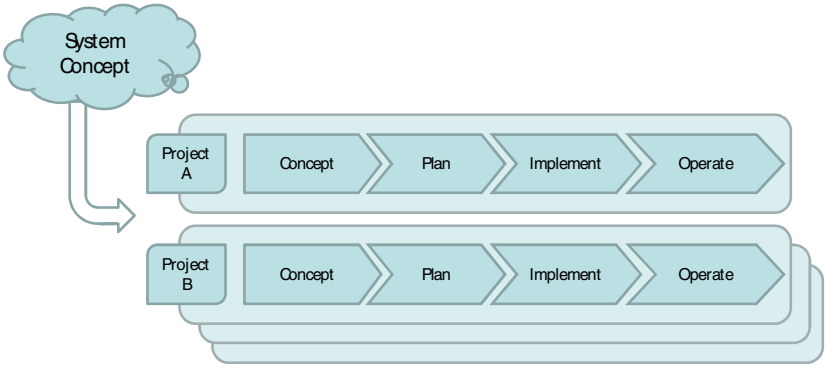

Fig. 2. Development process of a system starts from drawing a system concept. Each project is planned to realize the system concept employing processes starting from planning concept to operation.

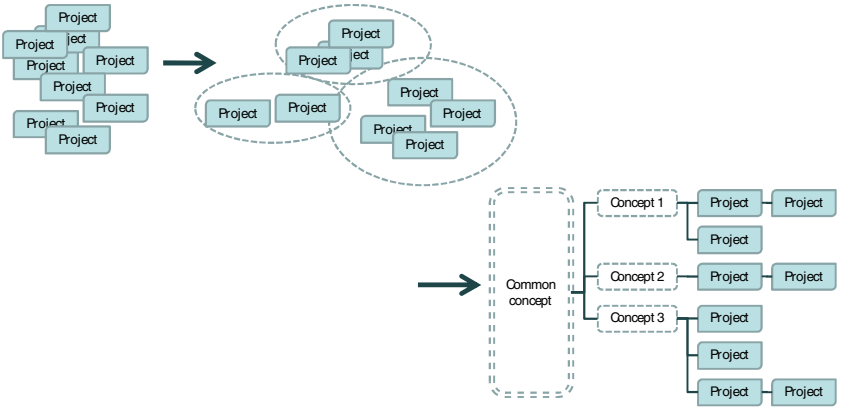

Fig. 3. Actual planning process of a social system may not follow the system development process. Concept of a system is drawn after organizing smaller projects that are already in progress in the administration body such as government.

Social systems such as ITS and e-government in Japan are planned in manners project-dependent (Figure 2) or technical seeds-oriented. This is often the case in developing a comprehensive plan by local governments. The first step taken by the department responsible is to ask all other departments to submit information of relevant projects they are handling. Then projects are organized into categories and concepts are developed to make a framework (Figure 3).

4 HCD in Social Systems

Considering the situation described in the previous chapter, questions arise how HCD approach is able to contribute with the framework of HCD process diagram in ISO13407 (Figure 4). They include:

- What scopes shall be insisted for social systems?
- How can the methodologies be applied?
- What and how the solutions can be evaluated?

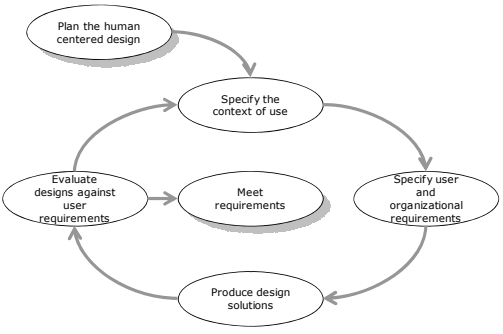

Fig. 4. Simple diagram for Human-centered design stated in ISO 13407[1]. This diagram shall be operated in every process of system development.

Scopes. Examples of social systems in Japan have been targeting at utilizing element technologies or "technical-centered approach." On the other hand, HCD approach focuses on services and experiences provided to users. When implementing HCD approach to social systems, it is indispensable to cope with the two approaches or the two scopes (Figure 5). Adding to the issues on scopes, size of the users shall be in consideration. The users of a social system are expected to vary in a wide range in the population. Most social systems have more target users than that of a product. And as the system provides public services, and thus the system shall not reject any users, which make the target user and user requirements more difficult.

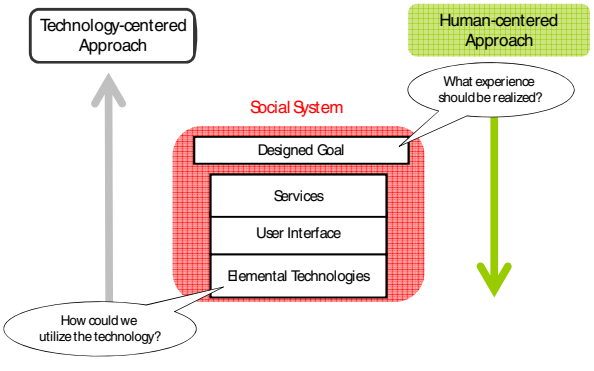

Fig. 5. Approaches to develop a social system can be described as "Technology-centered approach" and "Human-centered approach." Scope of "Technology-centered approach" targets on elemental technologies while HCD on the services provided to users.

HCD methodologies. The conventional methodologies that are often used in HCD process such as persona, scenario and prototype need to be explained in the context of developing social systems. For instance the appropriate number of personas and scenarios will be asked when employed to a social system and to form a prototype as well. Relatively larger size and wider range of user population seemed to be affecting these issues.

Evaluation. The objective of integrating HCD into social system is to have the system more understood and shared among the public as well as researchers of technologies and service operators. As a social system that influences the society, sharing future "context of use" and "quality of use" among stakeholders help improve the system to be more effective and affective. Considerations of the procedures stated in the laws and regulations are crucial.

Evaluation after the implementation of a system, for example, road, bridge, railway, railway station, and transportation policy, is often discussed[25]. However, these discussions are often conducted after or during the period of implementation, and concentrate on a subject such as if the prediction methods and estimates of demand by the project were proper and acceptable, which were expected to affect the society at the planning stage[26].

Incorporating conventional planning and implementing processes into context of V-model (Figure 6) would be essential for further discussions.

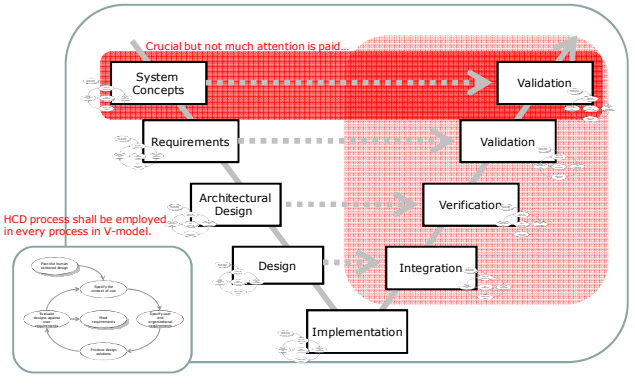

Fig. 6. System development process is described in V-model where system concepts are the basis for validation, requirements for validation and so on. When HCD approach is employed, HCD diagram shall be iterated in every process of V-Model.

5 Conclusions

In this research, the needs for Human-centered design in the field of social systems are explained, focusing on e-government, road administration and ITS in Japan. Then ITS was employed as an example of a social system for HCD to be implemented. In analyzing ITS as a social system, lack of design and examination of the system concepts were pointed out. In terms of a system before physically implementing a system (or a part of a system) derives start operating the system without evaluation.

In other words, conventional HCD processes do not fully cover the area of designing and implementing large social systems such as ITS. Adding to this is that in-depth understanding of policy making procedures usually authorized by laws and regulations, or by government is inevitable to actually adopt the procedure.

Extension of our research focuses on defining the specific difference between product developing processes and social system developing processes, along with extending HCD methodologies for a system with larger user population.

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