CATEGORIZING U-BIKE SERVICE AND ASSESSING ITS ADOPTABILITY UNDER IT-BASED CITY

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ABSTRACT

Bicycle is one of the most important eco-friendly transport mode which can cope with global warming and ICTs(information and communication technologies) on bicycles became a dominant factor for success to the spread of bicycles to public.
In this paper, conceptualization and classification of U-bike services are fulfilled and its adoptability was examined using AHP method. Group capabilities technique was invited to eliminate bias on appraisal. 12 U-bike services were conceptualized to u-bike information system, u- bike cycling services u-bike and transit system, u-public bike system and u-bike management and additional services system.
By AHP process to evaluate the order of priority, economic factors such as profitability has revealed as more important ones than policy factors and technology factors. U-service with highest of adoptability was 'bike and ride' service which can link bicycle to public transportation. 'Prevention system from abandonment and theft' and 'public bike system' similar to Velib system in Paris are also considered to very important services in U-city. These services are expected to eliminate the reasons of current limitation on using bicycles. Conceptualization and adoptability of U-bike services based on scientific methods can contribute the adaptation of bicycle as a eco-friendly transportation mode in U-City.

Keywords: U-bike service, U-city, conceptualization, adoptability, AHP method

INTRODUCTION

Two aspects recently highlighted in the urban planning and urban management field are eco-friendliness to overcome global warming and adaptation of ICTs(information and communication technology) to physical spaces. U-City, ICTs based urban places which is developed from Asian countries such as Korea and Japan, is under the way of evolution toward U-Eco City, a city aiming a sustainable urban region based on ICTs(MLTM et al., 2009). Yigitcanlar and Han(2009) stressed that the integration of Eco City and Ubiquitous City is important to improve the sustainability and quality of life in cities.

Bicycle is one of the most important eco-friendly transport mode which can cope with global warming(Koike, 2009). This device, unfortunately, has been alienated for decades in almost of countries except several nations such as the Netherlands, Japan, etc. due to automobile oriented transportation policies. After consciousness on environmental issues it regained the impaired reputation. Especially, we know the success story of Paris's new public bike system, Velib, which adopted ICTs on public bicycles. One of the main success factor of this useful system is ICTs which can make people go to anywhere at anytime using its technologies. Velib is just only an example of bicycle services based on ICTs in U-City and the role of U-Bike services will be strong and various as we expect the eco friendliness in U-City.

The purpose of this study is to conceptualize U-Bike services and derive the adoptability of these services in the U-City environment. For this, U-Bike services which could be applied in U-City are listed up and sorted to five categories. Moreover, AHP method was hired to examine the suitability and possibility of the services.

LITERATURE REVIEW

Classification of U-services and the status of U-Bike service

Lots of U-City services were suggested and classified on the process of its conceptualization. Ministry of Information and Communication(2005) categorized U-City services by the usage and spatial infrastructure; living, transportation and public environment. Another classification was carried out from the viewpoint of urban functions. National Information Society Agency(NIA, 2005) of Korea, grouped U-services into urban common services such as U-underground facility management, U-transportation, U-environment management, U-crime/disaster prevention and urban specialized services such as U-port, U-tourism, U-convention and U-silver services.

Jeong et al.(2006) suggested the U-service assortment by industry classification and NIA(2005) proposed a division of U-services using the matrix composed of urban spaces and urban activities. Also U-services were classified by the using bodies of information(NIA, 2006).

In the U-City, by the needs for a environment oriented new space, the gravity of pedestrians and bicycles could attach great importance. Especially individuals are the supplier and user of this mutual service. U-transport service will include more and more activities and classes

of people especially pedestrians and bicycle users who are estranged from ITS services. The status of U-Bike service among U-transport can be described in (Figure 1).

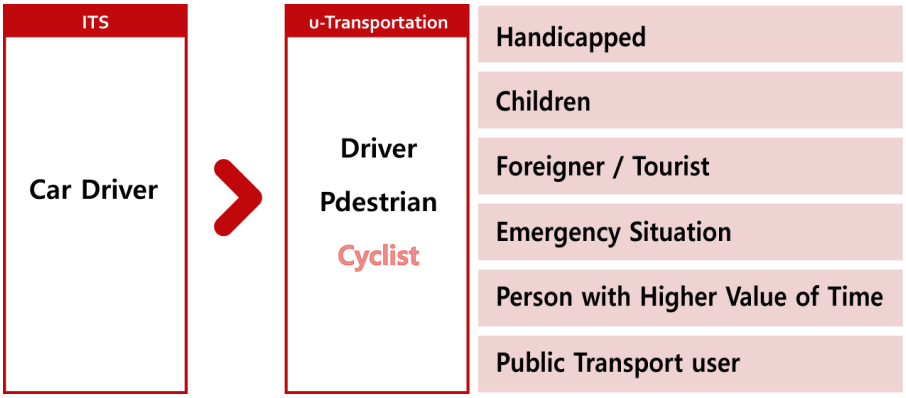

Figure 1 - Status of U-Bike in U-City Environment

Since U-City service classification has had some problems of its scientific basis and lack of flexibility, more delicate researches are required upon the logically verified theories such as AHP. Cho(2007) suggested the AHP method and apply it to the classification of ITS services. Jeong and Cho(2007) drew proper criteria to prioritize and evaluated U-City services with weighted model. Research results derived public security, crime prevention, and security as prospect service for public segment; telecommunication, broadcasting, publishing, and physical distribution service for corporate segment; education and home-service for private segment. Jang and Um(2008) developed u-service priority model in the context of multi-criteria framework integrating customers' and suppliers' view using high technology acceptance theory as major controlling factors. The selection criteria for the model variables were derived from high technology acceptance theory and AHP approach through the analysis of frequency count, elimination of overlapping factors and brainstorming with specialists.

ICTs related to bicycle

U-City is supported by 5 main technologies; sensing, network, interface, processing and security technology(Lee, J., 2009). Even these technologies are composed of urban scale U-service and U-technologies, U-Bike service standards are not constructed yet. They point out that U-Bike service requires recognition technology such as RFID(radio frequency identification), Bluetooth(IEEE 802.15.1), Zigbee(IEEE 802.15.4), etc. on the basis of U-City Network and PAN(personal area network) technologies for communication between bicycles and U-infrastructure. Especially, research on the SAL(Smart Active Label) technology is expected to overcome the functional shortcomings of RFID in recognition distance, embedding objects and so on and would be very helpful for U-Bike service.
Moreover mobile broadband communication technology for the provision of information contents, LBS, GIS and GPS technology for identification of the location of bike might be necessary for U-Bike service. Information protection and registration technology are also kinds of principal technologies. Table 1 shows the applicable fields of each technology.

Middleware S/W and operating technology for integrated control centre also should be modified to accommodate U-Bike services.

Table 1 - Basic Technologies for U-Bike Services

Basic technologies	Application
ITS Infrastructure RFID, USN, Zigbee	▪ Collection of bicycle traffic information ▪ Detection of traffic volume and real time signal control ▪ Establishment of bicycle management system
Mobile broadband communication	▪ Various and large data handling, analysis and service
LBS/GIS, GPS	▪ Service based on the location - location identification of bicycles
Information protection and registration	▪ Bicycle theft preventing system
Integrated control center operation M/W	▪ Linkage between bicycle services and other traffic services

CONCEPTUALIZATION OF U-BIKE SERVICES

Selection of U-Bike services and classification

As to the development of communication technologies like USN and RFID, they have drawn lots of U-services in many fields. However, efforts to adapt these kinds of technology to bicycles were performed lately. In other words, U-Bike services are not effectively conceptualized yet and its contents are still limited. This paper tried to conceptualize and classify U-Bike services following the flows seen in Figure 2.

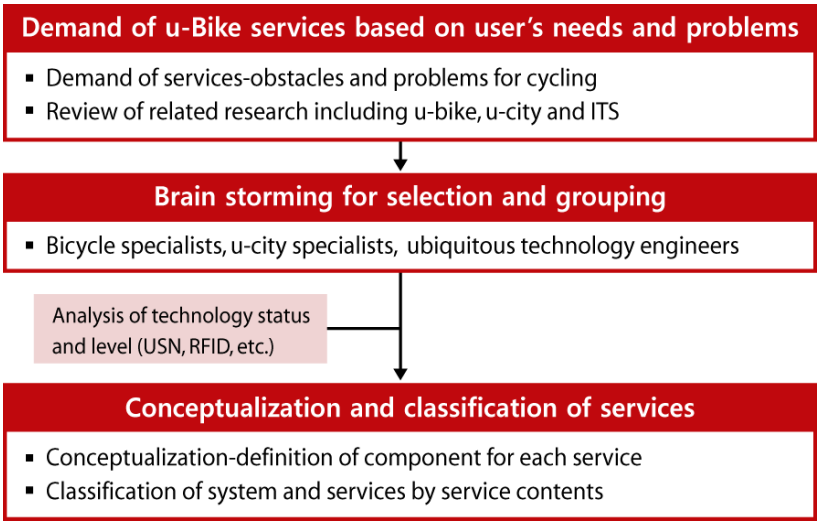

Figure 2 - Procedure of Conceptualization and Classification of U-Bike Services

Deriving demand of U-Bike services

The demand of U-Bike services was derived by the survey from bicycle users about their inconvenience and its betterments. The biggest reason of not using bicycles is lack of bicycle

tracks or paths. In addition, safety, parking and cost are pointed out as major causes(Ministry of Construction and Transportation, 2006).

Also, most of advanced countries in plenty of bicycle use have problems of theft and abandonment of bicycles. Linkage between bicycle and other public transportation mode such as bus and subway also has an important role in the spread of bicycles to a city.

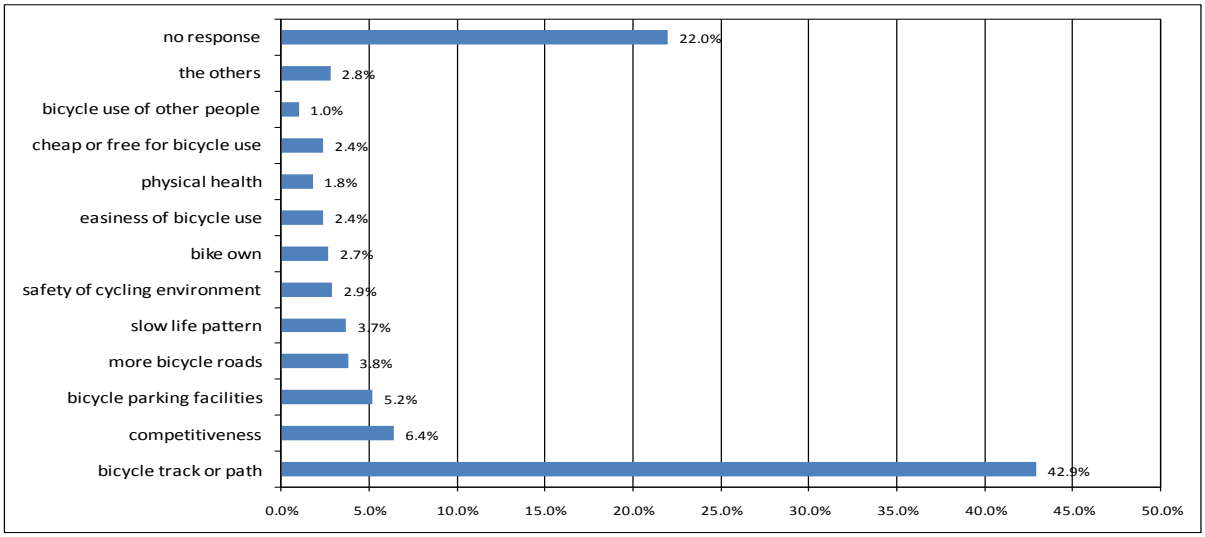

Figure 3 - Major Reasons Not Using Bicycles in Korea
(Source : Ministry of Construction and Transportation(2006)

Conceptualization of U-Bike Services

Due to that classification of U-Bike services are not fulfilled concretely, the concepts are not systemized yet as well. This paper established 5 systems with 12 services of U-Bike service by brain storming on the behavior and operation U-Bike service. Experts of U-City planning and Green transport were invited. Table 2 shows the result of classification of U-Bike services.

Table 2 - Classification of U-Bike Service

System	Service	Concept of service	Components
U-Bike information system	Tour guide service	▪ Provision of cycling route in urban area ▪ Information of cycling course and route in suburban and inter-city	▪ Mobile and fixed unit ▪ Multi language service
	POI Information	▪ Information of travel place and facilities ▪ Accommodation, reservation, coupon information , etc.	▪ Mobile and fixed unit
U -bike cycling system	Real time traffic control service	▪ Detecting of traffic and real time signal control using RFID, DSRC and Zigbee	▪ Detector and algorithm for control
	Accident warning system	▪ Accident place identification, emergency service	▪ Mobile phone - emergency network
	Safe cycling service	▪ Warning by sound and light at dangerous point of conflict	▪ Detector, warning, light device
	Parking management service	▪ Information of location, linkage for bicycle parking area, locker, stands. ▪ Check of bicycle parking status using internet	▪ Bicycle parking control device ▪ Control tower
U -bike	U-Bike and ride service	▪ Information of bus and subway ▪ Auto charging and management system	▪ Parking facilities ▪ Wireless network

and transit system	U-ride with bike service	▪ Information of bus and subway ▪ Auto charging and management system	▪ Wireless network
U -public bike system		▪ Public bicycle system which serve auto charging, auto bike rent and identification of bike location using RFID, GPS, LBS technology	▪ Bicycle for PBS ▪ Station based on internet ▪ Management network
U -bike management and additional service system	U-registration service	▪ Registration at home using mobile phone and internet	▪ Mobile phone, internet
	U-abandon and theft prevention service	▪ Information system to police for abandoned bicycle and auto check for theft bicycle	▪ RFID tag bicycle ▪ GPS
	U-Bike health service	▪ Advice service for bicyclists' health analyzing exercise data	▪ Mobile unit

PRIORITY OF U-BIKE SERVICES

Criteria and method of appraisal

In this study Appraisal criteria of U-City service were reviewed before set up our U-Bike service criteria and there were summarized as adoptability, reliability, effects of service, possibility, etc. Public and academic fields of researchers considered welfare and beneficial factors as main factors but they are little bit idealistic. On the other hand, criteria of companies for appraisal of u-service used very pragmatic and specific factors like financial and b/c analysis.

In development of U-Bike service, it is needed to consider both individual and social view points. Because U-Bike services are the goal for individual transport mode but also have characteristics of social service because of its effects of bicycle promotion and social benefit. This study established technology factor based on the U-Bike service in addition to economic and policy factors in the viewpoint of general feasibilities study of SOC.

With considerations on the procedure of choosing specialists for appraisal a group which consists of bicycle specialists, U-City specialists and engineers who have over 10 year carriers in their field was constituted. For the evaluation, team expert choice(group capabilities) method of EC version 11 which is computer program for decision making and appraisal was hired. This group capability is good for this kind of analysis since we need understanding for the U-Bike service and communication between each group. Through this method, bias was deleted by difference of knowledge level for U-Bike service. The participants of decision making process are as follows;

Table 3 - Participants of Decision Making

Factors and alternatives	Participants for team expert choice	Number (person)
Importance by factors Alternatives	▪ U-City specialists(national U-City project managers) ▪ Bicycle transportation specialists(national bicycle plan committee) ▪ U-technology engineers(u-technology company)	2 2 2

Hierarchy of AHP Analysis

Building hierarchy of criteria is very important because it affects directly on the result. For this, we got a meeting for the brain storming and set up the hierarchy with three levels. The first level consists of economic, policy, and technology factors and each of factor has second and third level of evaluation items.

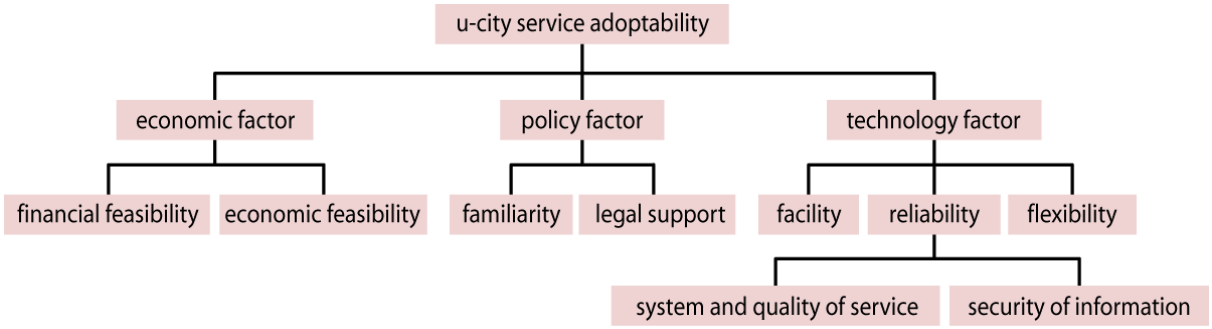

Figure 4 - Hierarchy of U-Bike Service Criteria

Table 4 - Criteria and Explanation of U-Bike Services

Level 1	Level 2	Level 3	Explanation
Economic Factor	Financial feasibility		▪ Market, financial benefit for service
	Economic feasibility		▪ Including social benefit in addition to financial feasibility
Policy Factor	Familiarity with service		▪ How users accept these services
	Legal support possibility		▪ Legal and systemic support for services
Technology Factor	Facility		▪ Easiness, simplicity
	Reliability	System and quality of service	▪ Stabilization and fast service
		Information security	▪ Privacy and security for individual information
	Flexibility		▪ Flexibility for future needs and technology development

Importance of Factors and Priority of U-Bike Services

Analysis of importance of each factors showed that economic and policy factors have comparatively higher scores than that of technology factors. This result means that most of participants think ubiquitous related technologies are enough to adopt service. So, it can't be difficult to develop services.

Economic feasibility which is including social benefit is more considerable than financial feasibility and it means that social benefit of U-Bike service is more important because of its social effectiveness such as environmental and sustainable society. Also, 'familiarity of the service' of policy factors was most important factor. It indicates that bicycle user's behavior and level of cognition for bike mode are should be considered in process of the U-Bike

services development. Especially, legal support was appraised more important because legal and institutional support is necessary for the U-Bike service in the early U-Bike era.
Lastly, though technology factor was not important one in first level, 'system and quality of service' was comparatively highly ranked among three factors.

Table 5 - Analysis of Importance by Factors

Factors			Local Score	Global Score
Economic factors			0.423	0.423
	Financial feasibility		0.474	0.200
	Economic feasibility		0.526	0.222
Policy factors			0.336	0.336
	Familiarity with service		0.546	0.183
	Legal support possibility		0.454	0.152
Technology factors			0.242	0.242
	Facilities		0.465	0.113
	Reliability		0.312	0.076
		System and quality	0.738	0.056
		Security of information	0.262	0.020
	Flexibility		0.222	0.054

Inconsistency = 0.04

Combined instance-Synthesis with respect to: U-City adoptability
Overall Inconsistency = 0.06

Figure 5 - Result of Appraisal for Factors of U-Bike Services

Priority analysis was performed using the result of importance and each score of 12 alternatives were gained by absolute scoring method. The item with first priority of 12 services was 'bike and ride service' and 'abandoned and theft prevention service', 'public bicycle service', 'bicycle parking management service' and 'bicycle registration service' were followed by the order respectively. A meaningful characteristic of this result is that all of these services are related to the bicycle use obstacles and potential of bicycle use as long as some services are improved.
However, U-Bike health service, safe cycling service and real time traffic control service were ranked at low level. It means that these services are little bit strange and it will be realized if more people use bicycle like passenger cars.

Table 6 - Priorities of U-Bike Service

System	Services	Economic		Policy		Technology				Final score	Rank
							Reliability				
		Financial feasibility	Economic feasibility	Familiarity	Legal support	Facilities	System and quality	Security of information	Flexibility		
U-Bike information system	Tour guide service	0.64	0.78	0.67	0.37	0.48	0.30	0.09	0.20	3.54	6
	POI Information	0.60	0.78	0.62	0.35	0.48	0.31	0.09	0.22	3.46	7
U-Bike cycling system	Real time traffic control service	0.48	0.67	0.67	0.44	0.50	0.27	0.09	0.21	3.34	10
	Accident warning system	0.54	0.78	0.56	0.47	0.44	0.31	0.11	0.19	3.40	9
	Safe cycling service	0.57	0.71	0.50	0.40	0.40	0.26	0.10	0.19	3.13	11
	Parking management service	0.64	0.81	0.70	0.49	0.54	0.30	0.09	0.23	3.80	4
U-Bike & transit system	U-Bike & ride service	0.70	0.95	0.67	0.51	0.54	0.35	0.09	0.20	4.03	1
	U-ride & bike service	0.57	0.78	0.62	0.49	0.46	0.30	0.08	0.16	3.46	7
U-public bike system		0.80	0.85	0.70	0.49	0.46	0.27	0.09	0.23	3.89	3
U-Bike management & additional service system	U-registration service	0.64	0.78	0.62	0.54	0.42	0.30	0.10	0.22	3.61	5
	U-abandon & theft prevention service	0.67	0.81	0.73	0.61	0.50	0.28	0.11	0.23	3.94	2
	U-Bike health service	0.60	0.64	0.45	0.30	0.36	0.27	0.10	0.20	2.93	12

CONCLUSION

In this paper, conceptualization and classification of U-Bike service are fulfilled and its adoptability was calculated using AHP method. Group capabilities technique was invited to eliminate bias on appraisal. 12 U-Bike services were grouped and categorized to U-Bike information system, U-Bike cycling services, U-Bike and transit system, u-public bike system and U-Bike management and additional services system.

By AHP process to evaluate the order of priority, economic factors such as profitability has revealed as more important ones than policy factors and technology factors. U-service with highest of adoptability was 'bike and ride' service which makes linkage between bicycle and public transportation. 'Prevention system from abandonment and theft' and 'public bike system' similar to Velib system in Paris are also considered to very important services in U-City. These services are expected to eliminate the reasons of current limitation on using bicycles.

Conceptualization and adoptability of U-Bike services based on scientific methods could contribute the adaptation of bicycle as a eco-friendly transportation mode in U-City.

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