CONSTRUCTION INFORMATION MANAGEMENT SYSTEM ON THE BASIS OF THE MOBILE INTERNET

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ABSTRACT

Currently, in spite of continual efforts, the information utility of the construction industry does not communicate well with other industries. This problem arose from mistaken and misguided efforts on the parts of the construction industry because it left out of consideration construction characteristics which are at the center of construction, and this information system was directly introduced and operated from outside the industry. There were also other mistakes that the existing information systems disregarded in trying to fix these problems. Therefore, this study describes a new process, which proposes to build and utilize a construction information management system using the mobile internet concept, to solve the problems of the existing construction information management system.

KEYWORDS

Mobile Internet, Construction Information Management System, Information Technology

1. INTRODUCTION

According to the statistical data of the Korean Ministry of Commerce, Industry and Energy, information technology of the Korean construction industry is judged to be less advanced in comparison with the others. In figure 1, the construction industry is located in the group II of the information technology in companies with the shipbuilding industry, and the mechanical industry. Common characteristics of this group II show lack of enthusiasm because these industries tend to avoid sharing business information. But, for the active exchange of information technology, these industries of the group II, classified as heavy industry, need mutual communication and interchange of information because of their separated workplaces. In order to receive information technology as the method that raises industrial competitiveness, the construction industry is required to use the present method with diversified information techniques and needs to introduce information technology that can efficiently supply information to the construction site. This new information technology is the 'mobile internet' concept. This technology can easily be used by construction workers. Introduction of this construction information management technology that uses the mobile internet, it is believed, will create a systematic construction management system that can make logical connections of various kinds of job data to the support facilities of information management which was once

unavailable. Therefore, the goal of this study is the embodiment of the construction information management system into a mobile internet which is grafted onto a moving handset connected to the mobile internet.
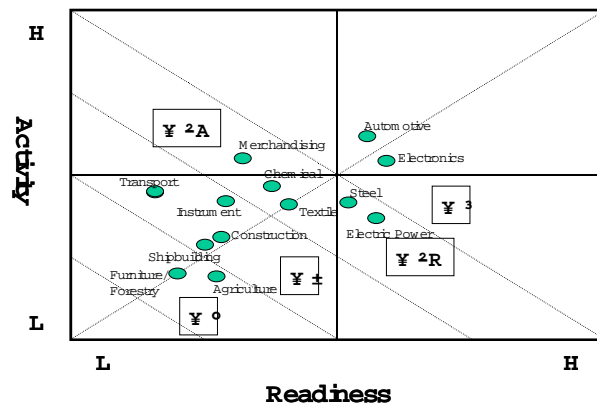

Figure 1:Levels of Information Classified by Industries

2. RANGE OF THE MOBILE INTERNET

The literal meaning of the mobile internet is a support of data service through a wireless device that is not fixed. This definition of "mobile" is an inclusive concept of the two meanings: "can move to anywhere" and "can communicate without connection line". For instance, a cordless phone at home or a cell phone are wireless devices that are connected to a wireless network. But the mobile internet is internet service in a moving format rather than a wireless concept. According to this definition, wireless communication of fixed format like Wireless Local Loop (WLL), Local Multipoint Distribution Service (LMDS), and Multichannel Multipoint Distribution Service (MMDS), are not the same processes. Though internet with a satellite is classified as a moving format, it is generally used as fixed format. So it is different, too. Wireless LAN is included in the concept of the fixed format, but it is due to its have roving ability of a higher level than in the mobile internet. Mobile Internet classified as a fixed format or a moving format is based on the point of view because most wireless LANs operate in a close area of specific businesses and building units e.g. campus, airports etc. From this point, the mobile internet is defined as a "moving format internet" and its range includes a system that can realize the operation of the internet regardless of the kinds of network, platform etc. The range of the mobile internet includes internet access through cell phone, laptop with LAN card and using the internet with a Personal Digital Assistant (PDA). However, it is mostly indicated as a moving handheld communication device when we say generally mobile internet. This premise applies whenever users can operate internet with a portable handset, but limited portable like a laptop is excepted from this category. Therefore, mobile internet has a narrow meaning:, "embodiment internet with portable handset".

Mobile internet devices are divided into "data only" and "voice & data" according to their transmitted data forms. In a representative case of "data only", the original model is a mobile data communication service that was begun in the early 1980s. "Voice & data" is a representative case of internet through cell phone or PDA, as it is a form that is added internet and data communication service to a voice communication service. Use of the most recent "data only" form tends to diminish gradually in proportion to the increase in the spread of cell phone use. In the strictest sense, one must discriminate between the mobile internet and mobile data communication. Mobile data communication is closer to a private net of an enterprise than a net for the general public because its users adjust the focus of a simple data input, working order, messaging etc. instead of analysis or searching for complex data. In this point, Short Messaging Service (SMS) is included in mobile data communication service rather than the mobile internet. But the universality of the internet has made boundary between mobile data communication and the mobile internet meaninglessness. So, there is not the data communication net of the past, with the bulk using the Intranet like the internet and most information being exchanged through the Web remove mobile data communication without Web at early 1990s. Therefore, as previously stated, this thesis has analyzed the mobile internet using a narrow definition.

3. COMPARISONS BETWEEN INTERNET BY WIRE AND MOBILE INTERNET

Mobile internet is also included within the range of the internet, but it differs in form and approach from the general "internet by wire". In the concept of mobile internet, one common mistake is treatment the mobile internet the same as the internet by wire. There is no problem in using the internet with a laptop of the same as using internet by wire with a desktop. However, in the case of using the internet as a cell phone or PDA in Korea and Japan like today, there is a mutual disparity in concept. Namely, if it treats mobile internet without defining it clearly, a special feature of the mobile internet would be passed over. The next three items compare the mobile internet and internet by wire. This comparison analysis will be considered on the basis that it can apply to information management in the construction industry.

① Comparison of internet platforms.

② Comparison of attributes of the Reach and Richness in information propagation.

③ Comparison and analysis of user preference.

3.1. Differences of Internet Platforms

First, a cell phone and a PDA which are mobile internet handset are kinds of "dummy terminals" which lack high power processing abilities. The reason they are called "dummy" here is because cell phones and PDAs are high technical devices that have complex software, and one characteristic of the devices is the function of a terminal. But, a personal computer, which is a platform of internet by wire, has s strong operation capacity. Because mobile internet devices of the terminal type lake the ability of self-support they absolutely must depend on the network. That is to say, the mobile internet is difficult to expand independently and requires an intelligent network. Otherwise, handsets cannot perform new function alone, and this dummy terminal is useless. As business type or internet speed of mobile internet is decided from a investment perspective, it is important to know the power of the network company. Thus, before deciding on which network to use, an analysis of a network's service has to be done before everything else. On the other hand, a desktop, an internet by wire device, can perform standalone though a network connection is limited. The PC, then, can transact a high degree of business as a standalone.

Second, replacement of a mobile internet device is easier because its price is less than a desktop or laptop (portable handset priced like a cell phone: 1/10~1/5 of a desktop, and PDA price 1/4~1/3 of a desktop. According to research, the PC replacement cycle by a user is 4 years and a mobile device is 1.5~2 years. Thus, though a mobile internet device has advantages over PC-type platforms for introducing new functions and services, it requires mutual assistance to access network technology.

Third, with a mobile internet device, it is not necessary to pay more when a user changes his own device. But a PC requires additional expense when a user purchased a new PC or upgrades his old one.
Fourth, if we consider this characteristic of the mobile internet device, the level of its application must have low degrees. As complex application require to many device options it incongruent in handiness terminal. So it must have simple functions like *request* and *respond*. Since the interfaces of input and output are limited in cell phones, it cannot perform hard processes or manage a great deal of content. But, the PC has not this problem because it can enlarge its hardware and has both a keyboard and a big monitor.

3.2 Comparison of Attributes of the Reach and Richness in Information Propagation
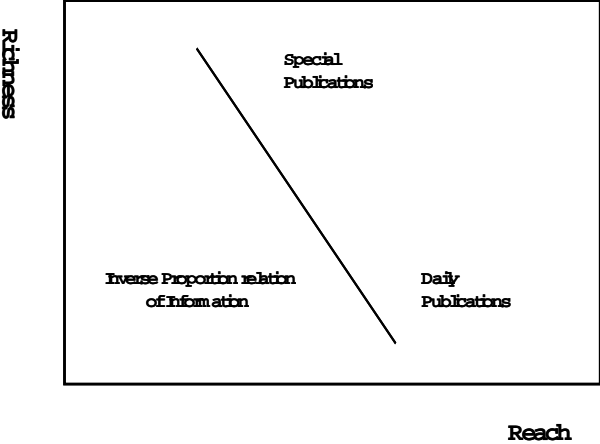

Figure 2: Traditional Relation Between Richness and Reach

Professor Jeffrey L. Funk of Kobe University illustrates the differences between the mobile internet and internet by wire as "Reach and Richness". *Richness* is the quality of information, and *Reach* is determined by width and depth of information the public has ownership of. The relation between Richness and Reach is ideal at a high rate, but these two concepts actually have inverse proportion. Figures 2 and 3 show this theory. Internet by wire is a suitable tool for supplying deep information, and the mobile internet is a compatible larger medium for a user than internet by wire. Namely, internet by wire has *reach* and mobile internet has *richness*. Therefore, this difference suggests the distinction of using these application in a business model.
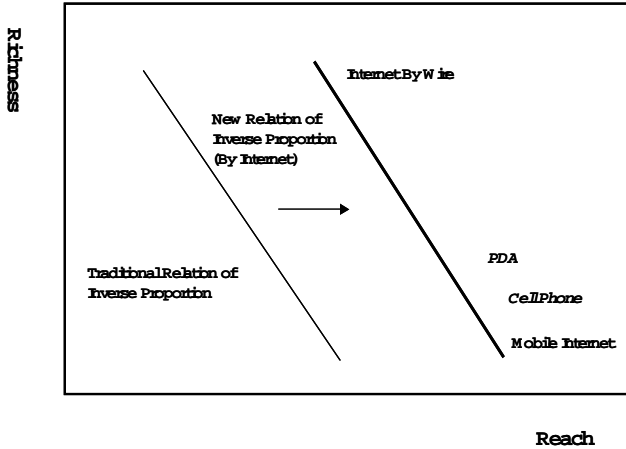

Figure 3: Change of Richness and Reach by Internet

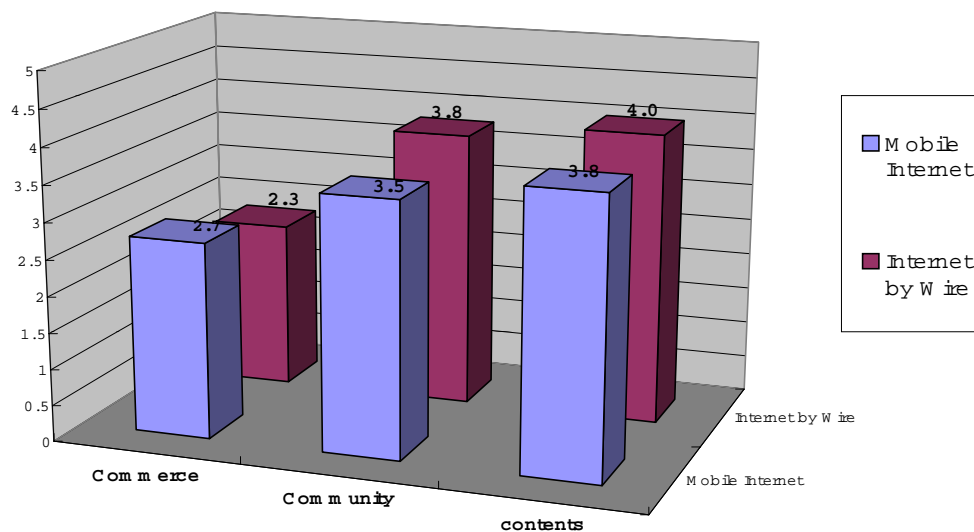**3.3 Comparison and Analysis of User Preferences**

Figure 4:Comparison of 3C's Importance

In the mobile internet, the most important elements are the users and their requirements. Users of the mobile internet are divided into enterprise users and the general public. Most enterprise users are the client class of past mobile data communication and the general public is the client class of the mobile internet that has entered the market most recently. In the enterprise client class, the needs of the mobile internet are gradually tending upwards as mobile business executives are increasing. According to research by the Gartner group of 2002, 5400 million executives spend 20% of their working hours away fro the office. Generally, 40% of the labor force of an advanced country are mobile managers and half of them outdoor service employees. During working hours away from the office, managers need communication tools for increasing productivity. Security of the times and information are indispensable conditions for survival for sensitive data. As the internet becomes an important part of the infrastructure of information technology, enterprises construct information systems of the mobile internet and internet by wire within an intranet system. Since data communication has higher accuracy and reliability than voice, it is profitable for delivery of information like order and volume. Figure 4 analyzes user's preferences with kinds fo communication systems. These preferences were divided as Commerce, Community, and Content (3Cs) and analyzed each consequence of the 3C's under certain conditions. A perfect score is 10 points. The results are revealed in Contents (3.8, 4.0), Community (3.5, 3.8), Commerce (2.7, 2.3), in that order. An interesting aspect of these results, is that users think that Commerce has priority in a mobile internet. a point that leads to the result that the mobile internet is suitable for business and that after this, the mobile internet will grow for applications.

4. PRACTICE USE PLAN OF MOBILE INTERNET IN CONSTRUCTION INDUSTRY

As mobile internet has user facility, its users can perform their jobs whenever and wherever they choose. Practice use plan of these merits in the construction industry is the connection between mobile internet and the existing construction information management system. The embodiment of this connection system requires analysis of the user's requirements. So, this study quoted from Karin Eisenblatter's report (Carnergie Mellon University, Jan. 2001). Where is the quotation from the study you mentioned? The questionnaire of this report was responded to by 15 construction workers from 10 different construction companies.

Q1) In which kind of daily paperwork the construction or project manager is involved?
    Is there any potential to streamline paper flow by using computer tools?
A1) Interviewed project or construction managers reported that a huge amount of paperwork is managed by them
    and suggested lots of ideas how to reduce some of this paperwork. Depending from the company they are

working for and the kind of contract, the paperwork includes correspondence with the client, correspondence with subcontractors, jobsite progress monitoring and scheduling, budgeting, document management and distribution of drawings to all contractors. Figure 1 shows a very comprehensive and meaningful classification on jobsite information needs that was published in "Wireless Communication and Computing at the Construction Jobsite" by de la Garza and Howitt from Virginia Tech in the USA. In the interview construction managers wished to have a tool for recording data into the specified templates right at the construction site, e. g. data for force accounts or claims could be filled into the specific template for force accounts and signed and later in the office the information would be downloaded to the computer. This saves time and reduces mistakes in data because the construction manager records data only once, instead first on paper and second into the computer.

Table 1:Classification of Required Information in Construction Site
(By de la Garza and Howitt from Virginia Tech in the USA)

Request for information	Materials management	Equipment management	Cost management	Schedule and means and methods	Jobsite record keeping	Submitals	Safety	QC/QA	Future trends
Design intent and classification	Access to material management	Equipment location	Budget	Schedule updates	Recording timesheets	Test results	Accident reporting	Initiate inspections	Positioning data
Subcontractor information	Material location	Fuel monitoring	Material cost accounting	Delay recording	Progress reporting	Revision to submittals	Reporting violations	Report QC/QA problems	Sensory data
contract specifications	Material order status		Equipment cost accounting	As-built records	Exception reporting			Report inspection results	
Contract drawings	Request materials to site			Productivity information	Visitor's log				
work package information	Place material orders								
Means and Methods									
Implementation problems									

Q2) Which information is needed at the jobsite (file format)?

A2) Drawings are the most important information source. Therefore it is crucial that engineers and workers at the construction site work with the latest set of drawings. Other important documents are specifications or shop drawings, time schedules and work reports.

Q3) How common is the use of Internet providers and e-mail for the daily contracting work of a construction project?

Q3) There are companies that do not make any use of e-mail for business purposes. But most commonly, construction companies use e-mails for correspondence and request for information. Future use of electronic mail will increase strongly and become standard as new security standards released and electronic signatures will be established by law. A less common issue is the use of online services for collaboration in project management. Mainly large construction companies take advantages of these services.

Q4) How does the process of ordering materials looks like?

A4) The main bulk of material is part of the bidding process and therefore is sealed before the construction process starts. Smaller orders or changing orders, e. g. because of defect or stolen material are issued by the construction manager during the construction process. The construction manager makes a phone call to the supplier and places a order. The material will be delivered to the site by the supplier and confirmed by a worker at the construction site. The supplier sends the invoice to the accounting office of the construction company that will forward it to the construction manager. As last step he will check invoice against order and bill of delivery. An alternative application was a prototype for a PDA that would allow the construction manager to issue orders from the site via the PDA. But detailed investigations and discussions with construction managers condemned the idea as not very useful. Construction companies work together with suppliers mainly over long time and

over projects. Therefore small orders do not require a signature, just a phone call and a password. Other arguments were that orders should not be placed individual and some construction managers mentioned that this paper flow should not be automated.

Q5) What for construction managers would like to use a mobile computer device?
A5) Interviewed construction and project managers wished to have the newest drawings on the mobile device or at least a list of the newest drawings. They mentioned that it would be very useful if parts of different drawings could be displayed in one view. Further, they would like to have access to different information ranging from specifications to financial accounts. Or a tool that allows dictating letters, signing and sending. Someone would like to use a PDA in personal up-front meetings and asked for a application that would simplify note taking.

5. EFFECTIVENESS OF THE MOBILE INTERNET IN CONSTRUCTION INDUSTRY

The next are expected effectiveness of mobile internet in construction industry from the questionnaire from Chapter 4.
1. Because the business of the construction industry is practiced outdoors, practical use of mobile internet can improve productivity.
2. As communication among participants of construction through the mobile internet leads to reduced elements of construction project claim, it can turn a construction project into a successful project.
3. Because observance of a term of works in construction project is an essential condition and it connects directly with success and failure, practical use of the mobile internet is an important element of working efficiently on a construction site. Since data communication through the mobile internet has a higher accuracy of information delivery than voice at a mobile construction site, delivery of business information like orders, specifications, and drawing is improved.
4. Practical use of mobile internet reduces omissions and error because of the single entry of data.
5. Performance with mobile internet prevents illegal practices from occurring between the work site and the office.

6. CONCLUSIONS & SUGGESTIONS FOR IMPROVEMENT

6.1 Development of Applications that will Increase the Capability of a Handset

Drew Leavy said, "A mobile internet must first be built before it can sell". Like this statement, for introduction of mobile internet to the construction industry, it is necessary to develop applications that are considered to characteristics of the construction industry and the mobile internet. The following subjects must also be addressed:

① Consideration of limited handset's expression ability
-Handset's screen restricts expression types of information.
-Because the image of a complex drawing is hard to view on a handset screen, it must be viewed on a full-size monitor.
-Handsets of mobile internet must have the ability to exactly and easily express information.

② Consideration of limited handset's input ability
-Handset's screen of mobile internet have to be in a format which leads to fast decision-making. Namely, users can easily move to desired sites when using the internet by wire but handset of mobile internet cannot do it. Because handsets of mobile internet have limited input ability, input operation is hard and this information service is important in mobile internet.
-Thus, the practical use of mobile internet is possible as the flow of information for downloading and reading rather than mutual information interchange between client and server host.
- Recently, input technology by voice has been improved. For the future, this technique is selected as a profitable technique in special circumstances like construction sites, and it will be adopted for handsets of mobile internet.

③ Consideration of limited handset battery
- Handset of mobile internet is limited by the supply of handy power resources a condition that can become an operational problem. So, applications of mobile internet is required small-scale because of this problem.

6.2 Development Applications that are cConsidered Characteristic of the Handset

① Consideration of moving ability.
- It must consider that users can move anywhere. In case of internet by wire, it is either on-line or off-line. But mobile internet has reduced this problem because of moving ability. This advantage is used for supply and demand of materials and can also supply location information

② Consideration of personality
-Because handset of mobile internet is portable, it can be personalized, making easier business management and increased business effectiveness.

③ Consideration of portable
- Developer must know well that users want to use the same information from internet by wire as the mobile internet. Thus, it must incorporate existing functions and information in mobile internet.

6.3 Developing a Handset that Considers Conditions at a Construction Site

As construction site is located in wild situations, handset of mobile internet must first be suited to users' conditions and facilities. Handset of mobile internet has functions that are required in the construction industry, but the current handset has various limitations for operating at a construction site. Thus, for successfully introduction of a mobile internet to construction site, requires the following:

① Improvement of expression' limitations.
② Improvement of input' limitations.
③ Improvement of durability in wild circumstances.
④ Development of communication infrastructures for mobile internet in construction site

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