An Economic Geographic Analysis of Mobile Internet Acceptance in Japan

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Abstract— Rapid penetration of internet-enabled cellular phones are witnessed in worldwide. It opens completely new business opportunity. However, the methodology to understand how the cellular phone Internet changes the electronic commerce business is still premature. There are two challenges to cope with the rapidly growing new mobile commerce market. One is how we can capture the mobile commerce specific characteristics. The other is how we can cope with the rapid changes in this field. This paper presents the difficulties in e-mobile business analysis. Then, the methodology to understand the e-mobile business based on an economic geographic analysis is proposed. The case studies are performed to analyze the economic geographic features of mobile commerce business. They show the service-specific characteristics of mobile commerce acceptance in Japan from a viewpoint of economic geographic analysis.

I. Introduction

THE dramatic changes now occurring in internet-empowered information appliances have the potential to change the PC-based internet business and people's every day's lives as much as the first workstation based browser did in the past. The first decade of Internet was dominated by workstations and personal computers. A growing number of information appliances, like cellular phones, personal digital assistants (PDAs), game consoles set-top-boxes (STB) appear with Internet capabilities. The dominance of information appliances is predicted by many market researchers. Information appliances have a wide variety of operating systems and application interfaces.

The widely accepted usage of information appliances has now very little doubt. However, the acceptance of the services in these appliances will be, highly likely different from those of PC Internet. It is a critical issue that how we can capture the each diverse user behavior patterns in this newly emerging computer communication domains.

Mobile Internet can cover a wide spectrum of Internet usage. However, in this paper, we call the Internet users who access the Internet using micro-browsers on a cellular phone handset as *mobile Internet users*. It is not so accurate, however, it is natural to focus on the handset based users considering the significance of cellular phone based users in the Internet users who have mobile characteristics.

This paper explores the issues in mobile e-commerce analysis. An methodology based on economic geographic approach is proposed. The case studies are presented to outline the preliminary results from this methodology to capture the characteristics of real world mobile e-commerce.

II. Issues in Mobile Internet Users

Only one or two years ago, the mobile Internet use was just a dream. People did not agree that a small display on a mobile handset can help people actively access to the Internet. In addition, people could not see that most people will endure the input pains using just ten keys on a handset.

The e-commerce world has been drastically changing these days. In Japan, the number of the people accessing the Internet from mobile handsets almost equals to that of the

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PC Internet access. There are about 39 million active mobile handset based Internet users in Japan at the end of June 2001. It is estimated that the number of mobile handset Internet Users will reach 50 million by the end of year 2001. The widely accepted use of Compact NetFront™, a HTML subset-based Internet aligned solution for a micro-browser on a cellular phone handset is one of the keys of mobile Internet growth in Japan.

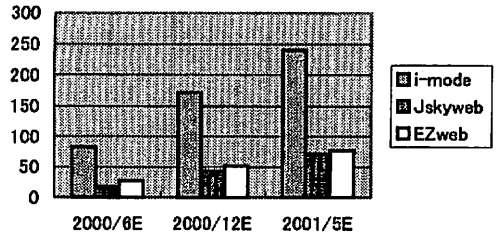

Fig.1 Mobile Internet Users in Japan (in million)

The mobile Internet is a significant portion of the Internet in Japan. It naturally leads to the questions like followings:

- Are the mobile Internet users similar to the PC Internet users"?
- If the mobile Internet users are different, in what aspects they are different from the PC Internet users?

Any attempts to capture the mobile Internet users encounter the challenge that the mobile Internet users' behavior is so dynamic and volatile.

III. Preliminary Findings of Mobile Internet Specific User Behavior

The rapid growth of mobile Internet users started in 1999 in Japan. The growth was too fast to establish any systematic approach to analyze the mobile Internet users. The users grew and the nature of a group of mobile Internet users continued to change. It penetrated into the majority of Japanese in an amazing speed.

This year 2001 finally witnesses the slowdown of the mobile Internet penetration. The user increase per month is below 2 million these days. By the end of this year, the mobile Internet users will reach 50 million, more than 80% of the cellular phone users in Japan. Now it is ready to capture the interesting behavior for this new emerged market segment.

Is the mobile Internet different from PC Internet?

It is definitely yes. The display size is significantly small compared to that of PC.

Our preliminary observation was made on several i-mode services in Japan. I-mode is the most popular Internet access service from mobile handsets using Compact HTML, a subset of HTML. Its share in Japanese market is approximately 60%.

From the initial observation, the user share in metropolitan areas was significant. Tokyo, Kanagawa, Saitama, Chiba, an area within 50 km from the center of Tokyo occupied about 40% of the users.

Is it the common nature of the mobile Internet? Or it depends on the diffusion stages, e.g. the early adopters are metropolitan residents, but gradually the effect of early adoption will vanish?

In addition, a new question arises that it is just a metropolitan and non-metropolitan or any area-specific characteristics are observable.

From the early observation, we think the mobile Internet users are typical metropolitan users at least in the early stage.

The metropolitan area occupancy ratio in two services is measured in a preliminary study, as presented in Fig. 2.
There are 47 prefectures in Japan. The 6 prefectures in 3 major metropolitan areas (Tokyo, Osaka, Aichi, Saitama, Kanagawa, Chiba) include 38% of the Japanese population. In Service A, the ratio is about the same as the population ratio. In Service B, the ratio is much higher, and it shows that the service B is more metropolitan-centric service. The service A is a commercial services listed in the mobile carrier service directory which is easily accessible from the handsets. The service B is one which is not listed on the carrier service and operated by an independent compay without any assistance from the carrier.

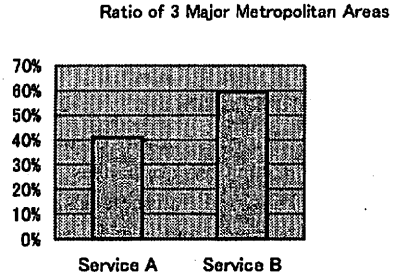

Fig.2. Ratio of 3 Major Metropolitan Areas

In the past, there is no quantitative research available about the distribution of mobile Internet users.

The user ratio in major metropolitan areas was high in the past Internet services. When the network game service emerged in the middle of 1990s, the ratio was about half of the total commercial users in a preliminary study. The dominant factor of the dominance was not clear at that time because the market segment of network game users was so focused on young male metropolitan users. Therefore, the general evaluation of the factors was not clear.

IV. Economic Geographic Analysis

This study is motivated from the initial observations in which major mobile Internet services have a high ratio of metropolitan users. Tokyo, the biggest metropolitan area belongs to the Kanto region. The difference between the north Kanto area distant to Tokyo and the south Kanto area adjacent to Tokyo is clear.

It leads to the economic geographic analysis based on the region and relative metropolitan nature in that region. Japan has multiple regions and each region has a region-central area.

Based on the preliminary study, this paper tries to capture and compare the user distribution density in region base. Kanto, the Tokyo-surrounding area is treated differently. Tokyo, South-Kanto(adjacent to Tokyo), North-Kanto are treated in a separate manner. In each other region, the prefecture which has the region-central city is separately analyzed to identify the difference.

It means that this economic geographic analysis is based on the following assumption:

- Japan has a three-layer geographic structure to adopt an advance service
- The first layer is Tokyo
- The second layer consists of Tokyo-adjacent area and each region's central area
- The third layer consists of each region except the second layer regions

From this assumption, the analysis is done by the prefecture groups depicted in Fig. 3.

a) Tokyo
b) South Kanto(Kanagawa, Saitama, Chiba)
c) North Kanto (Tochigi, Gunma, Ibaraki)
d) Tokai (Shizuoka, Gifu)
e) Metropolitan Tokai (Aichi)
f) Koshinetsu (Yamanashi, Nagano, Niigata, Toyama, Ishikawa, Fukui)
g) Metropolitan Kinki (Osaka)
h) Kinki (Kyoto, Shiga, Mie, Nara, Wakayama, Hyogo)
i) Metropolitan Chugoku (Hiroshima)
j) Chugoku (Yamaguchi, Shimane, Tottori, Okayama)
k) Chikoku (Ehime, Kagawa, Tokushima, Kochi)
m) Metropolitan Kyushu (Fukuoka)
n) Kyushu (Saga, Nagasaki, Kumamoto, Kagoshima, Miyazaki, Oita, Okinawa)
o) Metropolitan Tohoku (Miyagi)
p) Tohoku (Aomori, Akita, Yamagata, Fukushima, Iwate)
n) Hokkaido

Fig.3. Economic Geographic Classification

To compare the difference among regions, it is calculated whether each region has more/less users per population in a statistic significant manner. The Z-values in prefecture groups are calculated for comparison.

$$Z = \frac{|\ Pa - Pg\ |}{\sqrt{P * (1 - P) * (\frac{1}{Na} + \frac{1}{Ng})}}$$

$$P = \frac{Na * Pa + Ng * Pg}{Na + Ng}$$

Fig 4. Z value calculation

Ng is the total population of Japan. Na is the population of each area. Pa is the user ratio in each area. Pg is the user ratio in Japan.

The Z value is used to verify whether the sample value is within the random error range. When we consider the sign of the (Pa - Pg), we can verify whether it is larger or smaller in the statistic viewpoint.

When (Pa - Pg) is positive and more than +1.96, we can say that the ratio is statistically larger then the total average with the confidence level 97.5%. When (Pa - Pg) is negative and less than -1.96, we can say that the ratio is statistically smaller than the total average with the confidence level 97.5%.

V. Case Studies

There are four i-mode services available for case studies. The case study results is shown in Table 1.

	Tokyo	South Kanto	North I	Tokai	Metro Tokai	Koshin	Metro Kinki	Kinki	Metro Chugo ku	Chugoi	Shikok	Metro Kyush u	Kyush	Metro Tohnk u	Tohoku	Hokkai
Service A	11%	20%	7%	4%	4%	7%	6%	11%	1%	4%	3%	4%	6%	2%	6%	4%
Z value	3.38	6.64	5.98	-2.50	-5.84	-0.70	-2.00	1.22	-4.11	-1.31	-0.46	0.94	-4.40	-1.71	-0.73	-3.07
Service B	19%	22%	4%	3%	8%	5%	8%	10%	1%	2%	3%	3%	4%	1%	6%	3%
Z value	24.46	9.44	-4.66	-6.62	7.75	-6.29	1.89	-1.49	-6.59	-7.99	-3.22	-5.50	-12.25	-4.68	-1.34	-5.26
Service C	14%	27%	7%	6%	7%	5%	3%	9%	2%	2%	3%	3%	6%	1%	3%	2%
Z value	2.05	3.40	0.98	0.82	0.76	-1.11	-2.12	-0.79	-0.64	-1.09	-0.35	-0.47	-1.05	-1.16	-1.66	-1.47
Service D	25%	24%	4%	4%	3%	5%	7%	9%	2%	3%	2%	2%	3%	1%	2%	3%
Z value	19.05	6.73	-2.14	-1.45	-3.58	-2.24	0.16	-1.93	-2.08	-2.22	-3.52	-4.35	-6.27	-1.70	-6.96	-2.71

Table 1. Z values with sign in 4 services

The case studies were performed on the 4 different services. Some services provide the feature for a user to register the residential area postal code. From the user input, the users' residential areas are estimated. It should be noted that a user may input a false post code.

Service C requires a user to input a postal code to send a commerce catalog. The user area estimation is made from this catalog mailing logs.

- Service A: car information service
- Service B: Web mail service
- Service C: Commerce catalog request service
- Service D: Computer news information service
-

All services are i-mode services.

At the time of the analysis

- Service A: 8 months old

- Service B: 10 months old
- Service C: 15 months old
- Service D: 7 months old

The usage pattern in Service A is shown in Fig. 5. The black area shows the areas where the usage is statistically larger than the total average. The gray area shows the areas where the usage is statistically smaller than the total average. This notation is also applicable to Figs. 6-8.

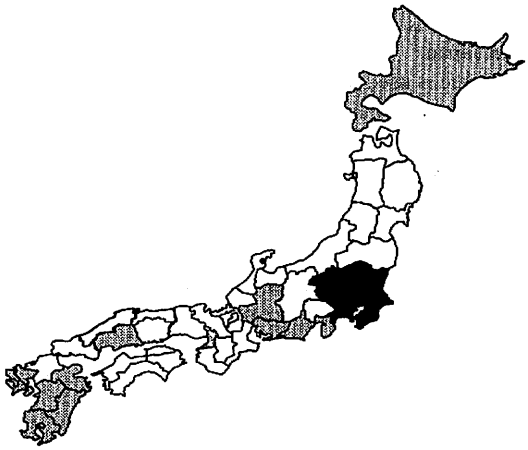

Fig.5 Geographic Usage Patterns in Service A with some region specific distribution pattenrs

It should be noted that the near the Tokyo metropolitan area is the most active area. Some of the rural areas are inactive areas where the usage is statistically lower than the total average.

Service B's geographic usage pattern is shown in Fig. 6. It should be noted that the two of major metropolitan areas, Tokyo metropolitan area (Tokyo, Saitama, Kanagawa, Chiba) and Nagoya metropolitan area (Aichi) are positive. The Kinki areas including Osaka are not statistically different from the total average. All other rural areas except Tohoku are statistically smaller than the total average.

Service C's geographic usage pattern is shown in Fig.7. It should be noted that the areas near to Tokyo are the high usage area and the Osaka area is the low usage area. However, most of the areas are not positively different from the total average. This is the relatively flat usage pattern.

Service D's geographic usage pattern is depicted in Fig. 8. It should be noted that the Tokyo and South Kanto area, which are near to Tokyo metropolitan area are the areas where usage is statistically larger than the total average in all four services. Hokkaido and Kyushu, two remote areas, show that the usage is lower than the total average in three out of four services.

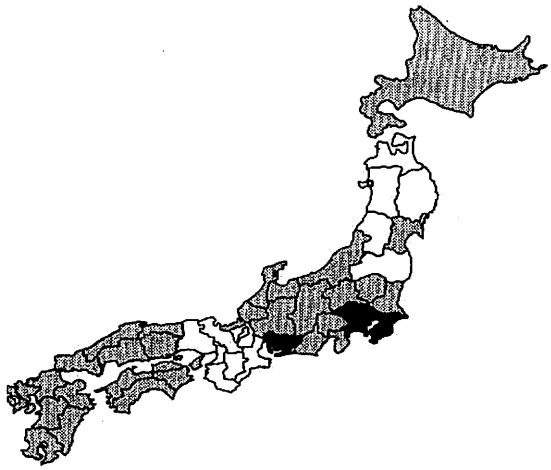

Fig 6. Geographic Usage Patterns in Service B with high centralization in Tokyo metoroplitan areas

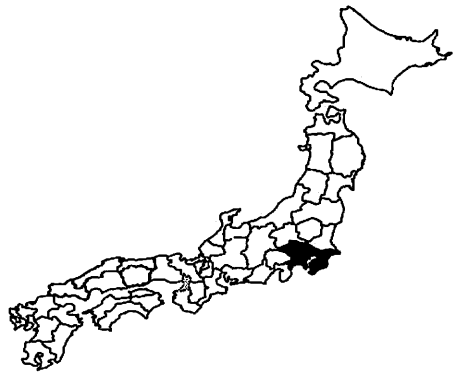

Fig 7. Geographic Usage Patterns in Service C with relatively uniform geographic distribution patterns

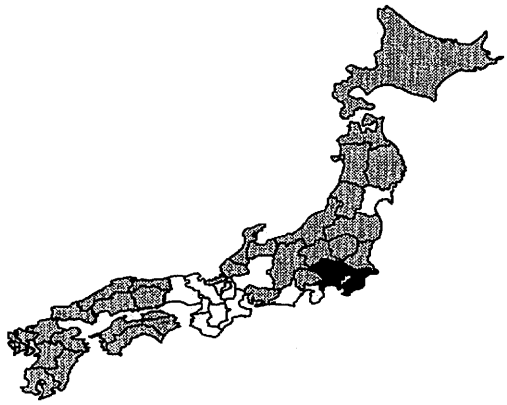

Fig 8. Geographic Usage Patterns in Service D with some metropolitan-biased distribution pattenrs

These four services are classified with the two major patterns:

- Metropolitan centralized usage pattern (as shown in Fig. 5, 6 and 8)
- Flat usage pattern (as shown in Fig. 7)

The future mobile commerce may emerge using both patterns, but it needs further studies to analyze the usage pattern transitions for successful mobile commerce.

VI. Correlation Analysis among Regions and Serivces

Each geographic area has different population. To normalize it, the author focuses on the relative user ratio per head count (RUR). RUR is 1.00 when the user ratio equals the total user ratio. Using this RURs in four i-mode services, the author made the principal factor analysis. Using the major two principal factors, the sixteen areas are categorized as shown in Fig. 9. The X and Y axis are the largest factors to explain the correlations among geographic regions. The first principal factor shows the usage of service B and service D, the two major services that metropolitan area people prefer. The second principal factor shows the negative usage of service C. Service C is generally not area-specific service that covers the most of the areas.

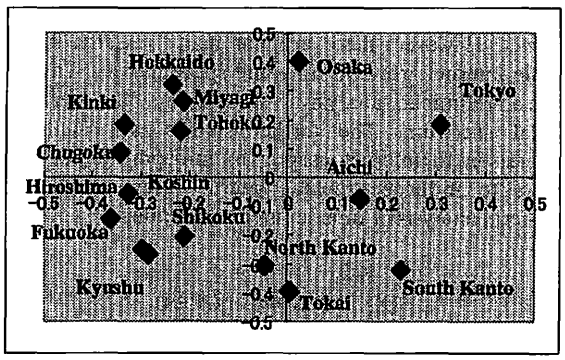

Fig 9. Principal Analysis Using correlations of the per head use ratio among the sixteen geographic areas

The service classification using the principal factor analysis is shown in Fig. 10. The four services are classified using two categories. The x-axis is generally explained by the positive use of Tokyo and South Kanto, Japanese major metropolitan urban areas, and negative use of Koshinetsu , Fukuoka and Kyushu. The y-axis is generally explained by the positive use of Osaka and Hokkaido and the negative use of South Kanto. The first factor seems generally dominated by the urban factor. The second factor needs further investigation. Considering the general tendency of user concentration in metropolitan areas in mobile Internet, there could be two clustering methods found in Fig. 10 that shows the similarities of services calculated from correlations of per head user ratio. The one is (a) service A, B, and D, and (b) service C. The other is (a) service B, C, and D, and (b) service A. In the former clustering, the service C is unique for its flat usage over the geographic areas. In the latter clustering, the service A is unique for its irregular geographic usage pattern. In other words, the service A has a clear geographic dependency embedded in the nature of the services. The implications from the clustering are for further studies.

It is an interesting topic. However, we don't have any significant clues how the mobile Internet use will emerge. There could be two different approaches. The early-adopter centric approach can focus the most active users to penetrate into the mobile Internet market. On the contrary, the flat usage may be the ideal state for the mobile Internet. In the latter sense, the metropolitan biased situation is just a transition phenomenon. It is an interesting research topic how we can distinguish these two penetration strategies considering the user behavior and the nature of the services.

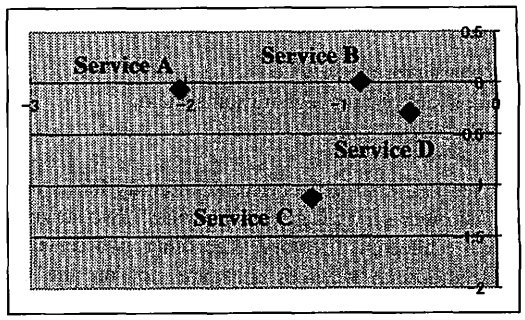

Fig.10 Principal Analysis using correlations of the per head count user ratio among the four services

VII. EVALUATIONS

A. *Findings*

There is a significant diversity in the use of Internet. Especially, early adaptors are metropolitan area residents. In size of 40 million active mobile Internet users, there is an apparent tendency that metropolitan area users tend to use mobile Internet more actively. There are some big cities in each region. However, the major central prefectures do not show the significant difference compared to the surrounding regional areas. The main contrast of the use is depicted between the four major prefectures (Tokyo, Kanagawa, Saitama, and Chiba) and others. Osaka is the central commercial area in west Japan, however, the analysis shows the initial finding that the Tokyo metropolitan area shows the clear advantage over the other areas.

In addition, the economic geographic study shows the preliminary result to compare different mobile services using the correlations of per head user ratio in regions.

B. Limitations

This is a preliminary study that tries to cover the various mobile Internet service factors in a consistent manner. The limitation comes from the following three issues:

- Fairness of the evaluation
- Accuracy of the geographic estimation
- Dependency of the carrier
- Lack of the survey of the control factors
- Lack of links to general geographic economic theories

First, the services observed in the case studies have differences in service characteristics, the fairness of the comparison should be tested in a further study. Each service has different exposure to the mobile users. At this point, there is no measure which factor dominates the geographic factor of the user distribution. There are several points to be investigated in the further studies. There are some differences in the services in the case studies.
They are:

- charge for the service,
- conventions for registration system,
- directory listing.

One service is a charged service. A monthly fee is about 3 dollars. All other services are free services. Two services are listed in the telecom directory. The other two services are so-called unofficial services that are not on the carrier directory. These factors should be for further studies.
Second, each service has a different method to estimate the user's location. It influences the accuracy of the user's geographic distribution.
One service mandates a postal code input for your registration. Without registration, a user cannot use the service. The other two service mandates a postal code input for additional premium service. There is no charge for the premium part, however, a user can live without a post code input when one does not use the premium part. The other service lacks the registration system. Each time a user requests a service (a catalog mail request), one inputs a post al code.
Third, the case study depends on the particular carrier service, i-mode. It is the most popular service in Japan,, however, it has its own geographic user patterns. The market share of i-mode varies from area to area even though its market share is about 60% in Japan. This is another point that needs further investigation.
Fourth, the geographic distribution may be a second factor that is driven by a hidden major factor. For example, metropolitan users may mean young male users. This case study investigates the geographic pattern only without further user profile information. Further studies in user profile information may reveal more implications about the geographic distribution and its transition in mobile Internet.
Fifth, this case study shows the different patterns of geographic distribution, however, its implications are not clear. Whether the early geographic distribution analysis and comparisons can improve the services or marketing strategies is for further studies. The geographic distribution comparisons may suggest more implications to the mobile Internet diffusion or other theories to understand the social process in the wireless Internet. These in-depth considerations are for further studies.
In addition, this is a preliminary case study, therefore the continuous follow-up analysis should be done to verify the stability of the analysis.

VIII. CONCLUSIONS

The economic geographic analysis of mobile Internet use reveals several important findings. In any services, the Tokyo metropolitan areas show the significant more users than other areas. Each service has a different economic geographical usage pattern. Our preliminary analysis shows the two measures about the mobile Internet analysis from the economic geographical approach: one is the degree of concentration in metropolitan areas, the other is the degree of diversity of use among geographic areas.
Japan is a leading mobile Internet country and it is expected that the other countries will follow in 5 years. In some of the mobile Internet standardization, it plays a leading role[1][2][3][4]. It gives a plenty of keys to analyze how the commerce and marketing are characterized in the mobile Internet. However, there are not many research how the mobile Internet grows in time and space metrics. This study gives a preliminary analysis to study the mobile Internet in a special spectrum. The further studies will include (a) comparison to Internet usage, (b) in-depth studies on the factors to influence mobile Internet usage, and (c) the long-term analysis of mobile Internet adoption.

IX. ACKNOWLEDGMENT

The author expresses thanks to Dr. T. Kamada and the people in Research and Development department in ACCESS for his insightful remarks and encouragement.

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