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User Acceptance of Location-based Services

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***Abstract*—**Location-based services (LBS) exploit the known location of a user to provide services dependent on their geographic context and personalized needs [1].

The development and arrival of broadband mobile data networks supported with mobile terminals equipped with new location technologies like GPS have finally created opportunities for implementation of LBS applications. But, from the other side, collecting location information data in general raises privacy concerns.

This paper presents results from two surveys of LBS acceptance in Croatia. The first survey was administered on 181 students, and the second extended survey involved pattern of 180 Croatian citizens. We developed questionnaire which consists of descriptions of 15 different applications with scale which measures perceptions and attitudes of users towards these applications.

We report the results to identify potential commercial applications for LBS in B2C segment. Our findings suggest that some types of applications like emergency&safety services and navigation have significantly higher rate of acceptance than other types.

***Keywords*—**Acceptance, location-based services, m-application.

I. Introduction

TECHNOLOGICAL progress of mobile communications enables a new manner of doing business – mobile business as a separate type of electronic business established on use of various mobile devices (mobile phones, PDAs etc.) connected with wireless telecommunications infrastructure. Mobile business has a potential that will change the global market [2], and in accordance with predictions overcome a traditional electronic operations based on Internet [3].

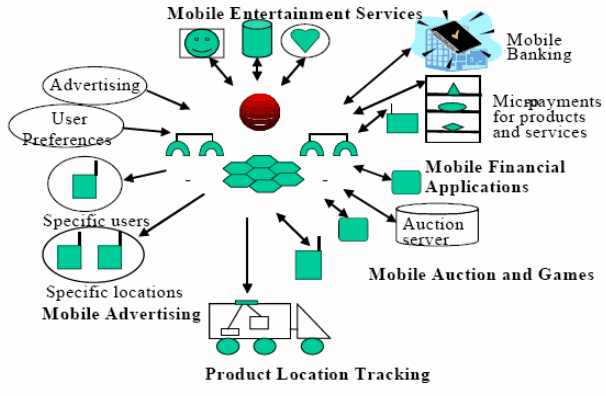

Fig. 1 Several mobile commerce services[1]

[1] Source: Varshney and Ravikumar 2004

The Fig. 1 taken from [4] illustrates the spectrum of possible m-commerce services.

M-commerce applications include mobile financial applications, mobile inventory management, product locating and shopping, wireless engineering, mobile auctions, wireless data centers, and mobile advertising [5].

This particular paper focuses solely on specific location applications, product location tracking and advertising adapted to the user location and its acceptance.

II. Survey Motivation

Mobile operators and mobile phones manufacturers hectically search the 3G technology starter service „killer-application" which would prompt users to massively upgrade devices and subscriber to new services. These will, in all likelihood, by the opinion of many authors, be the location based services, i.e. location of users (Location Based Services, LBS) [6, 7, 8].

Location technologies of mobile operators are on the basis of principle of measuring the signal of user's mobile terminal device and calculation of the location on the basis of measurement results. Possibility of definition of the exact position of a mobile terminal device initiated the development of location services. The purpose of this explorative and descriptive survey study is to survey the level of user adoption of specific applications of location services.

On the basis of use of data on the location of user many services have been made. These can be offers for best shopping, various services (gas stations, ATMs, hotels, restaurants, pharmacies, post offices etc.), tracking of people and pets, selection of place of meeting with other people, guidance to specific locations, calls for help and security systems, playing interactive games based on the player's location and intelligent advertising based on the location of users.

We will separate two out of many definitions of LBS:

LBS definition 1:

LBSs are information services available via mobile devices and use of mobile networks and are based on the capability of definition of location of mobile device [9].

Very similar is the second definition given by Open Geospatial Consortium (OGC).

LBS definition 2:

LBS is a wireless IP service using the geographical information of a mobile user, i.e. each application service using the position of a mobile device [10].

This definition describes LBS as an intersection of three

technologies (Fig. 2).

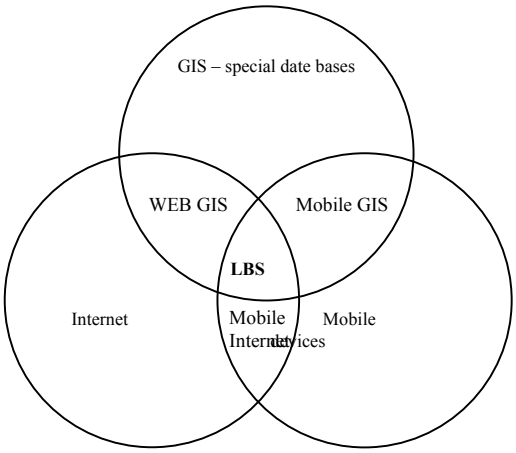

Fig. 2 LBS as intersection of three technologies

According to the results of the analysis by the author of this paper a critical factor for the success of LBS implementation is the setting up of standardization on a global level which should include:

1) positioning techniques,
2) network characteristics of 2G and 3G service providers,
3) technologies of users' terminal devices,
4) design of user interface,
5) use of geographical information systems and data bases,
6) mapping of location data.

As in Croatia all key players (mobile operators, manufacturers of mobile equipment and content providers) have reached the level that enables very fast LBS implementation the authors wanted to survey the potential used adoption of such services.

III. Types of Services

Data on location of mobile phone user has opened a wide spectrum of business possibilities. Until today many locations based services have been developed but continuously new services interesting to customers get discovered. There are many divisions and grouping of location services into specific groups. One of the most frequently used divisions has been given by Van de Kar and Bouwman [11] who have distinguished three types of services: emergency services, services of mobile operators and value added services (VAS), focusing on the last category as a primary opportunity for development of m-business. This group includes: information services, entertainment, communication services, transaction services, mobile office and business processes support services. Levijoki [12] offers a simpler categorization: collection, security, information, monitoring and proximity services. D'Roza and Bilchev [13] classify services into two groups: those requested by users once their location has been defined and those who start automatically once specific conditions have been met. Out of this division later other authors like Steinfeld [14] have developed a division to so called «*push*» and «*pull*» services. «*Push*» services are services when information is sent to the user proactively on the basis of a prior consent of the user that they want such a type of information (e.g. «*opt-in*» mobile advertisement). «*Pull*» services are services initiated by users themselves entering into a specific information area. One of the latest divisions by Huang and Wu [15] specially points out the factor of information dynamics and prefers division according to statistical and dynamic location services. Division preferred by authors in this paper is the division which considers the possibility provided by location services to m-business on two basic groups of location services:

- services for business between company and end users (B2C)
- services for business between companies (B2B)

and is based on [16] who within B2C service group have recognized three sub-groups: information, transactions and monitoring, while for the purpose of this paper 12 different applications have been constructed which we have separated into 7 basic groups of B2C applications.

TABLE I
Classification of Location Services

	Types of location services
Location services for business between company and end users Business -to-Consumer (B2C) LBSs	Emergency calls
	Information services, Travel services
	Navigation/Routing, Automotive assistance
	People and pet tracking
	Transactions
	Intelligent advertising (Banners, Alerts, Marketing)
	Entertainment
Location services for business between companies Business -to-Business (B2B) LBSs	Vehicle tracking
	Product tracking
	Traffic management
	Product replenishment
	Mobile sales
	m- customer support
	Field personnel support

1. Emergency, safety and medical services could give the location of patients who suddenly experience severe medical conditions. Using specialized cellular devices, it could be possible to transmit some basic medical data to a hospital or paramedics. Emergency service is designed in such a way to automatically forward every emergency call together with

coordinates of the caller to the center which is in that country in charge of emergency, security and medical calls. In many countries that is the 112 center.

But, it is not impossible to build onto such services added value and provide them also on commercial basis. For example, combination of LBS with telemedicine techniques where a person requesting help is sent back the data of psychological nature how to behave in a given situation, description of medical interventions the person can do themselves while waiting for rescuers etc.

2. Information services are services which could give you the location for example of the nearest restaurant or gas station. Information services are all the location services based on the location of user like weather forecast, tourist sights, restaurants, hotels, parking lots, public transportation, theater, cinemas etc. where the use of the information on the location of user gives more useful, better and more usable information [17]. In this segment of location services are unsurmised possibilities of development of specific location service products like for example in the USA popular service „I look for contractor" where with the question e.g. carpenter – user gets information on several such contractors registered nearest to their location.

3. Navigation/routing services - could give you turn by turn directions to your destination. Navigation services are in fact an upgrade of information services. With information services user wants and gets the information which identifies different destinations, and with navigation service that information is upgraded with a possibility of leading the customer along best routes to the desired location. Although already many car manufacturers equip vehicles with GPS systems, mobile devices with supporting location services should enable better mobility and flexibility of customers (the device is not connected exclusively to the vehicle) and combined with current traffic data will be able to select the fastest route for the customer. In the previous example of the service «I look for contractor» the navigation system is the upgrade of the information system that sent us information of the nearest contractors we are looking for and with the navigation system we can, without fear of loosing our way, come to the desired carpenter.

4. People and pet tracking services Location services can be used to track people, animals, objects, vehicles etc. That segment of location services causes most doubts ethic and privacy wise. Tracking services can help prevent thefts of valuables and people also (especially underage children) or pets. Tracking in combination with navigation services can ease delivery procedures and enable optimization of the delivery of objects to customers.

5. Transactions and billing services, In Japan and USA mobile operators started to offer special tariffing and collection services based on caller's location (e.g. in user's flat or house enabled is the identical price of calls from a mobile phone as from the land line), so that mobile operators would get biggest possible market share from classical land line operators. Mobile business services can include a use of wireless devices for tracking of for example theater tickets, cinema tickets or public transportation and for paying for goods in stores. For such transactions information exchange is demanded for payment between a wireless device and POS device in the store. In USA for example the company «Merchant Wired» equipped as early as 2001 its stores with wireless LAN network and enabled transactions in its stores via mobile phones with a discount for such payment since it did not require time and resources of their employees.

6. Entertainment services

From 2003, when the company «It's alive» developed the game «BotFighters» offered to customers by the operator «Telia Mobile» as a pioneer service from the field of entertainment based on location of users until today many products from the field of entertainment location services have been developed and it is expected that that segment will become the leading commercial segment of use of location services [18].

7. Advertising adapted to the user location

Basic idea of the intelligent advertising service is that users, who in advance have given their consent for such a type of location service, receive text or picture adverts onto their mobile phones according to their personal preferences and location. For example, the user receives a message to visit the technical equipment store they pass by because it holds sale and in CRM customer bases there is a datum that the customer is very interested in all types of technical goods and services.

For each of the stated types of LBS apart from the field of transactions and billing services applications where the proposed applications would, by author's opinion, look too imaginary since in Croatia they had no chance so far to see anything like that, we have created specific applications and tried to test the possibility of their use in the market.

IV. Materials and Methods

The goal of the survey is to test the possibility of adoption of LBS by end users taking into consideration aspect of user's privacy. Considering all prior stated we have decided to create three hypotheses which should mark basic trends in future development and adoption of LBS and be a starting point of future surveys.

Hypothesis of this work are:

H1. Users of mobile networks are willing to accept LBS.

H2. Student population has a higher level of adoption of LBS from the general population.

H3. Level of user adoption of LBS depends on user's opinion on perception of endangering user's privacy

To test the above stated hypothesis we have formulated a questionnaire with 15 potential LBS applications that we described and we offered to tested people possibility to choose between 4 levels of answers on future use of LBS: yes, maybe, no and I cannot answer (see appendix A). At the end of the questionnaire the tested people stated on the Lickert scale from 1 to 5 how much the stated services could jeopardize privacy of users

V. Results

A. Subjects

The 181 subjects in the first survey were Croatian students of the third year of a university course in information systems. They were highly computer literate and familiar with the Internet and various other information and communication technologies. Most of the subjects were 20-25 years of age (average 21 years), of whom 22% were female. Also, more than 98% of the subjects had used the mobile phone for 4 years of more, and more than 98% of them had used the Internet for 2 or more years.

The 180 subjects in the second survey were Croatian citizens, with following conditions:

- were mobile users at least one year,
- out of two respondents at least one was employed,
- both respondents were of different sex,
- none of the respondents was below 18 and over 55 years of age,

Sex of the respondents: 94 women and 86 men.

Education degree of respondents: non skilled – 3, secondary education - 94, associate degree – 31, university degree - 48 and masters or PhD degree – 4. This structure of respondents should represent an average sample of general population.

Demographic indicators of respondents from both surveys are illustrated in Table II.

TABLE II
RESPONDENT DEMOGRAPHICS

Sample	1. survey – students (N=181)	2. survey Croatian citizens (N=180)
Gender	**%**	**%**
Female	22	48
Male	78	52
No skills	-	1,7
Secondary education	-	52,2
Associate degree	-	17,2
University degree	-	26,7
Masters degree or PhD	-	2,2

B. Descriptive Statistics

Results show a high level of interest for all proposed types of LBS with both population groups and are shown in Table III. These results prove the hypothesis 1 that Croatian mobile users are willing to accept LBS.

TABLE III
RESULTS PRIOR TO ADOPTION OF LBS

Type of services	I will use this service (%)		I will maybe use this service (%)	
	students	citizens	students	citizens
Emergency	Not tested	87,8	Not tested	10,6
Navigation	56,2	71,2	32,6	19,2
Information	54,3	42,2	31,7	30,7
Tracking	48,3	32,1	26,9	29,6
Entertainment	22,6	8,9	38,5	27,8
Intelligent advertising	41,4	31,7	32,6	21,1

Since the first survey on student population with a questionnaire did not contain the question on adoption of emergency services in Table III. there is no data on potential adoption of that service among student population. If we analyze in more detail the adoption of certain types of applications it is visible that emergency services and navigation have by far the highest percentage of adoption, but since we offered to respondents a higher number of information services we must differentiate adoption of e.g. cultural and art events with 51,8 % with general population as opposed to information on disco and night clubs where the adoption is 32,6 % with general population. Student population on the other hand show the highest interest for student restaurants 68,5 %, disco and night clubs 63 %, cultural and art events 55,8%, while in the end is interest for cultural-historical monuments and institutions with 45,3 % and cinemas with 44,2 %. Also the interest is much higher for tracking applications related to vehicle tracking then for people tracking (difference in adoption percentage is more than 10%). In bigger towns, e.g. Zagreb, there is almost 90 % interest for the service of navigation to a free parking space with general population.

Although the student population, which is highly computer literal, shows a higher interest globally for LBS applications, one cannot claim in general that they have a higher LBS adoption then the general population since for some segments of LBS applications (e.g. navigation) they show less interest than the general population and it can be considered that the hypothesis H2 is partially proven. These results point out to the future market segmentation considering the demographic characteristics of LBS application users.

Since the first survey on student population was initial, we have done the second survey in more detail and, during the analysis, we noticed several other behavior trends on the general population. In the second survey out of all 15 created applications from the questionnaire, one unique scale of user acceptance of LBS with alpha = 0.83, Cronbach consistency factor, can be created. When one makes a correlation with the criteria factor which is in fact the response to the question how much the stated service jeopardize the privacy of users one gets a correlation ($r = -0.17$, $p < 0.01$) which defines the negative connection between the adoption of LBS and opinion on danger to the privacy of users which proves the hypothesis H3. In the following surveys we will try to additionally survey which social features of users impact their perception of ethics and privacy of use of location services.

Both surveys have shown some common correlation links which should in future be additionally surveyed. For example, only a small statistically significant correlation ($r \approx 0.10$, >0.01) was found between the adoption of some application and gender, indicating that the male subjects in our survey would probably be more inclined to use various LBSs and in future surveys impact of demographic features of users on potential adoption of location services will be additionally researched.

VI. Conclusion

Since the results of the survey show a very high number of users interested in navigation services (10% - 20% more than in average for the offered package of location services) and considering the tourist potential of Croatia which is annually visited by several million foreign tourists, the implementation of certain services of navigation to tourist destinations is soon to be expected.

After those pioneer services for foreign tourists (roaming users), from the area of location services all other services will start to be developed which will be accepted by domestic users but in the first place, services more users are interested in according to the conducted opinion polls, e.g. navigation to desired destinations and free parking spaces in bigger towns, tracking of underage children etc. A full demographic market segmentation needs to be done considering individual types of LBS applications since it is obvious that certain applications are much more adopted by certain demographic groups and in that sense additional surveys need to be done in future.

Of course, mobile operators are not the only players in the market that dictate the tempo of implementation of location services. Manufacturers of mobile devices must recognize that the time has come to install GPS devices in mobile terminal devices because this is a prerequisite to use location services. In this chain of important players in the market of location based services companies that will create location service applications are also important and they will offer them to operators.

Appendix A

List of potential applications of LBS

YES MAYBE NO ?	When you are traveling geographical position or position on the city map with your mobile phone, with input of area map on mobile phone.
YES MAYBE NO ?	Info o cultural, art, sports and other events in towns you come to and locations on town maps with instructions on how to reach the destination.
YES MAYBE NO ?	Info on disco clubs, night clubs and other places with music with their opening hours and current events and with location on town maps and instructions how to reach the destination.
YES MAYBE NO ?	Various other information that include tourist information, marketing messages, availability of service (e.g. free rooms in hotels or tables in restaurant) etc., with an illustration of location on map which is read on a mobile phone and according to need, leading to the approximate location.
YES MAYBE NO ?	Info on sales actions and discounts in technical, furniture, clothes, food and other stores, with an illustration of location on the map which is read on the mobile phone and according to need, leading to the approximate location of the store.
YES MAYBE NO ?	Instructions to move in a specific geographical area with reading of the map and mark of own location as well as the location of the building on the map where I want to come (if it is in the data base, i.e. if I know its address or position).
YES MAYBE NO ?	Data that enable tracking of location where a personal vehicle is situated (motor, car, truck) or a vessel (boat, yacht or ship) owned by the service user, with reading of the map of area on mobile phone and according to need, leading to their approximate location.
YES MAYBE NO ?	Data relating to tracking and informing on positions of other persons who approved the sending of information on their location (family members, friends, spouses, members of sports team, business associates etc.) with reading of area map on mobile phone and according to need, leading to their approximate location.
YES MAYBE NO ?	Data relating to locations of persons one wishes to establish a friendship or romantic liaison (combined with service for meeting new people or establishing romantic liaisons), with reading of area map on mobile phone and according to need. Leading to their approximate location or agreed meeting point.
YES MAYBE NO ?	Data containing the information on free parking space, their reservation and leading to them.
YES MAYBE NO ?	Data relating to tracking and informing on position of pets.
YES MAYBE NO ?	Playing interactive games based on our location or location of other participants.
YES MAYBE NO ?	Emergency service – i.e. calling 112 in case of emergency where 112 service locates you and sends help.
YES MAYBE NO ?	Reception of information on marketing actions in stores near the place you are at.
YES MAYBE NO ?	Other similar services I can subscribe to or get upon request.

How would the stated service jeopardize privacy of users?
Not at all a bit some a lot very much

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