Mathematical Model to Study the Cost Effects and Mobile-Users Trust on Location based Data Access in Mobile-Commerce Transactions

RPS. Tomar, Ph.D.
Director-MCA, IPEM,Ghaziabad(India)

Archana Sharma
Asstt. Prof., IPEM,Ghaziabad(India)

ABSTRACT
In location based M Commerce services, the service provider provides service to mobile users like their locations with a certain level of granularity to maintain a degree of secrecy. This level of granularity depends on their perceived risk as well as the incentives they receive in the form of monetary benefits or improved M-Commerce services. The factors included perceived risk are unauthorized access hidden and unconsciousness computing derived from mobile applications. Thus, perceived risk has a negative effect on intention to use M – Commerce by mobile users. To build the trust in the mobile user and to reduce the access cost of the M-Commerce, a mathematical Model using Mixed Integer Programming has been developed.

Keywords
Perceived Risk, LBS, HLR, M-Commerce, LPP

1. INTRODUCTION
In M-Commerce the mobile users can request services through their mobile devices via Information Service and Application Provider (ISAP) from anywhere at any time. M Commerce is based on the cellular network composed of several base stations. The communication coverage of each base station is called a cell as a location area. The area of a cell is the radrial distance between two cells. When users move within the mobile network, their locations and service requests are stored in a centralized mobile transaction database. The location plays an important role for M-Commerce applications with relative success of click and mortal E-Commerce applications which uses information on the geographical position of the mobile device.

Due to expansion of smartphone in market the LBS are used in a variety of contexts, such as health, entertainment, seeking information to identify ATM locations, Weather forecasts, vehicle tracking, receiving alerts, location based advertising, payments for tickets at theaters and on public transportation and vending machines, warning of traffic jam etc. But the utilization of wireless data services is far below the expectations of network operators[1].

Generally, Location Based Services integrate a mobile device's location with other information in order to provide added value to the user [2,3]. Location Based Services have become a global phenomenon due to advances in Wireless Communication Technology and the popularization of mobile phones [4]. The mobile users get benefit from a service provider by disclosing their location with certain degree of accuracy[5] in Location Based Services of M-Commerce. At the same time, disclosing their location information bring users certain risks and compromises their privacy [6], which reflects the potential losses associated with the release of personal location information to the LBS provider [7]. A mobile user's privacy come forward if he feels that his information is exposed and he is not able to control his personal information[8]. The individuals' concern about information privacy may have four dimensions– collection of personal information, unauthorized use of personal information, errors in personal information, and improper access to personal information [8]. There are additional apprehension about the information privacy in M-Commerce transactions that there is perceived risk related to fraud and inappropriate product quality.s. Thus, perceived risk has a negative effect on intention to use M – Commerce by mobile users.

2. PROPOSED MODEL
As a mobile user with wireless data services, it is is crucial for him to access location-based services. There are different perceptions of mobile users about LBS services as these are 'value added service' rather than 'must have service by considering the accessing cost. User think that LBS services will be more attractive to use, if mobile network operators make these wireless data services more affordable or free for users. Therefore, the success of location-based services is affected by the cost of wireless data Services.

Thus with the help of this paper, a model has been developed to minimize the cost, time and increase user satisfaction to build the trust in M-Commerce.

In general, with the change of user's location a previous query may become invalid. As a result, the user may have to avoid doing the broadcast channel repetitively [9]. Due to this effect, it significantly increases not only the access time but also the access cost involved. Data caching has been proposed for reducing access latency and access cost in Location- Based query processing to improve mobile communication services. Data caching is a data replication mechanism in which copies of data are brought to a mobile unit as a response to a query and retained at the cache for possible use by subsequent queries thereby improving data accessibility and minimizing access costs. The idea behind pre-fetching is to transfer information, which the user might need in the future, so that it is already stored in the mobile user's cache when it is accessed [10,11]. In mobile environment, the usage of uplink and downlink channel has to be taken into serious consideration and also the usage of uplink channel increases the communication cost [12].

Three factors location, volume and time have been considered in this proposed model to discuss the affect of these factors on cost of M- Commerce due to cell change of mobile user and how M -Commerce can be better utilized by Mobile User. The total cost of mobile transaction can be optimized, if access cost could be minimized. The perceived risk to use the M Commerce service can be analyzed.

If the following three parameters are maintained then the cost of Mobile Commerce can be further reduced and services can be made more attractive. Caching and pre-fetching has been adopted[13] to increase the performance of information transformation in mobile requirement and the quality of LDS can be further updated to reduce the congestion.

2.1 Location:

LBS have been introduced in various applications scenarios such as location identification. Location identification for a mobile user depends upon the radial distance of the cell and also the mobile customer identify mentioned in the Home Location Register (HLR). Because the mobile user is not having a fixed location so the location is not fixed but the location based services are fixed.

2.2 Volume:

In case for a mobile user say 'x' the services are available in the same cell then the volume will not increase but the traffic volume will increase in case the customer is on the move and the services are not access at the same point of time to many users.

2.3 Time:

With the exponential growth & demand of M-Commerce, congestion is the main problem for services. Congestion may be reduced by increasing the cell area or configuration of the new cell and optimization of data Traffic.

3. PROPOSED MODEL FOR COST SAVINGS DUE TO CHANGE OF CELLS: MIXED INTEGER PROGRAMMING(MIP) APPROACH

Today lot of challenges with the M-Commerce Services Providing Companies due to the rate of mobility of customer. So swapping or exchange of information among the service providers is collaborative in one way or another . As Hussain R.[15] developed a MIP model to give a scientific approach to change of cells. This model emphasis on the Volume, Location and the Time of the change of location in order to better utilization of services in a particular cell and maximizes the saving or reducing the mobile cost further.

Hypothetically (say) there are 5 cells in a Region 'R1'. In this Region, it is to determine where to locate a cell but the location of mobile service providers may be in either of the cell. The minimum numbers of service providers are also varying from cell to cell. It is assumed that minimum distance is 15 Km. among the service providers.

Table:1
Cells

		To				
	From	1	2	3	4	5
Cells	1	0	10	20	30	30
	2	10	0	25	10	20
	3	20	25	0	15	30
	4	30	35	15	0	15
	5	20	20	30	15	0

Then there are two possibilities

$X_i = \begin{cases} 1 \text{ if a service provider is in cell one.} \\ 0 \text{ otherwise} \end{cases}$

Objective Function: Total No. of service operators provide services

Min $Z = x_1 + x_2 + x_3 + x_4 + x_5$

S.T. constraints:

A service provider within 15 KM of each cell. The location that can reach each cell is 15 km.

cell1	1,2	$x_1 + x_2 \geq 1$	(cell1 location)
cell2	1,2, 4	$x_1 + x_2 + x_4 \geq 1$	(cell2 location)
cell3	3,4	$x_3 + x_4 \geq 1$	(cell3 location)
cell4	3,4,5	$x_3 + x_4 + x_5 \geq 1$	(cell4 location)
cell5	4,5	$x_4 + x_5 \geq 1$	(cell5 location)

$x_i = 1$ or 0; i= 1,2 ..5

Result: From the above matrix, it is true if the services are available in the same cell to a customer then $x_i = 0$ and if distance is less than 15 Km. for getting a service then $x_i = 1$.

Here an optimum solution Z =2 if $x_2 = x_4 = 1$ and $x_1 = x_3 = x_5 = 0$

i.e. the Minimum cost incurred will be if the distance is 2 Km among the User and Service provider.

3.1 Service is Available in the Same Cell and User is getting it

The mobile user uses a wireless broadcast channel to prefetch data that are expected to be used in the near future and caches and maintains the data at a location close to the Service Provider's location as 2 km. in previous example. Pre-fetching can be performed without adding any load on shared resources such as wireless bandwidth [14]. In pre-fetching, the user prefetches the contents in anticipation of future accesses. In general the query result depends on the geographical location where the query originates and that result may be valid only in a particular region. For location-dependent data, valid scope areas have been considered as an indicator of the access probabilities for different data values. The probability of access the data will higher in case of large region as compare to small region.

The Linear Programming (LP) Models (Non-Change of the cell model) NCLP, thus provides an LP model to minimize M Commerce cost under certain constraints. (1) the distance which can be greater than radial distance of the cell (2) time to access the services (3) No. of customers access the service at the same point of time.

The NCLP Model provides a basis for comparison to evaluate the advance of change LP (CLP) over NCLP. It is followed by following Scenarios. In the LP Model without Change (NCLP), if we assume two service providers in the same cell say firm 'X' and 'Y' respectively, when each firm provide service to its own customers. i.e there is no change of customers.

Optimum Function 1

$Z_1 = Min \sum_{i=1}^{n1} ci\ xi$

Subject to the Constraints (s.t.)

(i) $\sum_{i=1}^{n1} xi \leq S_x$

(ii) and $x_i = b_i$ i=1,2,….n_1

with a Restriction
$x_i \geq 0 \quad \forall\, i$

Optimum Function 2

$Z_2 = Min \sum_{j=1}^{n2} dj\ yj$

Subject to the Constraints (s.t.)

(i) $\sum_{j=1}^{n2} yj \leq S_y$

(ii) and $y_j = b_j$ j=1,2,……..n_2

with a Restriction

$yj \geq 0 \quad \forall j$

Where

x_i = Amount & type of service / information from firm 'X' to its i th customer.

c_i = Cost per Service / Information transmitted from firm 'X' to ith customer.

b_i = Amount of time required from firm 'X' by its ith customer.

y_j = Amount & type of service / information from firm 'Y' to its jth customer

d_j = Cost per Service / Information transmitted from firm 'Y' to jth customer.

b_j = Amount of time required from firm 'Y' by its jth customer

S_x = Total Services available with firm 'X'

S_y = Total Services available with firm 'Y'

n_1 = No. of Customers with firm 'X'

n_2 = No. of Customers with firm 'Y'

There are various solutions for these two LP Problems. The following four models designed (as proposed by Khorramshahgal, el. Al [15].

3.1.1 Scenario-1: No Change of Customers or Services

Both firms satisfy their own customers & no risk from customer point of view.

Min c = $\sum_{i=1}^{n1}[c_i x_i + d_i' y_i') + \sum_{j=1}^{n2}(d_j y_j + c_j' x_j')$

s.t.

$$\sum_{j=1}^{n2} x_j' = \sum_{i=1}^{n1} y_i' \qquad - (1)$$

$$\sum_{i=1}^{n1}(x_i + y_i') \leq S_x$$

This equation represents the total amount of information transmitted by company 'X' for the customer of company 'Y' and vice –verse but total amount of information transmitted by companies are same.

$$\sum_{j=1}^{n2}(y_j + x_j') \leq S_y$$

$$x_i + y_i' = b_i \quad i = 1 \dots \dots n1$$

$$y_j + x_j' = b_j \quad j = 1 \dots \dots n2$$

$$x_i, y_i', y_j, x_j' \geq 0 \quad \forall\ i \text{ and } j$$

where

y_i' = Amount of information transmitted from Y to the ith customer of X.

x_j' = Amount of information transmitted from X to jth customer of Y.

d_i' = Cost per transaction of service from Y to the ith customer of X.

c_j' = Cost per transaction of service from X to the jth customer of Y.

3.1.2 Scenario 2: Restrictions on Change of Services based on Percent of Capacity

Here upper limit is imposed on the total services available due to the following reasons.

1. Inter change of services is risk because of leak of identity of the customer.
2. Service limitation by both the companies.
3. Firms want to fix its customer for future business.

To accommodate for the restriction on change of services, the following constraint must substitute constraint (1) in Scenario (1)

$$\sum_{j=1}^{n2} x_j' + \sum_{i=1}^{n1} y_i' \leq .3(S_x + S_y)$$

The choice of 30% change of services is for illustration purpose. It can be chosen any percent as per the common consent.

3.1.3 Scenario 3: Services not Available in Same Cell, Customer is supposed to Change the cell for getting Services

The second cell has its own capacity of customers; it may or may not accept the customer of another cell. Before acceptance, this cell may assume/ensure the possible services to the customer.

The following two constraints also substitute in equation (1) information of scenario (1)

$$\sum_{j=1}^{n2} x_j' \leq .4\ S_x$$

$$\sum_{i=1}^{n1} y_i' \leq .4 S_y$$

40% change of services has been taken for illustration purpose. The two firms can use any number.

3.1.4 Scenario 4: Some Specific Services can be excluded from Change

In M-Commerce customers are based upon the specific services e.g. Hospitals, Banking, Restaurant etc. Here change of service provider is not possible or the service is denied. This is because of a high order quality and the company wanted to maintain a long relationship. Here the two extra constraints are needed to add.

$y_i' = 0$ Where $i \in i'$

and

$x_j' = 0 \quad j \in j'$

3.1.5 The Combined Model

The following model combines all the previous four Scenarios to include various Constraints that two service providers may consider a change to reflect their prospective customers for various degree of change.

Min c = $\sum_{i=1}^{n_1}(c_i x_i + d_i' y_i') + \sum_{j=1}^{n_2}(d_j y_j + c_j' x_j')$

s.t. $\sum_{j=1}^{n_2} x_j' = \sum_{i=1}^{n_1} y_i'$

$\sum_{j=1}^{n_2} x_j' + \sum_{i=1}^{n_1} y_i' \leq .3(S_x + S_y)$

$\sum_{j=1}^{n_2} x_j' \leq .4 S_x$ and $\sum_{i=1}^{n_1} y_i' \leq .4 S_y$

$y_i^{'} = 0 \ i \in i^{'}$

$x_j^{'} = 0 \ j \in j^{'}$

$x_i, y_i^{'}, y_j, x_j^{'} \ \geq 0 \ \forall \ i \ and \ j^{'}$

In this model the two service providers not only change same amount of services, but they are also taking into consideration other limitations, such as total no. of services available, while restricting the changes to select customers.

The following two variations namely weighted customers and MINMAX risk approach in this paper is only for illustration purpose and examples.

4. MINMAX RISK APPROACH

The customer feels that the M Commerce services are risk oriented eg. (1.) Disclosure of identity/password. (2) Product is not timely available. (3.) Quality of product. We consider a Risk Min Function.

$Min \ \sum_{i=1}^{m} (\frac{u_i}{w_i}\frac{n_i}{} + \frac{v_i}{w_i}\frac{p_i}{})$

s.t. $f_i(x) + n_i - p_i \ = b_i$ where i=1…..m

$x \in C_s$

$x \geq 0, n_i \ p_i \ \geq 0$ i=1.......m

Where n_i is the i^{th} low risk variable.

u_i = weighting factor of low risk variable i.

w_i = normalization factor related to risk variable i.

p_i = is the i^{th} high risk variable.

v_i = weighting factor for high risk variable i.

fi(x) = is the i^{th} Objective Function.

x = vector of decision variables.

b_i = is the i^{th} target value.

C_s = optimal set of hard Constraints.

Each objective function f_i (x) is given a target value bi the low risk variable, n_i, measures the amount of under achievement of the target and the over achievement is measured by the positive risk variable ‘p_i’. The unwanted risk from the target value (e.g. low risk from profit target, or positive risk from capacity target) is then placed in the achievement function to be minimized, the value of u and v are set to reflect the decision maker’s preferences.

The normalization constraint w_i can be written as

$$w_i = \sqrt{a_{i1}^2 + a_{i2}^2 + .. a_{in}^2}$$

This depends on the goal value $\sum_{j=1}^{n} a_{ij} \ x_j + n_i - p_i = b_i$

5. EXAMPLES: SERVICE ACCESS COST IN INDIAN PERSPECTIVE

The data in this section, presented in Table 2 and Table 3 is composed of the service and access costs. Even though these figures simply reflect the opportunity (monitory) costs of supply of services, they can be actual figures incorporating factors such as risk, quality and type of the srvices (eg, Railway Ticket Reservation). The costs in table 2 & 3 provides the cost (in Indian Currency) per route Km, type of services supply to M – Commerce customers by two companies X and Y i.e for each service providers, These tables present the cost of supply to its own customer and its competitor’s customers.

The data in table 2 indicate that the cost for Service Provider –X to supply its customer one is free of cost. However, Service Provider–Y can supply the same customer of ‘X’ for only Rs. 10 per service including the access cost. The rest of the data in table 2 & 3 can be interpreted in similar manner.

Table : 2 Cost per service of supplying customers of ‘X’

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5
X. customers	1	2	3	4	5
From X(c_i)	0	2	4	6	8
From Y($d_i^{'}$)	10	12	14	16	18

Table: 3 Cost per service of supplying customers of ‘Y’

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5
Y. customers	1	2	3	4	5
From Y(c_j)	0	4	8	12	16
From X($d_j^{'}$)	8	12	16	20	24

The service providers estimated their total revenue during the planning period under consideration to be Rs. 100/- for customers of ‘X’ (denoted by S_x) and Rs 80/- for customers of ‘Y’ ($S_{y).}$

6. RESULT

Table 4 below gives the solution to the two service providers change of all cell problem for LP and MINMAX Model, presenting the total cost and amount of information required from one cell to another cell. MINMAX is the result for experiments where all the unwanted risk from their target values are treated by giving the weight 1 i.e equal v1=v_2 = v_3= v_4 =v_5 =u_1=u_2 = u_3 =u_4 = u_5 =1. If the above said weight changed then the result may also change. The table 4 also indicate the total cost of transition of data in terms of radial distance from cell to cell and the service provider point of view of two companies ‘X’ and ‘Y’ which is absence of change of cell.. The cost decreases according to the radical distances congestion in cells, and the availability of service as by desire of the customer. Authors taken this cost as per their wide experience as using mobile service to save the logistics.

Table :4

Mode	Total Cost	X to Y Customer	Y to X Customer
LP without change of cell	80	Nil	Nil
LP with change of cell	1000*	100	80
MINMAX**	50	20	20

*If the services are accessed 100 times in a year a Rs. 10/- per access

** The Risks are considered Min during transaction of services.

7. CONCLUSION

The authors effort in this paper to enhance the applications of Linear Programming for optimization of cost with a single objective for change of cells analysis point of view in the mobile industry. Change of cells by the mobile users is a prevailing phenomena and each cell may have different service providers. The multi-objective approach is also application if the cells are changing frequently by the mobile users.

Multiple risk with the change of cells are also pre-dominated or M-service providing companies X and Y as mentioned in this paper authenticate to each other not to disclose the identity or other confidential data of individual user. The illustrated examples depict real world situations and scenarios were developed through authors experience and interview of service providers. As discussed in the results and evaluated in terms of criteria such as cost savings, services requirements. The proposed models offer flexible and practical scenarios, allowing the SPs to consider viable alternatives, performance & minimize Risk and outcomes to reduce the cost and plan to add more and more M-Commerce services in India and internationally which can be further utilized to save the logistics.

8. REFERENCES

[1] Dhar, S., & Varshney, U. (2011). Challenges and Buesiness Models for Mobile Location-Based Services and Advertising. Communications of the ACM, 54(5), pp. 121-129.

[2] Barnes, J.S.,(2003) " Known by the Network: The Emergence of Location -Based Mobile Commerce" In E.P. Lim and K. Siau (eds.), Advances in Mobile Commerce Technology. Hershey, PA: Idea Group: 171 – 189.

[3] Xu, H. and S. Gupta,(2009) "The Effects of Privacy Concerns and Personal Innovativeness on Potential and Experienced Customers' Adoption of Location Based Services," Electronic Markets , Vol. 19, No. 2: 137 -149.

[4] Rao, B. and L. Minakakis,(2003) "Evolution of Mobile Location Based Services," Communications of the ACM , Vol. 46, No. 12: 6 1 65, 2003.

[5] Berg Insight,(2012)"Mobile Location-Based Services," http://www.berginsight.com/ReportPDF/ProductSheet/bi-lbs4-ps.pdf, 2012.

[6] Junglas, I. A. and R.T. Watson,(2008) "Location-Based Services," Communications of the ACM, Vol. 51, No. 3: 65-69.

[7] Xu, H., X. Luo, J. M. Carroll and M. B. Rosson,(2011), "The personalization privacy paradox: An exploratory study of decision making process for location-aware marketing", Decision Support Systems, Vol. 51, No 1: 42-52.

[8] Sheng, H., Nah, F.-H., & Siau, K. (2008). An Experimental Study on Ubiquitous Commerce Adoption: Impact of Personalization and Privacy Concerns. Journal of the Association for Information Systems, 9 (6), 344-376.

[9] D. L. Lee, W.-C. Lee, J. Xu, and B. Zheng,(2002), "Data management in location-dependent information services: Challenges and issues," *IEEE Pervasive Computing*, Vol. 1, pp. 65-72.

[10] H Kirchner, Reto Krummenacher1, David Edwards-May2 and Thomas Risse1,(2004) "A Location-aware Pre-fetching Mechanism", Fourth International Network Conference: Plymouth, UK, 6-9 July 2004. Plymouth: University Plymouth, pp. 453-460.

[11] Y Saygin , Ozgur Ulusoy and Ahmed K. Elmagarmid(2000), "Association rules for supporting hoarding in mobile Computing environments", Proc. Tenth International Workshop on Research Issues in Data Engineering, Page(s):71–78.

[12] Sang-Won Kang, Joon-Min Gil, SangKeun(2007), "Considering a User's Mobility and Query Patterns in Location-Based Services", Proc. Of the ACM conf Mobility'07 conf.

[13] Sharma, Archana, Tomar RPS(2013), 'Simulation Framework of Caching Techniques for Adoptability of M-Commerce in Location Based Services' International Journal of Computer Application (IJCA), Vol 84, issue 2.

[14] V. Grassi, "Prefetching policies for energy saving and latency reduction in a wireless broadcast data delivery system," in *Proceedings of International Workshop on Modeling Analysis and Simulation of Wireless and Mobile Systems*, 2004 pp. 77-84.

[15] Khorramshahgol R, Tamiz, M. and Al –Hussain. R,(2010) 'Application of Linear Programming to Swap Analysis in SCM of Oil Industry' Journal of Information and Optimization Science. Vol 31(6), pp. 1375-1388.