

Promoting Usage of Location-based Services, an Approach Based on Intimacy Theory and Data Mining Techniques

Dapeng Zhao¹, Jinhwa Kim^{2*} and Mina Woo²

¹Korea Advanced Institute of Science and Technology (KAIST), 291 Daehak-ro, Guseong-dong, Yuseong-gu, Daejeon, South Korea; dapeng@kaist.ac.kr

²Graduate School of Business, Sogang University, 35 Baekbeom-ro, Daeheung-dong, Mapo-gu, Seoul, South Korea; jinhwakim@sogang.ac.kr, drminawoo@gmail.com

Abstract

Objectives: To explore factors pertain to Smartphone users' resistance to location-based services using data mining techniques, and to develop strategies to promote the usage of LBS. **Methods:** To analysis Smartphone users' characteristics and conduct user segmentation, we used K-mean clustering to segment 165 Smartphone users based on their intimacy with service providers. Then, decision tree analysis was used to explore the characteristics for each user group. At last, the association rule analysis was used to figure out the relationship among users' Smartphone usage patterns and their willingness to use LBS and willingness to provide location information. **Findings:** The result shows that Smartphone users can be clearly categorized into five groups based their intimacy towards LBS providers. The user group that showed the highest intimacy to service providers is also characterized as high willingness to use LBS and also high willingness to share their location information. Also, we explored the factors that prevent users from disclosing their location information and factors that facilitate users to use LBS for each users group respectively. The results suggest that in addition to the privacy concern, the concerns of battery life, data usage and perceived low usefulness are also accounted for users' hesitation to share their location information to use LBS. The high needs of life information (traffic, weather and restaurant), high frequency of outdoor activities, friends' recommendation as well as unlimited data plan were associated with users' high intention to use LBS. Based on the association analysis result, the promotion strategies were developed for each user group respectively. **Applications/Improvements:** This study extends the knowledge of factors hinder users from using LBS, and also provides LBS providers with practical insights about how to promote users to a higher intimacy group.

Keywords: Association Rule Analysis, Decision-tree, Intimacy Theory, Location-based Services, User Segmentation

1. Introduction

With the increasing popularity of Smartphone, various kinds of applications providing Location-Based Services (LBS) have been developed in today's mobile service market. However, lots of Smartphone users are not willing to share location information to use LBS. According to previous studies, the privacy concern is one essential factor that accounts for this phenomenon¹. Lots of studies have been done to promote the usage of LBS; however,

conventional studies on mobile service personalization do not take the customers' perceived intimacy level into consideration². In the absence of knowledge about how intimacy influence the users' intention of using LBS and their willingness to share location information, in this paper, we used the Bubble theory³ and the intimacy development model⁴ as theoretical background, and used data mining techniques include decision three, k-mean clustering, and association rule analysis to analyze the people's Smartphone usage data to develop appropriate

*Author for correspondence

LBS promoting strategies from the customer relationship management (CRM) perspective.

2. Literature review

2.1 Intimacy and Bubble Theory

Edward Hall suggests that people are surrounding with others with a 'Bubble' of personal space³. According to Edward Hall, the inter-personal distances between different people can be divided into 4 kinds: from 0 to 1.5 feet is an intimate distance; from 1.5 to 4 feet is personal distance; from 4 to 12 feet are social distance, and the distance which is further than 12 feet can be seen as public distance.

2.2 Bubble Theory on Dynamic Web Personalization

In accordance with Edward Hall's research, suggests the Bubble Theory² can also be extended to measure the intimacy level between users and service providers. In² argues that the mass technology users can be divided into four kinds of groups in terms of intimacy distance. The group shows minimum distance can be categorized as the idealized group in terms of intimacy with services provider.

2.3 Intimate Experience and Intimate Behavior

In⁶ defined intimacy as an interpersonal process that results from the intimate interaction between two people⁵. According to⁶, the process of intimate interaction contains two important parts: Intimate experience and Intimate behavior. Intimate experience refers to the positive feeling evoked by the counterpart who received the personal information and response with emphatic behavior actively. Intimate behavior includes disclosing personal information or preferences⁶.

3. Proposed Work

3.1 Data collection

The data was collected from 165 participants in three universities locate in Seoul, Korea through questionnaire survey. The data used for analysis consist of 35 variables,

including demographic information, user mobile use patterns, actual LBS app usage situation and attitudes regarding LBS.

3.2 Test method

We use three kinds of data mining techniques for analysis purpose: first, we implemented the K-mean clustering to segment the participants into different groups based on their perceived intimacy level to service providers⁷. Second, we conducted the decision tree analysis using SAS to explore the Smartphone usage characteristics for users in different clusters. At last, an intra-clustering analysis was conducted using association rule analysis⁸ to explore the factors associated with two clustering criteria: Intimate Behavior and Intimate Experience for each user group, and to extract meaningful association rules, which can be used for targeting and developing strategies for mobile application market.

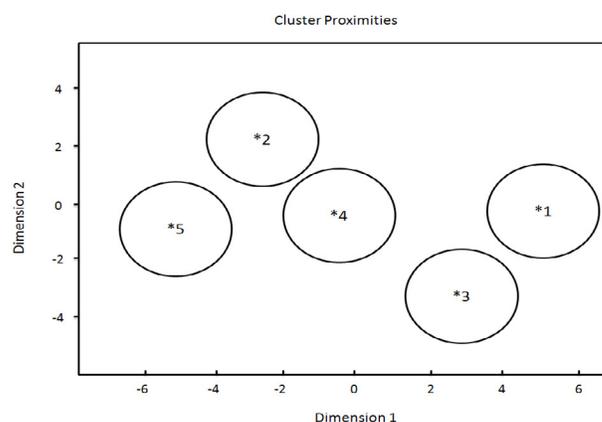


Figure 1. Distance between 5 clusters in terms of selected criteria.

3.3 Results

3.3.1 Test Result

We segmented the 165 participants using a K-mean clustering algorithm with respect to the factors reflecting users' intimacy level to service providers: factors about intimate behavior and expectation of intimate experience. For the selection of cluster numbers-K, we tried different alternative K-values varied from 2~10. (The maximum K value was selected as 10 because too many clusters will reduce the practical meaning of classification and make it hard to generate due to over-fitting problem) Some of

the K-values either gave rise to significant imbalance in the users' number in each group or failed to clearly divide users. Only when we use 5 as the K-mean with a Newton algorithm generated most balanced and clearly-divided clustering results, as shown in Figure 1.

The distance among different Smartphone user groups and the frequency of each cluster was shown in Table 1.

Table 1. Description of Clustering Result.

Cluster	Frequency	Nearest Cluster	Distance to Nearest Cluster
Cluster 1	42	Cluster 3	2.01277
Cluster 2	12	Cluster 4	1.95688
Cluster 3	24	Cluster 1	2.01278
Cluster 4	50	Cluster 2	1.95687
Cluster 5	37	Cluster 2	2.26358

In order to explore the other Smartphone usage characteristics for different user groups all in addition to users' intimacy to service providers the decision tree analysis was also conducted. Based the decision three analysis result, we can identify the specific criteria which automatically be selected in clustering analysis process.

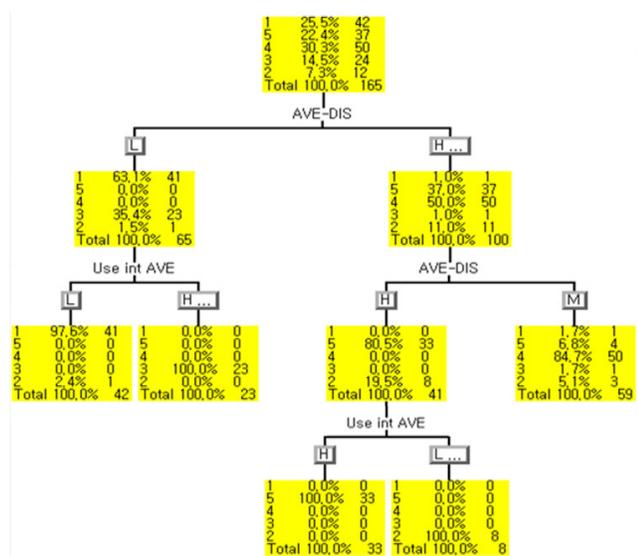


Figure 2. Decision tree analysis-intimacy level for each cluster.

Description of Clustering Criteria: AVE-DIS: Willingness to disclose personal information; Use int AVE: Intention to use LBS for personalization. (L: Low level, M: Middle level, H: High level) show in Table 2.

Table 2. User group characteristics.

User groups	Willingness to disclose personal information	Intention to use LBS
Cluster 1	Low	Low
Cluster 2	High	Low
Cluster 3	Low	High
Cluster 4	Medium	Medium
Cluster 5	High	High

From the results of decision tree analysis which as shown in Figure 2, the Willingness to Disclose Personal Information⁸ and Intention to use location-based services^{9,10} were selected by SAS as criteria for clustering in order to make each cluster far away from each other. Also, in terms of LBS usage the cluster 5 which as characterized as high willingness to use LBS and also high willingness to share their location information. These characteristics make the cluster 5 user group the idealized user group which showed the highest intimacy to service providers and the target group for users in other groups to become.

3.3.2 Intra-Cluster Association Rule Analysis

Table 3. Rules related to intimate behavior- Willingness to disclose Personal Information for Cluster 1.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.02	40.48	100	Invasion Experience(High) ==>Disclose Pers-Info. (Low)
1.02	57.14	100	Sens-GPS (High) ==>Disclose Pers-Info. (Low)
1.02	42.86	100	Hangout Habit (High) ==>Disclose Pers-Info. (Low)
1.02	45.24	100	Privacy Concern (High)==>Disclose Pers-Info. (Low)
1.02	42.86	100	Trust (Low) ==>Disclose Pers-Info. (Low)

For users in cluster 1, as shown in Table 3 and 4, factors account for their low willingness to disclose personal information are: the past personal information invasion experience, the high information privacy concern, and

low trust towards service providers. In addition, regarding the intimate experience expectation, it can be seen that factors that account for users' low intention to use LBS apps are: the highly battery consumption concern lead to rarely open the GPS function, they are late/mass technology adaptors in the technology adoption circle. Also, the low perceived usefulness of used of is another reason account for their low intention to use LBS.

Table 4. Rules related to intimate experience-intention to use LBS to received personalized services for Cluster 1.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.03	59.52	83.33	Tech Adopt Circle(Late) ==>LBS Use Intention (Low)
1.02	66.67	77.78	GPSOpen(Low) ==>LBS Use Intention (Low)
1.01	42.86	81.82	Tracking(Low) ==>LBS Use Intention (Low)
1.06	42.86	85.71	Info.-search (Low)==>LBS Use Intention (Low)

Table 5. Rules related to intimate behavior-willingness to disclose personal information for cluster 2.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.5	41.67	100	Trust (Medium) ==>Disclose Pers-Info. (High)
1.29	50	85.71	SNS Usage (Medium)==>Disclose Pers-Info. (High)
1.25	41.67	83.33	Gender (Male) ==>Disclose Pers-Info. (High)
1.17	58.33	77.78	Location Sensitivity (Medium) ==>Disclose Pers-Info. (High)

Similarly, for users in cluster 2, the association rule analysis results in Table 5 and 6 suggest that factors that may account for the users' high willingness willing to disclose their location information in cluster 2 are: moderate trust toward service providers, not very sensitive to

location information, and the gender effect (male users are more willing to disclose their information). Besides, users in cluster 2 have habit that use SNS through mobile phone. Also, for the intimate experience expectation, we can see that factors accounts for users' low intention to use LBS are: perceived low usefulness of past experienced of LBS, and less frequently use the instant message service.

Table 6. Rules regarding intimate experience-intention to use LBS to received personalized services for cluster 2.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.31	58.33	87.5	Instant Massager(Low) ==>LBS Use Intention (Medium)
1.29	50	85.71	SNS Use (Medium) ==>LBS Use Intention (Medium)
1.25	41.67	83.33	Past Experience (Y) ==>LBS Use Intention (Medium)
1.13	50	75	Recommend (High) ==>LBS Use Intention (Medium)
1.07	41.67	71.43	Facility Search(High)==>LBS Use Intention (Medium)

Table 7. Rules regarding intimate behavior-willingness to disclose personal information for cluster 3.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.04	45.83	100	Tech Adopt Circle(Late) ==>Disclose Pers-Info. (Low)
1.04	41.67	100	Location Sensitivity High ==>Disclose Pers-Info. (Low)
1.04	41.67	100	Data Plan (Low)==> GPS Open (Low)
1.04	54.17	100	GPS Open (Low) ==>Disclose Pers-Info. (Low)
1.04	54.17	100	Trust (Low)==>Disclose Pers-Info. (Low)

Table 8. Rules regarding intimate experience-intention to use LBS to get personalized services for Cluster 3.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.17	58.33	87.5	Facility Search (Medium) ==>LBS Use Intention (Medium)
1.14	50	85.71	Needs for Check-in (Low) ==>LBS Use Intention (Medium)
1.13	45.83	84.62	Past Experience (Y) ==>LBS Use Intention (Medium)
1.04	41.67	100	Privacy-concern (Medium) ==>LBS Use Intention (Medium)
1.04	45.83	73.33	Battery Concern (Low) ==>LBS Use Intention (Medium)

For users in cluster 3, the association rule analysis results in Table 7 and 8 suggest that factors account for users' low willingness to disclose their personal information would be: highly sensitive towards location information and low trust towards service providers. In addition, for the intimate experience expectation, we can tell that factors give rise to users' medium or high intentions to use LBS applications are: their relative low privacy concern. Also, the low concern on battery consumption was also associated with users' mediate intention to use location-based services continuously in cluster 3.

Table 9. Rules regarding intimate behavior-willingness to disclose personal information for cluster 4.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.07	61.22	93.75	Privacy-concern (Medium)==>Disclose Pers-Info (Medium)
1.06	53.06	92.86	Tech Adopt Circle Late==>Disclose Pers-Info (Medium)
1.03	57.14	90.32	Location Sens (Medium)==>Disclose Pers-Info (Medium)

1	44.9	88	Internet Surfing(Medium) ==>Disclose Pers-Info (Medium)
1	44.9	88	Past Experience (N) ==>Disclose Pers-Info (Medium)

For users in cluster 4, the association rule analysis result in Table 9 suggests that factors that account for users' intermediate willingness to share their personal information are: mediate information privacy concern, they are late (mass) technology adaptors in the technology adoption circle, and mediate sensitivity towards their location information. In addition, no past use experience of LBS apps was also found to be associated with users' medium intention to disclose personal information in cluster 4.

Table 10. Rules regarding intimate behavior-willingness to disclose personal information for cluster 5.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.04	61.54	80	GPS Open (Medium) ==>Disclose Pers-Info. (High)
1.11	46.15	85.71	Data Plan (Unlimited) ==> Disclose Pers-Info. (High)
1.01	53.85	77.78	P-usefulness (Medium) ==>Disclose Pers-Info. (High)
1.3	46.15	100	Trust (Medium) ==>Disclose Pers-Info. (High)

Table 11. Rules regarding intimate experience - intention to use LBS to get personalized services for cluster 5.

Lift	Support (%)	Confidence (%)	Rules: Antecedent ==> Consequent
1.18	46.15	100	Facility Search(High)==>LBS Use Intention (High)
1.18	46.15	100	Tracking (High) ==>LBS Use Intention (High)

1.18	46.15	100	Info.-search (Low) ==>LBS Use Intention (High)
1.18	46.15	100	Needs for Check-in (High) ==>LBS Use Intention (High)
1.07	76.92	90.91	Recommend (High) ==>LBS Use Intention (High)
1.01	46.15	85.71	SNS Use (Low) ==>LBS Use Intention (High)

Users in cluster 5 are users who keep most intimate distance with service providers. The association rule analysis result in Table 10 and 11 suggests that factors associated with users' high willingness to disclose personal information are: perceived medium usefulness of experienced LBS. Besides, the unlimited data plan makes users developed the habit of turning on GPS most of the time, and subsequently facilitated their intention to disclose personal information. In terms of the intimate experience expectation, the results suggest that factors make users in cluster 5 have high intention to use LBS applications are: high perceived usefulness for functions provided by LBS applications, for instance, 'Recommendation of Restaurants', as 'Tracking the Position of Relatives/Friends', 'Find the Nearest Facilities', as well as 'Update Location when travel to new places'.

4. Conclusion

In this study, two main contributions are made: first, we proposed a new user segmentation strategy from an intimacy perspective, and found that best user group segmentation number based on intimacy level (K-value) should be 5. Second, we explored the Smartphone use patterns for each user group and identified the factors associated with users' different level of LBS use intention and willingness to disclose personal information (two intimacy indicators). Our results not only identified the

key role that perceived intimacy plays in the customer relationship management, which in accordance with previous researches. Also, by taking advantage of different data mining techniques, we extended the knowledge about factors prevent users from sharing personal information, all in addition to privacy concern.

5. References

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