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Business Intelligence Through Personalised Location-Aware Service Delivery

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1. Introduction

Advances in mobile communication and location-based technologies have presented business and decision-makers (such as marketing managers) with a new paradigm for Business Intelligence (BI). It has created a channel for location-aware advertising - defined as targeted advertising initiatives delivered to a mobile device from an identified service provider that is specific to the location of the consumer (Unni & Harmon, 2007). With the increasing popularity of the new generation of Global Positioning Systems (GPS)-enabled smartphones (Bellavista et al, 2008) and their ubiquity, marketers and other service providers are able to utilize this emerging technologies to deliver targeted, tailored (Gauntt, 2008) and personalized services (such advertising) based on consumers' geographical locations (W3C, 2009) and prediction of their needs (Barnes, S. & Scornavacca, 2004), and to reach them through their mobile devices on a geographically targeted basis. As a result, there are now a number of location-aware services that have been classified as - Information and navigations services, emergency assistance, tracking services and network related services (Al-Bayari & Sadoun, 2007). Location aware services means that the application is aware of the current location and can use this information to present, retrieve or filter the information appropriate to the user at a particular position. For example, current offers at restaurants that are within 10 metres could be shown to a user that is out for a night meal with friends and the device can guide them to the destination. Location-Aware Service (from now on referred to as LAS) revenues are expected to increase to about \$19 billion by the year 2014 (Kobsa, 2007).

Despite its ubiquity and growing popularity, LAS is yet to be fully utilized from BI perspectives for a number of reasons - one of which is users/consumers resistance /unwilling to accept this new pervasive and intrusive means of service delivery. Whilst there are limitations and concerns over indoor location technology and a fragmented location ecosystem, another impending factor is privacy-related user acceptance (Kobsa, 2007) and security/trust related issues. The potential intrusion of privacy is an important concern for users of location-aware services (Kobsa, 2007; Soroa-Joury & Yang, 2009). However, there is a clear presupposition that users with different profiles using different access networks and mobile devices require personalized services that meet their needs at specific locations. Therefore, it is important to investigate how users are responding and how BI can be properly utilized for effective location-aware customer relation management.

The key to successful development of LAS is the ability to provide users with correct, preferred and personalized content. Furthermore, user preferences and profile adjustment is necessary for an acceptable and usable personalised LAS delivery.

This chapter presents an investigation on the development of a LAS delivery framework, by integrating user's personal preferences, profiles, an efficient adjustment algorithms, attributes of their geographical location and the application BI processes in order to provide personalised LAS. The remainder of the chapter is organised as follows: Next section (Section 2) provides a theoretical background by presenting a thorough review of existing LAS applications, systems and enabling technologies including current approaches to user preferences/profiling and recommendations. Section 3 describes the development of a LAS delivery model based on a set of user requirements, which integrates user's personal preferences, profiles, an efficient adjustment algorithms, attributes of their geographical location and the application BI processes. Section 4 describes the development of a personalized Scarborough LAS demonstrable prototype system that is able to respond to user profile adjustments and an evaluation of the approach, effectiveness of the prototype presented in Section 5. Section 6 concludes by discussing some of the lessons learnt, the limitations of the approach and further work being undertaken.

2. Background

The availability of existing LAS is a clear indication of its progressive recognition by industry and the gradual maturity of the related platforms and techniques. These services have been and will continue to be adopted for public and commercial activities. Whilst these services are on the increase, the ability to provide users with relevant and contextual content and information continues to be a major concern and challenge. This section presents a review of LAS, user profiling and preferences, and personalization of services.

2.1 Location aware services (LAS)

LAS system uses mobile and location technologies to exploit knowledge about where an information device user is located and present them with relevant services, such as marketing adverts. Chen (2002) defined this service as the application of which the service and information provided is determined by the user location. This location is normally determined using the mostly recognized global positioning system (GPS¹) and other emerging positioning technologies (Sadoun and Al-Bayari, 2007). There are many other positioning technologies that can be used to provide LAS - this includes radiofrequency, ultrasonic, inertial, infrared, magnetic fields - each one with different drawbacks and advantages (Marco et al, 2008; Son and Orten, 2007). These other technologies are network based positioning and typically rely on various means of triangulation of the signal from cell sites serving a mobile phone. In addition, the serving cell site can be used as a fix for location of the user. There is no single positioning

¹GPS is a navigation technology designed to give instantaneous information about longitude, latitude and altitude anywhere on the globe.

technology that is suitable for every service or scenario. The availability of low-cost smart phones that are currently shipped with various positioning technologies has significantly increased the ubiquity of LAS. While there have been so many concerns regarding security and privacy issues with these services (Kobsa, 2007; Soroa-Joury & Yang, 2009), the mutual benefits for both the user and the provider are potentially enormous. In addition to their commercial benefits, these has been extended to provide distinct services and many applications such as vehicle car tracking systems (Al-Bayari & Sadoun, 2005), emergency rescue services ((Al-Bayari & Sadoun, 2005), location-aware medical information system for determining a hospital worker's current location from a hospital information system (Rodriguez et al., 2004), and in the entertainment and education fields (Chen, Li, & Chen, 2007), etc are operating in this context. Steinger et al (2006) identified mobile devices, communication network, positioning component, service and application provider, and data and content provider as the five infrastructural elements for the effective operation of LAS.

LAS applications cover a wide range of services, which can be categorised into two paradigms – pull and push. Clearly, both push and pull services rely on the networks ability to locate a mobile user/device and are further enhanced by user profiles that are normally established and updated either by the subscriber or the LAS system. This help in assuring that the information delivered to each user is truly customised.

2.1.1 Taxonomy LAS Applications

Personalised LAS applications are currently on the increase covering a variety of industry services and day-to-day activities of mobile users. The different LAS applications can be categorised from different perspectives as can be seen in Table 1. From table 1, we can see that most of LAS have been design to provide added value by enabling the provision of such services. Different classification scheme exists, but the author have provided a taxonomy that defines three broad categories of LAS and existing principle upon which they have being provided currently.

The Information and navigation services provide data directly to end-users, in particular for destination location and criteria for trip optimization. Most contemporary and modern vehicles are now GPS-equipped that give directions to drivers on display screens and through synthesized voice instructions. Finding someone or something, person by skill (doctor), business directory, navigation, weather, traffic, room schedules, stolen phone, emergency calls

Business and management services provide targeted location aware systems for commercial and management purposes. This includes targeted advertising and promotional services. Some example applications include payments based upon proximity – egg EZ Pass, toll watch. Management services such as resource tracking with dynamic distribution – includes taxis, rental equipments, etc. are common profile matching (dating), automatic airport check-in.

Security systems include emergency assistance *to* provides the location of mobile users in case of distress and need for assistance, such as tracking services.

LAS Categories	LAS Applications	Type
Information and Navigational Systems	<ul style="list-style-type: none">• locating social events and people	Pull
	<ul style="list-style-type: none">• locating essential /nearest services such as hospitals and medical centres, emergency centres, stores, police	Pull
	<ul style="list-style-type: none">• receiving alerts – such as Traffic Jam warnings	Pull or Push
	<ul style="list-style-type: none">• information requesters –eg. news services, treasure hunts	Pull
	<ul style="list-style-type: none">• navigational systems – such as Tom-tom	Pull and Push
Business & Management systems	<ul style="list-style-type: none">• targeted advertising or promotional operations	Pull and Push
	<ul style="list-style-type: none">• location sensitive billing –eg toll payments	Pull and Push
	<ul style="list-style-type: none">• fleet scheduling – such as taxis	Pull and Push
	<ul style="list-style-type: none">• asset /resource tracking and recovery systems	Pull or Push
	<ul style="list-style-type: none">• common profile matching	Pull
	<ul style="list-style-type: none">• tracking medical staff and patients care systems	Pull and Push
Security Systems	<ul style="list-style-type: none">• localised parental control - allows parents to know where their children are	Pull and Push
	<ul style="list-style-type: none">• emergency assistance such as calls, stolen phones, roadside assistance etc	Pull
	<ul style="list-style-type: none">• home land security systems – such as tracking criminals	Push

Table 1. Taxonomy LAS Applications

2.1.2 A review of positioning techniques

There are a number of geolocation technologies and more are still in development. However, wireless geolocation technologies have three main common major components as follows:

- the location sensing device that allows determining relative position of the mobile device
- a positioning algorithm that computes the metrics reported by the location sensing device, in order to estimate the position of the mobile device,
- a display system, which displays computed positions of the mobile device

Positioning techniques can be categorized into network-based and handset-based methods. Each technique has its own pros and cons, under a number of constraints. The table 2 below presented an analysis of the strengths and weaknesses of some positioning techniques. Positioning techniques can be categorized into network-based and handset-based methods. Network-based techniques generally utilises the service provider's network infrastructure to identify the location of the handset, while handset-based techniques utilises client software on the handset to determine its location.

Categories	Techniques	Strengths	Limitations
Network –Based	Cell ID (CID)	<ul style="list-style-type: none">• low cost of implementation since it operates in GSM, GPRS and UMTS networks• Can work indoors – provided there is network coverage	<ul style="list-style-type: none">• requires a network to identify the base station for communication and location• can only provide an estimate of the location of a phone device
	Received Signal Strength (RSS)	<ul style="list-style-type: none">• Useful for urban and indoor geolocation systems• Already available for cellular and WLAN networks	<ul style="list-style-type: none">• measurement of the distance from RSS cannot be reliable• sensitive to channel parameter estimation
	Angle of Arrival (AOA)	<ul style="list-style-type: none">• usually used to discover the location of private radio stations• delay of arrival of each element is easily measured directly	<ul style="list-style-type: none">• may confuse the location of the handset• installing and aligning antenna arrays on base stations can be costly
	Uplink Time Difference of Arrival (U-TDOA)	<ul style="list-style-type: none">• completely network-based and therefore works very well in outdoor and indoor environments• has a more wider distance accuracy	<ul style="list-style-type: none">• requires additional network location measuring unit (LMU) equipment, and therefore costly• limited in rural conditions
Handset-based	GPS	<ul style="list-style-type: none">• reliable and accurate for outdoor situations. Although dependent on clear open sky• most mobile phones now shipped with GPS hardware• lots of development technologies available• easy and cheap to use	<ul style="list-style-type: none">• limited performance for indoor situation• mobile units need special hardware and software for receiving GPS signal• suffers from relatively long delay to get an initial fix on the location of a mobile unit
	Assisted-GPS (A-GPS)	<ul style="list-style-type: none">• more reliable and accurate for outdoor situations• resolves the long delay that can occurs in locating a mobile unit when using GPS• operates on GSM, GPRS, UMTS networks• easy and cheap to use	<ul style="list-style-type: none">• indoor coverage is still not ideal and best accuracy is still in open sky• requires A-GPS circuitry inside the phone, legacy handsets cannot be supported without modifications• suffers in rural environment where stationary GPS receivers are more widely spread
	Enhanced-Observed Time Difference (E-OTD)	<ul style="list-style-type: none">• operates in GSM and GPRS networks• takes less time to locate a mobile unit	<ul style="list-style-type: none">• expensive to operate as the also requires the use of LMUs• still vulnerable to accuracy degradation from multipath and signal reflections

Table 2. Strengths and weaknesses of some positioning techniques

Caffery (2000) clearly describes how conventional positioning techniques rely on the angle of arrival (AOA), received signal strength (RSS), the time of arrival (TOA) and the time difference of arrival (TDOA) measurements. Also note that there are technologies that fall with both the network and handset categories. For example, the Multiple Input Multiple Output (MIMO) that typically includes multiple antennas at both the receiver and transmitting stations and has incorporated Orthogonal Frequency Division Multiplexing in most 4G wireless networks.

2.2 User profiling and preferences

For a system to be able to provide personalized services, it must be able to make inferences about the users' profiles and preferences. Such information as well as information about the users' previous experiences is stored in a user model (Garcia-Cerspo et al., 2009). As discussed in the next section, recommender systems offer guidance based on users' profiles or preferences. Therefore, every recommender system builds and maintains a collection of user profiles and preferences. User profiles contain the subscriber's preferences (e.g., likes/dislikes, schedules, and formats) and permissions (i.e., whether they can be delivered with advertisement content or not). The user's profile and preferences would normally reside in a database maintained by the network provider, which is used to push services to subscribers. For example, if a user likes a particular type of food, the network will see the preference in the user's profile and will push information regarding restaurants that serve that type of food in the general locale of the user. Similarly, the user will be able to request this same information from the network (pull) if he or she chooses not to have this information pushed to the wireless device. There are different approaches to building user profiles. For example, Rich (1983) identified three important dimensions that characterize user models:

1. One model of a single, canonical user vs. a collection of models of individual users.
2. Models specified explicitly either by the system designer or by the users themselves vs. models inferred by the system on the basis of users' behaviour.
3. Models of fairly long-term user characteristics such as areas of interest or expertise vs. models of relatively short-term user characteristics such as the problem that the user is currently trying to solve.

Based on the above categorization of user models, a personalized recommender system may maintain an individual user model or some user models that represent classes of users. These classes are called stereotypes (Kobsa et al., 2001), which are used in user modelling in order to provide default assumptions about individual users belonging to the same category according to a generic classification of users that has previously taken place. This method has the advantage of providing personalized recommendations from the first interaction of the user with the system. However, a main disadvantage of this approach is that users may be similar in some characteristics but differentiate in many others. Furthermore, a user's characteristics and preferences may change over time. Thus defining and maintaining a personal and profile and preferences are fundamental in building an effective and potentially usable personalized recommendation systems.

To offer personalized LAS that are tailored to mobile users' activity contexts, service providers gather user profiles and preferences (including personal location information)

through mobile communication and positioning systems. This information can be gathered in two ways - covert and overt approaches (Sundars & Marathe, 2006). In the covert approach, service providers send relevant services to users by covertly observing and capturing their behaviour through tracking physical locations of their mobile devices. With these data, personalization systems tailor LAS services based on the user's known proximity to a data or content provider. Sheng et al (2008) describes a covert-based application that pushes information to customers whenever appearing in the vicinity of a participating store, the customer's mobile phone triggers a system within the application provider that evaluates that customer's purchase history against existing offers from the nearby store. If the system indicates an available will be of interest, it sends a text message to the customer's mobile phone with the rental details on the film. On the other hand, the overt personalization systems only locate users' mobile devices when they initiate the requests. This type of LAS may be seen in some 'on demand' services where the user dials or signals a service provider for specific information/service such as a request for the nearest medical centre. In this approach, location information is ephemeral and useful only to complete the transaction requested (e.g., sending coupons of the nearest Starbucks to the user). One example was a service launched by ZagMe in the United Kingdom. By calling a number or sending a text message to activate location tracking, customers could receive promotional information and coupons through text messages based on their geographical location in a designated mall.

2.3 Personalization of services

Research about the provision of personalized services has been carried out within recommender systems since the early 1990s in order to address one of the most challenging problems of today's ever expanding mass of information. It is clear that the selection of the relevant bits of information is becoming more important than the retrieval of data in today's information age. One of the early recommender systems was a mail filtering system (Tapestry) developed by Goldberg et al (1992). Since then, there have been numerous studies on recommender systems have been developed (Hong et al., 2009; Zhang & Jio, 2007). For example, Sarwar et al (2000) developed a product recommendation system for electronic commerce using user's feedback. Middleton et al.(2004) developed a k-NN-based recommender system that recommends research documentation based on similar users' preferences and uses Ontology to analyze the profiles of users, and "VISCORS" a wall paper recommending system in mobile web coming collaborative filtering with content-based image retrieval was developed by Kim et al. (2004). Singh and Dey (2005) developed a document ranking system based on users' preferences using a filtering agent. Cao and Li (2007) developed fuzzy-based system for recommendation of product optimized based on customers' needs extracted using interaction between systems, and a personalized eLearning system based on contextualizing multimedia systems suggested in Eze et al.(2007) and a personalized tourism services aim at helping the user finding what they are looking for, easily without spending time and effort described in Kabasi (2010). These system have been classified into two types: ones that develop and test new recommendation methods, and the others that investigate empirically the factors affecting the usefulness of recommendation systems, or the effects of using recommendation systems on consumer purchasing processes (Ahn et al., 2010).

The purpose of establishing a recommendation system is to solve the problem of information overload. The importance of these systems within the electronic commerce and business industry has since been established and currently being adapted for social and personal services. Recommendation systems are clearly based on the understanding of the user and the recommended products in order to predict the user preferred item or service and thereby recommend an associated item or service. In general, recommendation systems are based on user profiles and preferences, which clearly includes system components for the collection of information to be used to building an initial user profile or preference, processing and analysis of the stored user profiles *visa vis* existing or potential available products or services to be recommended and then the recommendation. In order to process and provide recommendations, a variety of approaches have been used to perform recommendations in these domains, including content based, collaborative, demographic, knowledge-based or hybrid approaches and many others (Montaner et al., 2003; Sarwar et al., 2000). Content-based and collaborative filtering have been the most popular approaches used in the literature. Content-based filtering refers to recommending items or services based on analysis of the user's previous actions or purchases, while in collaborative or demographic filtering, the items are recommended based on the recommendations of other users (Sarwar et al., 2000). See Kabasi (2010) and Burke (2002), for a detailed description of the recommendation techniques.

The final and important component required for an effective recommendation system is feedback. This provides a means for the system to capture and update user profiles and preferences. The interaction between recommendation system and the user can be divided into explicit (requiring user input on which the system will base its recommendation) as well as implicit (enabling the system to collect or observe user behavior to detect preferences) methods (Leavitt, 2006). The effectiveness of adopting explicit methods for LAS recommender systems requires more empirical investigation given the limited interface display on mobile devices. However, exclusive implicit method would require the system to collect enough user experience before building an appropriate profile and preferences to be used for recommendations. Therefore, there should be a way of integrating both approaches where a user is allowed input.

The challenge with personalised location-aware services is not in the applications but in the implementation. For location services to be of any real value, the network provided must be able to determine the location of subscribers to a high degree of accuracy. Most current LAS have proposed applying global positioning system (GPS) capabilities in handsets to help locate subscribers. However, GPS relies on the ability its receiver to connect to multiple satellites orbiting the Earth. If the receiver has no access to the sky (i.e., it is indoors), no location information can be provided. In addition, to the location, the network provider must be able to determine various other statistics – must be “aware” of the users' availability and propensity. Privacy groups have already expressed concerns regarding the awareness or intrusion of potential users. It is critical that service providers and users manage permissions within an LAS.

To address these issues, this research integrates both explicit and implicit recommendation methods, and designs a model in which the user is allowed to register and conduct preference inputs in the web environment, which will reduce the user input time on the mobile device. In addition, the research proposed a new algorithm that is capable of learning user preferences in order to reduce the burden of the system and to raise the correction rate in recommendation.

3. Development of a LAS delivery framework

This section presents the development of personalised LAS delivery framework, by integrating user’s personal preferences, profiles, an efficient adjustment algorithms, attributes of their geographical location and the application BI processes. The framework was based on Scarborough² as a case study. Scarborough (shown in Fig. 1) is often considered as possibly the Britain’s first seaside holiday destination, which has operated as a holiday resort for nearly 400 years. It offers a wide range of entertainment, leisure facilities, and shopping facilities. It is a University Campus town attracting over 2500 students each year. The town clearly unique distinction for deploying and trialling a personalised location aware services. The personalised system is expected to utilised data mining and business intelligence to target users with specific adverts and services based on trends related to their account details, profiles (including purchase histories) and tends. The system would use data mined from the users’ profiles and preferences to provide personalised location aware product/service recommendations based on current locations of a user. Since most contemporary mobile phones support GPS and a connection to the network, combining these technologies clearly gives us a convenient approach for developing location aware services.

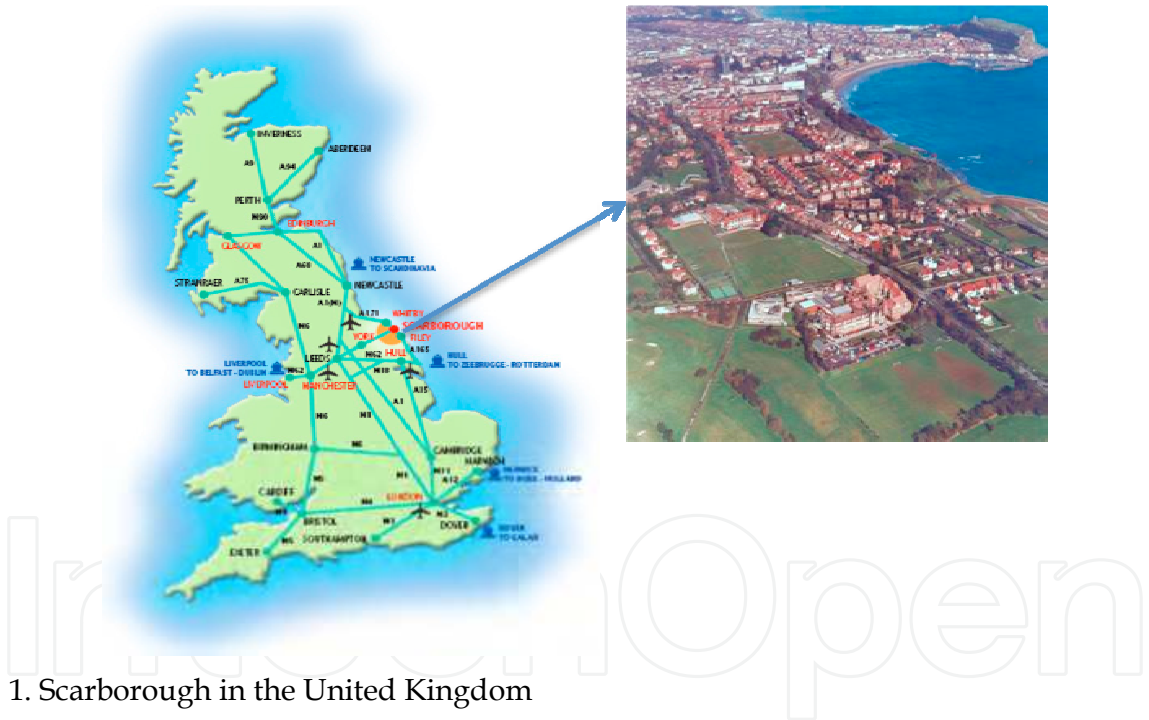


Fig. 1. Scarborough in the United Kingdom

This is a very broad scope that can encompass both commercial and public services, from offering the user deals, price comparisons and alternative shopping options, to helping to plan a day out in at a local theme park, by providing targeted information on the user tastes in rides, queue times and dietary requirements to suggesting available accommodation. The proposed framework (as presented in Fig. 2) consists of a number of components. From a high level perspective, the framework is divided into the 'Internal' – the main application and 'External' – the different systems that interact with users and the internal system.

²Scarborough Borough Council- <http://www.scarborough.gov.uk/>

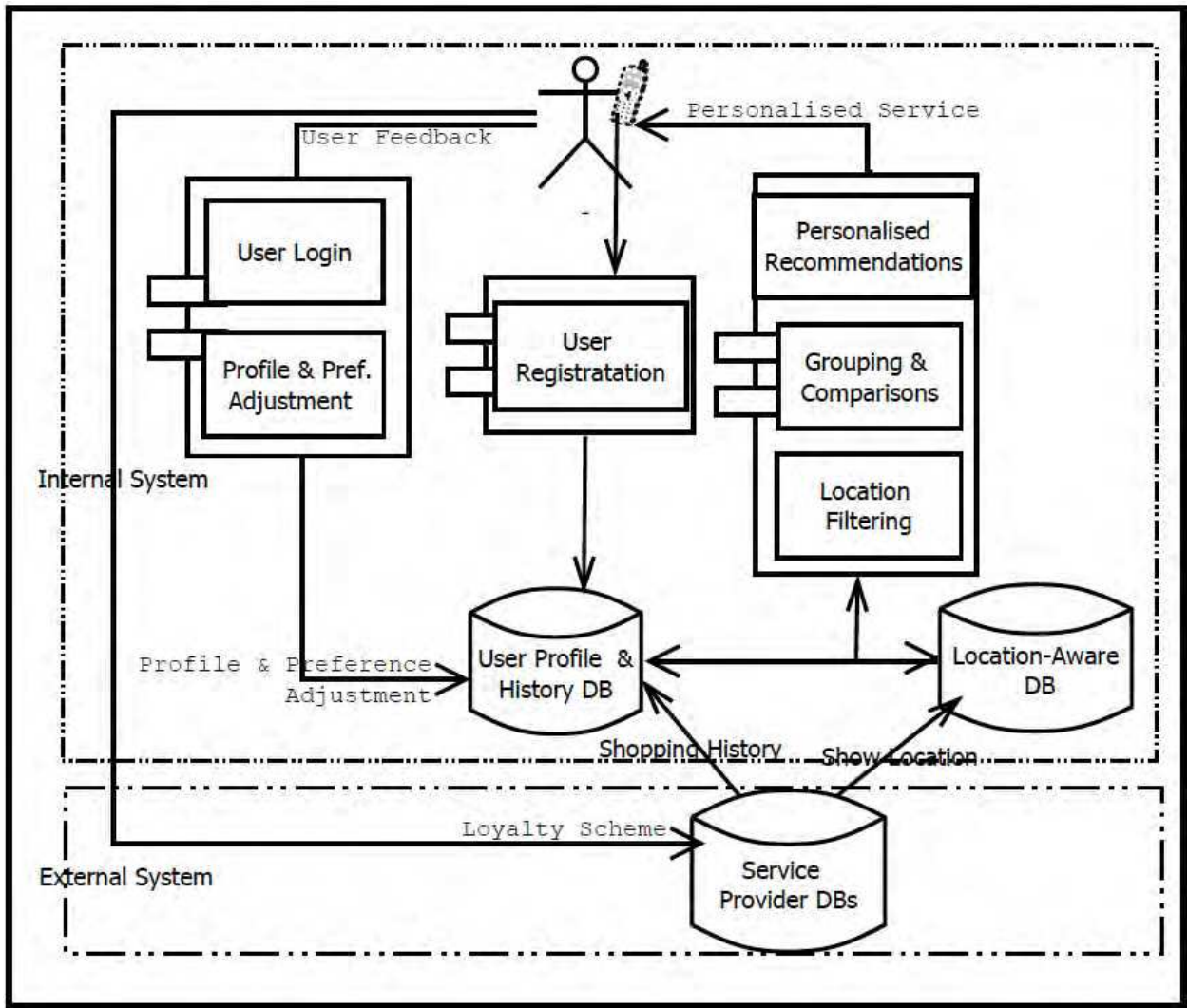


Fig. 2. Personalised Location-Aware Services Model

The model is divided into user registration component, access and feedback component, and the service personalization component, and these components interact with each other through a variety of databases. The description of each of the components have been presented below:

3.1 Registration component

The registration component of the system establishes the initial user profile and preference information that is stored on the profile and preference database to be used as the basis of the initial system recommendation. After the registration, the service personalization component checks the location of the mobile user synchronizes their profile with the location databases to present the user with recommendations. At this point, what the system knows about the mobile user is mainly the basic device and user information –such as the device identification, device type, user name and password, personal information – including name, age, sex, job, hobby, basic preference and privacy consent to accept push information.

3.2 Access and user feedback component

Although the system is designed to push personalized services to registered users, it is essential to provide a data-gathering component incorporating the login and the user profile and preference adjustment modules. The first, which is the login module, is designed to enable users access to the system in order to provide feedback and to allow them update their profiles and preferences. In addition to user static data such as user name, mobile device identification information that has been captured during the registration process, the design of the access and user feedback component should allow for the capturing of user dynamic data, which could be according to the dynamic attributes of location-aware data items. This is to reflect the change of the user preference. As a result, the effective and efficient system should adopt a learning approach to adjust user preference upon receipt of the user feedback. It is also essential that the user be given certain level of control over their profiles and preferences that has been stored on the system, as such, they should be able to see and update aspects of their currently stored profiles and preferences on the system database. The update profile and preference will be stored in profile and preferences are then stored in the user profile and preference database being used for making personalized recommendations. In order to calculate the probability that a user may prefer certain products and services, it is necessary to calculate the probability of the user profile and preferences towards those products and services. After calculating such a probability, the system would save the results of the predicted product and service preferences in the profiles and preference database, which is to be used for delivering the next personalized products and /or services. The recommendation result will be recorded in the profile and preferences database, and the user preference will be modified through a preference adjustment in order to achieve personalized recommendation process.

This also includes using the GPS module on the user device to receive the GPS signal and calculate the coordinates that would be used in the user profiles and location-aware databases.

3.3 User profile and history database

The user profile and history database persistently keeps the record of user profiles and adjusted preferences and historical transactions (including previous purchases and delivered services from all the participating service providers) between the users and recommendations. Clearly, this database serves as the main backbone to the system as it will contain most of the user profiles. It should contain all recommendations made to each user and their response to the recommendations. The logical (recommendation component) requires the information kept on this database to make comparisons against all the different parameters. Note that this database can be implemented as a data warehouse in order to integrate the required information to be mined from a variety of data sources. The benefits of using a data warehouse for this for implementation include scalability, and the ability to classify and organize data around meaningful personalized concepts.

3.4 Location-aware database

The location-aware database is designed to keep updated location information about participating service providers – such as stores. The database will store the Global Positioning Systems (GPS) latitude and longitude coordinates of the precise location of each of the participating provider. This coordinates are then used to calculate the proximity of the

user and nearby service providers to identify potentially relevant personalized products and services to be delivered to users. Service providers can additionally use GSM numbers associated to devices or GPRS to transmit the personalized information via SMS or via GPRS in form of Internet Protocol (IP) packets.

3.5 Service personalization component

The service personalization component is considered the “brains” behind the “brown”. This is the main recommendation system, which integrates and interacts with other internal and external systems and makes logical reasoning decisions required for personalized recommendation of products and services. It is the component of the system that analysis the relationship between users’ profiles and preferences, and services in order to build an appropriate and timely recommendation model for each user. Different data mining techniques including association rules to predict transaction patterns, classification rules such as decision tree algorithm. To provide the real time, proactive and personalized services, the training time is very important, as such the choice of an appropriate data-mining algorithm is essential. As shown in Fig.2, the component consists of the location filtering, grouping and comparisons and the recommendation modules. Details of each of the three main modules have been described below:

3.5.1 Location filtering

LAS are based on the use of location information, which can be collected in a number of ways. Location information is always attached to some entities that are being tracked. These tracked objects can be people, animals, objects and services. Whatever object in focus, the precision of location information is crucial for many applications, which also depends on the location determination technology used. Two types location information exists – relative and absolute. Absolute – when the actual location is known, for example, the coordinates of the location of a service provider such as a store. Relative - determines what located objects are nearby. There are many approached to location information – including the traditional and the commonly GPS, GSM, GPRS, magnetic or infrared tracking. There are other approaches involving the attachment of both passive markers such as a barcodes and active markers such as infrared transmitters to the environment. The current most widely used is GPS since most mobile phones, PDA’s, and even cars are now shipped with in-built GPS technology, making LAS more convenient and of course easy to locate any tracked object (Lee, 2009).

This module is responsible for locating and filtering the relevant information based on the user location in preparation for the main task of personalized recommendations. The module can utilize a number of available location technologies to identify whether a tracked user is in a range of service providers and then utilize relevant data mining and decision support techniques to indentify a recommendation package to be delivered to the a user. It uses the location database and user profiles to achieved the expected task.

3.5.2 Grouping and comparison

Upon identifying and filtering the location of a tracked user, the module utilizes relevant techniques to make comparisons. It checks the prices of all possible products or services that the located user is likely to require and makes product by product price comparison with

other participating service providers in order to identify a better deal. In making these comparisons, other information associated to the user profile –such as user habits, distance between the service providers, etc.

3.5.3 Personalized recommendations

The module is the logic system that analyzes trends, patterns, price, and location comparison. The module consists of a number of functionalities including:

- user profile and preference analysis – including an analyses of the previous behaviour of a tracked user with each of the identified location – for example the shopping behaviour of a tracked user around Tesco's Shopping Complex on a Saturday afternoons.
- the development of different association rule sets for discovering associations between products, services, location and the tracked user. A user personalized recommendation model is constructed based on users transaction histories, profiles and preference, number of previous recommendations and their responses to such recommendations. This includes a market-basket analysis (studying the composition a shopping basket of products purchased during the single shopping event), to identify user patterns and trends, which will also help in identifying which products tend to be purchased together by the tracked or target user. This information enables stores to make intelligence positioning decisions. Identify what products tend to be purchased together. Clearly, analysing transactional-level data can identify purchase patterns
- a personalized product or service recommendation list for a given tracked user is produced using their specific model. Determining user's likely in recommender systems is very important, since these likelihood should be the basis of personalized recommendations. And a variety of approaches have been used in recommender systems –including content-based, collaborative, knowledge based and a hybrid of those approaches (Kabassi, 2010; Zhang et al., 2007), with different methods such as the Bayesian networks or rule-based reasoning (Huang and Bian, 2009) have been used. Other common known techniques used for recommendations include neural networks (Zhang et al., 2007), Bayesian learning (Zhang and Koren, 2007), Markov models (Liu et al., 2007), multi-criteria decision-making theories, fuzzy multi-criteria decision making (Kabassi, 2010) and many others. Content-based filtering can be used to suggests to a user, products or services that are similar to those they bought in the past, by matching the characteristics of the products or service with the characteristics of the user that are maintained in their user model. Content-based filtering is based on facts that involve a particular use and may also capture changes on the user's profile or preferences. While this approach has a number of limitations –especially with the initial cold start approach to building a user model, this may be appropriate for personalized push recommendations.

The focus of this module is to provide the ability to use individual profile and preferences to define a specific dynamic user model that can be used to cluster relevant products and service that the user is highly likely to be interested on. For example, the system should be able to tell a user interested in gigs to build a potentially interesting package of gigs that are on –including prices, nearby venues, times, etc based on the uses needs and then also pass on some alternative artists, which are similar in style that the user likely to be interested on. Various methods for calculating the recommendation score including those described by Yuan & Tsao (2003) are available to be used.

From the provider's point of view, maintaining a profile of users that might be synchronised with provider databases also provides the providers with market-basket analysis (studying the composition a shopping basket of products purchased during the single shopping event), which helps them to identify which products tend to be purchased together by certain users. This information enables stores to make intelligence positioning decisions. Identify what products tend to be purchased together. Clearly, analysing transactional-level data can identify purchase patterns.

Despite the potential advantages of LAS personalized recommendation, there are increasing concerns about mobile users being tracked and profiled by behavioural advertisers to be able to send them personalized advertising (King & Jessen, 2010). Clearly, the risk that someone else cannot only know who you are but also where you are, creates an enormous potential for misuse of this data. Furthermore, King and Jessen (2010) have identified potential harms to privacy and personal data related to profiling for behavioural advertising. While, there are evolving legislations, solutions to the privacy issues of LAS application are still unclear. The type of the service also affects the privacy requirements, for example push and pull services have different kind of characteristics. The competition between operators, service providers and other parties also affects the privacy issues. The Legislation is not clear about which laws apply in particular situations. More progress is needed to show how laws will be applied and to decide whether or not new laws are required. Generally, permission from the user is required for using their personal location information but this may impede business and may so be resisted by businesses. Therefore, the development of a prototype described in the next section has been towards evaluating the feasibility and potential usability of the system, which may contribute to the development and or review of regulatory frameworks for protecting privacy and personal data in regards to profiling by behavioural advertisers that targets mobile customers.

4. Development of a personalised LAS prototype

There are a variety of positioning systems available for the development of a personalised LAS system. Therefore choosing the best positioning technology is of fundamental importance. The performance (range, accuracy, etc) and ease of use are all key characteristics of consideration. Many technologies exist that are able to provide location information; nevertheless, few of them have a significant impact on final applications and none is perfect for every service (Mazes et al, 2004). The application designer should prioritize the requirements to choose the most appropriate technology. The most obvious considerations should include accuracy, range, refresh frequency, and cost. Other issues are infrastructure and robustness of the chosen infrastructure.

After reviewing various current available positioning technologies presented table 2, a review of development platforms and technologies was further undertaken (see Fig.3) to define an architecture needed for the development of a proof-of-concept prototype.

GPS location technique with Google Map API (for mapping and latitude /longitude translation service) was adopted for the development of a proof of concept prototype. Google Maps API was further integrated with the W3C Geolocation API to provide latitude/longitude information regarding the geographical location of the mobile device.

Most phones support GPS and a connection to the network, so combining the technologies gives us the convenient location based service. This also includes using the GPS module on the user device to receive the GPS signal and calculate the coordinates that would be used in the user profiles and location-aware databases. Therefore, the prototype was developed for a web browser based interface, enabling compatibility for a range of mobile devices. PHP, HTML 5 and JavaScript was the development tools used to develop the prototype, which is only available for GPS enable mobile devices such as the iPhone, HTC, Blackberry phones. MySQL was used to provide the backend functionality. There is, however, a disadvantage by relying on GPS alone as a location system. The GPS receiver must have a direct line of sight to the satellite, making it almost useless indoors and in dense urban areas.

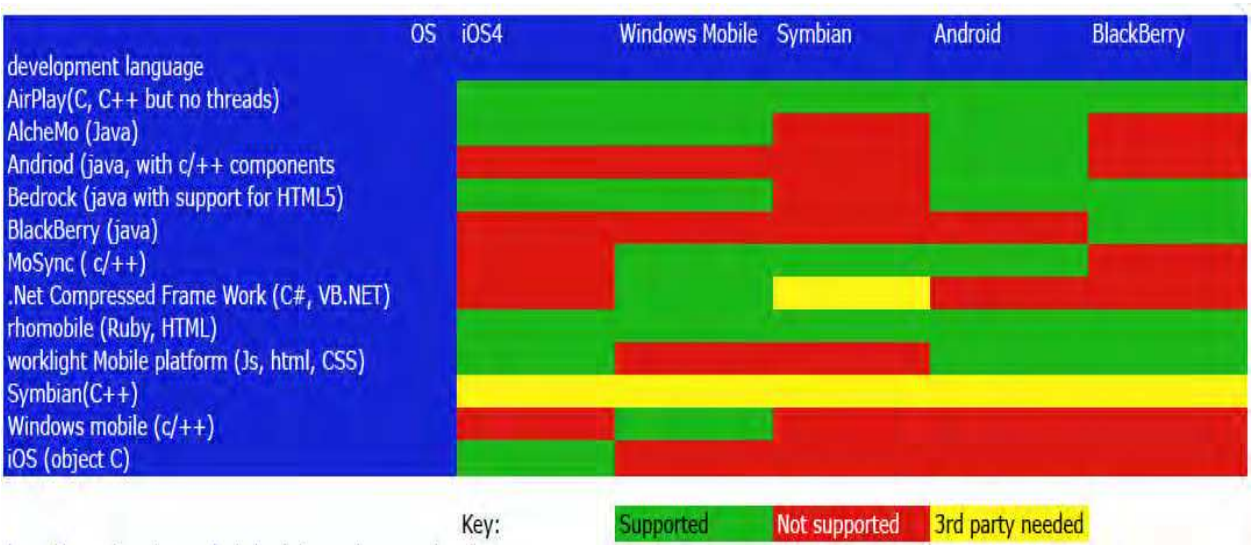


Fig. 3. Location-aware development platform

The development of a LAS prototype system was designed in such a way that is able to track and respond to user profile adjustments. It was also developed within the Scarborough context as a typical case scenario previously described in section 3. The prototype - Scarborough Location-aware Advertising project (ScarLaS³) aims to provide a demonstrable prototype that illustrates the feasibility of Location-aware Services in Scarborough. The system adopts the above recommendation model as the design basis of the prototype system, the design of attributes such as location-based information (see Table 1) and user preference. The main components of the prototype are in accordance with the defined framework presented in section 3 (see Fig. 2). In order to allow involvement of a wide variety of mobile users, the first component is the web page for registering user profile, which is provided for the user to conduct service registration and initial preference setting. The second one is the core of system for providing personalized advertisements. Taking into consideration the limited display ability and the convenience in the user operation, the system follows two steps in order to provide this functionality. First, the system will base on the user location to filter the participating shops within the area and determine the appropriate recommendation to deliver to the user. The result is shown to

³<http://www.celproject.co.uk/lba/client/>

the user and they can see the suggested offers. Subsequent recommendations are adjusted based on user feedback from previous recommendations. Brief description of the implemented prototype is presented according to each of the proposed components.

4.1 Prototype implementation

The interface of the system can be used without a mobile user having to register to access the system. From the Fig. 4 below any user is assigned a default username and where the service personalization component checks the location of the mobile user synchronizes their profile with the location databases to present them with all offers in the range.

As can be seen in Fig. 4 above, the system the system automatically retrieves all offers within a reasonable geographical range with no user profile to use in personalizing the offers to be presented. The system is also only able to track the user through the device identification and the user number, which information stored in the database. Therefore, in order to provide a personalized recommendation, the registration component allows the user to update their details using the “update” functionality of the system interface (as shown in Fig. 5).



Fig. 4. ScaLaS access interface

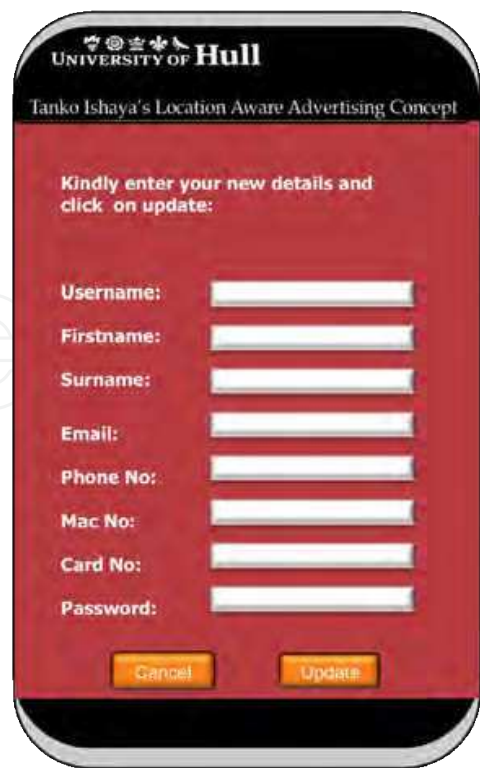


Fig. 5. ScaLaS profile update interface

After updating the user information using the above interface, the system is able to identify a mobile user through the device and user information –such as the device identification, device type, user name and password, personal information –including name, age, sex, job, hobby, basic preferences and privacy consent to accept push information. These user profiles and preferences are then stored in the profile and history database. A location-aware database was implemented to keep updated location information about participating service providers – mainly stores at the moment. The database stores the Global Positioning Systems (GPS) latitude and longitude coordinates of the precise location of each of the participating stores. This coordinates are then used to calculate the proximity of the user and nearby service providers to identify potentially relevant personalized products and services to be delivered to users. The registered user is still delivered with all available offers in the range, since the system is yet to have any history of those users transactions. In addition to user static data such as user name, mobile device identification information that has been captured during the registration process, the design of the access and user feedback component needed to allow for the capturing of user feedback. Current interface required the user to manually provide the details of their purchases instead to using QR codes or participating store feedback to provide the learning component. However, the user profile is then adjusted after an initial transaction from any of the participating service provider. The logical (recommendation component) then uses the continually adjusted profile to make personalized recommendations. It is the component of the system that analysis the relationship between users’ profiles and preferences, and services in order to build an appropriate and timely recommendation model for each user.

Fig. 6. is a typical delivery to a user with an appropriate profile and their transaction history. The user Mike is known to have previously had some transactions from Starbucks and tesco on a Saturday afternoon, which is when the service was delivered.



Fig. 6. ScaLaS interface with personalised offers

The user can check to see the details of each of the offer as shown in Fig.7. below.

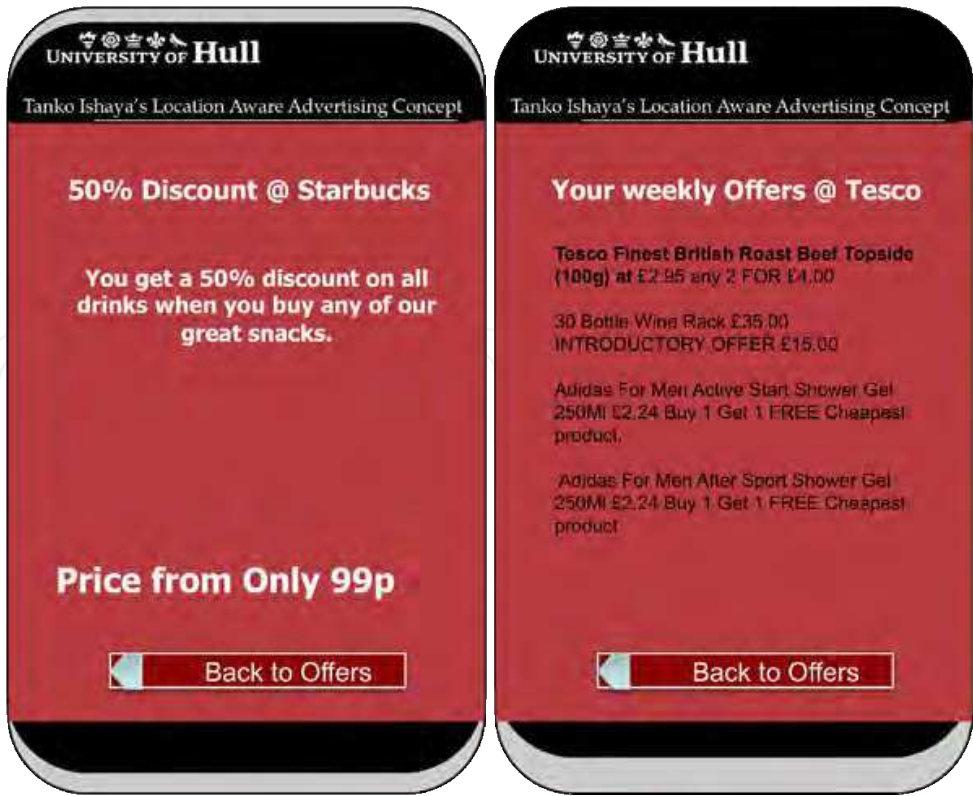


Fig. 7. ScaLaS interface with personalised offers

Ideally, the recommendation component integrates and interacts with other internal and external systems to make logical reasoning decisions required for personalized recommendation of products and services where different data mining including classification rules such as decision tree algorithm are implemented. However, the developed prototype is limited in its ability to communicate and interact with external systems, so the data from the set of potential participating service providers were hardcoded to demonstrate the concept. Furthermore, the prototype used basic analytical techniques for personalized delivery of recommendations. In order to calculate the probability that a user may prefer certain products from certain stores, it was necessary to calculate the probability of the user profile and preferences towards those products. After calculating such a probability, the system would save the results of the predicted product in the profiles and preference database, which is to be used for delivering the next personalized products and /or services. The recommendation result is also recorded in the profile and preferences database, and the user preference will be modified through a preference adjustment algorithm in order to achieve personalized recommendation process.

5. LAS prototype evaluation

The evaluation of developed prototype was focused on the potential usability and adoptability of the system. Given the privacy and ethical concerns regarding the use of LAS (Casas et al, 2006), a focused group study and analysis was undertaken to investigate how users are responding and how BI can be properly utilized for effective location-aware customer relation management.

Although, main concerns raised has been with respect to privacy, data protection and appropriateness of the recommendations, it was argued that personalization approaches and personal characteristics would influence the influence the way mobile users balance between the potential usefulness gained by disclosing personal information in LAS and the adverse effects of not using the service. Privacy requirements are associated with the information gathered from the users, and ethical issues are related to use or misuse of that information. LAS technology in general allows more and more collection of information from users, and sometimes this is done simply because the technology allows it. It is therefore useful that users be properly informed on how information such as obtaining consent for location, the exact nature of which will vary depending on the user profile, data storage, and data security is being handled by the system. Recent studies on the ethics of LAS (Perusco & Michael, 2007) posed unanswered questions about these LAS and also revealed the need for a suitable legal and ethical framework to address these concerns

Analysis from the qualitative evaluation provided some preliminary evidence to indicate that the truly personalized delivery of offers –especially on weekly grocery shopping is more likely to entice spontaneous response to LAS advertising. The evaluation suggested that users could more likely regard LAS as valuable if advertising messages are perceived to be relevant and customized to their context. Therefore an effective recommendation techniques used with LAS systems should be efficient. Furthermore, it was agreed that such systems would operate better, if participating stores within a particular town such as Scarborough were to operate a single loyalty scheme cards as a means for providing proper feedback to the system for the purpose of learning. While, the implementation of the prototype as web application was seen to have clear advantages, it was felt by most that a

native application, which is able to use A-GPS would be more useful to some category of potential users.

The key to successful development of LAS is the ability to provide users with correct, preferred and personalized content. Furthermore, user preferences and profile adjustment is necessary for an acceptable and usable personalised LAS delivery.

6. Conclusion and further work

This chapter presents an investigation on the development of a LAS delivery framework, by integrating user's personal preferences, profiles, an efficient adjustment algorithms, attributes of their geographical location and the application BI processes in order to provide personalised LAS. There is clearly an increasing demand for LAS applications and while the developed retype is basic in its current stage, it is able to identify the location of an information device user, search for offers that are within a defined range and present the offers to the users, the findings of this research have provided preliminary empirical evidence about how users are willing to strike a balance between value and risk. The current research contributes to existing literature by theoretically investigating various approached for developing LAS applications and techniques for personalization. The framework developed in this study has clearly laid down groundwork for future research along various possible directions could contribute to extending the theoretical and practical implications to foster the acceptance of LAS

7. Acknowledgements

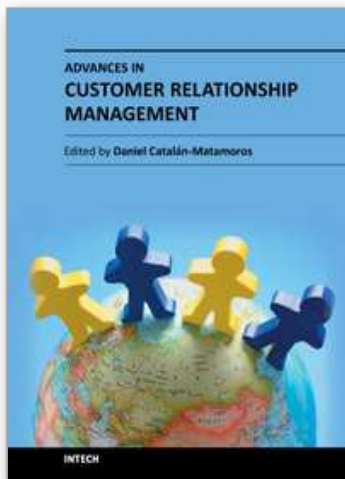
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Customer relationship management (CRM) strategies have become increasingly important worldwide due to changes in expectations from customers as well as changes in the nature of markets. This book puts forth a conceptualization that attempts to not only outline CRM's domain but also to reconcile the divergent perspectives found in the academic and popular literature. Readers can see through measurable data-containing examples how the theory is applied with great success by various real-life examples. This book presents innovative proven methods for determining whether a CRM strategy for changing the way a company provides service (by adding new technology, processes, and procedures) will realize the return on the investment projected. It could be a great help to CRM personnel, student, managers and any one that works directly or indirectly with customers.

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