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A Mobile Decision Support Web 2.0 Service to Improve the Customers Satisfaction in their M-Commerce Experiences

I.J. PÉREZ [a], S. ALONSO [b] F.J. CABRERIZO [c] and E. HERRERA-VIEDMA [a]

[a] *Dept. of Computer Science and Artificial Intelligence, University of Granada, 18071 - Granada, Spain. E-mail: ijperez@decsai.ugr.es, viedma@decsai.ugr.es*

[b] *Dept. of Software Engineering, University of Granada, 18071 - Granada, Spain. E-mail: zerjioi@ugr.es*

[c] *Dept. of Software Engineering and Computer Systems, Distance Learning University of Spain (UNED), 28040 - Madrid, Spain. E-mail: cabrerizo@issi.uned.es*

Abstract. The aim of this paper is to present a new mobile decision support web service applied to improve the customer satisfaction in decision making situations related with m-commerce. The application is included as a new mobile web service under a social net framework such as web 2.0. It allows that users with the same user profile that the potential customer can act as a set of shop assistants that advices him/her according with their experiences. To facilitate the system-user interaction the service uses computing with words tools and implements an ease to use mobile interface. Therefore, users can provide their advice at anytime and anywhere by using their own mobile devices.

Keywords. Group decision making, mobile commerce, decision support system, linguistic approach, web services, web 2.0.

Introduction

E-commerce (electronic commerce) is the buying and selling of goods and services on Internet, especially the World Wide Web. E-commerce is now spreading into all walks of life. This is demonstrated, for example, by the rapid growing of shopping and auction web sites. It can be argued that as the users use electronic shopping services, they will probably want to access services regardless of their location, or device in use. This means that users would assume that they can view, select and pay for online services in a mobile framework. However, to do that, mobile commerce (m-commerce) has to develop into forms that the users are willing to accept.

M-commerce as well as being the buying and selling of goods and services it is also related with the explosion of applications and services that are becoming accessible from Internet-enabled mobile devices. It involves new technologies, services and business models operating through wireless handheld devices such as cellular phones and personal digital assistants (PDAs). Known as next-generation e-commerce, m-commerce enables users to access the Internet without needing to find a place to plug in.

Studies of m-commerce suggest that there is a general customer interest in the services that it provides, like shopping and banking applications [3,11,15]. Its adoption, however, has been slower than expected. Mobile phones impose very different constraints than desktop computers. It has been argued that this stems from complexity of the transactions, perceived lack of security, lack of user friendly mobile portals, etc. [7,15].

While it is true that the miniaturization of the screen and keyboard, as well as slow connections, we propose to incorporate mobile technologies in a decision support service (DSS) for advising customers in their m-commerce experiences because they open the door to new applications and services. Usually, people bring their mobile devices with they anywhere, making possible to use some mobile services wherever they go.

The central goal of DSSs is to process and provide suitable information in order to support individuals or organizations in their decision making tasks [4,6]. Therefore, appropriate mobile DSSs could bridge the gap and provide additional value to users as timely information supply or anywhere use. A mobile DSS should also provide a basis for more successful transactions.

The global build of Internet connectivity and growing availability of computing and communication devices have made the World Wide Web a virtual continent that is borderless. Anyone in the world with a computer and Internet access can now explore, join, build, or abandon any Web community at any time. This new freedom is often attributed to the "Web 2.0 era" of services and applications that let webizens easily share opinions and resources. Consequently, users can collectively contribute to a Web presence and generate massive content behind their virtual collaboration [13]. Under this new social framework, the users can associate in social networks and collaborate between them to improve their Internet usage satisfaction by sharing all kind of information and obtaining a community's "collective intelligence". We propose to compute this collective intelligence with a MDSS to aggregate recommendations and use this collective advice to improve the customer satisfaction in decision making situations related with the m-commerce activities. Moreover, by using mobile tools, a possible customer could receive this collective aid in real time, in anywhere through his own mobile device.

In this paper, we present a MDSS as a new Web 2.0 service. It could be incorporated into a social web tool to aid customers in their m-commerce activities. To advice customers in their m-commerce elections, the MDSS shows to the user the collective advice calculated from the individual preferences. In such a way, our system allows that the set of users connected with the customer helps him/her to choose the best good or service of the stock according to the customer's needs. We use a *fuzzy linguistic modelling* [18] to represent the preferences provided by the social network members. It is an approximate technique which represents qualitative aspects as linguistic values by means of *linguistic variables*, that is, variables whose values are not numbers but words or sentences in a natural or artificial language. To compute the quality assessments we use computing with words tools based on the linguistic aggregation operators [10].

In order to do this, the paper is set out as follows. Some considerations about m-commerce and social Web 2.0, GDM problems and computing with words are presented in Section 1. Section 2 deals with the incorporation of the MDSS as a mobile web 2.0 service. Section 3 shows a tipical usage scenario of the service. Finally, Section 4 draws our conclusions.

1. Background

1.1. M-Commerce for Web 2.0

Emerging web and mobile technologies provide the foundation for new e-commerce opportunities and applications. They also generate the push for new enterprise system architectures in order to deploy new Web technologies and transform businesses into e-commerce driven operations. With the introduction of social networks and digital communities, the Web has a new business model for providing free content-sharing services. Using the power of the masses and the collective intelligence, Web 2.0 sites such as YouTube, MySpace, and FaceBook have quickly drawn users' attention. Popular content created by unknown individuals can attract thousands or even millions of viewers instantly. Along with viewer traffic, Web 2.0 sites have created enormous e-commerce opportunities for advertising, marketing and podcasts. The Web has become a media supported by advertisers that, in turn, sell their products to users via e-commerce. In digital cyberspace, e-commerce is moving into a new frontier, mixing physical and digital goods trading. Companies have even created their own digital currencies for online exchange of goods and services [1,12,13].

E-commerce is an area of study that has practical applications and a prominent future. Although the Internet bubble has generated some negative sentiment about the industry, many previously unsuccessful e-commerce ventures and business models have now reemerged and become feasible and profitable. With ubiquitous broadband connectivity and powerful personal devices (including PCs, mobile phones, and media players), m-commerce has become a growing part of our daily lives. More important, endless opportunities still exist to deploy new m-commerce products and services that are simply impossible without automated Web-based and mobile support [1,12,13].

In this paper, we want to identify an unexplored market and to create new products and services using intelligent m-commerce technologies. To do so, we propose a mobile decision support service that acts like a recommender system where the recommendations are given by other users of the social networking web site who have the same user profile that the customer. This application could improve the customers' satisfaction in their m-commerce experiences.

1.2. Group Decision Making Models

A decision making process, consisting in deriving the best option from a feasible set, is present in just about every conceivable human task. It is obvious that the comparison of different actions according to their desirability in decision problems, in many cases, cannot be done by using a single criterion or an unique person. Thus, we interpret the decision process in the framework of group decision making (GDM) . This has led to numerous evaluation schemes, and has become a major concern of research in decision making [9,14].

In a GDM problem we have a finite set of feasible alternatives. $X = \{x_1, x_2, \ldots, x_n\}$, $(n \geq 2)$ and the best alternatives from X have to be identified according to the information given by a set of experts, $E = \{e_1, e_2, \ldots, e_m\}$, $(m \geq 2)$.

Usual resolution methods for GDM problems are composed by two different processes [9] (see Figure 1):

1. *Consensus process:* Clearly, in any decision process, it is preferable that the experts reach a high degree of consensus on the solution set of alternatives. Thus, this process refers to how to obtain the maximum degree of consensus or agreement among the experts on the solution alternatives.
2. *Selection process:* This process consists in how to obtain the solution set of alternatives from the opinions on the alternatives given by the experts.

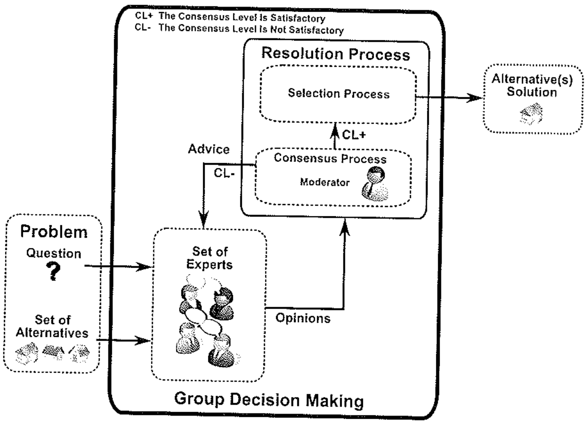

Figure 1. *Resolution process of a GDM*

1.3. Use of Linguistic Information in GDM Problems

There are situations in which the information cannot be assessed precisely in a quantitative form but may be in a qualitative one. For example, when attempting to qualify phenomena related to human perception, we are often led to use words in natural language instead of numerical values, e.g. when evaluating quality of a football player, terms like *good*, *medium* or *bad* can be used. In other cases, precise quantitative information cannot be stated because either it is unavailable or the cost for its computation is too high and an "approximate value" can be applicable, eg. when evaluating the speed of a car, linguistic terms like *fast*, *very fast* or *slow* can be used instead of numeric values [2].

The use of Fuzzy Sets Theory has given very good results for modelling qualitative information [18]. The fuzzy linguistic modelling is a tool based on the concept of linguistic variable [18] to deal with qualitative assessments. It has proven its usefulness in many problems, e.g., in decision making [16], quality evaluation, information retrieval models, etc.

The ordinal fuzzy linguistic modelling [10] is a very useful kind of fuzzy linguistic approach proposed as an alternative tool to the traditional fuzzy linguistic modelling [18] which simplifies the computing with words process as well as linguistic aspects of problems. It is defined by considering a finite and totally ordered label set $S = \{s_i\}, i \in \{0, ..., g\}$ in the usual sense, i.e., $s_i \geq s_j$ if $i \geq j$, and with odd cardinality (usually 7 or 9 labels). The mid term represents an assessment of "approximately 0.5", and the rest of the terms are placed symmetrically around it. The semantics of the label set is established from the ordered structure of the label set by considering that each label for the pair (s_i, s_{g-i}) is equally informative [2]. For example, we can use the following set of seven labels to represent the linguistic information:

$S = \{s_0 = N, s_1 = VL, s_2 = L, s_3 = M, s_4 = H, s_5 = VH, s_6 = P\}$.

Where N=*Null*, VL=*Very Low*, L=*Low*, M=*Medium*, H=*Hight*, VH=*Very Hight* and P=*Perfect*.

We assume that the experts give their preferences using fuzzy linguistic preference relations [2]. Preference relations are widely used in this kind of problems because they are more informative than preference orderings or utility functions, allowing the comparison of the alternatives in a pair by pair basis. Thus, experts have much more freedom when giving their preferences and they can gain expressivity against other preference representations. Therefore, we assume that each social network member e_h provides his/her preferences by means of a fuzzy linguistic preference relations (FLPR) P^h characterized by a membership function

$$\mu_P : X \times X \longrightarrow S$$

where X represents the set of shopping alternatives provided by the customer and $\mu_{P^h}(x_i, x_k) = p^h_{ik}$ is interpreted as the linguistic preference degree of the shopping alternative x_i over x_k for the member e_h.

On the other hand, an useful linguistic aggregation operator is the Linguistic Ordered Weighted Averaging (LOWA) operator which has been very used in the literature by its good axiomatic properties [10]. This operator, defined in [10], is based on the ordered weighted averaging (OWA) operator defined by Yager in [17], and on the convex combination of linguistic labels defined by Delgado et al. in [5]. We shall use it in our MDSS.

A LOWA operator of dimension n is a function $\phi : S^n \rightarrow S$ that has a weighting vector associated with it, $W = (w_1, ..., w_n)$, with $w_i \in [0, 1]$, $\sum_{i=1}^{n} w_i = 1$, and it is defined according to the following expression:

$$\phi_Q(p_1, \ldots, p_n) = \sum_{i=1}^{n} w_i \cdot p_{\sigma(i)}, \quad p_i \in S.$$

being $\sigma : \{1, ..., n\} \rightarrow \{1, ..., n\}$ a permutation defined on linguistic values, such that $p_{\sigma(i)} \geq p_{\sigma(i+1)}, \forall i = 1, ..., n-1$, that is, $p_{\sigma(i)}$, is the i-highest linguistic value in the set$\{p_1, ..., p_n\}$.

A natural question in the definition of OWA operators is how to obtain W. In [17] it was defined an expression to obtain W that allows to represent the concept of fuzzy majority by means of a fuzzy linguistic non-decreasing quantifier Q:

$$w_i = Q(i/n) - Q((i-1)/n), \quad i = 1, \ldots, n. \tag{1}$$

Therefore, in our model the collective FLPR is obtained as follows:

$$p^c_{ij} = \phi_Q(p^1_{ij}, \ldots, p^m_{ij}) \tag{2}$$

2. A Mobile Decision Support Service for Advising Customers in their M-Commerce Experiences

The emerging mobile commerce services, such as mobile auctions, mobile financial services, mobile entertainment services, mobile advertising and location-based services are receiving considerable interest in the research and development community. Mobile technologies have changed the users' mode of operation as they have started to carry the devices in their pockets or handbags and to use them almost anywhere. Consequently, the use environment has become an issue [1,15].

We propose the inclusion of a new mobile web 2.0 service to improve the customer satisfaction. This service is a MDSS to advise customers in their m-commerce experiences through "collective intelligence" of web 2.0 communities. The MDSS should provide a simple interface so that even the least sophisticated webizen can contribute input. In such a way, the customer can be advised by a set of members (other users of the social networking connected with him/her, with the same user profile and more experience) about some specific items provided by this customer.

To do so, the system asks customer his/her current needs (the tool offers a personalized service). Taking into account these needs, together with the community's collective knowledge, the system shows to the customer the collective advice through his own mobile device. Therefore, the customer receives a social support to choose his/her preferred items. The advise is represented by means of linguistic rankings of shopping alternatives obtained from the individual preference relations provided by the social network members applying a selection process.

To develop the service application, we have chosen a classical "Client/Server" architecture, where the client is a mobile device. The client/server paradigm is founded on the concept that clients (such as personal computers, or mobile devices) and servers (computers) are both connected by a network enabling servers to provide different services for the clients. When a client sends a request to a server, this server processes the request and sends a response back to client.

In addition, we can currently identify two approaches to mobile deployments: thick-client and thin-client.

- *Thick-client* deployments run special software on each type of mobile device, fed by special servers that manage the interactions with those devices. The client-side software controls how content is displayed. This was an important factor in the early days of mobile browsers, when each device displayed content differently.
- *Thin-client* architectures rely entirely on Web technologies to deliver mobile applications. No additional technology investment is required, and there is no risk of client-side software becoming obsolete. There is no need for additional servers, and no unique client-side software or upgrade costs. Its main drawback is that all content cannot be easily delivered to all browsers.

We have chosen a *thin-client* model for our implementation because we want to develop the system like a web service under a social web framework.

In what follows, we describe the client interfaz and the server structure in detail.

1. Client:
   The client software shows a specific interfaz to the users depending on the kind of user. At first, the user has to introduce his/her password in the system, then, the

system decides the kind of interfaz to show. There are two different interfaces: *Customer interfaz* and *Member Interfaz*.

(a) *Customer interfaz:* This interfaz is designed for the customers that need help with their m-commerce experiences.

- *Select alternatives:* To introduce the preferred items to buy.
- *Needs survey:* To choose the importance degree of the item's features.
- *Output:* At the end of the decision process, the device will show the set of solution alternatives as an ordered set of alternatives marking the most relevant ones.

(b) *Member Interfaz:* This interfaz is designed for the social network members that can help the potential customers.

- *Problem description:* The device shows to the members a brief description about the problem and the discussion subset of alternatives.
- *Insertion of preferences:* The device has a specific interface to insert the linguistic preferences using a set of labels. To introduce the preferences on the interface, the user has to use the keys of the device.

2. Server:
The web server is the main side of DSS. It implements the selection process and the database that stores the problem data as well as problem parameters and the information generated during the decision process. The communication with the client to receive/send information from/to the experts is supported by mobile Internet (M-Internet) technologies. The selection process implemented has two different phases [8]:

(a) Aggregation:
This phase defines a collective preference relation, $P^c = (p^c_{ij})$, obtained by means of the aggregation of all individual linguistic preference relations $\{P^1, P^2, \ldots, P^m\}$. It indicates the global preference between every pair of alternatives according to the majority of members' opinions. The aggregation is carried out by means of a LOWA operator ϕ_Q guided by a fuzzy linguistic non-decreasing quantifier Q [10]: $p^c_{ij} = \phi_Q(p^1_{ij}, \ldots, p^m_{ij})$.

(b) Exploitation:
This phase transforms the global information about the alternatives into a global ranking of them, from which the set of solution alternatives is obtained. The global ranking is obtained applying two choice degrees of alternatives on the collective preference relation QGDD and QGNDD. These degrees can be studies in more detail in [2].

3. Usage Scenario

To clearly explain the way of use and the tool's features, we simulate a usage scenario that shows the mobile interfaces of the social network service, which are displayed in the customer's mobile device before buying an item using m-commerce as way of shopping.

The example deals with the purchase of a car. Firstly, suppose that customer visits the car shop web site, selects a set of cars as possible shopping alternatives, and has not a clear idea of which car is more adapted to his/her needs yet. Therefore, the customer needs some advice to choice the best option. To obtain this help, the customer uses our MDSS, which acts as an advices unifier and is offered by the social network of whom the customer is member. To complete the advice process, the customer has to follow three easy steps:

1. The firs step is the authentication process (see Figure 2 a).
2. The second step is to select the set of cars that he considers that are the more adapted to his/her needs using his/her mobile device (see Figure 2 b).
3. Then, the customer send his/her needs about the cars environment to receive a personalized service. To do so, the customer has to answer some questions and submit the survey from his/her mobile device (see Figure 2 c)

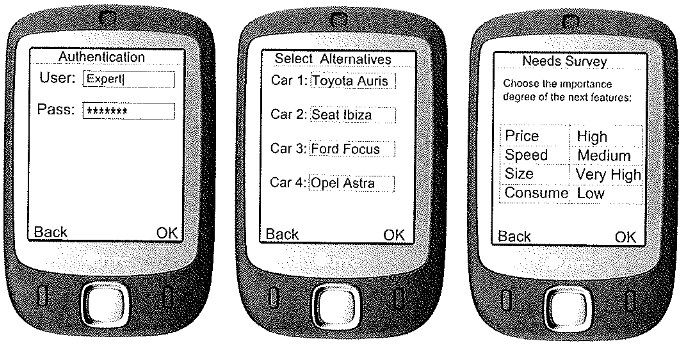

Figure 2. a) Authentication. b) Selection of alternatives. c) Needs survey

Once the customer has submitted his/her preferred items and his/her current needs, the members connected with him/her have to give their opinions, taking into account the customer's needs, about the alternatives that the customer has selected (see Figure 3). When all the experts have given their opinions using fuzzy linguistic preference relations as element of preferences' representation, the system starts the selection process.

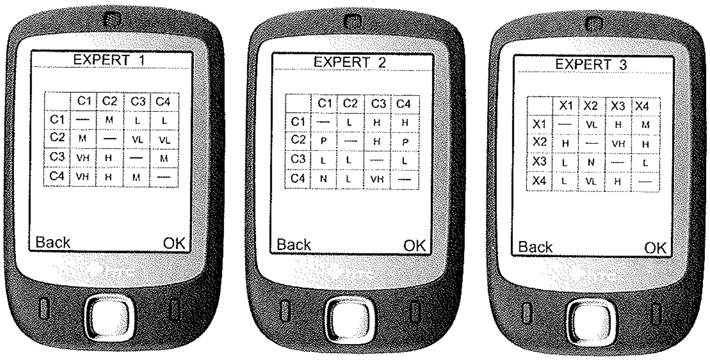

Figure 3. Insertion of individual advices

- Aggregation phase:
  We aggregate by means of the LOWA operator. We make use of the linguistic quantifier *most of* defined as $Q(r) = r^{1/2}$, that generates a weighting vector of three values $W = (0.58, 0.24, 0.18)$, and to obtain each collective ordinal linguistic preference value p_{ij}^c. As an example, the collective ordinal linguistic preference value p_{12}^c is obtained as follows [2]:
  (Note that the p_{ij}^k values can be obtained from figure 3)

  * $p_{12}^1 = M,\ p_{12}^2 = L,\ p_{12}^3 = VL \Rightarrow \sigma(1) = 1,\ \sigma(2) = 2,\ \sigma(3) = 3$
  * $p_{12}^c = \Gamma(w_1 \cdot \Gamma^{-1}(p_{12}^1) + w_2 \cdot \Gamma^{-1}(p_{12}^2) + w_3 \cdot \Gamma^{-1}(p_{12}^3)) = \Gamma(0.58 \cdot 3 + 0.24 \cdot 2 + 0.18 \cdot 1) = \Gamma(2.4) = L$

  The obtained collective ordinal fuzzy linguistic preference relation is:

$$P^c = \begin{pmatrix} - & L & H & M \\ VH & - & H & VH \\ H & M & - & M \\ M & M & H & - \end{pmatrix}$$

- Exploitation phase:
  The following quantifier guided dominance and non-dominance degrees of each alternative are computed [2]:

	x_1	x_2	x_3	x_4
$QGDD_i$	M	VH	H	H
$QGNDD_i$	VH	P	P	P

When the system has computed all these values, the customer receives them in his mobile device in form of advice (see Figure 4):

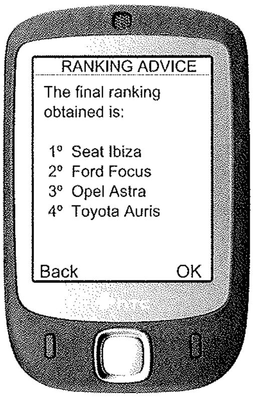

Figure 4. Displayed advice

4. Concluding Remarks

We have presented a MDSS based on GDM models as a Web 2.0 service related with m-commerce. This service uses the advantages of M-Internet communication technologies to advise the customer in their m-commerce experiences and, in such a way, it improves the customer satisfaction with the decision of purchase in anytime and anywhere. We have used smartphones as device to send the experts' preferences but the structure of the prototype is designed to use any mobile device as PDAs. In the future, we shall incorporate in the web service some options to manage incomplete and inconsistent preferences.

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