Towards a Framework for Weaving Social Networks into Mobile Commerce

Zakaria MAAMAR¹, Noura FACI², Soraya KOUADRI MOSTÉFAOUI³, and Fahim AKHTER⁴

¹Zayed University, Dubai, U.A.E
²Université Lyon 1, Lyon, France
³The Open University, Milton Keynes, U.K
⁴Monash University, Sunway Campus, Malaysia

Abstract. This paper discusses a framework that supports weaving social elements into mobile commerce applications. This weaving takes place through different types of social networks that identify the stakeholders taking part in completing these applications. These stakeholders are consumers, providers, and brokers and are connected to each other through relationships such as competition, referral, loyalty, and collaboration. Each relationship is mapped onto a social network upon which a stakeholder relies before engaging in any of these applications and afterwards, making any decision. The value-added of social networks to mobile commerce is illustrated with a set of experiments implementing a smart mobile restaurant guide.

Keywords: Mobile commerce, relationship, social networking.

INTRODUCTION

The Internet has made a huge impact on how individuals interact together and organizations operate. They both have access to a plethora of online services anywhere, anytime (Kouadri, Maamar & Rana, 2005). As a result, new business practices are put in place, new global opportunities are offered, and new security threats and privacy fears are observed. Commerce is one of these domains that the Internet impacted heavily. Indeed commerce has evolved from the traditional way of buying-and-selling goods to launching online transactions from browsers and lately mobile handled devices. This shift from commerce to e-commerce and then m-commerce shows how people embrace quickly IT means and gadgets. But this embrace is done on the expense of fostering the social interactions that characterize the traditional commerce like bargaining with vendors, shopping around with friends, probing friends for recommendations, and checking others’ purchases (Maamar, 2003). Injecting social elements into consumers’ commerce operations should make them aware of others’ success stories and pitfalls that they have come across prior to finalizing these operations. These social elements like fairness and trustworthiness are neither captured nor tracked, which raises questions about the soundness, correctness, and relevance of consumers’ and providers decisions.

With the emergence of Web 2.0 we witness a major change in software applications development by putting emphasis on the social dimension of end-users’ behaviors. Applications like Facebook, LinkedIn, and MySpace capitalize on the ability and willingness of users to interact, share, collaborate, and recommend. Social networking sites, blogs, wikis, and folksonomies exemplify social applications and, at the same time, reinforce the role of the Internet as a solid and inevitable platform for group collaboration. Users are now referred to as prosumers (Pedrinaci & Domingue, 2010), i.e., providers and consumers simultaneously. Goad (2010), Research Director at Experian Hitwise states that "... With currently only 7.51% of all traffic to transactional sites coming from social networking and forums, compared to 40.87% of all traffic from search engines, there is clearly a major opportunity for increasing traffic". The same reference, also, reports that media-based social applications are a critical factor for driving online sales in 2010.

In this paper we discuss the weaving of social elements into m-commerce and illustrate the value-added of this weaving to consumers’ and providers’ decision making process. Social elements identify relationships between consumers (e.g., collaboration, referral), providers (e.g., competition, collaboration), and both so that each stakeholder can benefit from the other’s experience. A three-block framework to support social, m-commerce applications is discussed where two blocks correspond to consumers and providers and a third block corresponds to brokers (or middlemen). The rationale and
characteristics of each block as well as the social networks that these blocks host are discussed throughout this paper.

In the following, we will start by motivating our work by examining e-/m-commerce from a social perspective and suggest a literature review on m-commerce and social networks use. We will then, present our framework to support social, m-commerce applications. Prior to concluding, a proof-of-concept implementation of our framework is presented.

**BACKGROUND**
This section discusses the motivations in the weaving of social elements into e-/m-commerce and then, proposes a literature review on m-commerce applications and social networks use in some application domains.

**Motivations**
Despite the variety of IT means and gadgets that are available to consumers and providers to reach each other, commerce still manifests itself with one of these forms (Liand & Huang, 2000): bargaining, bidding, auctioning, and clearing. The first two are bilateral (consumer and provider) and the rest are trilateral (consumer, provider, and broker). Briefly,

- **Bargaining** involves one customer who negotiates with a specific provider until an agreement is reached. In case negotiation fails, the customer looks for another provider and so on. In bargaining two social elements can be identified: trustworthiness of consumers in providers by not revealing their private details and confidence of consumers in providers to satisfy their demands as agreed upon.
- **Bidding** involves one customer and several providers. The customer calls for bids and then, compares the offers she receives from interested providers. At the end the customer selects the provider with the lowest offer. Besides trustworthiness and confidence social elements, bidding requires consumer fairness when processing providers’ offers.
- **Auctioning** (English type) involves one provider that fixes the lowest price for a product, several customers, and one broker. Acting on behalf of the provider, the broker advertises the product to customers prior to calling for auctions. Upon customers’ offers receipt, the broker selects the highest and informs the provider about it. Besides the English auctioning, Dutch and Vickrey are additional types of auctioning. Besides trustworthiness and confidence as explained earlier, auctioning requires broker fairness when processing consumers’ offers and trustworthiness of providers in brokers by keeping their expectations confidential.
- **Clearing** involves several customers, several providers, and one broker. Customers and providers send the broker their needs to satisfy and products to offer, respectively. In case of successful match, the broker notifies appropriate customers and providers so that both engage in direct negotiations. The broker is bypassed during these negotiations. Fairness of broker is one of the social elements to track in clearing.

It is clear that each form of commerce is the source of different types of social elements that, if captured, would have a value-added to commerce. In bargaining narrowing down the list of potential providers makes sense to consumers who are on the move and thus, subject to limited computing resources. In addition to narrowing down this list, elements like location and profile could help in shortening the negotiation cycle between consumers and providers (Chen, Liu, Huang & Sun, 2010). In bidding the number of providers that take part in the bidding process can be reduced by targeting those that have shown interest in handling demands of consumers. This interest can be associated with consumers’ confidence in providers. Consumers tend to deal with same providers (Lindberg, 2011). The same analysis continues for auctioning and clearing, which shows our motivations in weaving social elements into e-/m-commerce.
**Literature review**

According to the authors of a report mandated by the Government of Victoria in Australia, m-commerce is likely to become another choice for consumers, rather than a preferred option, with the benefits and risks weighted up against other forms of selling and buying (Standing Committee of Officials of Consumer Affairs, 2004). Although similarities between e-commerce and m-commerce exist, which are purchasing products or requesting services in a virtual environment, m-commerce needs to be recognized as a unique business opportunity that comes along with its unique set of characteristics and challenges. M-commerce is “not just an extension of Internet-based e-commerce” due to its ubiquity, convenience, accessibility, personalization, and localization characteristics (Xiaojun, Junichi & sho, 2010).

Fuller (2010) mentions that in many countries it is more likely that an individual will have a mobile handheld phone then a computer with Internet connectivity. Although the figures are somehow outdated a report by McKinsey research firm indicates that in 2005 there was an estimated 85% penetration rate for mobile phone usage in Europe. From a security perspective m-commerce faces the same security threats that e-commerce does plus many others related to the nature of purchasing online while on the move. These threats rise due to lack of user awareness, limited computing power, possible loss or theft of devices, incomplete authentication schemes, use of wireless transmissions, vulnerable operation systems, and use of unsecured technologies (Fuller, 2010).

Li defines m-commerce as a commercial transaction conducted over wireless network through mobile handheld devices (Li, 2010). Because of these networks data capacity handling, connectivity lasting, and these devices’ limitations, the well-known client-server model is an obstacle to the growth of m-commerce. Li adopts mobile agents; they can roam the Internet hopping from one node to another. Deploying mobile agents in m-commerce can reduce unnecessary network traffic, tolerate poor network connectivity, and provide more advanced service, just to cite some benefits. Consumers dispatch mobile agents from their handheld devices to visit e-stores so that operations like search, compare, evaluate, buy, and pay are carried out locally, i.e., within the virtual premises of the e-stores.

The use of social networks is reported in different domains such as social sciences, artificial intelligence, and business sciences (Maaradji, Hacid, Daigremont & Crespi, 2010; Xie, Du & Zhang, 2008). In a DEMOS (a London-based think tank, news.bbc.co.uk/2/hi/business/7695716.stm) report, organizations were invited to let their employees use social applications to set up and foster networks of contacts with their colleagues, customers, and suppliers. This should impact positively productivity, business development, and collegiality subject to using these applications properly. Organizations can, also, capitalize on social applications to attract new customers, identify appropriate suppliers, and be aware of competitors (Badr & Maamar, 2009).

In the field of distributed artificial intelligence, social networks allow the specification of coordination, cooperation, and negotiation mechanisms of software agents. Castelfranchi (1995) notes that “an agent can be helped or damaged, favored or threatened, it can compete or co-operate” (Castelfranchi, 1995). An agent is not an independent entity, but “lives” in a society in which it interacts with peers from this society and other societies as well. To assess the reputation of an agent in a society, Pujol, Sanguesa & Delago (2002) rely on the topologies of social networks and positions that the agent holds in these networks over time. In the field of recommender systems, McDonald (2003) uses social networks to recommend individuals for possible collaboration based on the expertise offered and needed.

**OUR FRAMEWORK TO SUPPORT SOCIAL, M-COMMERCE APPLICATIONS**

First of all we provide an overview of the social, m-commerce framework and the constituents populating the three blocks of this framework. Afterwards we discuss the potential relationships between these
constituents and how these relationships are mapped onto social networks. These relationships are either intra-blocks or inter-blocks.

**Architecture**

Figure 1 illustrates the general representation of our three-block framework to support social, m-commerce applications. The three blocks correspond respectively to consumers equipped with mobile devices, brokers, and providers. Each block hosts one to several types of social networks depending on the relationships that arise between consumers, providers, and brokers, and between all of them. Examples of relationships (or social interactions as shown in Figure 1) include competition, referral, and collaboration, which we detail in the next section.

![Diagram of social network architecture](image)

**Figure 1 Three blocks framework general representation**

- **Consumer** is any person who initiates online purchasing transactions from her mobile device. The consumer logs into dedicated Web sites and screens the products/services posted on line. Prior to launching or finalizing any order request the user capitalizes on the social networks that she is part of in order to request extra details or comments on the products/services, look for possible consumers interested in similar products/services, disseminate information on products/services, etc. The different actions that a consumer performs depend on her interactions with similar peers, providers, and brokers.
- **Provider** is any organization that has a presence on the Internet by selling products or offering services on line. Products range from electronics and garments to hardware tools and books, while services range from car rental and hotel booking to currency conversion and document translation. Prior to posting any product or service, a provider capitalizes on the social networks it is part of in order to identify possible competitors, locate potential suppliers, partner with other competitors (if necessary), etc. The different actions that a provider performs depend on its interactions with similar peers, consumers, and brokers.
- **Broker** is any third party that sits between consumers and providers to ease the completion of online transactions. Brokers receive requests from consumers and announcements from providers, so they match them together. Prior to processing requests or announcements, a broker capitalizes on its social networks in order to identify consumers or providers with similar requests or announcements, check with other peers about the latest trends, etc. The different actions that a broker performs depend on her interactions with other similar peers, consumers, and providers.

Figure 1 shows intra- and inter-social interactions. Intra-interactions involve parties of the same type, only, for example consumers and illustrate the operations that benefit a community populated by this type of party. These operations are cited earlier like customer seeking recommendations from other customers and provider seeking support from other providers. Inter-interactions involve parties of different types for example consumers and providers and illustrate the operations that require both like buying-selling
between consumers and providers and announcing-broadcasting between providers and brokers. According to Raab & Milward (2003) social networks are either bright or dark. Bright networks exist when the outcomes of socializing turn out beneficial for individuals, groups, businesses, and society at large. Contrarily, dark networks exist when the outcomes of socializing are obtained at great cost to individuals, groups, businesses, and social welfare. We expect that the same type of social networks in e-commerce will arise depending on the parties that participate in these networks. A social network of competing providers is probably dark as providers like to increase their market share on the expense of others. Contrarily, a social network of collaborating providers is probably bright as providers can get together to cater for large orders that they cannot handle individually.

**Types of social networks**

Each block in the framework hosts different social networks depending on who resides in the block. We discuss first the social networks associated with the intra-social interactions and then the networks associated with the inter-social interactions. For each social network we describe its design and value-added to e-commerce (Table 1). We recall that a network is a graph that consists of nodes and edges connecting these nodes.

**Social networks reflecting intra-social interactions**

In the consumer block, we identify the following social interactions: competition, referral, and collaboration. Building a social network of consumers requires that their identity is public.

- **Competition** between consumers is limited to auctioning, only. Other forms of commerce do not raise competition. A competition social network of consumers is useful to support the decisions of consumer (c) whether to engage in competition with a group of consumers (c_{ij}) as this requires committing computing resources that are for sure limited for c. In a competition social network of customers, nodes correspond to consumers and edges (bidirectional) correspond to competition relationship. To evaluate the weight of an edge, which we refer to as Consumer-Competition Level (C-ComL), between c and c_{ij}, we propose

\[
C - ComL_{c(i,j)} = \frac{C - WC_{c(i,j)}}{C - TR_{c(i,j)}}
\]

Where C-WC is number of times c_{ij} Won the Competition (i.e., auction) over c, and C-TC is Total number of times that c_{ij} and c_{ij} were involved in joint Competitions. If necessary the competition level can be fine-tuned by focusing on each member c_{ij} of the group of customers c_{ij}.

- **Referral** sheds the light on cases where consumers recommend products/services to other peers according to criteria like location and mobile device used. A referral social network of consumers is useful to assess the satisfaction of consumer (c) over the referrals received from another consumer (c_{ij}). Positive satisfaction means that c_{ij} did not have to commit her limited computing resources. In a referral social network of consumers, nodes correspond to consumers and edges (unidirectional) correspond to referral relationship. To evaluate the weight of an edge, which we refer to as Consumer-Referral Level (C-RefL), between c and c_{ij}, we propose

\[
C - RefL_{c(i,j)} = C - fbk_{c(i,j)} * \frac{C - RA_{c(i,j)}}{C - TR_{c(i,j)}}
\]

Where C-fbk is feedback (positive or negative) of c_{ij}, over accepting the referral of c_{ij}, C-RA is total number of Referrals that c_{ij} Accepted from c, and C-TR is Total number of Referrals that c_{ij} issued for the benefit of c_{ij}. The type of feedback function in the above equation does not fall into this paper’s scope.

- **Collaboration** sheds the light on cases where consumers come together unexpectedly (i.e., on an ad-hoc manner) to act like one group. A collaboration social network of consumers is useful to assess the partnership level of consumer (c) with a group of consumers (c_{ij}) as they have same demands and interests. A group puts them in a better position to ask for additional benefits when
interacting with providers. Only one consumer acts on behalf of the group members which avoids using these members’ computing resources. In a collaboration social network of consumers, nodes correspond to consumers and edges (bidirectional) correspond to collaboration relationship. To evaluate the weight of an edge, which we refer to as Consumer-Collaboration Level (C-ColL), between c_i and c_{ij}, we propose

\[ C - \text{Coll}_{c_i(c_j)} = \frac{C - SP_{c_i(c_j)}}{C - TP_{c_i(c_j)}} \]

Where \(C-SP\) is number of times \(c_{(j)}\) Successfully Partnered with c_i and \(C-TP\) is Total number of times c_i and c_{ij} Partnered together. If necessary the collaboration level can be fine-tuned by focusing on each member c_j of the group of consumers c_{ij}.

In the provider block, the social interactions are as follows: referral and collaboration. Building a social network for providers assumes that the identity of these providers is public.

- **Competition** between providers is limited to bidding, only. Other forms of commerce do not raise competition between providers. A competition social network of providers is useful when assessing the competitiveness level of a provider (p_i) towards a group of one to several providers (p_{(j)}). Continuous failures of p_i might indicate lack of competitiveness, which could require taking corrective actions. A provider would know if it is worth engaging in competition with others based on previous experiences reported in its competition social network. In this network, nodes correspond to providers and edges (bidirectional) correspond to competition relationships. To evaluate the weight of an edge, which we refer to as Provider-Competition Level (P-ComL), between p_i and p_{(j)}, we propose

\[ P - \text{ComL}_{p_i(p_j)} = \frac{P - WC_{p_i, p_{(j)}}}{P - TC_{p_i, p_{(j)}}} \]

Where \(P-WC\) is number of times p_{(j)} Won the Competition over p_i, and \(P-TC\) is Total number of times that p_i and p_{(j)} were involved in joint Competitions. If necessary the competition level can be fine-tuned by focusing on each member p_j of the group of providers p_{(j)}.

- **Referral** sheds the light on cases where providers replace others to handle amount of requests that exceed their respective capabilities and have strong constrained-QoS. Providers thus send mobile consumers to others more available with equivalent services. In a referral social network of providers, nodes correspond to providers and edges (unidirectional) correspond to referral relationship. To evaluate the weight of an edge, which we refer to as Provider-Referral Level (P-RefL), between p_i and p_j, we propose

\[ P - \text{RefL}_{p_i(p_j)} = P - fbk_{p_i(p_j)} * \frac{P - RA_{p_i,p_j}}{P - TR_{p_i,p_j}} \]

Where \(P-fbk\) is feedback (positive or negative) of p_i over accepting the referral of p_j, \(P-RA\) is total number of Referrals that p_i Accepted from p_j, and \(P-TR\) is Total number of Referrals that p_j issued for the benefit of p_i. The type of feedback function in the above equation does not fall into this paper’s scope.

- **Collaboration** sheds the light on cases where providers partner to handle requests that exceed their respective capacities. By doing this the providers constitute a major force when interacting with consumers and sometimes other providers. A collaboration social network for providers is useful to assess the partnership level of a providers (p_i) with a group of one to several providers (p_{(j)}). Successful partnerships of p_i might indicate strong similar interests with p_{(j)}. Since there is a risk of revealing private details on providers’ interests and strategies in a collaboration social network, a provider would know if it is worth engaging in partnership with other peers based on previous experiences. In this network, nodes correspond to providers and edges (bidirectional) correspond to collaboration relationships. To evaluate the weight of an edge, which we refer to as Provider-Collaboration Level (P-ColL), between p_i and p_{(j)}, we propose
Where $P - SP$ is number of times $p_{(j)}$ Successfully Partnered with $p_i$, and $P - TP$ is Total number of times $p_i$ and $p_{(j)}$ Partnered together. If necessary the collaboration level can be fine-tuned by focusing on each member $p_i$ of the group of providers $p_{(j)}$.

In the broker block, the social interactions are as follows: competition and referral. Collaboration is excluded as it can be treated as a kind of referral interaction between brokers. Building a social network for brokers assumes that the identity of these brokers is known.

- **Competition** between brokers arises when consumers and providers contact different brokers for the same needs and offers, respectively. The role of a broker is to match needs with offers while taking into account consumers and providers’ requirements like maximum time to conclude a match and minimum charges to bear. A competition social network of brokers is useful for both brokers and consumers/providers. To cater for the needs of each category, two competition social networks are to be built. The first social network connects brokers together and tells how competitive a broker is towards other brokers. And the second social network connects consumers/providers to brokers together and tells how successful a broker is in matching needs with offers compared to other brokers. This second social network is discussed in the context of inter-social interactions.

In a competition social network of brokers, only, nodes correspond to brokers and edges (bidirectional) correspond to competition relationships. To evaluate the weight of an edge, which we refer to as Broker-Competition Level ($B-ComL$), between $b_i$ and $b_{(j)}$, we propose

$$
B - ComL_{b_i(b_{(j)})} = \frac{B - WC_{b_i(b_{(j)})}}{B - TC_{b_i(b_{(j)})}}
$$

Where $B-WC$ is number of times $b_{(j)}$ Won the Competition over $b_i$, and $B-TC$ is Total number of times that $b_i$ and $b_{(j)}$ were involved in joint Competitions. By winning a competition, it is meant that the broker responded successfully to the request of matching a user’s need with a provider’s offer. If necessary the competition level can be fine-tuned by focusing on each member $b_j$ of the group of brokers $b_{(j)}$.

- **Referral** between brokers arises when these latter advise consumers or providers to check with other peer brokers. This assumes that the brokers are mutually aware of users’ needs and providers’ offers so that they can support each other. A referral social network of brokers is useful for both brokers and consumers/providers. To cater for the needs of each category, two referral social networks are to be built. The first social network connects brokers together and tells how responsiveness a broker is towards other brokers. And the second social network connects consumers/providers to brokers together and tells the satisfaction of consumers/providers towards the broker that was referred to them by another broker. This second social network is discussed in the context of inter-social interactions.

In a referral social network of brokers, only, nodes correspond to brokers and edges (unidirectional) correspond to referral relationships. To evaluate the weight of an edge, which we refer to as Broker-Referral Level ($B-RefL$), between $b_i$ and $b_{(j)}$, we propose

$$
B - RefL_{b_i(b_{(j)})} = B - f_{bk_{b_i(b_{(j)}}} \frac{B - RA_{b_i(b_{(j)}}}{B - TR_{b_i(b_{(j)}}}
$$

Where $B-fbk$ is feedback of $b_i$ over accepting the referral of $b_{(j)}$, $B-RA$ is total number of Referral requests that $b_i$ Accepted from $b_{(j)}$, and $B-TR$ is Total number of Referral requests that $b_i$ issued for the benefit of $b_{(j)}$.

Table 1 is a summary of the different social networks that the three blocks of the social, m-commerce framework host. These social networks identify relationships within the limits of these blocks.
Table 1 Value-added of social networks to the social, m-commerce framework

<table>
<thead>
<tr>
<th>Block name</th>
<th>Hosted social network</th>
<th>Value-added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer</td>
<td>Competition</td>
<td>Assist consumers weed out non-winning competition cases</td>
</tr>
<tr>
<td></td>
<td>Referral</td>
<td>Help consumers recommend products/services to their peers according to criteria such as location</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>Assist consumers exchange information on products and services with respect to criteria like location</td>
</tr>
<tr>
<td>Provider</td>
<td>Competition</td>
<td>Assist providers decide about the appropriateness for engaging in competition</td>
</tr>
<tr>
<td></td>
<td>Referral</td>
<td>Assist providers forward demands exceeding their individual capabilities to other peers</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>Assist providers handle demands exceeding their individual capabilities by seeking the support of other peers</td>
</tr>
<tr>
<td>Broker</td>
<td>Competition</td>
<td>Assist brokers decide about the appropriateness for engaging in competition</td>
</tr>
<tr>
<td></td>
<td>Referral</td>
<td>Assist broker direct consumers/providers to other peers</td>
</tr>
</tbody>
</table>

**Social networks reflecting inter-social interactions**

In Figure 1 the inter-social interactions connect consumers, providers, and brokers together. We build social networks upon these social interactions as per the following three connections: consumer-provider, consumer-broker, and provider-broker.

In the consumer-provider connection, the social interaction corresponds to loyalty¹.

- **Loyalty** shows the nature of relationship between a consumer and a provider. A loyalty social network of consumers-providers permits to a consumer to select the providers she likes dealing with and vice-versa as per previous experiences. In this network nodes correspond to consumers and providers, and edges (unidirectional from consumer to provider or vice-versa) corresponds to loyalty relationship. To evaluate the weight of an edge, which we refer to Consumer/Provider-Loyalty Level (C/P-LoyL), between c_i and p_j, we propose

\[ C/P - LoyL_{c_i,p_j} = C/P - fbk_{c_i,p_j} * \frac{C/P - TS_{c_i,p_j}}{C/P - T_{c_i,p_j}} \]

Where C/P-fbk is feedback of c_i over the performance of p_j, C/P-TS is Total number of times c_i Selected p_j, and C/P-TI is Total number of times c_i Interacted with a group of providers p_{j|} for the same need that was then handled by p_j, p_j is part of this group.

In the consumer-broker connection, the social interactions correspond to competition and referral as identified earlier in our discussions on the intra-social interactions for brokers.

- **Competition** tells how successful a broker is in matching needs with offers compared to other brokers from a user’s perspective. To evaluate the weight of an edge in a competition social network of consumer-broker, which we refer to as Consumer/Broker-Competition Level (CB-ComL), between c_i and b_j, we propose

\[ CB - ComL_{c_i,b_j} = CB - fbk_{c_i,b_j} * \frac{CB - TS_{c_i,b_j}}{CB - T_{c_i,b_j}} \]

¹Saunders (2010), Consulting Director at Verdict Research comments: “With growth of new customers levelling off it becomes increasingly important to change marketing strategies to focus on growing loyalty and increasing repeat visits rather than acquiring new customers”.
Where $CB-fbk$ is feedback of $c_i$ over the match of $b_j$, $CB-TS$ is number of Times $c_i$ Selected $b_i$ over other brokers $b_{(j)}$, and $CB-TC$ is Total number of times that $c_i$ contacted the group of brokers $b_{(j)}$. If necessary the competition level can be fine-tuned by focusing on each member $b_j$ of the group of brokers $b_{(j)}$.

- **Referral** tells the satisfaction of consumers towards the brokers that were referred to them by other brokers. To evaluate the weight of an edge in a referral social network for consumer-broker, which we refer to as Consumer/Broker-Referral Level ($CB-RefL$), between $c_i$ and $b_j$ as per the referral of $b_k$, we propose

$$CB - RefL_{c_i,b_j,b_k} = CB - fbk_{c_i,b_j,b_k} * \frac{CB - RA_{c_i,b_j,b_k}}{CB - TR_{c_i,b_j,b_k}}$$

Where $CB-fbk$ is feedback of $c_i$ over accepting the referral of $b_k$ to use $b_j$, $CB-RA$ is total number of Referral requests that $b_j$ Accepted from $b_k$, and $CB-TR$ is Total number of Referral requests that $b_k$ issued for the benefit of $b_j$.

In the provider-broker connection, the social interactions correspond to competition and referral that are similar to consumer-broker connection. Provider/Broker-Competition Level ($PB-ComL$) and Provider/Broker-Referral Level ($PB-RefL$) will have to be defined.

**PROOF-OF-CONCEPT IMPLEMENTATION**

The proposed framework is implemented as a prototype called the Smart Mobile Restaurant Guide (SMRG). The guide consists of a set of participating restaurants and can access a number of social e-commerce sites to whom the client may register in advance. SMRG’s use-case diagram is shown in Figure 2.

![SMRG use case diagram](image)

Figure 2 SMRG use case diagram.

A client accesses the SMRG through a mobile portal. She enters her credentials and then gets authenticated after which her profile is loaded from a mobile data base. The profile holds information
regarding the client’s preferences and some historical data such as recently visited restaurants, recently ordered menus, average amount spent per visit, and any dietary requirement. The client can, also, add through a mobile interface other requirements such as number of tables required for a given request, preferred location, etc.

The ‘Catalogue’ service then accesses the participating restaurants’ menus and browses the social e-commerce daily deals offers -if any, depending on the client’s registrations- and eligibility (at this stage participating restaurants and sites may enter into competition by offering more deals making use of the provider competition social network). The SMRG then ranks the restaurants and menus according to the client’s preferences and requirements and sends the ranked list back to the client’s mobile device. The client then makes a choice (at this stage the client can browse the reviews and feedbacks on the proposed services making use of the customer referral social network).

Once the client makes her choice, the SMRG contacts the chosen restaurant to confirm the order, and sends a short message (using an SMS mobile service) to the client giving the directions and an estimation of the waiting time. If the client is happy she makes a final confirmation and her credit card details are either collected from her profile or asked for. The details are then validated by the ‘Card Validation’ service. If everything goes according to the plan, the client’s account is debited and the SMRG’s account is credited. If the client is placed into a waiting list a short text message is sent when the table is ready in the chosen restaurant. If the client is not happy about the waiting time, she sends a message to SMRG. The SMRG, then flags the request as ‘unsolved’ (at this stage participating restaurants and sites may enter again into competition by offering more deals making use of the provider competition social network), a second offer is then made and the client can again makes her choice. Once a choice is made, the request is un-flagged, but providers can seize this opportunity to make additional offers such as apology’ vouchers and discounts.

SMRG continually monitors the operation of the different restaurants. If for some reasons (such as restaurants getting too busy during peak hours, or Christmas time) a restaurant is not able to satisfy all the incoming requests, the SMRG may offer a second choice to the client by redirecting to another nearby restaurant, (making use of the providers collaboration and the broker referral social networks). Table 2 summarizes the added-value of the different social interactions for the SMRG.

Table 2 Value-added of social networks to the SMRG system.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Hosted social network</th>
<th>Value-added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client (consumer)</td>
<td>Competition</td>
<td>Help clients recommend restaurants/menus to their peers. Clients can, also, rate the different restaurants, menus, dishes and facilities to improve the service quality.</td>
</tr>
<tr>
<td></td>
<td>Referral</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td></td>
</tr>
<tr>
<td>Participating restaurants and social e-commerce sites (providers)</td>
<td>Competition</td>
<td>Restaurants may compete by making more offers using for example mobile vouchers; restaurants can send offers and deals to existing clients on their mobile devices, this will increase the chances a restaurant get chosen.</td>
</tr>
<tr>
<td></td>
<td>Referral</td>
<td>Assist participating restaurants decide the appropriateness to engage into a competition to serve certain requests. For example, by checking if there are requests from usual clients.</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>Assist participating restaurants handle demands exceeding their individual capacities (e.g., redirect a client to another nearby</td>
</tr>
</tbody>
</table>
restaurant if a menu is not available or particular requirements cannot be satisfied provided the client accepts the offer). This will allow the company to satisfy demands in a prompt and responsive manner.

<table>
<thead>
<tr>
<th>SMRG (broker)</th>
<th>Competition</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Referral</td>
<td>Assist SMRG forward clients’ requests to other participating restaurants.</td>
</tr>
</tbody>
</table>

In order to implement the different elements of the SMRG, we looked for an easy to use, lightweight open source Web GUI. We have then chosen the WireIt editor (http://neyric.github.com/wireit/); which is an open source JavaScript library to create Web wireable interfaces for dataflow applications, visual programming languages, graphical modeling, or graph editors. For the purpose of this implementation and for the sake of simplicity, the SMRG uses WireIt to search, select and create its composite services. Our first experiments have shown there is some overhead introduced by using the social networking capabilities as shown in Figure 3. The execution time with and without social-networks use was analyzed in three cases:

- Case 1 uses only one type of social networks (namely, customers’ referral, where clients recommend menus/restaurants to their peers), this introduces slightly some overhead.
- Case 2 makes use of two types of social networks (namely, customers’ referral and providers’ competition). This case shows that there is more overhead with two networks as there are more interactions generated before the client gets the service offer.
- Case 3 makes use of three different social networks, the two former ones and the providers’ collaboration network. Case 3 shows clearly that there is much more overhead generated when using the providers’ collaboration network. It is worth noticing here that for the purpose of this implementation we have manually created the cases needed to generate the desired interactions.

![Figure 3 overhead of social interactions.](image)

We have then adopted the analytical method presented in (Kouadri & Younas, 2007) in order to analyse the effect of engaging into social networks on the throughput of the SMRG. This method is based on the probability theory which assigns various probabilities to the commit and abort actions of an m-commerce transaction (in this case we have associated each SMRG request with a data base transaction). We have then conducted a set of experiments in different contexts (different number of requests, times, etc.,) using various probabilities and accordingly calculated the throughput (number of successful requests) of SMRG. Figure 4 shows the success/failure rate.
We have used the same three cases developed earlier to test the overhead. A rapid analysis of Figure 4 clearly highlights that there is an increase in the number of successful requests when using the above-mentioned social interactions. It also shows that there is a drastic decrease in the number of failed requests when using social interactions. Thus, the benefits of social networking outweigh its limitation in terms of processing overhead.

**CONCLUSION**

In this paper we presented a framework for weaving social elements into mobile commerce. This framework consists of three blocks referring to consumers, providers, and brokers and ensures their connection through different relationships like collaboration, loyalty, competition, and referral. These relationships are then mapped onto social relationships. The value-added of each social network was also discussed. For instance a competition social network assists consumers weed out non-winning competition cases so that her resources are not engaged. The same type of network allows providers decide about the appropriateness of competing against other peers. The implementation of this framework was illustrated with a Smart Mobile Restaurant Guide. In terms of conclusions out of this implementation it was clear that there was an increase in the number of successful users’ requests when using social networks. It was, also, shown that there was a drastic decrease in the number of failed users’ requests when using these networks. Thus, the benefits of social networking outweigh its limitation in terms of processing overhead.

**REFERENCES**


