Ubiquitous proximity e-service for trust collaboration

Yuan-Chu Hwang
Department of Information Management, National United University, Taiwan, and
Soe-Tsyr Yuan
MIS Department, National Chengchi University, Taiwan

Abstract

Purpose – The authors seek to propose the notion of ubiquitous proximity e-service for exploring collective wisdom in the ubiquitous environment. Ubiquitous proximity e-service highlights the collective effort focused on collecting the user group's power as the reference for ubiquitous trust decisions.

Design/methodology/approach – This paper provides some theoretical utility support for ubiquitous proximity e-service. The "homophily" describes the tendency of individuals to associate and bond with similar others. By highlighting the "homophily" of e-service participants, these isolated individuals can be treated as a group with proximity. The main value of ubiquitous proximity e-service utilizes the network effect from the collective effort of interpersonal social network.

Findings – In order to leap the trust barrier for users to embrace these ubiquitous e-services, ubiquitous proximity e-service makes it possible for users to collaborate with their nearby user groups to establish a reliable and trustworthy interaction environment. The simulation outcomes for trust decision quality enhancement show a significant improvement in a variety of environment settings.

Practical implications – A significant value of ubiquitous proximity e-service lies in the increased possibility of establishing innovative social network relationships. From the interpersonal perspective, unfamiliar strangers can make connections with individuals who are proximal and homoplastic to them. The strength of proximity gives people better chances to make interpersonal connections, including both weak ties and strong ties. By combining those interpersonal tie relationships, ubiquitous proximity e-service can easily cause information diffusion and effectively encourage collective wisdom.

Originality/value – The paper advocates the utility of ubiquitous proximity e-service that can be realized in the e-commerce environment and which enables information diffusion effectively.

Keywords Trust, Social networks, Communication technologies, Computer networks

Paper type Research paper

1. Changes of proximity in the u-commerce era

The ongoing developments of ubiquitous commerce have brought human life into a new era. Classic social science studies long ago demonstrated that proximity frequently increases the rate of individuals communicating and affiliating in organizations and communities (Allen, 1977; Festinger *et al.*, 1950). Proximity also develops strong norms of solidarity and cooperation. While advanced telecommunication technologies have led some to conclude that the problem of distance has been overcome, others argue that proximity remains essential to group functioning and that new technologies cannot eliminate the challenges faced by members of geographically-dispersed teams. The essentiality of proximity may be controversial, but the definition of proximity might change owing to technological innovations in the u-commerce era.

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We proposed the notion of ubiquitous proximity e-service (UPS) for exploring collective wisdom in the ubiquitous environment. The UPS highlights the collective effort focused on collecting the user group's power as the reference for ubiquitous trust decisions. Some security design was elaborated in Hwang and Yuan (2007), including three conceptual methodology designs: the privacy design, reputation management design, and trust management design. But in is paper we focus on the theoretical support of proximity value.

The ubiquitous proximity e-service can be treated as a new scope of ubiquitous e-services that highlight the collective effort of proximity participants within a ubiquitous environment. Due to the dynamicity and complexity present in the ubiquitous world, it is unrealistic to expect humans to be able to reason and act effectively to address potential risks in the ubiquitous environment. In order to propose a new e-service paradigm that aims to mitigate potential risks and threats present in the ubiquitous e-service environment due to its flexible, dynamic, and collaborative nature, we will begin our discussion by considering the collaboration with proximal participants.

Sociologists and anthropologists have long recognized that people can feel close to distant others and develop common identities with distant others who they rarely or never meet (Anderson, 1983; Habermas, 1991). Besides geographical distance, in the u-commerce era, proximity places increased emphasis on individual homophily personal characteristics. The principle of homophily provides the basis for numerous social interaction processes. The basic idea is simple: "people like to associate with similar others" (Aristotle, 1934; Lazarsfeld and Merton, 1954). As mentioned above, ubiquitous proximity e-service stresses the collective efforts of participants in the dynamic environment. Homophylic user groups are more likely to combine the strength of different individuals to achieve specific objectives.

Furthermore, as stated in Metcalfe's law: "the usefulness, or utility, of a network equals the square of the number of users." This law has been modified to consider the number and value of the network resources (i.e. available services). The network effect results from Metcalfe's law, which states that, "network effects refer to the notion that as more individuals participate in a network, the value of the network to each individual participant increases". Network adoption rate increases in proportion to network utility. Services become more valuable as more people use it, thus encouraging growing numbers of adopters.

Ubiquitous proximity e-service exploits the network effect and tries to enhance collective effort by gathering energy within a dynamic environment. The relationships within the *ad hoc* ubiquitous environment involve social network theory. Interpersonal social relationships can be defined by tie strength as weak or strong ties based on the following combinations: time, emotional intensity, intimacy, and the reciprocal services that characterize the tie (Granovetter, 1973). According to Marsden and Campbell, tie strength depends on the quantity, quality, and frequency of knowledge exchange between actors, and can vary from weak to strong. Stronger ties are characterized by increased communication frequency and deeper, more intimate connections.

Although strong ties tend to provide greater social support than weak ties (emotional aid, goods and services, companionship, and a sense of belonging), weak ties tend to link individuals to other social worlds, providing new sources of information and other resources (Granovetter, 1982). Their very weakness means that they tend to connect people who are more socially dissimilar than those connected via strong ties. Individuals with few weak ties within a community become isolated from receiving new information from outside circles and can only hear information re-circulated within their own clique of close friends (Granovetter, 1982). A weak tie link linking strongly tied groups is termed a local bridge (Granovetter, 1973). Weak ties contribute to social solidarity; community cohesion increases with the number of local bridges in a community (Granovetter, 1973). According to Friedkin the mix of weak and strong ties increases the probability of information exchange (Friedkin, 1982).

The ubiquitous e-service environments are in an *ad hoc* composition where social relationships may not well spread. Strong ties may only rarely be available within this *ad hoc* environment. The nature of *ad hoc* e-service is such that rare connections between individuals are more likely to establish. Proximity may be the reason for participants establishing ties. Even weakness ties then have an opportunity to become strengthened interpersonal relationships.

Homophily (namely, love of the same) describes the tendency of individuals to associate and bond with similar others. Homophily has been found in numerous network studies. By highlighting the homophily of e-service participants, these isolated individuals can be treated as a group with proximity (that is: common goals, similar interests, etc.). Interpersonal ties can be established in addition to some interactions. Loose-coupled e-service participants thus can be empowered to form groups/clusters with weak ties. Proximity thus enables *ad hoc* e-service participants to contribute their strength for ubiquitous collective wisdom.

The remaining sections of this paper are organized as follows: in section 2, we review the literature about proximal collective wisdom and rationalize the significance of the ubiquitous proximity e-service. In section 3, we provide some theoretical utility support for ubiquitous proximity e-service from two aspects: efficiency and cost. In section 4, we present a case that utilize ubiquitous collective wisdom and highlight the value of proximity. We subsequently illustrate the evaluation results of UPS and discuss the significance and contribution of ubiquitous proximity e-service in section 5. Finally, concluding remarks are provided in section 6.

2. Significance of ubiquitous proximity e-service

The main value of ubiquitous proximity e-service utilizes the network effect from the collective effort of interpersonal social network. By obtaining unique, non-reproducible interpersonal experiences from e-service environments, those information sources originate and shape collective wisdom. The involvement of more participants further increases the possibility of strengthening collective wisdom. The collective value derives from individual mental proximity. The characteristics of proximity encourage loose-coupled or isolated individuals to form groups with weak tie relationships and facilitate the creation of collective wisdom. Information diffusion and gathering via the peer-to-peer method can obtain "unique" data sources. The following paragraphs discuss collective wisdom based on the proximity e-service environment and a critical trust issue regarding how to collaborate with unfamiliar strangers.

Collective wisdom has a similar meaning to the term "collective intelligence", which describes intelligence based on the collaboration and competition of numerous individuals (an intelligence that appears to have a mind of its own). One pioneer of research on collective intelligence, George Pór, defined collective intelligence as:

> The capacity of a human community to evolve toward higher order complexity thought, problem-solving and integration through collaboration and innovation (Pór, 1995).

The collective wisdom regarding ubiquitous proximity e-service is based on social networks. Since ubiquitous proximity e-services may utilize internet environments, they transmit information various ways: the external method that permits effective information spread and diffusion; and the internal method that helps individuals to gather and obtain useful information via personal social networks. Proximity e-service participants propagate information voluntarily via their own social networks voluntarily. Information diffusion for proximity e-services is more efficient than in Internet environments, and weak ties help information propagation and diffusion via the personal networks and relationships of nearby users.

However, a critical problem exists regarding trust decisions for strangers, "why individuals should share information with strangers in an unfamiliar environment?" This problem involves problems of both interpersonal trust and efficiency. Relying solely on fixed Internet it is impossible to establish such extensive interpersonal trust networks in an *ad hoc* e-service environment. In the *ad hoc* e-service environment, it is necessary to integrate social networks with trust issues. It can be said that ubiquitous e-service participants may also be unfamiliar with each other. However, in the real world, it is usually accepted that "trust" or "confidence" is necessary for commerce activities. Despite the need for precautions, it is said that: "you have to trust your partner". The commerce environment is rife with asymmetric information, moral hazard, opportunism, and so on. Vulnerability exists in commerce environments. Nevertheless, collaboration may be necessary in many situations in which goals cannot be achieved by single units (persons, firms, groups etc.). Thus, *ad hoc* e-service participants have to accept, at least, a minimum vulnerability to achieve cooperation with partners. An optimistic concept may increase the chance of collaboration becoming a reality. However, cautious assessments of interaction events are also crucial.

It is difficult for users to collaborate with complete strangers. No collective wisdom can be established in environments in which participants are completely isolated. A significant value of the proximity e-service lies in the increased possibility of establishing innovative social network relationships. From the interpersonal perspective, unfamiliar strangers can make connections with individuals who are proximal and homoplastic to him (that is, shared interests cause users to gather at a single exhibition). The strength of proximity gives people better chances to make interpersonal connections, including both weak ties (i.e. someone you know each other) and strong ties (i.e. good friends).

Similarity breeds connections (McPherson *et al.*, 2001). Ubiquitous proximity e-service utilizes homophily to connect separated individuals via weak tie relationships. These weak connected groups together with their original owned interpersonal connections then can enhance the collective effort by extensive information sharing and cooperation. By combining those interpersonal tie relationships proximity e-services can more easily cause information diffusion and effectively encourage collective wisdom.

3. Theoretical utility support for proximity e-service

The concept of the small-world phenomenon was observed over 30 years ago in social systems. The small world phenomenon (also known as the small world effect) is the hypothesis that everyone in the world can be reached via a short chain of mutual acquaintances. Small-world behavior can be defined generally and physically by considering the efficiency of information exchange over the network. The proximity value benefits from the small world phenomenon, which gathers available information sources and facilitates collaboration within the ubiquitous e-service environment. There are two aspects of the theoretical support for proximity e-service: efficiency and cost.

Since we have redefined the proximity in ubiquitous e-service environment, we will compare the value of ubiquitous proximity e-service with the internet e-service environment. Comparisons are made between two scenarios: ZigBee-based ubiquitous proximity e-service environment and internet-based WiMax e-service environment.

3.1 Comparing the chance to establish weak-tie connectivity for collective wisdom

Ubiquitous proximity e-service focuses on the characteristic of "homophily". As mentioned above: people like to associate with similar others, similarity begets friendship, and people love those who are like themselves. Proximity e-service in ubiquitous environment is characterized by "geographical proximity" as well as "user characteristic proximity". Homophily leads unfamiliar participants to form new connections. Participants may have the opportunity to make connections via weak-tie relationships, and may even have the opportunity to form interest groups. ZigBee supports the local range connections and thus is suitable for proximity e-service, which also emphasis on interacting with nearby participants. Compared to individuals who only have the "user characteristics" homophily, ubiquitous proximity e-service based on ZigBee has more opportunities for unfamiliar individuals to build some new relationships (since proximity e-service own both user characteristics homophily and geographic homophily). Proximity increases the opportunities for unfamiliar ubiquitous e-service participants to form weak-tie interpersonal relationships.

Internet-based WiMax makes it more convenient for mobile users to connect to the world. Although users may have the characteristic proximity in the internet-based WiMax environment, their geographic distances are significantly larger than in the ZigBee-based environment (9.6 kilometers for WiMax versus 100 meter for ZigBee). Extensive service range is not the advantages for real-time interactions particularly given that e-service focuses on communicating with nearby participants. Since individuals may sometimes wish to make a connection with other distant individuals. It is unrealistic to establish real-time interactions over long distances. According to Hill and Dunbar (2003), social networks have a cap of approximately 150 individuals (above this size they cease to be effective). Increasing connection numbers by extending service range cannot improve social network efficiency. Furthermore, the homophily characteristics of broad range peer groups are looser than the surrounding proximal users in terms of network density. It is less efficient for individuals to perform real-time interactions or obtain e-services from service providers. The effect that weak-tie gathered from user characteristics homophily also exists in the internet-based WiMax environment. However, in the absence of geographical homophily, WiMax is weaker than the proximal range of ZigBee-based ubiquitous proximity e-service. In terms of the intensity of real-time interactions, ZigBee-based ubiquitous proximity e-service is stronger than internet-based e-services.

Hereby, we have the first explanation for the utility of proximity e-service in ubiquitous environment as follows: "ubiquitous proximity e-service has better opportunities to build up weak-tie connectivity than internet e-service environment."

$$\varrho_{\text{proximity}} > \varrho_{\text{internet}} \tag{1}$$

where ϱ represents the probability of establishing interpersonal connections.

3.2 Comparing the cost of establishing social relationships

The cost of establishing the social network can be various, including communications costs, the involvement of the social network, etc. All of these costs are related to communications between mobile devices. Transmissions increase with involvement of virtual sociality. However, increased communications generally result in increased power consumption for transmitting messages via mobile networks. Without loss of generality, this investigation uses power consumption as the communication cost which represents the cost of building interpersonal relationships. Indeed, mobile devices suffer power supply constraints. Without power supply, mobile users are isolated from their networks and their mobile device becomes useless. As mentioned above, ZigBee describes a standardized wireless protocol for personal area networking, or "WPAN". ZigBee differs from other wireless standards in being designed to serve a diverse market of applications requiring low cost and low power wireless connectivity, and provides greater sophistication than was previously available for the price. ZigBee focuses on low data rate and low duty cycle connectivity, a segment that existing standards to not service well. WiMax supports wide range communications, but has higher power consumption than ZigBee, and thus requires higher capacity battery. According to Texas Instruments (TI), WiMax currently stays in the stage for mobile users accessing the broadband network. The mobility of WiMax will confront with the roaming problem, power consumptions problems, network switching issues, etc. in the future. Attempts to apply WiMax to mobile applications will meet these problems.

This study provides another explanation for the utility of proximity e-service in ubiquitous environments, as follows: "ZigBee-based proximity e-service can establish social relationships more cheaply than Internet e-service environments."

$$\gamma_{\text{proximity}} < \gamma_{\text{Internet}} \tag{2}$$

γ represents the establishment cost for establishing interpersonal connections.

3.3 Information diffusion efficiency via proximity e-service environment

Unlike the fixed internet-based network topology, mobile *ad hoc* networks (MANETs) comprise mobile devices fitted with short-range radio transmission. Devices can communicate within their respective radio ranges. The mobility of ubiquitous e-service participants leads to frequent topology changes in ubiquitous proximity e-service environment. Considering information diffusion efficiency within ubiquitous proximity e-service environments, this study found that traditional information propagation theory may not be applicable to current ubiquitous e-service environments. Ubiquitous proximity e-service benefits from social network theory and improves the diffusion efficiency through various tie relationships.

Based on the definition of economic small world, the economic small world focuses on the low cost and high efficiency of information propagation. Consider the information propagation between two nodes i and j. The path length (that is, distance) between the two nodes is defined as $\{dij\}$. Moreover, the information diffusion efficiency (ε) is defined as $1/\{dij\}$. When distance $\{dij\} = +\infty$, efficiency $(\varepsilon) = 0$.

Ubiquitous proximity e-service is based on mobile *ad hoc* network structure, in which users are generally unfamiliar with surrounding participant peers. In the absence of any existing relationships, those total strangers may not establish connections. If Peeri and Peerj are totally unfamiliar with each other then no relationships exist between the two peers. Since the peers are unconnected, the path length (i) to (j) is $+\infty$, meaning $\{dij\} = +\infty$. Based on the efficiency definition, the information diffusion efficiency is zero ($\varepsilon = 0$).

Two of the ideas mentioned above are:

(1) Ubiquitous proximity e-service has a better chance of improving weak-tie connectivity than the internet e-service environment.

(2) ZigBee-based ubiquitous proximity e-service has lower cost for establishing social relationships than the internet e-service environment.

Ad hoc e-service environment's nature (i.e. short term lived identities) may cause participant unfamiliarity. In such e-service environment, proximity e-service has a better chance of establishing weak-tie connections with nearby peers while achieving lower communication costs.

Because ε is directly proportional to ϱ. Additionally, ε is inversely proportional to γ. Accordingly, it was found that $\varepsilon = \beta(\varrho/\gamma)$. Efficiency ($\varepsilon$) increases with increasing ρ. Higher cost (γ) also leads to lower efficiency (ε). In this formula, β is a constant greater than 1.

From (1) and (2), since $\varrho_{\text{proximity}} > \varrho_{\text{Internet}}$ and $\gamma_{\text{proximity}} < \gamma_{\text{Internet}}$, it is concluded that $\varepsilon_{\text{proximity}} > \varepsilon_{\text{Internet}}$.

$$\varepsilon_{\text{proximity}} > \varepsilon_{\text{Internet}} \tag{3}$$

Some possible future scenarios are considered below:

- The service range of the internet-based WiMax e-service environment is reduced, reducing in a situation where $\varrho_{\text{proximity}} > \varrho_{\text{Internet}}$. Since $\gamma_{\text{proximity}} < \gamma_{\text{Internet}}$, in which case the information diffusion efficiency of ubiquitous proximity e-service remains higher than in the internet-based WiMax environment.
- Advanced technologies reduce communication costs, leading to $\gamma_{\text{proximity}} < \gamma_{\text{Internet}}$. Since $\rho_{\text{proximity}} > \rho_{\text{Internet}}$, in which case the information diffusion efficiency of ubiquitous proximity e-service remains higher than in the internet-based WiMax environment.

Neither of these situations influences the result. This study thus reaches the following conclusion: the information diffusion efficiency in the ubiquitous proximity e-service environment exceeds that in the internet-based environment.

4. Value of proximity: a case scenario

Participant social relationships of a conference scenario resemble a small world network. Small world networks have shorter average path length between nodes and higher node clustering than in the case for a random distribution. Watts and Strogatz (1998) demonstrate how social networks, electricity power grids and neural networks small world properties and how their model can be used to create graphs with such properties. The conference attendees inhabit a proximity e-service environment, which participants are in some level similarity of their interests in geographic proximity as well as cognitive proximity. Figure 1 represents the conference proximity e-service scenario.

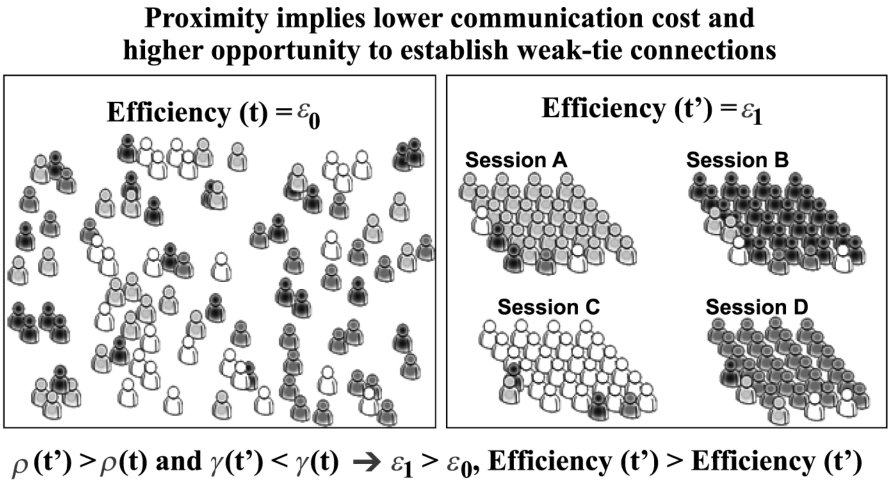


Figure 1.
Conference proximity e-service scenario

This study considers the following scenario that offers proximity e-service in a conference. The scenario involves a conference with numerous delegates, at which several sessions generally occur simultaneously. Attendees move freely between sessions, depending on the subject and their interests. Relationships between colleagues and friends are considered strong-tie relationships. Meanwhile, familiar strangers describe individuals who are regularly encountered but with whom there are no interactions. Some strangers encountered repeatedly at the same conferences over consecutive days may be treated as a familiar stranger during a later meeting in a restaurant. Familiar strangers can have different varieties of proximity to a given individual, with geographic proximity and cognitive proximity (interest in similar research topics) representing the possibility for strangers to form weak relationships with others.

Assuming a proximity e-service environment is available in the conference, each participant has their own mobile device with facilities for exchanging information with others within a limited range. Individual mobile users manage their own information, including owner identity, scheduled presentations, copies of presentation slides, bibliographic references, and URLs. Users can also provide research interest information and a list of colleagues/friends who are also attending the conference.

Mobile users can exchange information dynamically and spontaneously given physical proximity. In such contexts, individual physical encounters provide good opportunities for information exchange. Such information exchange can occur only during a limited period that cannot be statically known. Owing to the limited communication time available during each encounter, it is important to rapidly access the most relevant information.

Some forms of collective wisdom can be generated. The group notes provide an example: all participants can take notes of their own or share notes with others (for example, sharing notes with colleagues attending another session). During discussion of conference sessions, participants can contribute their ideas for discussion by referring to their conference notes. Moreover, presenters can update their slides and make notes during discussions and share them with session participants. These personal notes can then be gathered in the form of group notes containing numerous heterogeneous viewpoints. These group notes may lead to extensive discussion regarding the social networks of individual participants simultaneously and participants can contribute some innovative thoughts. Colleagues and friends have similar interests particularly background domain. Those proximal participants may form strong tie clusters in the conference social network. The sessions include numerous network relationship clusters. The proximity of "cognitive view" (that is, participant homophily) may form weak tie relationships which will increase the effectiveness of information diffusion. The characteristics of proximity make it possible for those total strangers to treat others as familiar strangers and generate some collective efforts. Furthermore, collective wisdom is more likely to occur in a proximity e-service environment. Conference attendees may find some clues to connect to some unfamiliar people within the proximity e-service environment and carry out extensive collaboration.

Another form of collective wisdom is considered below. Andrew has just arrived at the conference. While registering at the conference, Andrew runs into his old friend and ex-colleague, Katrina, who is on her way to the same conference. They start talking about the research they are working on and decide that they would like to try to write a paper for another conference with a deadline in a few weeks. To plan their writing, they exchange current contact information, information about the conference, notes, documents, work pointers, and so on. This information is located on one or other of their mobile devices. Even though only a subset of these resources would normally be available to each other, they can still share the information they need for their collaboration.

Another example involves Katrina planning to publish a paper in another domain with which Andrew is not familiar. However, Andrew is familiar with an editor-in-chief who is also interested in this domain. Andrew thus sends an e-mail to the editor and recommends Katrina's work, and the editor then invites Katrina to join a research discussion. This relationship connects the isolated personal social networks and binds the strong tied relationship networks of individuals.

However, in proximity e-services all interactions occur within the context awareness environment. Contextual awareness means that private mobile user information may be exposed to others. In certain cases the anonymity of the owner of the information must be guaranteed, for example during an encounter between individuals who have previously never met and who do not want to know each other. In other situations the confidentiality of information to be transferred must be guaranteed.

The collective wisdom of ubiquitous proximity e-service environment comprises various levels. In *ad hoc* ubiquitous e-service environments, even participants are not familiar with each other. UPS enables proximal e-service participants to contribute their experiences and form collective wisdom. Based on user preference or behavioral stereotype settings, UPS facilitates collective filtering which provides information to identify trustworthy partners via an experience co-creation process. In such unfamiliar *ad hoc* environments it is good to have information to serve as a reference for making good decisions.

Those ubiquitous proximity e-service cases have some common attributes that each participant just owns some pieces of information. Aggregate more information pieces will improve the decision quality, and then the collective wisdom will appear. Mobile and ubiquitous computing has changed its emphasis from "anywhere, anytime" into "in this specific place, at this specific moment, for this specific person", and pervasive communication is connecting proximal e-service participants to contribute ubiquitous collective wisdom.

5. Simulation and justification

The ubiquitous proximity e-service is designed to enhance the decision quality on trust evaluation via exploration of the collective wisdom of the surrounding user groups. In the *ad hoc* e-service environment, a multitude of transactions take place between anonymous sellers and buyers. Since users do not have permanent identities, they have to handle the trust problem. Mostly, a seller deals with this problem by insisting on payment in advance, thereby, protecting himself from deceitful buyers. The seller delivers the service package only after receiving payment from the buyer. The buyer therefore must be confident of the seller's willingness to deliver the service package.

Because the available e-service provision is highly dependent on the resources of the service provider, customers may not always get what they ask for. Aggressive sellers who are not able to provide requested services may decide to promote alternative choices, but customers may not want to waste their computational resources on annoying spam messages. After receiving the seller's response, buyers have to decide whether to accept the provided choice. The interaction between the buyer and the seller can be formalized as a simple trust game discussed in several studies (Bolton *et al.*, 2004; Buskens and Raub, 2002; Coleman, 1990; Dasgupta, 2000) but we emphasize encouraging overall trust collaboration instead of the individual gain payoff.

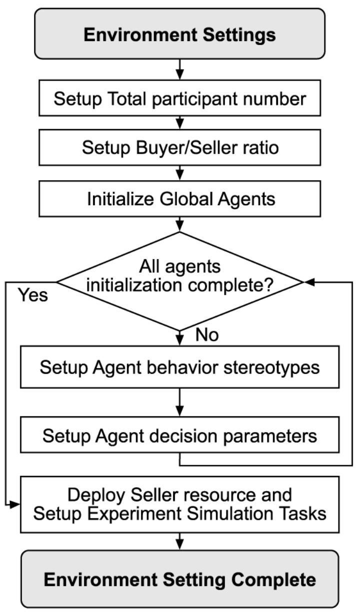
The goal of the simulations is to verify whether the collective wisdom gathered from the ubiquitous environment could improve the decision quality for estimating the trustworthiness of an unfamiliar user. In the following sub-sections, several simulation experiments will be deployed to justify the performance of ubiquitous proximity e-service in the quality trust estimation. We introduce the simulation environment in section 5.1. In section 5.2, the overall trust evaluation will be verified to distinguish the performance of proximal collective wisdom in different environmental settings. In section 5.3, we compare the ubiquitous proximity e-service with traditional e-commerce evaluating techniques to verify the performance of trustworthy estimation. In section 5.4, the balance between interaction costs as well as the decision quality will be evaluated, which provides the reference material to determine the scope of future service applications.

5.1 Simulation environment

The simulation experiment is a design for two main purposes. One purpose is for evaluating how the trust collaboration from proximal users could eliminate the potential risks when the users interact with those unfamiliar transaction partners. The other purpose is for evaluating how the collective effort from proximal user's experiences could support trustworthy transactions and encourage e-commerce interactions. The simulation focuses especially on the beginning stage of interactions where there is seldom information available within the environments. The ubiquitous proximity e-service could be utilized for establishing a prosperous and protective e-commerce environment by exerting the collaborative wisdoms of proximal users.

An initial process should be completed before simulation experiments take place. The environment setting is designed to simulate a ubiquitous commerce environment where users gather together occasionally and do not know each other. Considering the possibility of self-absorbed human nature may take place in the ubiquitous commerce environment, user behaviors are categorized in four stereotypes according to their perishability and anxiety level. Perishability represents the level of urgency the user brings to completion of the task, the desire to obtain the service as soon as possible. With higher perishability, users prefer to consume their resources (equation time and processing capability, etc.) in service discovery rather than comparing which user is more reliable. Instead, once the service provision is acceptable and the provider's reliability fulfills their basic trustworthiness threshold, a transaction begins. The anxiety level represents the user's mental perception of security protection. Users with lower anxiety levels may consider various received service information as an alternative choice even though the provided services may not be related to their request. Not only the potential risks of the humanity, the experiment environment settings also take user's characteristics (e.g. willingness to share information with others, active or passive interaction strategies, personal trustworthy thresholds, etc.) into consideration. Figure 2 (A) indicates the procedures of environmental setting before simulation. The configuration parameters manipulated in the simulation experiments is shown in Figure 2 (B).

In the experiments, an agent's interaction procedures are shown in Figure 3. Besides the global environment settings, each agent is assigned with a task and some initial



1. Total participants number (25, 50, 75, 100)
2. Buyer/Seller ratio (20:80, 50:50, 80:20)
3. Seller's resources allocation (Rich = 9, Normal = 6, Poor = 3)
4. Distributions of agents' behavior stereotypes (Group A.B.C.D)
5. Transaction Rounds (Small: 10, 20...100, Large: up to 3,000)
6. Agents' decision parameters
   – Will-to-respond (generated randomly)
   – Trustworthy threshold (generated randomly)
   – Creditability Investigation (Y/N, determined by Stereotype)
   – Survey waiting time (random distribution)
   – NLT weight (determined by Stereotype)
   – PLT weight (determined by Stereotype)
   – GR weight (determined by Stereotype)
   – Records expiration time (random distribution)
7. Global Reputation (GR) (calculate dynamically)
8. Nearby Local Trust (NLT) (calculate dynamically)
9. Personal Local Trust (PLT) (calculate dynamically)

Figure 2.

(a) Simulation environment initial settings

(b) Configuration parameters

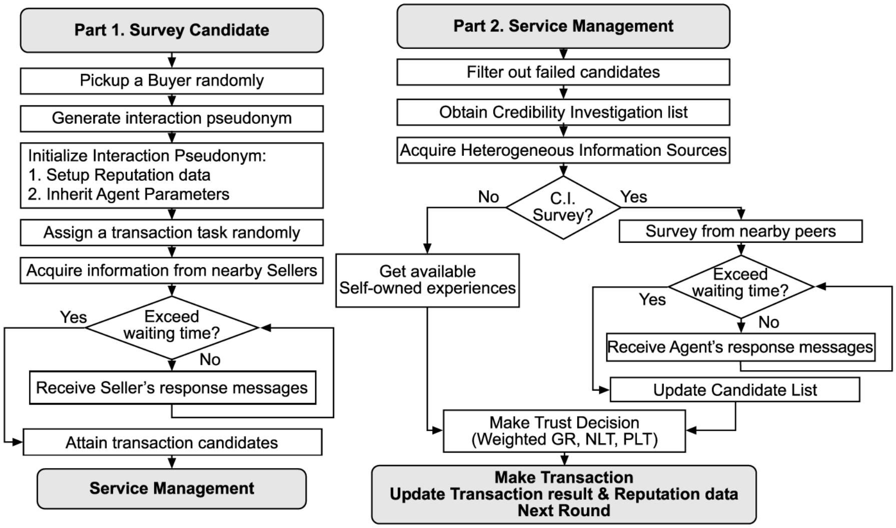


Figure 3. Interaction procedures of an agent

decision criteria. The interaction process include two major parts, agents are designed to interact with surrounding agents according to the procedure. In beginning, agents can survey and interact with nearby agents for possible candidates. Next, the service management procedure is applied for information gathering that help agents consider the trustworthiness for final decision.

5.2 Healthy environment vs malicious environment

Lack of trustworthy infrastructure within the *ad hoc* mobile e-service environment, each peer basically needs to maintain all threats in the environment on its own. Ubiquitous proximity e-service enables the collective wisdom from e-service participants and supports collaborative trust evaluation of nearby users. It should be expected that UPS could integrate available resources within an e-service environment to prevent malicious events. In order to evaluate the performance of UPS in various situations, we then set up three kinds of environments: healthy environment, malicious environment, and neutral environment. The "healthy environment" contains 80 percent honest users and 20 percent malicious users. On the contrast, the "malicious environment" contains 80 percent malicious users and 20 percent honest users. A "neutral environment" has half honest users and half malicious users as a benchmark for normal environment settings. We stabilize other parameter settings: there are 20 users within the e-service environment with a balanced buyer-to-seller ratio. User behaviors are assumed in normal distribution within a normal resource level.

Figure 4 illustrates that use of UPS would help decrease cheat transaction rate. As interaction increases, the collective wisdom generated from participants' co-experience would assist deter cheat transactions. The use of UPS is most effective in malicious environment – the cheat transaction rate could be lowered to 29 percent initially and would be down to 14 percent after 100 transactions take place. As in the "healthy environment", with the use of UPS, cheat transaction rate would remain under 8 percent for the whole simulations and drop to 1 percent after 100 transactions take

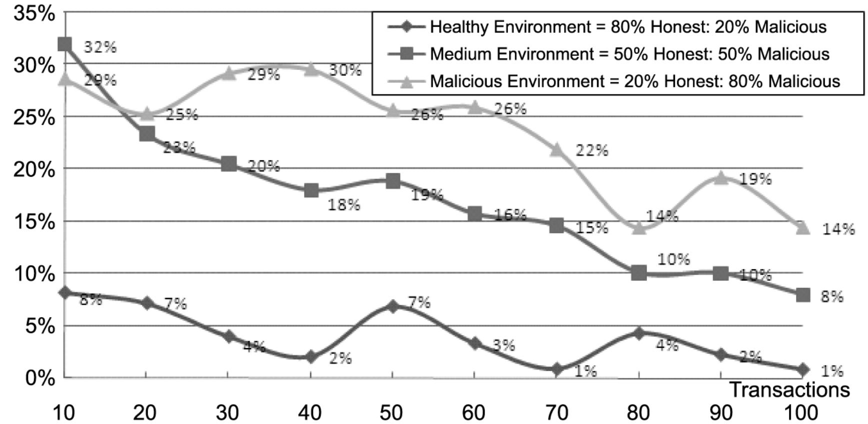


Figure 4.
Cheat transaction rate in healthy/neutral/malicious environment

place. Simulation results indicate UPS's collective wisdom mechanism would assist improve decision-making quality for all environment settings.

The simulation results clearly show that ubiquitous proximity e-service makes it possible for users to collaborate with the nearby user groups for establishing a reliable and trustworthy interaction environment. The ubiquitous proximity e-service realizes the collective wisdom and provides a feasible solution for quality decisions in the dynamic and distributed environment.

5.3 Ubiquitous proximity e-service vs traditional e-commerce techniques

Comparing with the traditional e-commerce techniques (ECT) that only consider global reputation data as information source, ubiquitous proximity e-service (UPS) explores ubiquitous collective wisdom as an alternative quality information source. The following simulation result indicates the performance of the two different approaches, which is shown in Figure 5.

In the *ad hoc* ubiquitous e-service environment there is rare information available for users to estimate which user is trustworthy. This problem is more serious when a

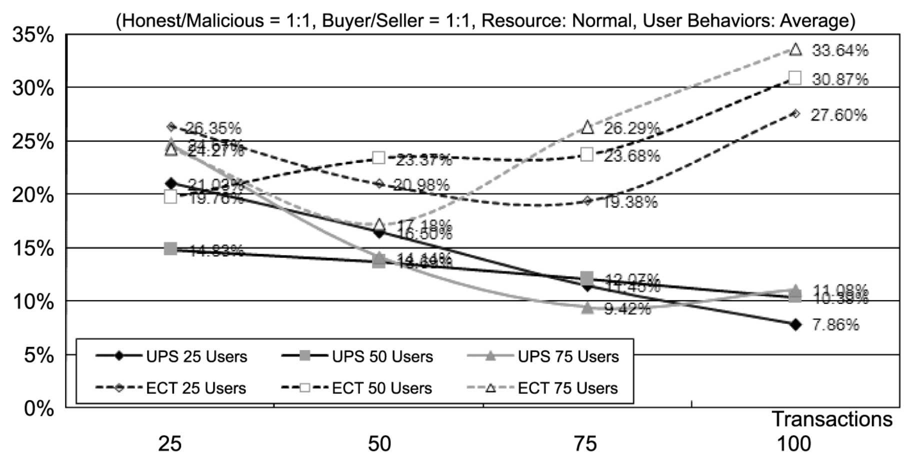


Figure 5.
Cheat transaction rate in UPS and ECT designs

new market is opened since the global reputation of each identity is zero and may not satisfy the user's trustworthiness threshold. This will lead to a desolate e-service environment since users may be afraid to transact with unfamiliar users. As the number of transactions increases, more interaction experience is stored in the environment. At the beginning stage the average cheat rate of UPS is 20.18 percent while the ECT is 23.46 percent. After 100 transactions take place, the average cheat rate of UPS falls to 9.77 percent while the ECT remains high at 30.70 percent. We can see that the cheat transaction rate of the UPS decreases significantly when the number of transactions increases. But the cheat rate of the ECT design is remains at the initial levels.

Ubiquitous proximity e-service is particularly useful for users to strengthen themselves when they belong to the initial stage of the e-commerce environment. Although it is known that the use of global reputation data in e-commerce environments does decrease cheat transaction rate at some extends. But it requires some pre-interactions or transactions that keep the reputation data within the environment. As our experiment is to simulate the initial stage of a risky e-commerce environment with 50 percent of malicious users, there are not any pre-determined reputation data for each agent. Also, the user behavior stereotypes is assigned to each agents with different decision criteria and desired resources, which makes the ETC method may not decrease the cheat transaction rate significantly. While analyzing those ETC cases, we found an interesting clue that may tell us why the cheat transaction rate is high during the simulation. For those ETC cases, we found there are some agents assigned to acquire scarce resources that are only possessed by malicious users. This maybe explains why the cheat transaction rate increases or remains at the initial levels during the simulation.

In an *ad hoc* e-service environment, people will be more careful to trade with those unfamiliar participants. Lake of trust or reliable information usually cause cautious users withdraw transactions. Figure 6 represents the successful transaction rate in the UPS and ECT designs. In the risky environment setting, the successful transaction rate shows a significant difference between UPS design and ECT design. Since the UPS can

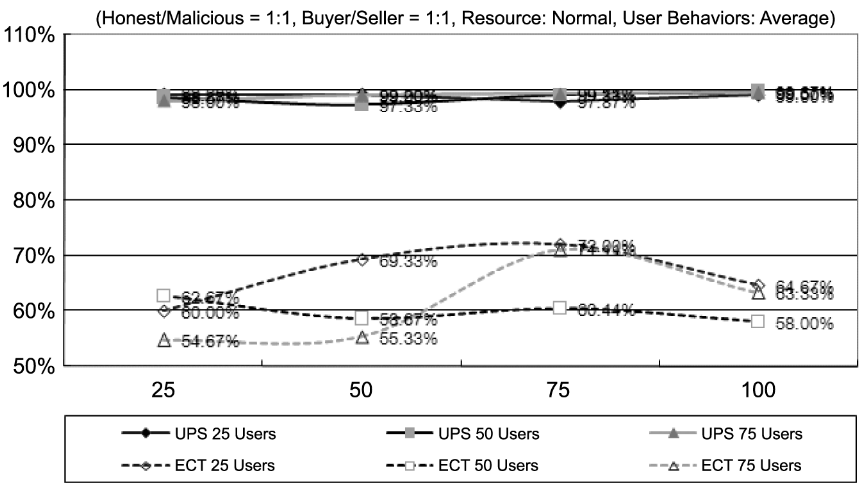


Figure 6.
Successful transaction rate in the UPS and ECT designs

gather nearby user's interaction experiences as an alternative information source for trust estimation, this design will diminish user's sense of insecurity and encourage users to carry on their transactions when they feel insecure about or unfamiliar with the transaction target. The ECT takes only the self-owned experience and global reputation into consideration. However, in the beginning stages, that information is not enough to encourage users to participant in and embracing their desired e-services. The average successful transaction rate of UPS is 98.82 percent while the ECT is 62.52 percent. The barrier for users to enter the unfamiliar e-service environment can be overcome by exploring the collective wisdom of the ubiquitous environment. Simulation experiment results indicate that the UPS design can enhance the decision quality by exploring the collective wisdom of the ubiquitous environment. Moreover, the UPS design provides quality information sources that increase the possibility of transactions.

5.4 Interaction cost vs decision quality

The following simulation experiment focuses on the system side. Heterogeneous information sources represent the possibility of bordering on the scope of collaborations. A larger number of transaction tasks taking place in the e-service environment may imply rich information availability, yet also higher interaction costs. The balance between interaction cost and decision quality should be examined to suggest the best e-service environment situation for ubiquitous proximity e-service. Average system interaction cost would be analyzed against improved decision quality.

5.4.1 Large scale simulations. The first part of the simulation experiment takes place with large group size for large-scale transactions. Up to 3,000 transactions will be simulated within four different group sizes. Considering the proximity e-service supports short-range transmissions, the group size of participants in UPS environment are unfolded into four types – 25 users, 50 users, 75 users and 100 users – for simulation experiments. The experiment is designed for exploring the feasible general environmental parameter settings regarding group size and transaction number that should be further observed.

Simulation experiment regarding UPS performance in different group sizes and transaction settings are shown in Figure 7. In a hazardous environment that contains 50 percent malicious users, we wish to lower the cheat transaction rate to below 10 percent with reasonable interactions. As the UPS highlights dynamic interactions and focuses on the value of the moment, long ago interaction experiences may be useless in improving the UPS performance. Although the simulation result indicates the cheat rate for all parameter settings would be below 5 percent after 3,000 transactions. However, it is not reasonable to assume such extensive interactions may take place in a short period of time especially in such an *ad hoc* e-service environment. Moreover, according to the communications shown in Figure 8, the interaction costs are comparably high in such extensive interaction situations. It is more reasonable to assume that the distribution of e-service participants would be sparser rather than a crowded deployment. Based on aforementioned reasons, advanced experiments will focus on the group size less than 25 users and observe the UPS performance under 100 transactions hereafter.

5.4.2 Small group simulations. Based on the large-scale simulations results, we suggest that the advanced simulation experiments should focus on small group

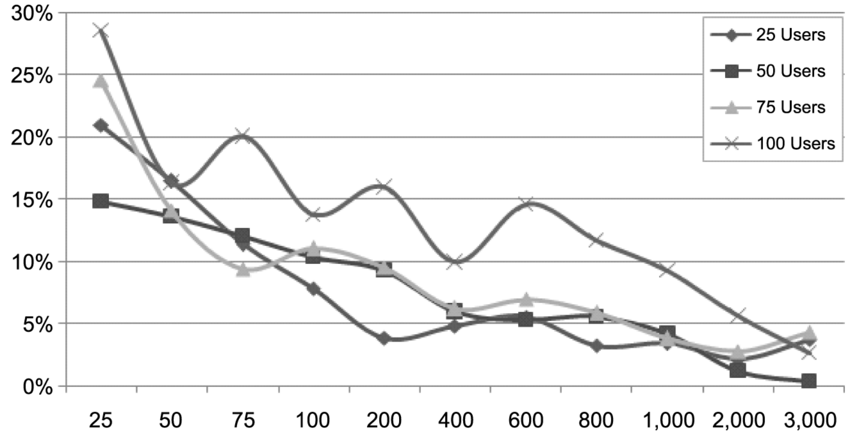


Figure 7.
Cheat transaction rate in various group size and transaction settings

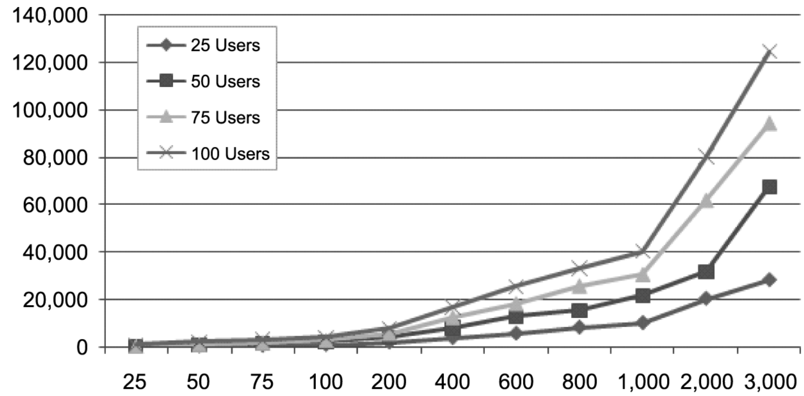


Figure 8.
The interaction cost for various environmental settings

interactions. The second part of the simulation experiment takes place with five smaller group sizes within a certain limited scale of transactions. The group sizes fall into five categories: five users, ten users, 15 users, 20 users and 25 users within the e-service environments. The objectives of the simulation experiment are to verify the performance as well as to find acceptable interaction costs of UPS in small group interactions. Both malicious/honest user ratio and the buyer/seller ratio are set to be equal, respectively. Also, the user behavior types are normally distributed. Resource richness is set in a neutral level. The performance of UPS in the small group experiments shows in the same manner as that in the large-scale simulations. Collective wisdom of UPS generated from proximal user interactions assists reduce the cheat rate smoothly and keeps it under 10 percent after 50 transactions under all scenarios. Figure 9 clearly presents the decision quality of UPS in the small group simulations.

Figure 10 represents the interaction costs for communication among e-service participants. Comparing with large-scale simulations among large group size participants, the interactions costs among small group sizes are relatively affordable in a mobile environment. The more participants within the e-service environment, the more interactive communications must take place. As interactions increase, more experiences will be gained and shared within the e-service environment. The heterogeneous information sources are indispensable for quality decision making, especially in the *ad hoc* e-service environment.

The results of successful transaction rate experiment are shown as Figure 11, in which one may see the rate is more than 90 percent in the initial stage for most of the cases. UPS could encourage unfamiliar e-service participants' collaboration and therefore to facilitate the transactions successfully.

6. Conclusion

In this paper, we advocate the utility of ubiquitous proximity e-service that could be realized in our daily e-commerce environment and enables information diffusion effectively. Those interpersonal connections bring huge homogeneous and heterogeneous information sources for user to establish an experience co-creation environment for safety interactions. The social networks with the proximity concept can enhance prosperous interactions of users. Ubiquitous proximity e-service encourages users to establish a healthy commerce environment as users may not only benefit from their proper and honest behaviors but also utilize the ubiquitous

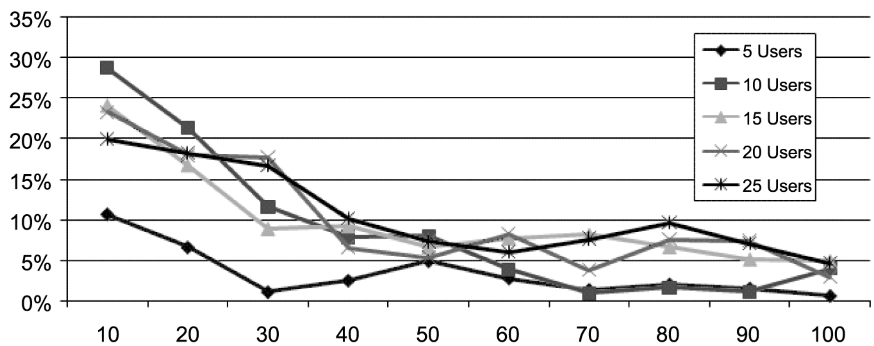


Figure 9.
Cheat transaction rate for applying UPS in small groups

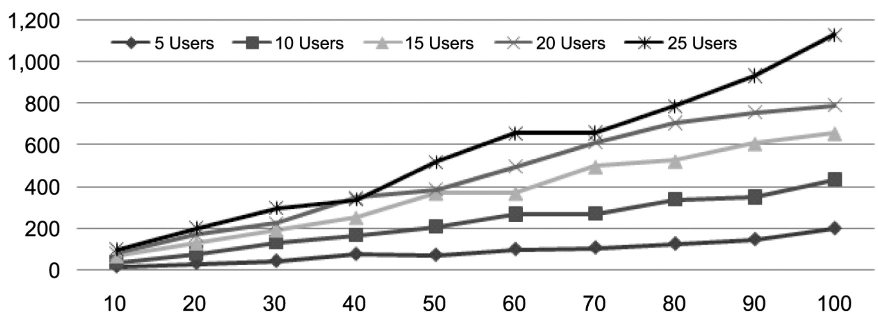


Figure 10.
The interaction cost for small group simulations

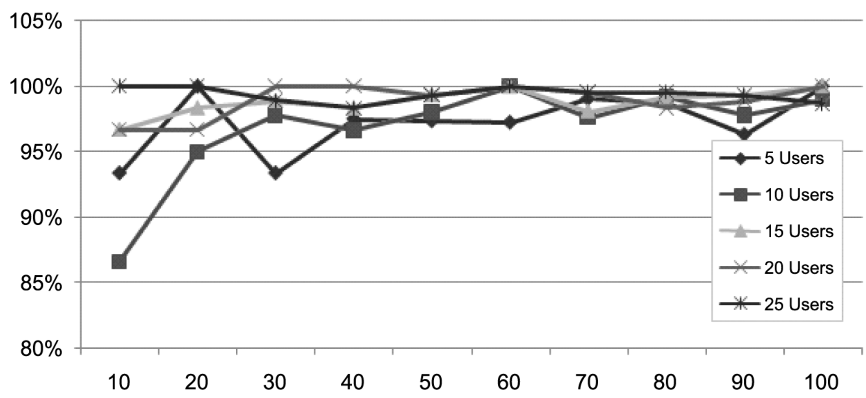


Figure 11.
Successful transaction rate for small group simulations

proximity e-service to identify who might be the malicious users and eliminate potential risk in an *ad hoc* commerce environment.

Considering a user's willingness of participation, once the number of participants of an e-service diminishes, the e-service application would collapse. The concept of proximity encourages users to collaborate with other proximal and homoplastic users. The strength of proximity gives people better chances to make interpersonal connections. By combining those interpersonal tie relationships, ubiquitous proximity e-service can easily cause information diffusion and effectively encourage collective wisdom.

On the other hand, a convenient and safe environment would also encourage users to participate and interact with each other. Ubiquitous proximity e-service also enables diminishing the chance of fraud and deceit. Users within the proximity e-service environment may provide various data sources (i.e. experience or subjective opinions) for others to make a strategic decision. These collective efforts encourage the building of the sense of pervasive trust by engaging the reliability of fraud detection in proximity e-service environments. Different information sources are exerted to facilitate great utilities derived in behalf of users. Once the risk level of transactions can be curtailed, the convenience interactions of proximity e-services would be more prevalent and aggrandizing the chances for users to realize the power of collective efforts.

However, some systematical costs are required. Making decisions with heterogeneous data source provide a comparative reliability rather than depending on their own information, especially in the unfamiliar environment. For preliminary estimates, establishing a trustworthy e-service environment from proximal users might have to trade with some efficiency loss. Therefore, the trade-off between the cost and benefit is a major issue for further research in different application circumstances. Since the interpersonal relationship is one of the trends that highly influence the development of future network applications. Our future works include the practicability analysis for future business applications and the advanced study of user perceptions and their behaviors.

In conclusion, ubiquitous e-service is one of the most recent links in the chain of evolution that has characterized the different eras of the internetworking environment. In order to leap the trust barrier for the user to embrace these ubiquitous e-services, we present the notion of ubiquitous proximity e-service for exploring collective wisdom in the *ad hoc* ubiquitous environment. Simulation outcomes for trust decision quality enhancement show significant improvement in a variety of environment settings. The ubiquitous proximity e-service makes it possible for users to collaborate with the nearby user groups for establishing a reliable and trustworthy interaction environment. It also facilitates and empowers the potential benefits of various ubiquitous e-service applications.

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About the authors

Yuan-Chu Hwang received his PhD from MIS Department of National Chengchi University in 2007. Currently, he is an Assistant Professor of Information Management Department in National United University in Taiwan. Dr Hwang's research and teaching interests include e-service innovation, ubiquitous commerce and privacy/trust issues for social mobile applications. Yuan-Chu Hwang is the corresponding author and can be contacted at: ychwang@nuu.edu.tw

Soe-Tsyr Yuan received her PhD from Computer Science Department of Oregon State University in USA. Currently, she is a Professor of Information Management in College of Commerce of National Chengchi University in Taiwan. Her contemporary research areas include service science, service-oriented computing, mobile/ubiquitous commerce, intelligent agents and data mining.