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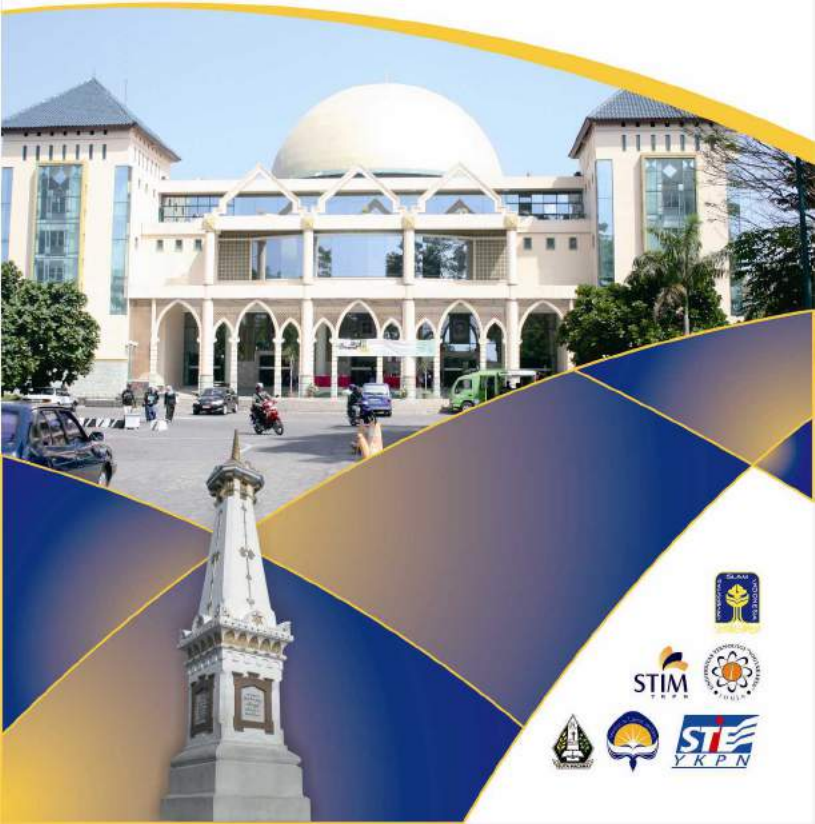
Indonesia Family Business Sustainability



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DAFTAR ISI

A Method for Creating Sustainability of Virtual Business Communities

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ABSTRACT

Virtual business community is a well-known cyberspace metaphor for the building of business trading and collaboration via online networks. A virtual business community could grow and prosper over time if its members are honest and trustworthy. They should also have a strong willingness to work together to reach pre-established goals. In order for communities to be successful and sustainable, there must be mechanisms to promote trustworthy behaviour amongst members. In this paper, we present a scientific method for supporting the sustainability of virtual business communities based on trustworthy behavior and transactions. The method proposes the use of a neutral third party agent to proactively and continuously monitor the performance of community members who carry out an interaction. This third party agent assists the administrator of the virtual business community to take the necessary steps to isolate or remove any untrustworthy or non-complying members in the community. Once the community comprises only those who are trustworthy in interaction, all members of the community will benefit and have greater social welfare.

We validate our proposed method with computer simulation using multi-agent system (MAS). MAS is an agent based modeling approach for Social Behavior Science. The value of computer programs as models for discovery, understanding and formalization has been better appreciated. These models were derived from work in a sub-area of artificial intelligence called distributed artificial intelligence (DAI). DAI could be applied to modelling social phenomena, which each agent representing one individual or organizational actor. The results of several simulations indicate that the method can help a community to identify the non-complying members so that the administrator can take the necessary steps to isolate them from the community. The ability to identify all non-compliant agents in the community will produce a community comprised only of compliant members. If community members always have an interaction and transaction with those compliant members, then they will derive maximum gain and incur minimum loss (high social welfare). The result shows that with the help of our method, as the number of interactions increases, a community will be able to identify all the non-compliant members, thereby promoting and increasing social welfare.

Keywords: Virtual business community, sustainability, trustworthy behavior

INTRODUCTION

'Virtual community' is a well-known web space environment for the building of social relationships via online networks (Voss 2000; Lau 2007). An enormous amount of existing literature discusses the benefits of virtual communities. The availability of virtual communities to some extent provides an easier means of social networking (Srinivasan 2004), encourages knowledge sharing (Kim and Kim 2009), provides a virtual forum for sharing of ideas (Hamel 2002; Bichler 2003), and promotes innovative products and services (Fachrunnisa, Hussain et al. 2009). All of these types of virtual communities are typically informal, self-organized and open, and the relationships are usually established without the involvement of any specific organization or party. A virtual community could grow and prosper over time if its member are honest and trustworthy (Voss 2000; Ishaya and Mundy 2004). They should also have a strong willingness to work together to reach pre-established goals (Wei-hong, Fu et al. 2009). Moreover, the overall membership of this community is characterised by the trusting behaviour or complying behaviour of other parties in the community (Meng-Hsiang Hsua 2007). The 'trusting behaviour' of the other parties in given community could be characterised by the set of activities carried out in the virtual environment.

Although there are many research discussions on the benefits of a virtual community, little research has addressed ways or strategies to sustain these virtual communities. This sustainability depends on the behaviour of the community members, in this case, their trusting behaviour as determined by the particular set of activities in the community. In order for communities to be successful and sustainable, there must be mechanisms to promote trustworthy behaviour amongst members. Trust as a socially acceptable behaviour is important for the continuity of the virtual community, where the workable rules are absent (Voss 2000; Wang, Hang et al. 2011). This is especially significant for virtual communities because research has shown that people in non-virtual communities work better with those whom they trust, while actively avoiding contact with those they do not trust (Javernpaa, Knoll et al. 1998). (Ridings, Gefenb et al. 2001) also argued that trust is a significant predictor of virtual community members' desire to exchange information, and especially to obtain information. People access virtual communities to exchange services – either by providing it to others or by soliciting it from others. This exchange is based upon the trust level that members have in each other, and without trust, there would be no exchange and the virtual community would cease to exist (Ishaya and Mundy 2004; Protopsaltou and Magnenat-Thalman 2005; Mezgar 2006; Vreeswijk and Lodder 2006; Wolfgang, Rosenkranz et al. 2007).

Therefore, a virtual community which wishes to remain viable or sustainable should have a mechanism for identifying and promoting trusting behavior amongst community members. A virtual community can be sustained by: (a) identifying non-complying agents and isolating them from any further interaction in the community; and (b) maximizing social welfare of community members.

In this research, we propose a generic strategy that can be used to proactively monitor members' interactions within any virtual community. This method can be utilized to identify any malicious or untrustworthy members in that community. The other purpose of this model is to protect the community from anyone within it who demonstrates non-compliant behavior. The proposed strategy in this research provides a generic mechanism for monitoring community members' behavior when carrying out an interaction with other agents (i.e. by keeping track of members' performance). By continuously monitoring their performance, the performance monitoring report can show the member's behavior pattern and determine whether an agent is trustworthy or untrustworthy.

LITERATURE REVIEW AND RELATED WORK

Various Types of Virtual Communities

The boost of Internet economy has created many kinds of virtual communities which are also broadly referred to as business ecosystems. In existing literature, the term 'virtual community' can be defined in several ways. Abdul-Rahman et al. (Abdul-Rahman and Hailes 2000) argued that virtual communities are just as real as those communities that meet physically or whose members exist in close or convenient proximity. The virtual community allows a 'group of people via Internet to interact with one another'. Schubert (Hameed, Jadaan et al. 2010) defined virtual communities as the union between users who share common values and interests using electronic media to communicate on a regular basis. Preece (Skopik, Schall et al. 2009) and Rosenranz and Fedderson (Devi, Samy et al. 2010) define a virtual community as 'any virtual social space where people come together to get and give information or support, to learn, or to find company'. Massa (www.facebook.com) categorized different online systems in the virtual environment as: (1) e-marketplaces (2) news, opinions and activity sharing sites (3) business/job networking and (4) social/entertainment networks. The different purposes of these sites may result in different types of virtual community.

This paper focuses on business-oriented interactions in the context of service delivery involving financial transactions taking place within a virtual community. In this paper, we consider in particular those commercial or business or transaction virtual communities which members join and within which they interact in order to exchange goods and services, or more specifically, engage in a service transaction involving monetary exchange. These communities are a specialized type of business-to-business alliances between partners or business-to-customer interactions. In a virtual business community, members have stronger ties than do the members of a non-commercial virtual community since their exchange involves money [30]. Virtual business communities allow members to review, purchase and leave reputation feedback or, generally speaking, a provider delivers a service to the requester via an online medium.

Sustainability of Virtual Communities

In the existing literature, the sustainability of virtual communities has been widely discussed. The main reason that a virtual community needs to be sustained is that it has a life cycle. The existence of a virtual community depends on the emerging and ongoing behaviors of its members (Wolfgang, Rosenkranz et al. 2007). This usually follows a general life cycle pattern, which can be traced from birth, expansion, leadership and self-renewal to even death (Williams and Cothrel 2000; McKnight and Chervany 2006) (Beenen, Ling et al. 2004; Ludford, Cosley et al. 2004). Therefore, a consistent effort is needed in order for a virtual community to extend its life cycle; otherwise, the community disappears or dissipates. However, very little literature focuses on how the community can be sustained. In particular, there is no literature that proposes and discusses metrics or measures to sustain the virtual community.

Venkantesh (Voss 2003) described a pattern of origin, stabilization and change that is embedded in the life cycle of the virtual network. In the first origin stage, the network is created based on the members' mutual interest. Over time, members have a greater awareness of the assets and resources of their community and start to demonstrate a willingness and capability to exchange. At some point in time after its origin, a community network may become more stable. At this time, the community should become well organized. This can be achieved in several ways: firstly, by institutionalizing the relationship between community members; and secondly, through better interaction regarding service delivery. However, after some institutionalization and formalization of interaction rules amongst members, the community may face a change cycle. This is because the virtual interaction may not be adequate, or members perceive that the community has become formal and strict in its interactions.

Mousavidin and Goel (Williams and Cothrel 2000) proposed a conceptual framework of the community life cycle and associated factors. 'Life of community' is defined as active participation from members and the next generation in community-specified content. Moreover, Mousavidin and Goel (Williams and Cothrel 2000) argued that active participation alone is not enough. The communities should consider socially-shaped aspects, technologically facilitated features, individually demonstrated characteristics, and external influences as important factors that need to be considered to extend the life cycle of a community. As technology is essential for this virtual interaction, features that suit the needs and interests of members also need to be improved. Socially-shaped aspects refer to scope of content, relationship and interaction norms that have been established in the community, techniques of moderation, size and the critical mass of the membership of the community. Additionally, the characteristics of community members which relate to concepts of public good, utilitarian perspectives and network centrality, may determine the long-term viability of the community. Lastly, the framework also included external influences such as demographics, external media, political environments, and top management support which could influence the existence of virtual communities.

Although Mousavidin and Goel (Williams and Cothrel 2000) argued that this framework is general and can be implemented in any of the content-specific virtual communities, unfortunately, it has not yet been validated and therefore requires further research, specifically from a validation perspective. Additionally, it does not give any indication about the ways in which the virtual community can be sustained based on several factors that they proposed. Porra and Porks (Keh and Xie 2009) explained that the larger the user membership of a virtual community, the greater is its sustainability. This model also recommended that effective interaction mechanisms and a high degree of awareness to maintain the community's humanness are important in creating a sustainable virtual community.

Hence, it can be concluded that in the literature, several models have been proposed for supporting the sustainability of a virtual community. The primary shortcoming here is that all the existing models are domain-specific. By this we mean that the sustainability mechanism might be applicable only to a given domain or platform. It is not possible to make use of the proposed methods as a generic mechanism for ensuring sustainable virtual communities, irrespective of the domain of the virtual community. Additionally, since the nature and type of activities carried out in virtual environment is very different, it is not possible to make use of the existing methods to engineer sustainable virtual business communities. The existing research focuses on the key factors that contribute to the longevity of a virtual community. Almost all of them focus on non-business virtual communities. However, none of them proposes a complete methodology for regulating members' interactions so as to produce virtual business community. Moreover, only Preece (Skopik, Schall et al. 2009) and Hong-Feng (www.myspace.com) consider the importance of the existing trust relationship between community members as a factor in sustaining the community and identifying any untrustworthy agents within it. Finally, another major shortcoming is that there is little focus on the empirical validation of the research.

In this paper, we propose a generic strategy for creating a sustainable community. This framework benefits virtual communities in four ways. Firstly, it assists administrators or organizers of a virtual community to identify untrustworthy entities. The presence of non-compliant members in a virtual community can be seen as signal-to-noise that is very detrimental to the sustainability and growth of the virtual community. Secondly, our proposed method shows how a virtual community can be sustained by means of using a third party agent to conduct continuous performance monitoring of members' interactions. The third advantage is that the framework can be used to engineer sustainable virtual communities.

THE PROPOSED FRAMEWORK

In this section, we provide an overview of the proposed framework for creating sustainable virtual business communities. The overall objectives of the proposed framework for creating virtual communities are: (a) to document the required complying behavior from the trusted agent in the form of a contract; (b) to have a proactive mechanism in place to determine the extent of the success of the interaction according to the agreement; and (c) to identify non-complying agents in the community after a certain number of interactions. The members of a commercial virtual community can be categorized either as a buyer or seller engaged in a goods/service exchange. First and foremost, sustainability requires a stable relationship between members in this community. In order to achieve this, it is crucial for the administrator or the organizers to be able to identify those who are disrupting the community interaction. In other words, the system should have a mechanism whereby untrustworthy members can be identified and isolated so that the community is comprised only of trustworthy agents. An overview of the conceptual framework of our proposed method is depicted in Figure 1.

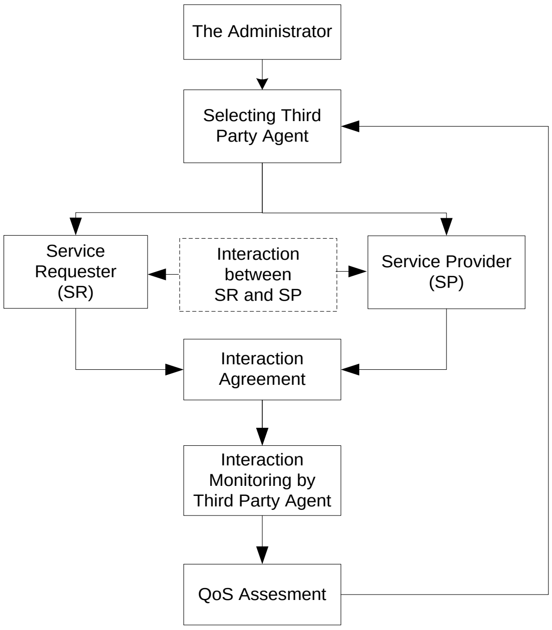

Figure 1. The workflow of the framework is as follows:

1. The administrator of the virtual community selects and creates a collection of third party agents or a neutral agent. The role of the third party agent is to supervise the interaction between service provider and service requester. This is a pre-interaction activity.
2. The third party agent is a professional agent who is experienced in judging and monitoring an interaction and has particular knowledge of, and expertise in the domain of the community business exchange. We assume that the chosen third party agents are honest. At the same time, two other parties (service requester and service provider) are involved in a service transaction. In order to have a guideline for their interaction, and to ensure the satisfaction of both parties during the service exchange, the buyer and seller need to have an interaction agreement that defines the type of service and time frame for service delivery. This agreement can be a contract or an SLA (Service Level Agreement). This contract documents all the rules and governance for conducting business such as the roles of seller and buyer, an arrangement of cooperation such as specification of products and services including a statement regarding the quality of services to be exchanged, the condition of exchange and methods of payment. All mutual exchange factors must be taken into account.

3. After both parties have established an interaction agreement, the administrator of the virtual community will choose an appropriate, qualified and expert third party agent to monitor this interaction.
4. Subsequently, both parties (A and B) engage in interaction. They exchange service that has been agreed upon in the interaction agreement. Both parties should transact according to this mutual agreement. At the same time, the third party agent monitors the performance of this interaction. Hence, this interaction agreement is used primarily as a guide to monitor both parties' performance progress.

   During performance monitoring, the third party agent will obtain a record of compliant and non-compliant agents in this interaction. A consistently non-compliant agent will be placed on the list of untrustworthy members, while a consistently compliant agent will be listed as a trustworthy agent. Each virtual community might have its own policy determined by the administrator regarding the number of interactions that need to be carried out by agents in order for them to be categorized as compliant or non-compliant agents respectively. In our proposed framework, the administrator maintains a black list of agents who have been categorized as non-compliant agents. Additionally, the administrator also maintains a white list of agents who have been categorized as compliant agents. The third party agent communicates this information to the administrator, who has a database that contains a black list and white list of agents in a community. This database is updated every time and for every interaction between community members. At regular intervals, this database is made publicly available so that another member candidate who wants to join this community can access information about an agent's reputation in such interactions.
5. At the end of the interaction, both seller and buyer assess the goods/service that they have exchanged. In our framework, we use a CCCI metrics that was proposed and developed by Hussain et al. (Chang, Dillon et al. 2006; Raza, Hussain et al. 2010) to measure the interaction performance. CCCI metrics is a set of metrics that can be used to measure the interaction

performance based on goods/service criteria, clarity of each criterion, and level of importance of each criterion (Chang, Dillon et al. 2006; Raza, Hussain et al. 2010).

6. Finally, both parties provide the third party agent with the result of the interaction performance's assessment. Hence, the third party agent obtains information about the performance of both seller and buyer in that transaction.
7. With this information, the third party agent will inform the administrator of the non-compliant members in this community based on a certain number of interactions. The administrator can then use this information to either isolate these members from the community or take the necessary steps to eliminate untrustworthy members from the community in order to ensure the sustainability of the virtual community.

RESEARCH METHODOLOGY

In order to validate our framework, we create an agent-based modeling for computer simulation. Agent-based modeling is an approach to simulate social behavior of a system. Computer simulation is set to become an important new method of building and evaluating theories in the social science. These models were derived from work in a sub-area of artificial intelligence called distributed artificial intelligence (DAI). DAI is primarily concerned with engineering effective solutions to real world problems, however, it was noticed that the technology of interacting intelligent agents could be applied to modeling social phenomena, which each agent representing one individual or organizational actor. As suggested by (Sawyer 2007), there are two general approaches to study of social behavior. Collect observational, survey, or other forms of data and analyze them, possibly by estimating a model; or begin from a theoretical understanding of certain social behavior, build a model of it and then simulate its dynamics to gain a better understanding of the complexity of a seemingly simple social system. Computer simulation, or computational modeling, involves representing a model as a computer program.

EXPERIMENT AND RESULTS

We created a synthetic situation of a virtual market by which a number of producers and cosumbers are interacted. We conducted a series of experiments and evaluations andw e engineered a multi-agent system using the JADE Multi Agent-Based Framework. The functionality of the JADE Multi Agent-Based Framework was extended using Java. The engineered multi-agent system has an interface, whereby the user can specify the necessary input parameters. We then established several evaluation criteria (benchmarks) to assess the performance of the proposed methodology and its ability to create sustainability in digital business ecosystems.

Benchmark 1: The ability to identify all non-compliant agents in a community

This benchmark measures whether the third party agents are able to provide performance information for any agents carrying out a transaction in the community. The aim of this benchmark is to capture the number of interactions needed to identify all of the non-compliant agents in the community. This is directly related to the number of non-complying agents that have been identified accurately by the third party agents. We created a virtual community with varying numbers of agent population: 8,000, 70,000, 80,000 and 90,000 agents. For each different agent population size, we introduced a certain percentage of non-compliant agents into the community environment. In this simulation, we have broadly classified agents into two categories (a) compliant agent and (b) non-compliant agent. If the compliance level of a compliant agent is 100%, this means that it will fully comply with the agreed behavior. On the other hand, if the compliance level of a non-compliant agent is 0%, this means that it will never comply with the agreed behavior. From the trust perspective, a non-compliant agent is an untrustworthy agent and a compliant agent is a trustworthy agent. The percentage of non-compliant agents in the community varies from 10% to 90%.

During the simulation process, two agents, say ‘A’ and ‘B’ as a service provider and service requester, are randomly selected from amongst the agent population for interacting with each other. Let us assume for discussion purposes that, service provider (agent ‘A’) is a non-compliant agent, meaning that this agent does not comply with the interaction agreement. The selected agents, ‘A’ and ‘B’ engage in an interaction and at the end of the interaction, both agents assign a trust value depending upon the Quality of Service (QoS) delivered. Given the non-compliant behavior of agent ‘A’, agent ‘B’ will assign a low QoS value to agent ‘A’. Additionally, the third party agent also has a record of both agents’ performance during the interaction. Following the last step of our methodology, agent ‘B’ will inform the third party agent of this ‘non-compliant’ behavior of agent ‘A’. Subsequently, the third party agent will investigate this non-compliant behavior and by using the performance track, if agent ‘A’ is found to be non-compliant, then it will notify the administrator about the non-compliance of agent ‘A’. A repeatedly complying agent will be placed on the white list, while a repeated non-complying agent will go on the black list. In each community, the administrator will establish a policy regarding how or when an agent will be placed on either the black or white list. A possible policy could be based on a certain number of repeated untrustworthy or trustworthy behaviors during a specified time period. The threshold of the number of times that an agent could behave in an untrustworthy manner so as to be characterized as an untrustworthy agent and placed in the blacklist could be specified as a parameter by the user at the start of the simulation. Moreover, users also can specify inputs regarding number of agents, and the percentage of non-compliant agents in that population.

Throughout the initial stages of simulation, the compliance of agents is not modeled completely or accurately, or both. By ‘complete modeling’ of compliance levels, we mean that the third party agent should know the compliance levels of all the agents in the community. On the other hand, by ‘accurate modeling’ of the compliance level, we mean that the actual level of compliance of the agents in the community should be as close as possible to the modeled or determined compliance levels by the third party agent. Once the third party agent’s information reflects accurately and completely the actual compliance of the agents in the community, the percentage of non-complying interactions will progressively decrease. In other words, once the group of third party agents has completely and accurately modeled the compliance levels of agents in the community, it creates a community in which non-compliant agents are blacklisted and only compliant agents are available for interaction.

Due to the random nature of agent selection during simulation, we conducted 20 series of experiments for every community size, as depicted in Figures 2 to 5. In order to remove any selection bias, finally, we drew an average line for those 20 experiments. Results of experiments show that as the percentage of non-compliant agents increases in the community, the average amount of time required to identify all of them as a function of the number of transactions, decreases. If the community has a large number of non-compliant agents, then it will be quicker to identify all of them. Consider, for example, Figure 2 which plots the experimental results for a community size of 8,000 agents. With 10% of them being non-compliant agents, on average, it takes 320,000 transactions to identify all the non-compliant agents in the community. However, if the percentage of non-compliant agents in the community is 90%, on an average, it takes only 90,000 transactions to identify all of them. We conclude from these experiments that our framework is effective in identifying all the non-compliant agents in the community. The role of the third party agent in monitoring the interaction based on the interaction agreement is effective as a means of identifying those who are not trustworthy.

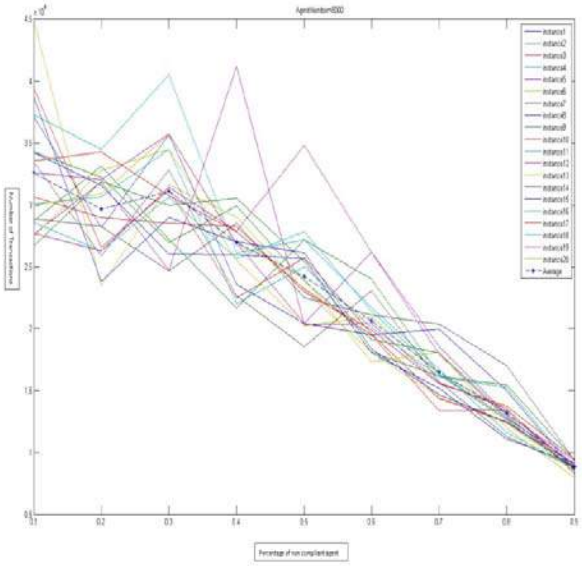

Figure 2. Simulation with 8,000 agents

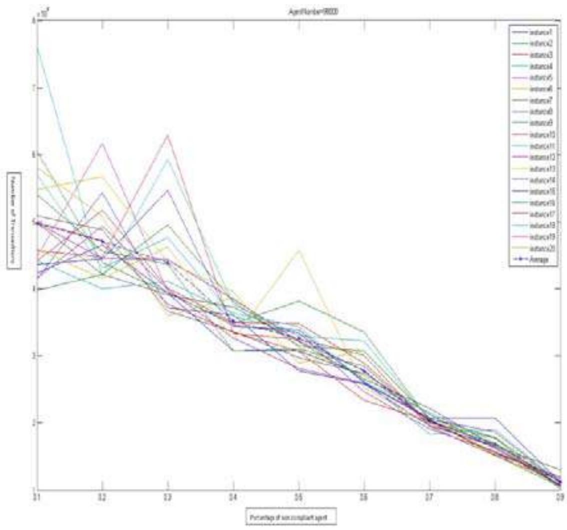

Figure 4. Simulation with 90,000 agents

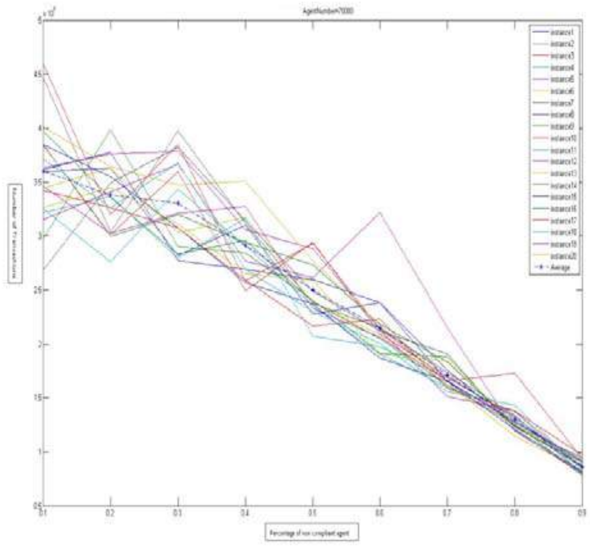

Figure 3. Simulation with 70,000 agents

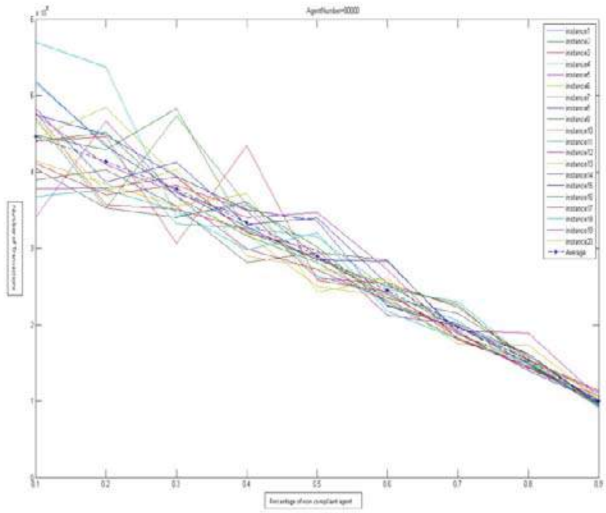

Figure 5. Simulation with 80,000 agents

Benchmark 2: Social Welfare of Community Members

The second benchmark is a meausurement of social welfare of community members. The purpose of these experiments was to determine whether our proposed methodology can help the community to increase the social welfare of its members. We define social welfare as the maximum amount of wealth or gain that community members obtain from interacting with other community members. The sustainability of a virtual community can be achieved if all community members derive maximum gain and suffer minimum loss from their interaction with any members in community. In order to measure and capture the social welfare of community members, we use the two criteria factors which are: (a) an agent will gain if s/he interacts with a trustworthy agent. This is because, by the end of the interaction, the trustworthy agent will deliver the product or service as agreed and (b) an agent will incur loss if s/he interacts with an untrustworthy agent as this agent will never completely deliver a product or service as agreed.

We conducted a series of simulation experiments similar to those of benchmark 1. We created a virtual community with an agent population of a certain size. We randomly selected two agents to play the roles of service provider (agent A) and service requester (agent B) in an interaction. A third party agent records the performance of both agents during the interaction. Based on the performance track of both agents, at the end of interaction, the third party agent will be able to determine whether the agent in this interaction is compliant or non-compliant. The third party agent then passes this information to the administrator. The administrator uses this information as an input for a database of the agents' behavior when carrying out transactions in a virtual community.

The administrator then gives the third party agent access to this database in order to determine whether an agent should carry out or otherwise terminate a transaction with another agent. Hence, our proposed framework provides a mechanism by which a third party agent will help an agent to determine whether or not to carry out an interaction with another agent. The determinants of gain or loss from an interaction are as follows:

a. If a given agent (say A) intends to interact with another trustworthy agent (say B), and the third party agent suggests that the interaction go ahead, then agent A will gain. Conversely,
b. If a given agent (say A) intends to interact with another trustworthy agent (say B) and the third party agent suggests that the interaction not go ahead (due to incorrect trust modeling of that agent by the third party agent), then agent A will lose (or incur loss).
c. If a given agent (say A) intends to interact with another untrustworthy agent (say B) and the third party agent suggests that the interaction go ahead, then the agent A will lose. Conversely,
d. If a given agent (say A) intends to interact with another untrustworthy agent (say B) and the third party agent suggests that the interaction not go ahead, then agent A will gain.

The result of this simulation is presented in Figures 6 and 7. Figure 6 shows the result of an experiment using a population of 10,000 agents, 50% of which are non-compliant. They carried out a total of 10,000 transactions. As we can observe, as the number of transactions increases, the total gain of community members increases and the total loss of community members decreases. It can be concluded that our mechanism can help community members to interact and transact with trustworthy agents only, so that the total community gain is high while total loss is low.

On the other hand, Figure 7 shows the total gain and total loss from 10,000 agents in a community where 90% of them are non-compliant. As the percentage of non-compliant agents is very high, we can observe that in the first 1,000 transactions, the total loss is higher than the total gain. However, with the passage of time, the third party agent is able to increasingly model the compliance of the agents in the community accurately and completely. As a result of increasing ‘accurate’ and ‘complete’ compliance modelling of the agents in the community by third party agents, we can observe that after 5,000 transactions, the total gain of the community (between 4,000 – 5,000 transactions) is greater than the total loss of the community (between 1,001 – 2,000 transactions, 2,001 – 3,000 transactions, and 3,001 – 4,000 transactions). Moreover, the total loss is higher than total gain in the initial interaction (between 1,000 – 2,000 transactions) and almost similar in interaction between 2,001 – 3,000 transactions. This is because in the initial number of transactions, the third party agent is not yet modelling accurately and completely the compliance behaviour of agents in the community. However, with the passage of time, after 5,000 transactions, the total loss is almost ‘0’. A similar conclusion can be drawn for the total gain and total loss in the community as the number of transactions (time) increase.

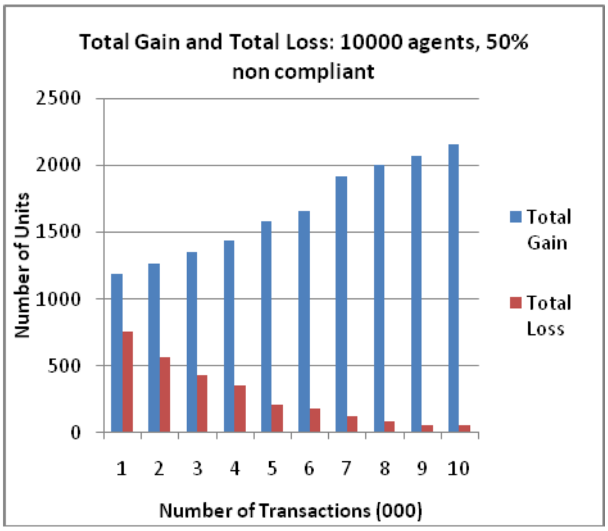

Figure 6. Experiments with 50% of 10000 agents being non-compliant

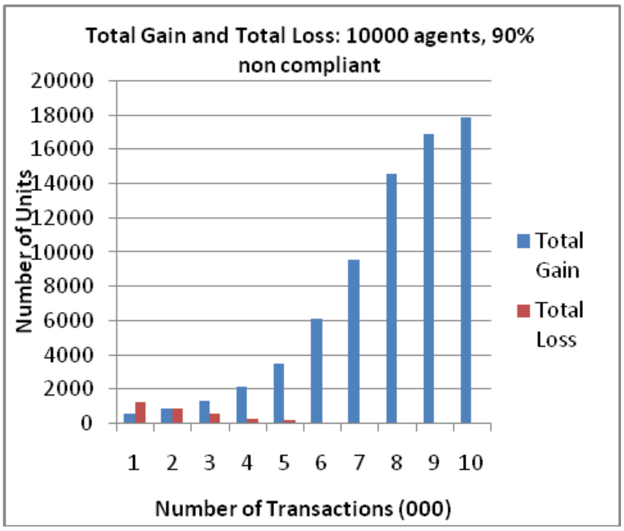

Figure 7. Experiments with 90% of 10000 agents being non-compliant

The purpose of this benchmark evaluation is to capture the correlation between the percentage of non-compliant agents in the community and the total gain and total loss of community members. The figures indicate that as the percentage of non-compliant agents in the community increases, total gain decreases and total loss increases. We can conclude from this that the role of the third party agent is a significant factor in promoting the social welfare of community members, which in turn contributes to the sustainability of a virtual community.

CONCLUSION AND FUTURE WORKS

In order to support the viability of a commercial virtual community, we need to examine ways whereby it can be sustained. The sustainability of a virtual community can be determined by decreasing the number of non-complying agents in the community who will not (or most likely not) deliver service as agreed by their interacting party. Using our framework, community members (either as service provider or service requester) will interact according to their mutual agreement and supervised by a third party agent. The role of the third party agent who is independent and unbiased is to proactively monitor this interaction. Based on this proactive monitoring, the third party agent will inform the administrator about the performance of members during the interaction. Repeated compliant agents are marked as trustworthy agents, and conversely, repeated non-compliant agents are marked as untrustworthy. The results of several experiments indicate that the framework can help a community to identify the non-complying agents so that the administrator can take the necessary steps to remove them from the community. Another advantage of this framework is that it can help the community to increase its members' social welfare. The ability to identify all non-compliant agents in the community will hopefully produce a community comprised only of compliant agents. If community members always have an interaction and transaction with those compliant agents, then they will derive maximum gain and incur minimum loss.

Our future work involves investigations along the following lines: (a) an assumption that we have made in our framework that the third party agent is honest. It is evident that the third party agents are crucial in ensuring the sustainability of a virtual community. We would relax this assumption in our future work. Subsequently, we would enhance our framework and make it robust against dishonest or colluding third party agents; (b) we would introduce varying degrees of compliance and non-compliance levels of the members in the community. We intend to investigate the robustness of our framework in this scenario; (c) we would investigate the impact of time-based varying behaviour/compliance by the member agents in the community. Subsequently, we would enhance the framework by developing intelligence techniques to accurately model time-based varying behaviour; and (d) we would deploy our framework in the real-world business ecosystem to measure its effectiveness.

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