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Designing A Social Support Mechanism For Online Consumer Purchase Decision Making

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Abstract

As online social network are so popular, their users are getting used to make decisions based on opinions collected from their friends. While conventional decision support system has been extensively investigated, little specific mechanism, however, on how social networks can help users with online purchasing decision-making is developed. By introducing design rationale and social impact theory into system development, we used information technology as tools to design a social network-based decision support system framework for consumer purchase decision problems. QOC schema was used to describe the reasoning process of possible product alternatives. Further, social impact was used to select the decision group members and measure the effect of changing decision members' attitude toward a specific options or criteria. Our empirical study further showed that the proposed framework can perform better than benchmark methods.

Keywords: Electronic Commerce, Social Network, Decision Support, Social Impact.

1 INTRODUCTION

Social networks are the grouping of individuals, and social network websites are now one of the most popular online communities. The friends that you can make are just one of the many benefits in online social networks. Other benefits include diversity because the internet gives individuals from all around the world access to these networks. Not only will you make new friends, but you may get information from your friends. The main purpose of using social networks should be socializing with people who you like and are interested in. It is not surprising that many people are hooked on with these sites, but predictions about the future of social networks are various.

1.1 Current Applications of Social Network

The rapid and constant pace of change in online social network is creating opportunities. The opportunities include the expanding application of social networking tools for marketing and branding, and the growing interest in the power of friends for more personalized purpose. At the same time, the pace of change creates significant challenges for application developers. To begin with, developers are playing technological catch up as users requirements emerge that require complex technological infrastructures and fancy functions. Some developers have been adept at creating tools for advertising and marketing, and efforts have also been made for entertainment such as social network games.

People are influenced by their friends' opinions. A social network game is a type of online games that is played through social networks. One of the most distinct features of social games lays on leveraging the player's social networks. Meanwhile, social network advertising is surprisingly effective in some segments. It does a great job of displaying advertisements to targeted users but also showing them which one of friends is interested in the advertisements or brands as well.

Most online social network services are used for sharing what you've done or what you're doing, but this may not be the only thing social networks can do. As social networking technology evolves and increasing online activities make more data sets available, we believe that social networks can be applied to other domains as well.

1.2 Research Problem

Browsing and searching a product to meet requirements on E-commerce websites is often a time consuming and frustrating task for consumers. For instance, consider a common phenomenon of product purchasing decision process. A customer John wants to buy a digital camera. He has searched for different brands and at this point he is interested in several models. However, he cannot make up his mind, so his friends are consulted. After collecting advice from them his final selection is made. Consumers pass through several stages before purchasing something. The consumer purchase decision model identifies Problem Recognition, Information Search, Evaluation of Alternatives, Purchase Decision and Post-Puchase Behaviour (Kotler, Armstrong, Wong & Saunders ,2008). In the above example, consumer has done the first two steps and wants to evaluate the alternatives based on friends' opinions. In this paper, we tried to develop a decision support mechanism to deal with product purchasing problem when consumers have some alternatives in mind. A typical consumer purchasing decision process is depicted in Figure 1.

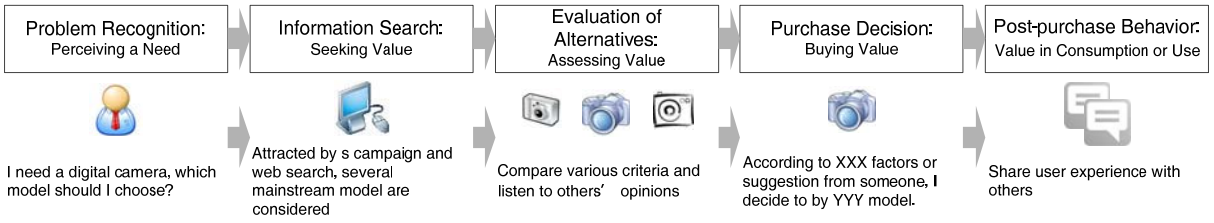

Figure 1 Consumer purchasing decision process

Kotler et al. (2008) argue that consumer purchases are influenced strongly by cultural, social, personal and psychological factors. Researchers know 90% of people ask for advice from friends and family when making decisions (Apprentice, 2011). This is obvious and frequently outweighs other facts because people feel confident, smarter and trust the advice of their own circle. Besides, Sinha and Swearingen (2001), found that consumers are far more likely to believe suggestions from people they know, i.e., friends and family-members. As online social network can be easily accessed through laptop or mobile phone, people are getting used to make decisions based on opinions collected from their own social networks. However, this method heavily relies on the identification of critical friends, that is, how to find those friends who are important to you and can influence your decision.

Human decision making is often based on heuristics than pure logic or weighing advantages and disadvantages. Besides, most of the time it is not easy to present decision problems in a well-structured format. Consequently, decision tools such as decision tree are hard to be applied. For those who are consulted during decision making process, their opinions or comments may not be well-structured as well. Free format text may be used to represent their idea or thought, making it hard to record and communicate the argumentation and reasoning.

Although traditional decision support system has been extensively investigated, little mechanism, however, on how online social networks can help people with decision-making is developed. The difficulty of developing such social decision support resulted from three factors. First, identifying friends who are helpful during decision making process is challenging. A typical social network is a sparse graph, involving hundreds of users with each being connected to only a tiny proportion of the network. This property rules out traditional spectral algorithms for graph mining (Newman, 2006). The social network analysis approach focuses on relations between people, rather than on attributes of people. For example, it measures the existence of friendship between individuals, rather than friendship. In moving from the analysis of attributes toward relation-centric analysis, network researchers appeared to have lost sight of social impact and its potential effects on decision making. What new decision support mechanism could we develop if social impact is taken into account, in addition to only connections between people? Second, the decision problem itself may be ill-structured. If we are sure about the processes to solve the decision problems, most of the time there would be not necessary to ask for suggestion or advice. However, if a problem contains some or no elements and relationships that are understood by the problem solver, friends may give some hints. Solving this kind of decision problems requires some assistant tools. Third, the presentation of rationale behind decision is not easy to capture because the context of information exchange during the alternatives design is often in the free form. The friends involved in the discussion of options and the design of alternatives may use text, graph or video to show their idea. Meanwhile, the social network sites provide no strictly format limitation about content. So data collected from social network sites would not be well-formatted. Thus, an effective way to transform the unformatted data into systematic representation for decision making is required.

1.3 Significance of the Study

While there is much on-going research on social network and their effects on business, there is relatively little solid research on social support. If new factors could be taken into consideration, then social network analysis could discover new things. In this paper, we present a system framework to

support decision making process based on social networks. By introducing social impact theory of social psychology into social network analysis process, we designed a new decision group recruiting method to select friends with higher impact power. An assistant tool was designed to collect options and criteria from the context generated during the discussing and designing phase of decision making. Finally, an adaptive structure for presenting the reason about decision alternatives was used in our system framework. This structure produces a representation which can help decision maker understand why the resulting design is the way it is.

The remaining part of this paper is organized as follows. In section 2, we discuss existing literature related to our research topics. Section 3 demonstrates our research model and in section 4 we describe the experimental data source, settings, and procedures. The experimental results and evaluations are discussed in section 5. Finally, section 6 concludes our research contributions and presents future research directions.

2 LITERATURE REVIEW

2.1 Human Decision Process and Social Impact Theory

Human decision making process has been characterized as relatively sequential, and it becomes more complex with distributed source of information and the quantity of information available through networked sources. From a psychological perspective, it is necessary to examine individual decisions in the context of needs, preferences and values. From a normative perspective, the analysis of individual decisions is concerned with the logic of decision making and rationality. The rationality is ensured if the process of decision making is carried out systematically.

Almost everything that a human being does involves decisions. According to Dewey (1997), problem-solving consists of five stages : (1) a felt difficulty, (2) the location and definition that difficulty, (3) suggestion of possible solutions, (4) development by reasoning of the bearings of the suggestion, and (5) further observation and experiment leading to acceptance or rejection of the suggestion. Herbert Simon modified Dewey's list of five stages to three principal phases (Simon, 1977):

- Intelligence: the decision-maker identifies the problem and gathers information about the problem.
- Design: the decision-maker structures the problem, develops criteria, and identifies the alternatives.
- Choice: the decision-maker chooses the best alternative that meets the criteria.

In real-world decision-making process, humans can experience emotional intensity and information overload that may affect their choices. Better decision support systems should address these issues and assist human decision making by developing systems that integrate capabilities from the human and computational intelligence. Social influence is the process by which individuals make real changes to their behaviours as a result of interaction with others who are perceived to be similar, desirable, or expert (Rashotte, 2007).Social impact theory suggests that social status, power and credibility can impact on decision (Latane, 1981). It refers to the idea that conforming to social influence depends on the strength of the group’s importance, its immediacy, and the number of people in the group (Aronson, Wilson, & Akert, 2009). Social impact theory proposes that the impact of information source is a function of three factors: the number of sources, their immediacy (i.e., closeness), and their strength (i.e., salience or power) (Latane, 1981):

This theory states that the likelihood that a person will respond to social influence will increase with:

- Number: how many people there are in the decision group.
- Strength: the importance of the influencing group to decision-maker.
- Immediacy: the closeness of the influencing group to decision-maker (in space and time) at the time of the influence attempt.

In our research, we followed the decision process proposed by Simon to design our system framework. Our decision support mechanism help decision makers with recruiting decision group members and

suggesting decision alternatives. Social impact theory was utilized to select decision group members and build opinion formation.

2.2 Design Rationale and Representation Schema

Due to the complexity of decision problem and communication process between decision-making group members, there is a strong need in formatting the solution design process to help members record, access and assess design rationale. Design rationale is used to provide information about why certain decisions were made. A clear design rationale provides a medium for communicating between decision group members. A design rationale is an important tool in arriving at the initial decision alternatives in the first place, and a representation is needed for capturing design rationale. A good representation schema is vital to enabling effective design and discuss. A representation schema explicitly documents the reasoning and argumentation occurring in design. It determines the methods used to capture and retrieve the design rationale.

One design rationale representation schema known as Questions, Options and Criteria (QOC) developed by McLean et al. (1991) focuses on the three basic concepts indicated in its name. QOC represents the design space using three components:

- Questions(Requirements): identify key issues for structuring the space of alternatives
- Options(Alternatives): provide possible answers to the questions
- Criteria: provide the bases for evaluating and choosing from among the options.

A design rationale presented by QOC schema is depicted in Figure 2.

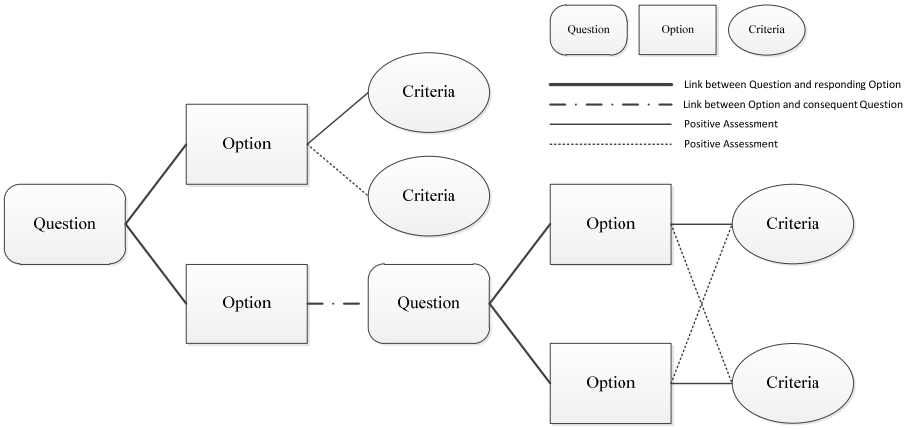

Figure 2 Question, Option and Criteria Representation schema for design rationale

In our research, we use QOC schema to represent the product purchasing decision problem, so that the alternatives design process and their design rationale could be recorded.

3 SYSTEM FRAMEWORK

Based on Simon's decision process, our system supports the decision-makers with necessary functions in every stage. Our requirements for this system are governed by the objective of designing a system to support product purchasing decision processes on social network. For more vivid picture of the study, Figure 3 served as the research paradigm. In the following, we describe our important system modules in detail.

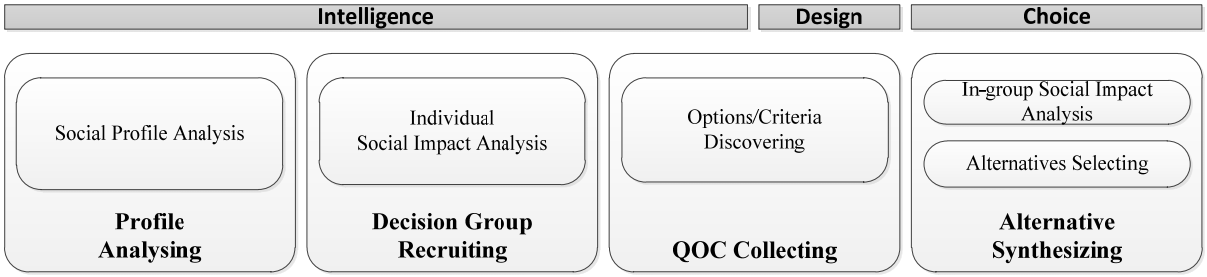

Figure 3 System framework

3.1 Social profile analysis

As social network analysis is used to analyse complex networks (Chi, Holsapple, & Srinivasan, 2007), in our model we choose closeness and betweenness from three commonly used centrality metrics to be characteristics of system users. Closeness is used to measure the immediacy in social impact (Rashotte, 2007).Closeness centrality is defined as the total distance of a user from all other users, and can be formulated as (Freeman, 1979):

$$C_C(p_i) = 1/\sum_{j=1}^{N} d\left(p_i, p_j\right) \tag{1}$$

where N is the number of users and $d(p_i, p_j)$ is the distance between decision maker i and his friend j. Individuals who are higher in betweenness are considered to hold greater power in the network (Killeya-Jones, Nakajima, & Costanzo, 2007). Betweenness centrality tracks the number of geodesic paths through the entire social network, and it is an approximation of influence (Chi, Holsapple, & Srinivasan, 2007). Besides, betweenness centrality best measures which members, in a set of members, are viewed most frequently as a leader, than other social network analysis measures. The betweenness centrality is defined as (Freeman, 1979):

$$C_B(i) = \sum_{i \neq j \neq l} g_{jl}(i) / G_{jl} \tag{2}$$

where G_{jl} is the number of the shortest paths linking two friends (i, j) and $g_{jl}(i)$ is the number of shortest paths linking the two nodes (j,l) containing node i.

Out-degree refers to the attribute that can present an initiative action from a user. The higher the number of out-degrees, the more motivation a user has to interact with others. When a target user posts comments or sends links to others, they make links of this type. Out-degree centrality is defined as (Freeman, 1979):

$$C_D(p_i) = \sum_{j=1}^{N} a(p_i, p_j) \tag{3}$$

where $a(p_i, p_j) = 1$ if and only if p_i and p_j are connected. Otherwise, $a(p_i, p_j) = 0$.

Social similarity (SS) and social interaction (IA) are two important factors for analysing friendship. Compared with social similarity, social interaction is a more dynamic relation that contains all kinds of people's actions (De Meo, Nocera, Terracina, & Ursino, 2010), and these actions can reveal social closeness. In our research, we used these two factors to define social relation. Social relation (SR) is defined as:

$$SR_{ij} = SS_{ij} + IA_{ij} \tag{4}$$

In our research we use the number of friends in common to measure social similarity, that is:

$$SS_{ij} = \frac{\{Friend\ of\ i\} \cap \{Friend\ of\ j\}}{\{Friend\ of\ i\} \cup \{Friend\ of\ j\}} \tag{5}$$

Besides, the social interaction between i and j is measured by the activities related to information sharing. For example, friends usually post their own status, share photos or comment on friends' status on Facebook. Therefore, the social interaction is defined as:

$$IA_{ij} = \frac{Total\ Interactions\ between\ i\ and\ j}{Total\ Interactions\ between\ i\ and\ All\ Friends} \tag{6}$$

3.2 Individual social impact analysis

In our work, we use social impact to be the selection factor of decision group members. Social impact was governed by social forces, psychosocial law and multiplication versus division of impact (Latane, 1981). Social forces law states that social impact is affected by strength (S), immediacy (I) and number of people (N), and

$$I_i = f\left(SIN\right) \tag{7}$$

The greater the number of sources of social impact in a social situation, the greater the impact would be. In our research, by applying the result from social profile analysis, the social impact of i is defined as:

$$I_i = \sum_{j=1}^{N} \left(C_{B(i)} * SR_{ij}\right) * C_C(p_i) * C_D(p_i) \tag{8}$$

3.3 Options/Criteria discovering

Information retrieval (IR) deals data where information items cannot be precisely defined. Since the discussion process contains various free-typing texts, we used IR methods to collect the options. A Part-Of-Speech Tagger (POS Tagger) reads text and assigns parts of speech to each word, such as noun, verb and adjective. In our system framework, we adopted POS tagger developed by Stanford University to identify POS. The tagged nouns were considered to be options from decision group members. WordNet is a large lexical database in which nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept. Synsets are interlinked by means of conceptual-semantic and lexical relations. To measure the semantic similarity between two synsets, we use hyponym/hypernym (or *is-a* relations). After the similarity is computed, the options are then presented to decision group by using QOC schema. Then the group members are asked to describe the criteria behind the options proposed. The same technique is used to collect the criteria during the discussion of criteria. At the end of this process, a complete QOC diagram can be obtained.

3.4 In-group social impact analysis

After the decision group members are selected, the decision support process starts. During the alternatives design phase, they can propose their own options related criteria. However, the group members are likely to impact each other. Some members may be persuaded and concur on others' options. Suppose the decision group consists of N members. Each of them can have opposite attitude on a certain criteria proposed by other members. Denote the attitude of member p as $\alpha_p = \pm 1, p = 1, 2, ..., N$. Member p agree with the criteria if $\alpha_p = 1$, and vice versa. Members can influence each other, and each of them is characterised by self-confidence $\beta_p > 0$, which is the strength of his/her influence and the confidence about his/her own criteria/options. Member p and q

have social distance d_{pq}. The change of attitude is determined by the in-group social impact exerted on every member:

$$GSI_p = -\beta_p - \alpha_p - \sum_{q=1,q\neq p}^{N} \frac{\beta_q \alpha_p \alpha_q}{g(d_{pq})} \quad (9)$$

Member p will change his/her own attitude if $GSI_p > 0$, or maintain his/her attitude otherwise.

3.5 Alternative selecting

At the final stage, the final alternatives shown to the decision-maker is synthesized based on QOC and in-group social impact. In QOC schema, an option can have positive and negative assessment about. By evaluating the in-group social impact, we can count the number of decision members who support or concur in a certain criteria. For a criterion, if the number of positive assessment exceeds that of negative assessment, then the negative assessment link is removed. The option with the largest number of positive assessment is then selected as final suggested alternative to decision-maker. The complete process is shown in Figure 4.

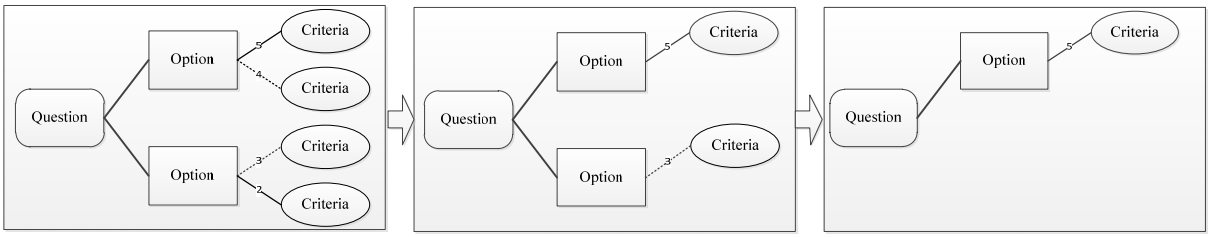

Figure 4 Alternatives selecting process

4 EXPERIMENT

4.1 Experiment process

To implement our system, Facebook was selected as experiment platform. For the purpose of collecting basic data required, a group of social network users were invited to be our participants. Snowball sampling is used to sample a specific population by making use of the social network that connects their members together, and it is a better way of finding a hidden population than random surveys (Newman, 2010). A snowball sampling procedure with S stages K names is described as follows. A random sample of individuals was drawn from a given population, and they were asked to name K different persons, where K is a predefined number. Each of the individuals in the first stage was then asked to name K different persons. This procedure repeats S times to complete the sampling process. In the initial stage, we drew 3 Facebook users randomly and divided them into three groups by their lifestyle. After filtering out those users who are not willing to join our experiment, we have student group, office worker and random member groups. By using 3 (S) stages 3 (K) names snowball sampling we have 40 participants for each social network (group). The characteristics of these social networks are summarized in Table 1.

ATTRIBUTES	SOCIAL NETWORKS		
	STUDENT	OFFICE WORKER	RANDOM GROUP
Number of participants	40	40	40
Age	20~35	25~45	22~43
Gender	Male: 21 Female: 19	Male: 25 Female: 15	Male: 22 Female: 18

Table 1 Characteristics of the three networks

After the networks were built, 3 randomly selected users (1 from each group) were invited to be our decision-makers. In our experiment, they can issue a decision problem and evaluate the effectiveness of decision alternatives. The decision-makers were asked to issue 2 product purchasing problems (one for mobile phone and one for digital camera) during the experiment, and these problems were delivered to the decision group members selected by our system. Users with top-5 individual social impact were selected as our decision group members, and the processes repeated every time when a problem was issued. That is, there are different decision groups for different problems. When a decision problem was presented to decision group, members can express their opinions online. They were asked to post their comments about the decision problems. Every alternative was asked to provide a hyperlink containing related information, so that the click stream data can be collected to compare with other methods. Besides, every alternative was evaluated by the decision makers so that we can understand if they are satisfied with the alternatives presented. Follow the method proposed in our research, decision criteria and alternatives are collected and presented to decision makers. To avoid information overloading, the first decision alternative of each method were selected, and total 3 alternatives were presented to decision makers for each problem. Since there is a strong tendency for users to spend a greater length of time reading articles of interest to them (Morita & Shinoda, 1994; Velayathan & Yamada, 2006), we collected these data to evaluate the effectiveness of our mechanism. The click count and stay time of each page linked to alternatives were recorded, and satisfaction was rated by decision makers on a 5-point Likert Scale for each alternatives presented to decision makers: Very satisfied, Satisfied, Neither Satisfied Nor Dissatisfied, Dissatisfied and Very Dissatisfied by a rating score of 5, 4, 3, 2 and 1.

4.2 Benchmark methods

To compare our mechanism with others, we selected three methods as benchmark.

- Random: this method was used as baseline benchmark. All the experiment process was the same as our mechanism except the decision group members were randomly selected from the friends of decision makers.
- Social relation only: the decision group members were selected by considering the result of social profile analysis only.
- Social relation with majority voting: the decision group member were select as above method, and the options presented in QOC schema was selected as final alternative based on majority voting.

5 RESULT AND DISCUSSION

In our experiment we collected clickstream data of every alternative presented, and the average stay time of different methods and groups on every alternative is plotted in Figure 5. As we can see, our proposed mechanism attracted decision makers to spend more time on the alternatives than other methods. More, as shown in Figure 6, the average satisfaction level of alternatives generated by our proposed mechanism is also higher than other methods. The related statistical results are shown in Table 2 and Table 3. To further examine if there are significant differences in average stay time and average satisfaction level, a statistical method is required.

Two-way analysis of variance (ANOVA) is a statistical analysis in which two independent factors are examined with regard to their impact on a dependent variable. In our work two-way ANOVA was used to test the impact of method used and user group on average stay time and average satisfaction level. As we can see from Table 4, the method used in the experiment has impact on the average stay time as the test result is significant at 0.05 (as 0.00<0.05). In contract, the user group has no impact as 0.646>0.05. For the same reason, we can conclude that based on Table 5 the satisfaction can only be influenced by method used during the experiment. Post hoc tests such as Tukey's test most commonly compare every group mean with every other group mean. Knowing that the methods used in the experiments could affect both stay time and satisfaction level, we use Tukey's test to see if there is a significant difference between different methods. From Table 6 and Table 7, we can see that there are significant differences between our proposed mechanism and other benchmark methods, also we have already knew that the average stay time and average satisfaction level are higher than other methods.

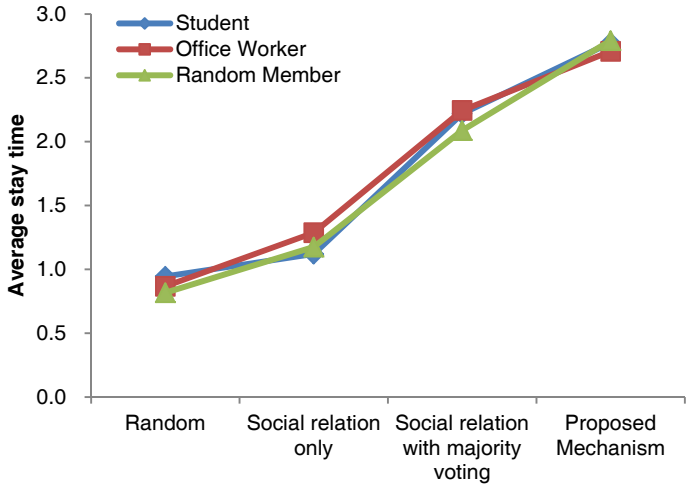

Figure 5 *Average stay time for different groups and methods*

Average Stay Time

METHOD	MEAN	STD. ERROR
Random	0.917	.110
Social Relation Only	1.294	.112
Social Relaton with Majority Voting	2.203	.100
Proposed Mechanism	2.711	.091

Table 2 *Mean and standard error of average stay time*

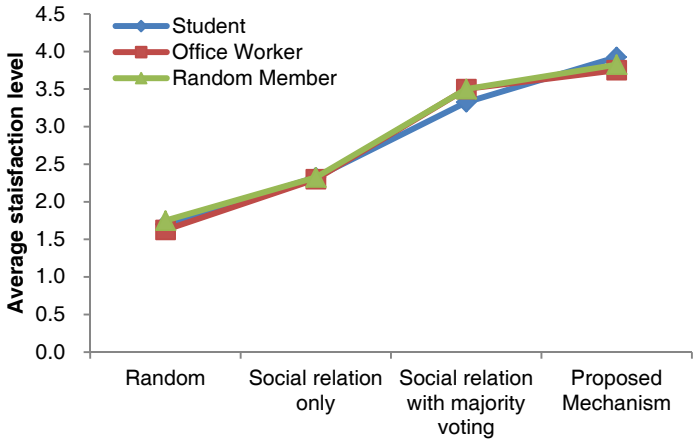

Figure 6 *Average satisfaction level for different groups and methods*

Average Satisfaction Level

METHOD	MEAN	STD. ERROR
Random	1.722	.092
Social Relation Only	2.278	.089
Social Relation with Majority Voting	3.417	.094
Proposed Mechanism	3.861	.087

Table 3 *Mean and standard error of average satisfaction level*

Dependent Variable: Average Stay Time

SOURCE	TYPE III SUM OF SQUARES	DF	MEAN SQUARE	F	SIG.
Group	0.309	2	0.154	0.437	0.646
Method	273.222	3	91.074	257.968	0.000

Table 4 *Tests of between-subjects effects for average stay time*

Dependent Variable: Average Satisfaction Level

SOURCE	TYPE III SUM OF SQUARES	DF	MEAN SQUARE	F	SIG.
Group	0.254	2	0.127	0.391	0.676
Method	352.775	3	117.592	361.939	0.000

Table 5 *Tests of between-subjects effects for average satisfaction level*

Average Stay Time Tukey HSD

(I) METHOD	(J) METHOD	MEAN DIFFERENCE (I-J)
Random	Social Relation Only	-0.3175*
	Social Relation with Majority Voting	-1.3075*
	Proposed Mechanism	-1.8817*
Social Relation Only	Random	0.3175*
	Social Relation with Majority Voting	-.9900*
	Proposed Mechanism	-1.5642*
Social Relation with Majority Voting	Random	1.3075*
	Social Relation Only	0.9900*
	Proposed Mechanism	-0.5742*
Proposed Mechanism	Random	1.8817*
	Social Relation Only	1.5642*
	Social Relation with Majority Voting	0.5742*

*. The mean difference is significant at the .05 level.

Table 6 Multiple comparisons of average stay time

Average Satisfaction Level Tukey HSD

(I) METHOD	(J) METHOD	MEAN DIFFERENCE (I-J)
Random	Social Relation Only	-0.6250*
	Social Relation with Majority Voting	-1.7500*
	Proposed Mechanism	-2.1417*
Social Relation Only	Random	0.6250*
	Social Relation with Majority Voting	-1.1250*
	Proposed Mechanism	-1.5167*
Social Relation with Majority Voting	Random	1.7500*
	Social Relation Only	1.1250*
	Proposed Mechanism	-0.3917*
Proposed Mechanism	Random	2.1417*
	Social Relation Only	1.5167*
	Social Relation with Majority Voting	0.3917*

*. The mean difference is significant at the .05 level.

Table 7 Multiple comparisons of average satisfaction level

6 CONCLUSION AND FUTURE WORK

In our paper, we introduced social impact theory into the design of social decision support mechanism. QOC representation schema was used to describe the design logic of decision alternatives. From the viewpoint of academic contribution, by using social impact theory a decision group selection mechanism and consensus-making within decision group were proposed and served as our tools to select adequate members to support decision-making process. By equipping decision support mechanism with proper design rationale representation schema a product purchasing decision problem can be understood clearly by decision members, and various discussion records can be easily communicated and assessed. An empirical study further proved the feasibility and effectiveness of our work. Our research successfully introduced the social impact theory and design rationale into the development of social network-based decision support mechanism. Besides, we also extended the concept of decision support system development to utilize social network platforms. From the viewpoint of practice, we showed a feasible way to develop a social network-based decision support system together with the related techniques for product purchasing decision problems. By dividing the system framework into modules, those who are interested in developing such kind of applications can further improve the system by plugging in new modules as needed.

Being one of the pilot studies in the development of social network based decision support mechanism, although the research has reached its aims, there were some unavoidable limitations. First, because of the time limit, this research was conducted only on a small size of population who were the users of Facebook. Therefore, to generalize the results over different social network platforms, the study should have involved more participants from other social networks. Second, to measure social impact we can only use the data collected from online social networks. To make our system more feasible, a friendship index such social relationship index (SRI) may be used to further improve the measurement of social impact. Third, there are various measurement used in the research of social network analysis. In our work, only betweenness, closeness and out-degree were considered. It would make our proposed social impact more comprehensive by introducing factors such as tie strength and trust.

Acknowledgement

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