The Impact of Affect on Assessment of Group Decision Support Systems

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ABSTRACT

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This thesis discusses the role of affect in users' assessment of a collaborative system. A web-based multi-attribute group decision support system (iMade) is developed that is characterized by both its adaptability for a variety of decision-making situations, and the resulted utility due to applying design science principles in constructing this artifact. We present findings of a controlled experiment designed to assess influence of affect and various other factors on adoption of information systems using a research model based on Technology Acceptance Model (TAM). Although many researchers have extended the TAM model and studied various antecedents of using that system, no one has systematically studied the effect of group members' behavior and their interaction with one another on the evaluation of the system that they are engaged in. It is hypothesized that the system features by themselves are not the sole factors that affect the users' perception and their intention to use it; but, group interactions play an important role in the user's perceptions of the system (Etezadi-Amoli and Kersten, 2008, Etezadi, 2010). To test this phenomenon, a group decision problem was developed and an experiment was carried out using the iMade system. Thirty subjects assumed the role of three groups of stakeholders and negotiated along with two experimenters as a group, with the task of purchasing a fleet of taxicab; the experimenters were required to induce either positive or negative affect within the group. Analysis of the data clearly shows that group affect significantly influences users evaluation of the system.

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Table of Contents

List of Figures

List of Tables

List of Appendices

1 Introduction

Existing literature regarding system evaluation aspects is limited for the systems that do not require group collaboration during using the system (indeed, there is only interaction between each user and the system) In tasks that other people are involved, there would be interaction-between people- which their effects shouldn't be ignored. In this study, I want to explore whether interaction between users (experience of such an interaction) would affect user's evaluation of the system or not.

Literature reveals that such an interaction can influence on mood or emotion of group members, and consequently affect the process and outcome of group decision making.

This research makes several contributions not only to improve models of acceptance, adoption or use, by considering and incorporating group affect, but the results and recommendations from this study can also benefit managers and practitioners by helping them to focus on interaction and existing affective states among employees who are supposed to use information technologies.

1.1 Research Problem and Purpose of the Thesis

In this study, I have attempted to integrate the two streams of decision support systems research by investigating the effect of social interaction among people on their perception of the decision support system. Kersten (1997) characterized group decisions and negotiations as processes consisting of two major complex activities which are decision making and communication; thus, unlike some information systems, group

decision support systems require team work in order to accomplish the assigned task. According to literature, group affect (whether positive or negative) in the workplace plays an important role in quality of group relationships, and success of the organization consequently. (Walter and Bruch, 2008)

This study is aimed to explore and gage the impact of affect on evaluation of group support systems and is an extension of Etezadi-Amoli and Kersten (2008), which was conducted for E-Negotiation systems. They concluded that "negotiation affect" has a direct impact on both perceived ease of use and perceived usefulness of system. Thus, accounting for the role of group behavior and group affect is pivotal in evaluation of system.

1.2 Research Question, Design, and Conceptual Framework

The main research question is whether group affects influence evaluation of various aspects of group decision support systems. More specifically, we will explore if group members who feel a positive and collaborative environment during the decision making process, assess characteristics of system different from those who experience a negative feeling and confider the group non-cooperative. As mentioned briefly in the previous section, this study considers users assessment of the system based on three major dimensions: perceived ease of use, perceived usefulness, and also behavioral intention to use the system in future.

1.3 Organization of the Thesis

This manuscript is divided into six major chapters. Chapter one is providing an overview of the research problem and purpose of this thesis. This study mainly follows

the research model proposed by Etezadi-Amoli and Kersten (2008), and has been adapted into context of group decision making instead of negotiation.

Chapter two provides the background and previous related works. In order to cover the related literature, this part has been stratified into three major area of research. First, there is an overview of past works in the area of technology acceptance model; second, decision support systems, and specifically GDSSs, have been studied in details. In the end, affect and its role in negotiation and group decision making have been discussed.

Chapter three discusses first the important role of design science research in information systems, then, the design issues of iMade including the design principles proposed by studies in the field of HCI (Human Computer Interaction) will be considered; moreover, descriptive elaboration of adopted technologies for implementing iMade is included in this section.

Chapter four presents the research model including the conceptual definition of the variables in addition to their adopted measures. Furthermore, the experimental design of this study is elucidated thoroughly in this section.

Chapter five exhibits the findings including analysis results of the quantitative data used to test the hypotheses. Following conducting a two-way factorial ANOVA, the research model is tested using path analysis.

Chapter six give details about both managerial implications and theoretical findings of this research; furthermore, it points out the existing limitations and potential future research at this topic.

2 Literature review

This literature review is structured around three major area of research. First, factors affecting success of information systems (IS) - specifically system use and IT adoption - have been elaborated. Then, there is a thorough research about the prior and existing DSS and GDSS including different decision making models applying into various decision making problem scenarios.

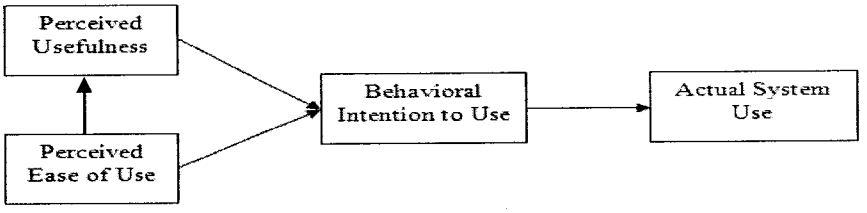
Finally, concept of affect and its various definitions in different literatures have been pointed out. Furthermore, the role of affect in negotiation and decision-making processes has been discussed.

2.1 Technology Acceptance Model

For decades researchers have investigated determinant factors that can be measured as success of information systems (IS) and effectiveness of management information systems. DeLone and McLean (1992) did a very thorough research (through many conceptual and empirical studies) on IS success measures, and have narrowed them into a model consisting of 6 dimensions or interdependent constructs known as a IS success model: system use, user satisfaction, system quality, information quality, individual impact, and organizational impact. In this study, system use is identified as a construct that mediating the effect of system characteristics (system quality and information quality) with system's individual and organizational impact. (Delone and McLean, 2003; Etezadi-Amoli, 2010)

Davis (1989) developed the Technology Acceptance Model (TAM) which is an information systems theory that models how users intend to accept and use a technology. He developed new scales for two specific variables, perceived usefulness and perceived ease of use, which are two fundamental determinants of system use. The presented scale items were first pre-tested for content validity; then their reliability and construct validity were highly supported. Many studies, which applied TAM model in their research model, have adopted these standard measures based on their specific contexts.

Figure 1-Technology Acceptance Model (Davis, 1989)



Lederer et al. (2000) studied the antecedents of "ease of use" and "usefulness" in Technology Acceptance Model. They realized that system' information quality is a determinant factor for perceived usefulness, and ease of both finding (e.g. navigation) and understanding the system affects notably ease of use of the system. This study confirms TAM model and their targets are both managers and developers of information systems.

Wixom and Todd (2005) studied perceptions of information systems success with developing an integrated research model with combining the technology acceptance and user satisfaction literature. They found that information satisfaction significantly affects perceived usefulness, and system satisfaction significantly affects perceived ease of use of system.

Venkatesh and Davis (2000) in their study extended the Technology Acceptance Model so that both cognitive instrumental processes (e.g. Output Quality) and social influence processes such as subjective norms impact on user acceptance of technology. In this study, I have omitted subjective norms which have effects users' perceived usefulness and intention to use of the system. This construct is more meaningful at the organizational level which is not relevant to this study.

Venkatesh (2000) did a longitudinal study (over a 3-month period) based on a field investigation to find out about antecedents of "ease of use" as an extension to Technology Acceptance Model. This paper finds a significant impact of intrinsic motivation conceptualized as computer playfulness, control (internal and external), and computer anxiety on early perception of "ease of use" of new system. Furthermore, this study concludes that users' general belief toward computers is the strongest determinant of perceived ease of use of the system. Thus, Venkatesh advocates more emphasis on the need for further research about individual difference variables rather than system-design related issues. TAM and TAM2 are mainly based on two social psychology theories, Theory of Planned Behavior and Theory of Reasoned Action. (Etezadi-Amoli, 2010)

Taylor and Todd (1995) studied the role of having prior experience in IT usage; they suggested that the effect of different variables - in the model - on intention and usage of the system would vary among experienced and inexperienced users. This study concludes that both TAM and TPB properly model prediction of IS use, However, TPB is more comprehensive than TAM in demonstration the behavioral antecedents of intention to use the system. (Etezadi-Amoli, 2010)

Castañeda, Muñoz-Leiva, and Luque (2007) studied the moderating effects of user experience on technology acceptance model; they realized that perceived ease of use of the website has a higher effect on attitude towards the website for users with higher experience - of the internet or a website - compare to users with low experience. Furthermore, perceived usefulness similarly has a higher effect on attitude towards the website for users with higher experience compare to users with low experience; besides, this paper identifies perceived usefulness – regardless to the level of users' experience - as the major determinant factor of the intention to continue visiting a website.

Djamasbi, Strong, and Dishaw (2010) studied the impact of positive mood on the acceptance of a decision support system. They noticed that task characteristics also should be considered in acceptance studies.

2.2 Group Decision Support Systems

Group decision support systems (or group support systems) are known as computer programs which are designed to help group members in various activities such as decision making, negotiation, planning, creativity, problem identification and analysis, etc. (DeSanctis et al., 2008; Poole, 2002)

The very first experimental study regarding decision support systems conducted by Ferguson & Jones (1969) for real-time computer aided DSSs.

Desanctis and Gallupe (1987) defined decision making group as "two or more people who are jointly responsible for detecting a problem, elaborating on the nature of the problem, generating possible solutions, evaluating potential solutions, or formulating strategies for implementing solutions".

Scholar studies have been categorized decision support systems differently. Power (2008) and Power and Sharda (2009) stratified them into 5 major categories as follow: Model-driven, data-driven, communications-driven, document driven, and knowledge-driven.

Pervan, Arnott, and Dodson (2005) studied 298 GSS articles published in 14 major journals from 1990 to 2003, and found that experiments have been the most popular research design in this field of research; moreover, demonstrating particular applications has been discussed a lot. They also noted that the major concentration of GSS research is on small groups.

2.2.1 GDSS Technology Parameters

One area which has got controversial (inconsistent) publications in the field of GDSS is factors affecting group members' efficiency and effectiveness in decision making in addition to each individual's satisfaction out of the process of decision making. (Baltes et al., 2002; Dennis et al., 1988; Dennis, Nunamaker, and Vogel, 1990; Gavish, Gerdes, and Sridhar, 1995) Various taxonomies have categorized GDSS parameters in different dimensions. For example, although Dennis et al. (1988) have considered time dispersion, group size, and group proximity as the major three GDSS dimensions, Gavish et al. (1995) identified 7 more dimensions which are as follow: task type, group structure and composition, time horizon, anonymity, meeting control, task complexity, and group's objective. Sambamurthy and Wynne (1994) stated that 4 major dimensions of performance for the group decision making are "post-meeting consensus", "users' confidence", "perceived quality", and Group decision making satisfaction.

Table 1 depicts the time dispersion parameter's different possibilities; indeed, meetings are not only having the choice to be held either at the same place or different locations, but they also can be either asynchronous or synchronous.

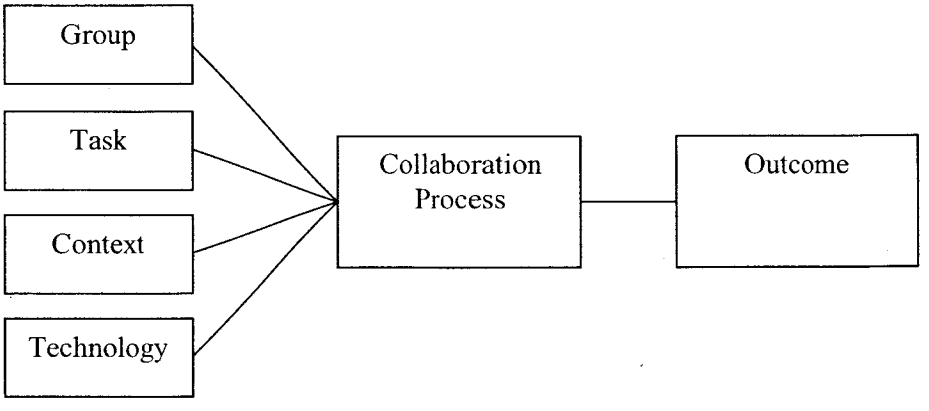
Table 1- Time / Space Matrix adopted from (Ellis et al., 1991; Shneiderman and Plaisant 2004)t 2004)

	Same Time	**Different Times**
Same Place	Synchronous local (F2F) (meeting / decision rooms)	Asynchronous local (group calendars, team scheduling)
Different Places	Synchronous Distributed (chat, video/audio conferencing)	Asynchronous Distributed (email, recordings, blogs)

Nunamaker and Deokar (2008) classified these affecting parameters that can have impact on both outcome and process into 4 major classes as follow: technology, group, task, or context [see Figure 2]

Major group characteristics can be classified as group proximity, group size, group composition, and group cohesiveness (Nunamaker and Deokar, 2008). For group size and its effect on efficiency of group decision making the literature have discussed them quite a lot. (Turoff et al., 1993)

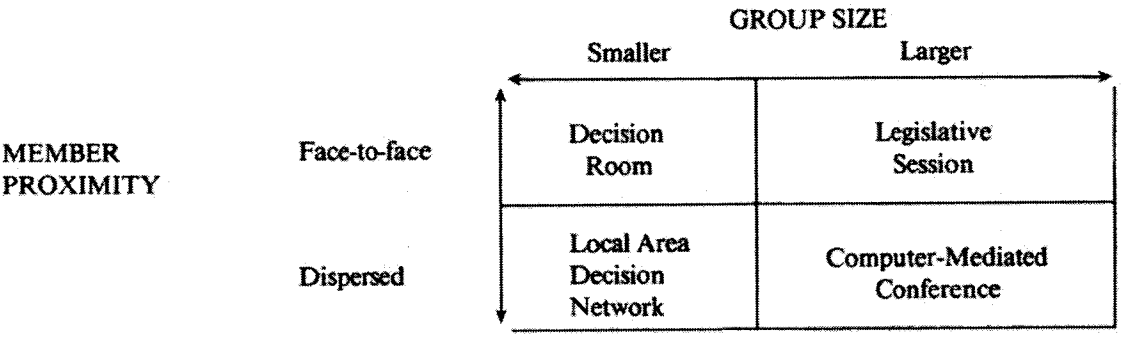
Figure 2- GDSS Parameters adopted from



As Figure 3 illustrates, two most important factors (group related) that play a crucial role in designing GDSSs are members' proximity and group size. (Desanctis and Gallupe, 1987)

Another determinant factor is the group task type. "the general variable 'group task type' is emerging as an especially important variable, often accounting for as much as 50% of the variance of group performance" (Poole, Seibold, and McPhee, 1985)

Figure 3- A taxonomy of GDSS settings adopted from (Desanctis and Gallupe, 1987)



Task is unquestionably the major reason that groups are formed, (Fjermestad and Hiltz, 1998) and the amount of effort needed for accomplishing a task is conceptualized as Task complexity. (Nunamaker and Deokar, 2008) In the GDSS literature, this parameter has been categorized differently, but two major classifications that have been used by many studies (Desanctis and Gallupe, 1987; Fjermestad and Hiltz, 1998; Nunamaker and Deokar, 2008) are as follow:

1. Planning and/or creativity (generating ideas, brainstorming)
2. Decision making and/or intellectual tasks

However, as Fjermestad and Hiltz (1998) investigated, decision making [choosing the preference of the majority as the final selection] tasks are the mostly used task type in the GDSS literature.

The degree of complexity can be identified based on the task type in such a way that if the group task is consisting of both above mentioned task types (decision making and generation), it is considered as a high complexity task; if not, it will be regarded as a low complexity task. (Nunamaker and Deokar, 2008)

2.2.2 Multiple Criteria Decision Making Models

Decision making in the presence of various conflicting criteria is known as multi-criteria decision making (MCDM). (Lu et al., 2007) In the decision science literature, multi-criteria decision making problems have been stratified into two major types of m*ulti-attribute* decision problems with discrete decision spaces and/or *multi-objective* decision problems with continuous decision spaces (Lu et al., 2007)

IS decisions are more inclined to fall under discipline of Multiple Attribute Decision Making since they are dealing with discrete decision spaces in a fashion that IS decision problem scenarios are consisting of limited number of attributes and alternatives. (Bernroider and Mitlöhner, 2005)

This study is also specifically aiming for MADM problems in which users should select their most preferred alternative from a list of available selections, based on their preferred attributes. Attributes have been considered as "the characteristics, qualities, or performance parameters of alternatives." (Lu et al., 2007)

2.2.3 iMade [Internet Multi-Attribute Decision Expert]

iMade is a web-based decision support system designed to assist users in decision making (for both individual and group levels) when they face complex multi-attribute decision problems (MADM). This application is context-independent in a fashion that

can be applied to any MADM problem scenarios. iMade can be considered as a computer-mediated communication system as well. Kahai and Cooper (1999) defined computer-mediated communication systems as "computer-based systems that enable entry, storage, processing, distribution, and reception of digitized information".

For developing this system, the methodology proposed by Etezadi-Amoli and Mak (2004) has been used to assess individual utility function. They have incorporated the well-known *additive multi-attribute utility model* of Keeny and Raifa (1976) considering its measurement error, although the famous quote of Sigmund Freud which is "there is no medicine against death, and against error no rule has been found" (Shneiderman, 2004)

Their major contribution was providing an error-free estimation of parameters of Keeny and Raifa's multi-attribute utility functions for analyzing multifaceted decision problems and eventually sorting alternatives based on user's preferences. (Etezadi-Amoli, 2008) They used the additive utility model based on the *linear additive utility model* as below:

$$\begin{cases} U(\mathrm{x}) = \sum_{j=1}^{n} W_j u_j(x_j) \\ \boldsymbol{n} = number\ of\ attributes \text{ And } \boldsymbol{W_j} = \text{relative weight of attribute j} \\ \boldsymbol{u_j(x_j)} = \text{single attribute utility function for the attribute number j} \\ \boldsymbol{W_j} > 0 \quad \text{and} \quad 0 \le \boldsymbol{u_j(x_j)} \le 1\,; \quad \text{and} \quad W_j \text{ and } u_j(x_j) \text{ have been considered as random variables.} \end{cases}$$

The measurement model and estimation procedures are precisely adopted from Etezadi-Amoli and Mak (2004) and Etezadi-Amoli (2008).

2.3 Affect

Affect is one of fundamental and interesting topics in the field of psychology that has been studied for many years. However, due to the elusive characteristic of this phenomenon, many controversial articles have been published regarding antecedents and successor of this construct.

As it has been stated in the introduction, we are interested to find out about the impact of affective states on cognition and decision making process, and more precisely influence of group affects and the feeling that group members experience on the cognition and people's assessment of the system that they are working with, so this section has been sorted out as follows: First, conceptualizing affect has been discussed in details. This section continues with demonstrating the fundamental issues regarding the relationship between affect and social cognition. Finally, the role of affect in negotiation and decision making has been pointed out.

2.3.1 Conceptualizing Affect

Affect represents a variety of specific affective states including moods, emotional experiences, and traits. (Anderson and Thompson, 2004; Forgas, 1995, 2001, 2006, 2008; Forgas and George, 2001) In fact, it can be regarded as an umbrella for these mental processes. (Bagozzi, Gopinath, and Nyer, 1999) Some studies termed affect and the ability of modifying one's affect by an object or stimuli as core affect and affective quality, respectively (Russell, 2003, 2009; Zhang and Li, 2005)

Four major characteristics that have been used for measuring perceived affective quality are sleepy, arousing, unpleasant, and pleasant. (Russell and Pratt, 1980; Zhang and Li, 2005) In this research, the major focus area has been the influence of affect on the cognition and decision making process. However, paying attention to determinant factors having impact on the affective states is vital and should be carefully considered by website designers.

In many studies, mood and emotion are used as affective states interchangeably; however, they differ in three major dimensions which are "intensity", "pervasiveness", and "specificity". (Djamasbi, 2007)

Incidental emotions are the emotions that are not related to the target object. For example, before you get to the meeting with coworkers, you are hit by a careless driver in the street; the resulted negative affect (mood or feeling) that will impact your decision making in the meeting is called incidental emotion. Incidental affect is indeed the situational affect which is "unrelated to the relevant intergroup context". (Kenworthy et al., 2003)

The influential impact of incidental affect on decision making processes have been discussed vastly in the affect literature. (Anderson and Thompson, 2004; Etezadi-Amoli, 2010; Forgas, 2001, 2006; Loewenstein and Lerner, 2003; Vohs, Baumeister, and Loewenstein, 2007; Yen and Chuang, 2008)

2.3.2 Fundamental issues and Nature of the relationship between affect and cognition

The relationship between affective states and social cognition has been studies thoroughly in the psychology literature. Forgas (2001) clarifies that prior studies have mainly concentrated on the influence of affective states on the content of memory, thinking and judgments. Two major types of theories that explain how affect is influential in people's decision and judgments are *affect priming model* and *affect-as-information model.* (Forgas, 2001)

Sometimes when people want to judge or make a decision they refer to their feelings toward the issue that requires decision making; they ask themselves, "How do I feel about this?"; in this case, affect is regarded as information (Peters et al., 2006)

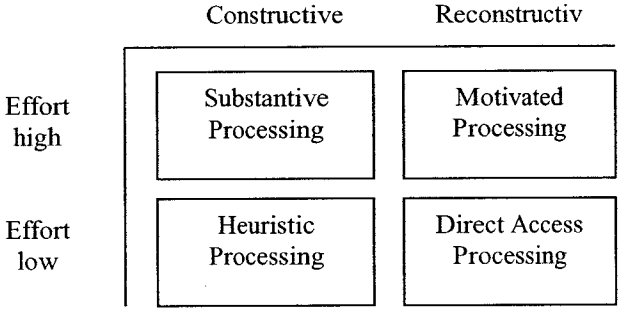
Positive and negative affect have different impacts on the cognition regarding how it processes information; indeed, positive affect results in more heuristic processing, but negative affect leads to more systematic processing.(Fiedler, 1990; Yen and Chuang, 2008) Therefore, affect also acts as information and inform the individual about wellness / difficultness of the situation that he / she is dealing with, to see if further action is required; Kenworthy et al. (2003) concludes that Negative mood depicts the problematic circumstance of the existing situation, so it requires further action and attention; thus, it results in more extensive information processing in addition to more openness to new information. However, positive mood signals that everything is fine so it's more associated with "more shallow and top-down (i.e., preference-driven) information processing". (Kenworthy et al., 2003)

Regardless of the state of affect (positive / negative) there are situations that mood affects our judgments, decision making, cognition, and behavior inconsistently. Affect Infusion model proposed by Forgas (1995) indicates that the degree of affect infusion

into judgments varies based on the strategies of information processing which are direct access, motivated, substantive, and heuristic processing. Definitely, each of these information processing styles is adopted due to the existing circumstances, and as Forgas (2008) stated these four styles are differing from each other by 2 major characteristics: processing quality (constructiveness) and processing quantity (effort)

AIM is illustrated below, in the Figure 4. Direct access processing is indeed direct retrieval of the stored information, which requires the least effort and it's not constructive. In this situation mood has the least impact on the judgment. On the contrary, affect most likely would infuse thinking and judgments when there is heuristic or substantive information processing. (Forgas, 1995, 2008)

Figure 4- Affect Infusion Model Adopted from Fiedler (2001) and Forgas (1995)



2.3.3 Affect in Negotiation and Decision Making

Kumar (1997) studied the role of affect in negotiations; consistent with prior studies' findings, his research reveals that affective states have impacts on both negotiation processes and outcomes. In addition to the theories stated in the previous section, positive mood theory (Djamasbi and Strong, 2008; Djamasbi et al., 2010; Isen, 1984; Isen and Labroo, 2003; Djamasbi, 2007) also explains the relationship between affective states and social cognition and their major concentration is the interaction

among people. Furthermore, *Social impact theory* explains the impact of other people on an individual; indeed, this model predicts that the resulted impact and member's conformity is a multiplicative function and depends on (direct positive relationship) the degree of immediacy, strength, and the number of influence in a group. (Turner, 1991) This theory is defined as "the great variety of changes in physiological states and subjective feelings, motives and emotions, cognitions and beliefs, values and behaviors, that occur in an individual, human or animal, as a result of the real, implied, or imagined presence or actions of other individuals." (Latane, 1981; Turner, 1991)

This study concludes that due to the nature of negotiation process – which proceeds in cycles – different stages in the negotiation process is getting affected by different emotional cycles in a sense that each cycle is characterized by various aspects such as duration of emotion, type of experienced emotion, intensity of emotion, etc. Although literature have discussed quite a lot about the influential impact of affective states on the decision making process and outcome, our major focus in this study is studying the impact of resulted affect – called negotiation affect by, Etezadi-Amoli and Kersten (2008) – on individual's judgment and assessment employing the Technology Acceptance Model (TAM).

3 iMade Design

Although originally developed for assisting people in individual decision making processes, iMade was found to be an effective support tool for group decision making after several preliminary. In this section, the description and goal of "design science" paradigm in information systems research will be discussed. In addition, there will a demonstration of issues related to design in the implementation of the iMade software.

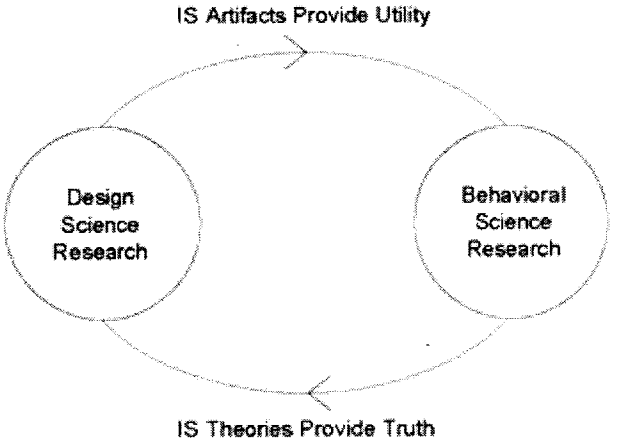
3.1 Design Science

IS research is categorized into two major streams which are behavioral science and design science. Although behavioral science has included a very large portion of research in the field of information systems, design science is becoming the prevailing trend in this field. (Hevner et al., 2004; Markus, Majchrzak, and Gasser, 2002; Vahidov, 2006; Walls, Widmeyer, and El Sawy, 1992)

These two different research paradigms are fulfilling dissimilar aspects and aiming for different goals; if it's supposed to categorize them with abbreviate terms, behavioral science is seeking truth; however, the major goal and product of design science is utility. (Hevner et al., 2004)

Figure 5 illustrates the complementary nature of behavioral science research and design science research in the field of information systems. Design science paradigm is also known as a problem solving paradigm. (Hevner et al., 2004) The major goal of design science is "to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts". (Hevner et al., 2004)

Figure 5 - IS Research Cycle adopted from (Alan Hevner and Chatterjee, 2010a)



Due to the growing trend of this field of research, an international conference called Design Science Research Conference in Information Sciences and Technology (*DESRIST*) has been established in order to bring together researchers from different disciplines related to IS to discuss new findings and challenges of design science research.

3.2 iMade Interface Design

iMade has been carefully designed for overall ease of use. The goal was for both professionals and novices to quickly acquire the necessary knowhow and use the system effectively. In order to increase the quality of overall design, I considered the design of a user interface from following various perspectives: Functional, Aesthetic, and Structural. The *Functional perspective* concerns itself with the usability and task completeness of the system, in addition to seeing whether or not the design is useful for its intended purpose (Johnson, 1992). The *aesthetic perspective* concentrates on the design of visual appearance of interface. In this perspective, graphical and textual figures, animation, style

of menus and buttons, icons, etc. have been considered (Johnson, 1992). These features, as long as they are well designed, will assist decision makers to improve their performance and better understand the provided information. Finally, the *structural perspective* the internal properties of the system including the systems modifiability, portability, maintainability, and run time efficiency are given primary consideration (Johnson, 1992).

In this study, I have expanded the working paper presented by Etezadi (2008) at proceedings of the third international conference on design science research in information systems and technology (DESRIST 2008). The flow of the demonstration of components of the system is similar to the manifestation of Etezadi-Amoli (2008).

In this section, more detail will be given on how the iMade has been designed and implemented. First of all, an overview of every important component of the system will be given along with a brief description of the role this component plays in the system. The adopted technologies section will introduce different development technologies that were used in the making of iMade. Finally, the usability evaluation section will discuss the guidelines that were followed to insure the usability of iMade's interface design.

3.2.1 Components of the System

In order to elaborate the components of the system, this section has been divided into three subsections which are input of the iMade, output of the iMade, and also a messaging application for facilitating the communication among users. In the following, iMade system components are demonstrated through a simple example. This problem scenario was provided to the study's participant as part of a laboratory experiment. In the following chapter (Research Methodology) it will be elaborated in further detail.

3.2.1.1 Input

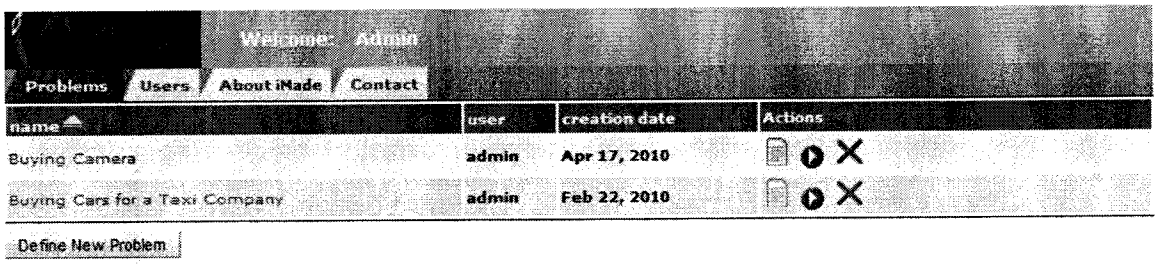
The input of the system is designed in such a fashion that facilitate users in accomplishing following three major tasks: definition of the problem, assessment of the relative weights (importance of the attributes), and elicitation of the utilities (values).

3.2.1.1.1 Definition of the problem

Upon logging into the system, as illustrated in Figure 6 and Figure 7, the user has two choices:

1. Introduce a new decision problem
2. Work on an existing decision problem

Figure 6- Choosing a decision problem



It must be mentioned that in this study, I solely authorized the system administrator for defining a new decision problem for the laboratory experiment conducted for data collection. After identifying the problem, as shown in Figure 7, the user will define all attributes and clarify if they are measured as continuous or categorical variables, as illustrated in Figure 8.

Figure 7- Description of new decision problem

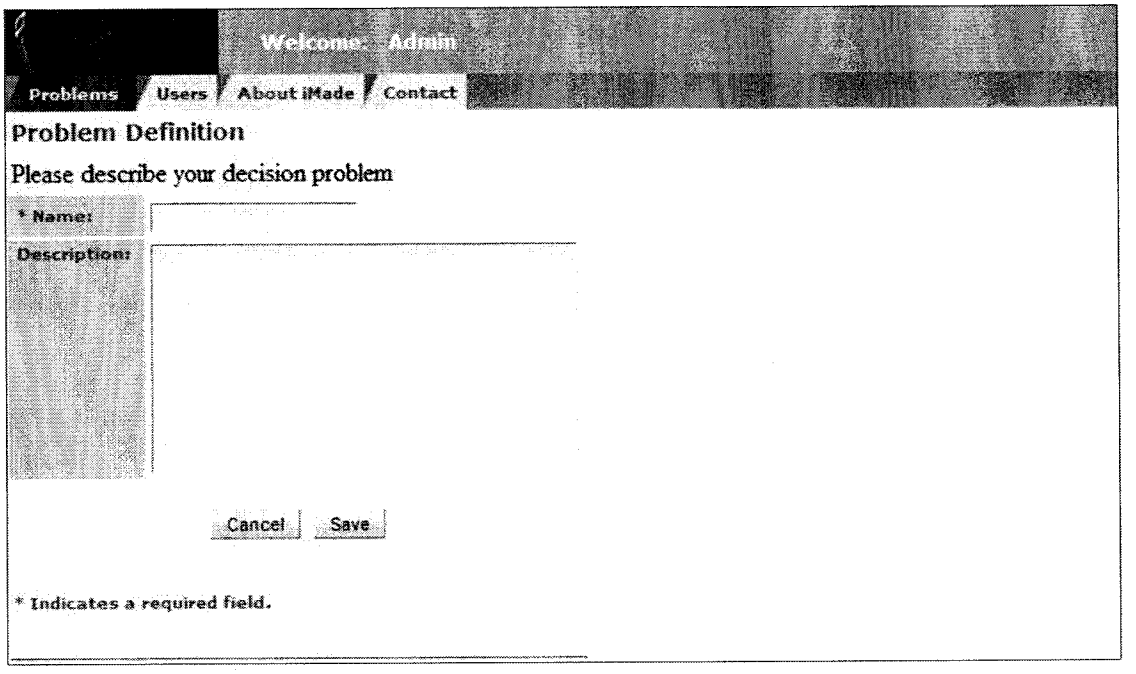
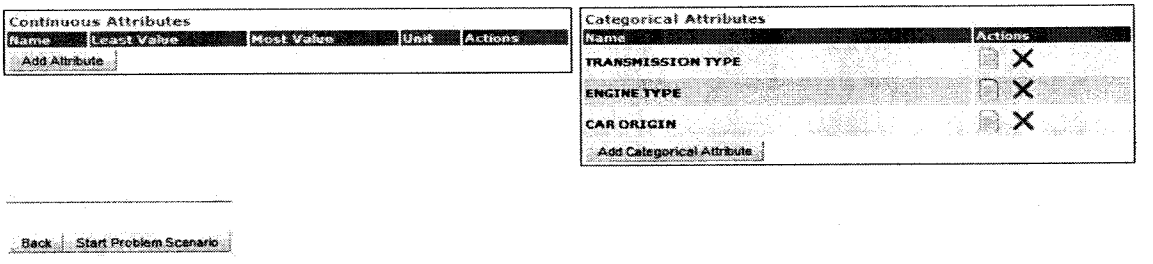
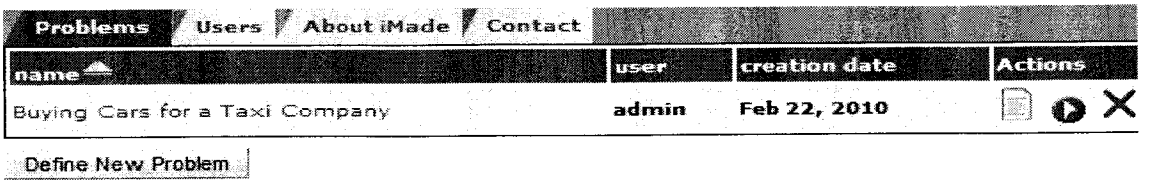


Figure 8- Clarification of the attributes



Furthermore, as it could be seen in Figure 9, the user has the ability to take different kind of actions regarding a specific existing decision problem, as it follows:

Figure 9- Manipulation of decision problems



✕ Used to delete the Created Decision Problem Scenario and is only usable by the problem creator himself / herself.

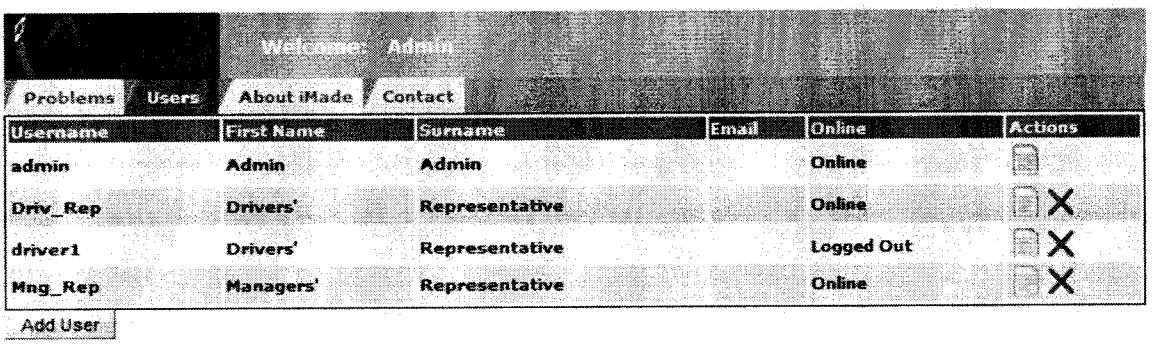
Start to Solve the Created Decision Problem Scenario

To edit the Created Decision Problem

Define New Problem This button is used to introduce a new decision problem

Moreover, another privilege held by the system administrator is having access to the registration wizard as illustrated in the Figure 10. This wizard is designed to facilitate the users' registration process.

Figure 10- Users' registration wizard



The wizard serves to aid in a variety of different actions pertaining to the users' registration. The actions that are at the system administrator's disposal are described as follows:

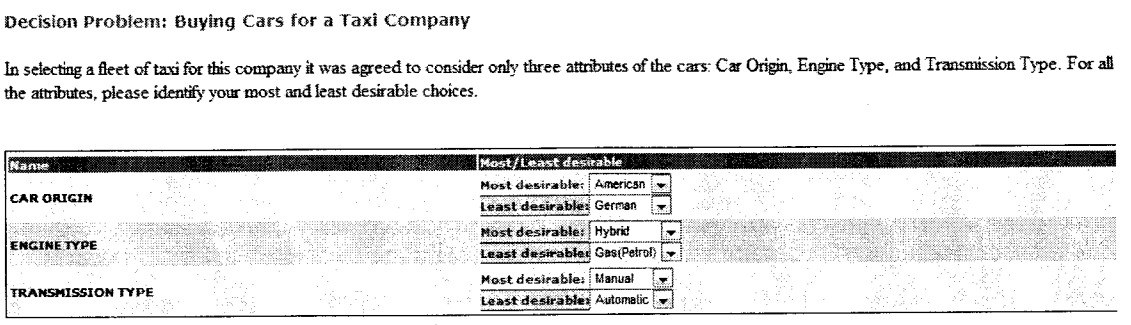
✕ Used to delete the registered users from Database

Used to edit an existing user's attributes

Add User Registers a new user into Database

Afterward, as shown in Figure 11, in this section, the full range for continuous variables, and all categories for the categorical variables, will be identified.

Figure 11- Identification of most/ least desirable choices for all kind of variables



3.2.1.1.2 Assessment of the relative weights

After the problem is defined and the relevant attributes are clarified, as shown in Figure 12 and Figure 13, the system states the best and the worst alternatives and asks the user to identify the most and the least important attributes.

Figure 12- Identification of the most important attribute

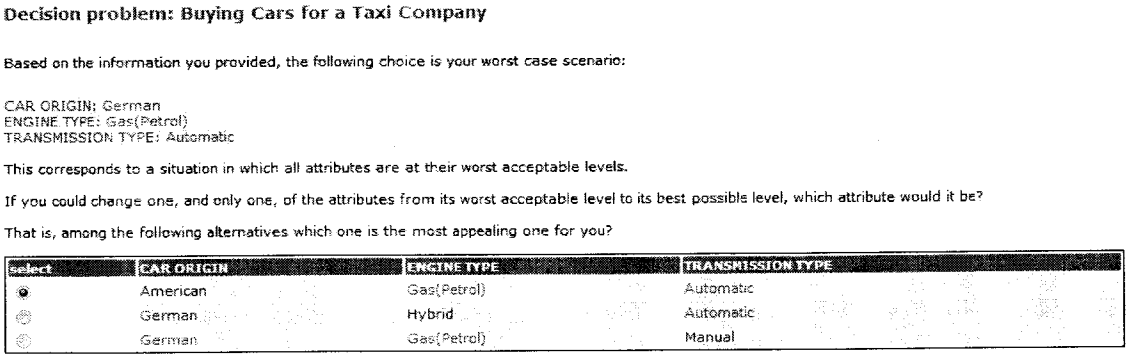
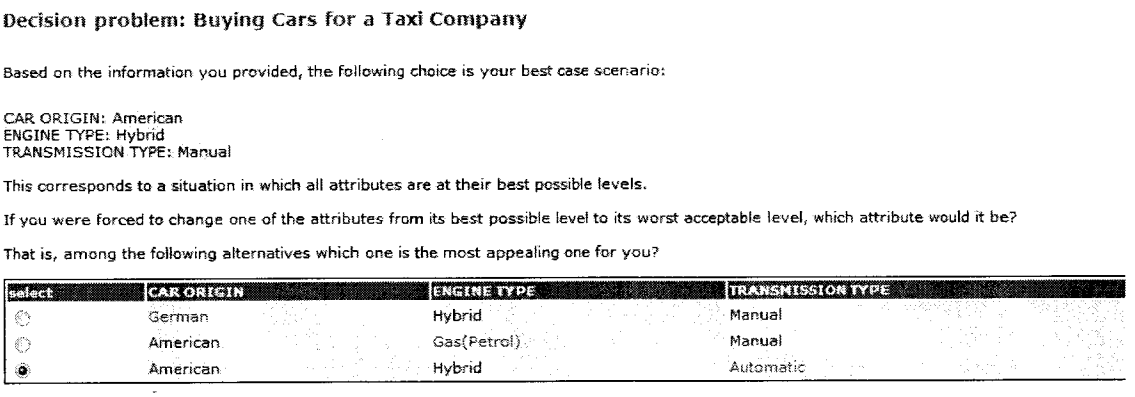


Figure 13- Identification of the least important attribute



Decision problem: Buying Cars for a Taxi Company

Based on the information you provided, the following choice is your best case scenario:

CAR ORIGIN: American
ENGINE TYPE: Hybrid
TRANSMISSION TYPE: Manual

This corresponds to a situation in which all attributes are at their best possible levels.

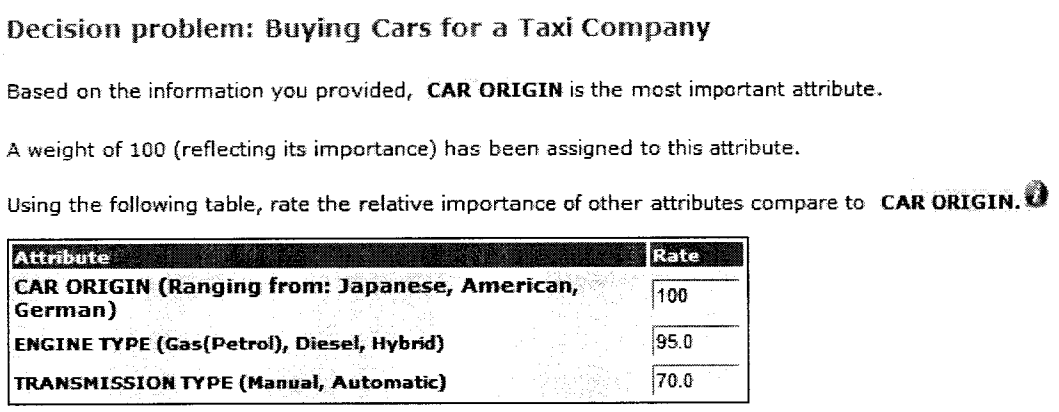
If you were forced to change one of the attributes from its best possible level to its worst acceptable level, which attribute would it be?

That is, among the following alternatives which one is the most appealing one for you?

select	CAR ORIGIN	ENGINE TYPE	TRANSMISSION TYPE
○	German	Hybrid	Manual
○	American	Gas(Petrol)	Manual
◉	American	Hybrid	Automatic

Then, as shown in Figure 14 and Figure 15, the relative importance of each attribute with respect to the best and worst attributes will be measured.

Figure 14- Assessment of the relative importance of the attributes (optimal choice)



Decision problem: Buying Cars for a Taxi Company

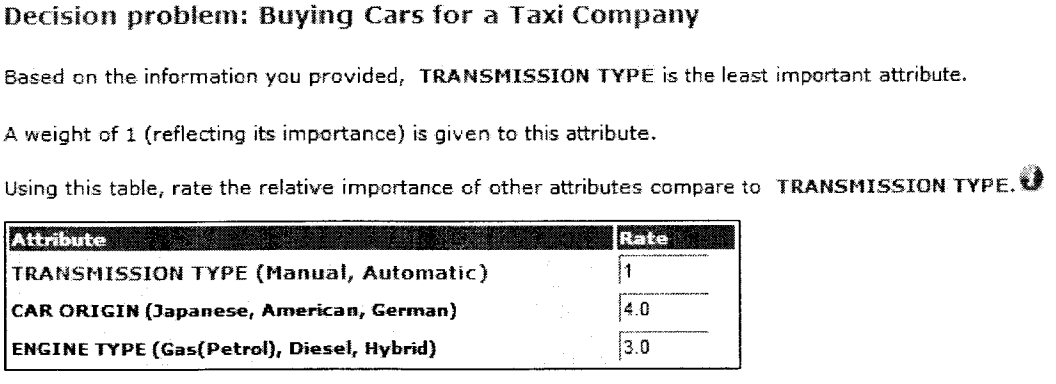
Based on the information you provided, **CAR ORIGIN** is the most important attribute.

A weight of 100 (reflecting its importance) has been assigned to this attribute.

Using the following table, rate the relative importance of other attributes compare to **CAR ORIGIN.**

Attribute	Rate
CAR ORIGIN (Ranging from: Japanese, American, German)	100
ENGINE TYPE (Gas(Petrol), Diesel, Hybrid)	95.0
TRANSMISSION TYPE (Manual, Automatic)	70.0

Figure 15-Assessment of the relative importance of the attributes (worst choice)



Decision problem: Buying Cars for a Taxi Company

Based on the information you provided, **TRANSMISSION TYPE** is the least important attribute.

A weight of 1 (reflecting its importance) is given to this attribute.

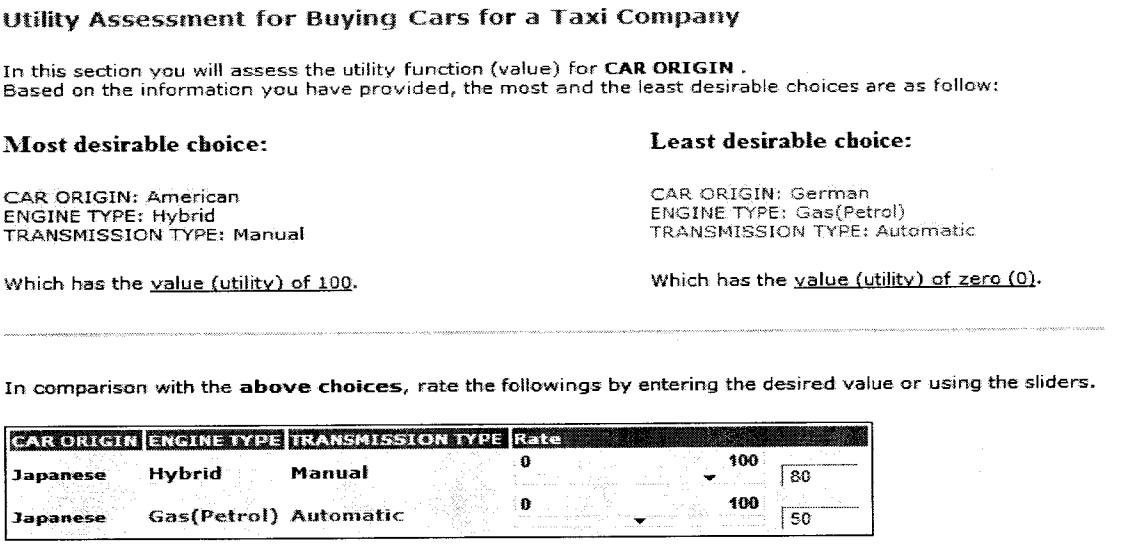
Using this table, rate the relative importance of other attributes compare to **TRANSMISSION TYPE.**

Attribute	Rate
TRANSMISSION TYPE (Manual, Automatic)	1
CAR ORIGIN (Japanese, American, German)	4.0
ENGINE TYPE (Gas(Petrol), Diesel, Hybrid)	3.0

3.2.1.1.3 Elicitation of the utilities

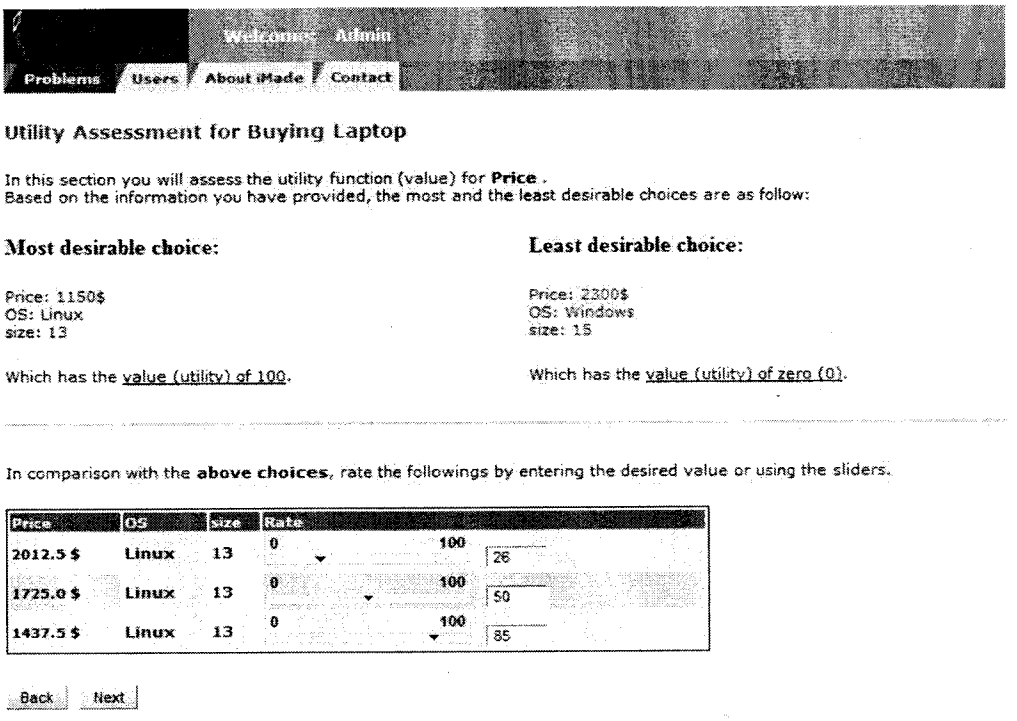
For each attribute, first, the utility of the worst and the best states of each attributes are set to be zero and hundred. Then for categorical variables, as shown in Figure 16, each category that lies between the best and the worst states, two measurements will be made. For estimation of the individual utility functions, if an attribute is continuous, as shown in Figure 17, the utility of three intermediate points between the best and the worst states will be measured.

Figure 16- Assessment of individual utility function for categorical variable



Since there is no continuous attribute in the decision problem belonging to the taxi company (such as price, horsepower, etc.), once I ran the system for a new decision problem scenario which is buying laptops. This problem includes 'price' as a continuous attribute, and it's ranging from $1150 to $2300. Figure 17 demonstrates the individual's utility assessment for the continuous attribute.

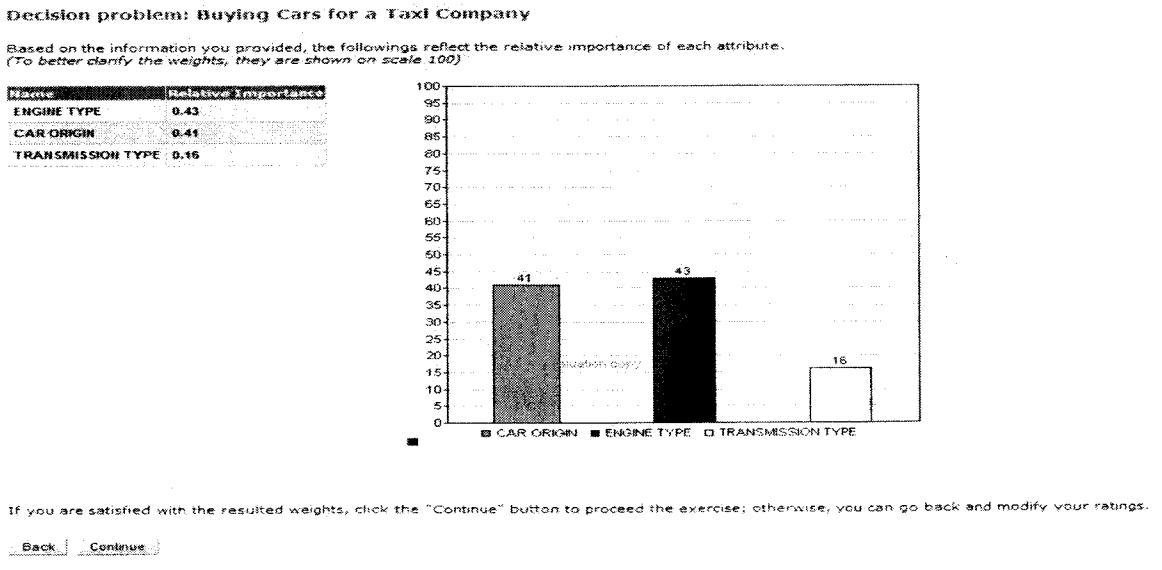
Figure 17 - Assessment of individual utility function for continuous variables



3.2.1.2 Outputs

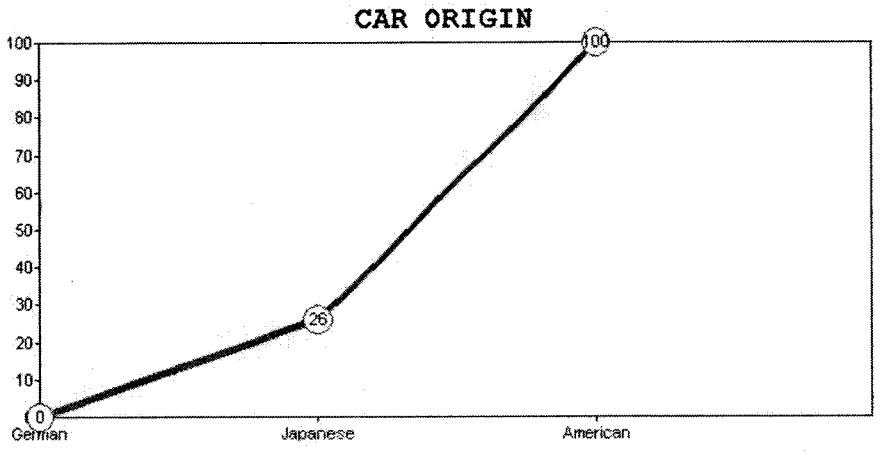
iMade reports relative importance of attributes (regression weights) and the individuals' utility functions. The relative weights, reflecting the importance of the attributes, are provided both in numerical and graphical form as shown in Figure 18:

Figure 18- Attributes' regression weights



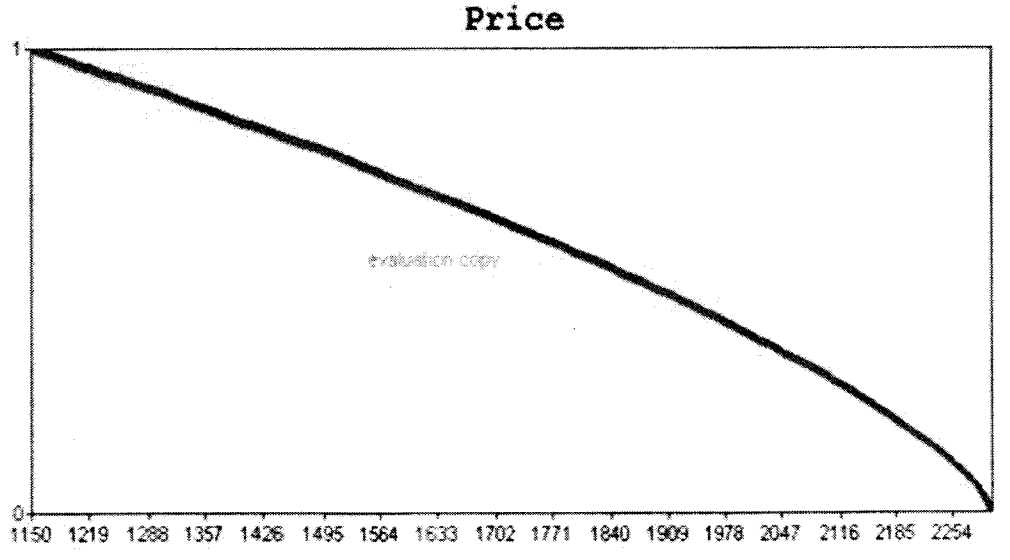
As illustrated in Figure 19 the system also provides a graph of the utility function for each attribute.

Figure 19- A graph of the utility function for the categorical attribute (car origin)



Below, Figure 20 illustrates the utility value for price of laptops, which is a continuous attribute, ranging from 1150 to 2300 dollars. Utilities of 1150$ and 2300$ are 1 and 0 respectively, which absolutely makes sense.

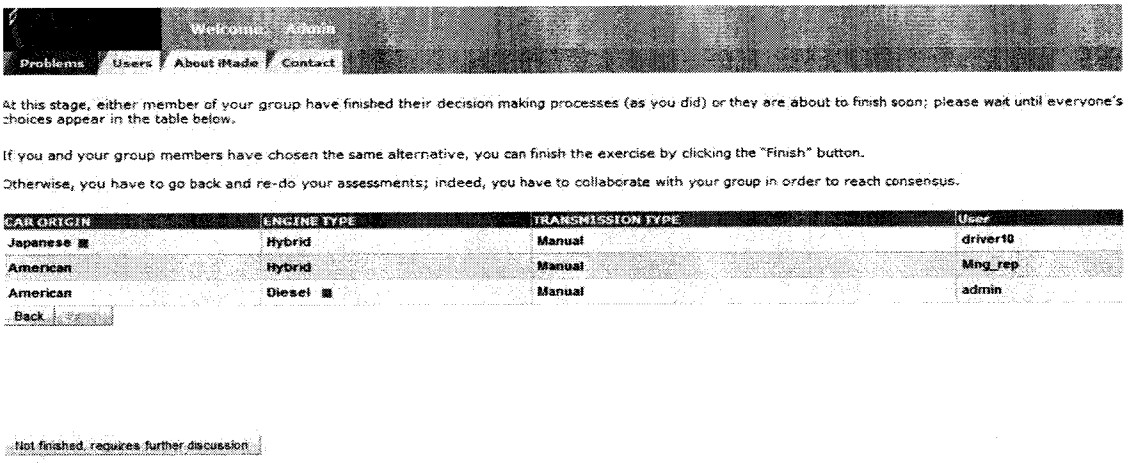
Figure 20- A graph of the utility function for the categorical attribute (price)



The relative weight of this attribute is: 0.3108

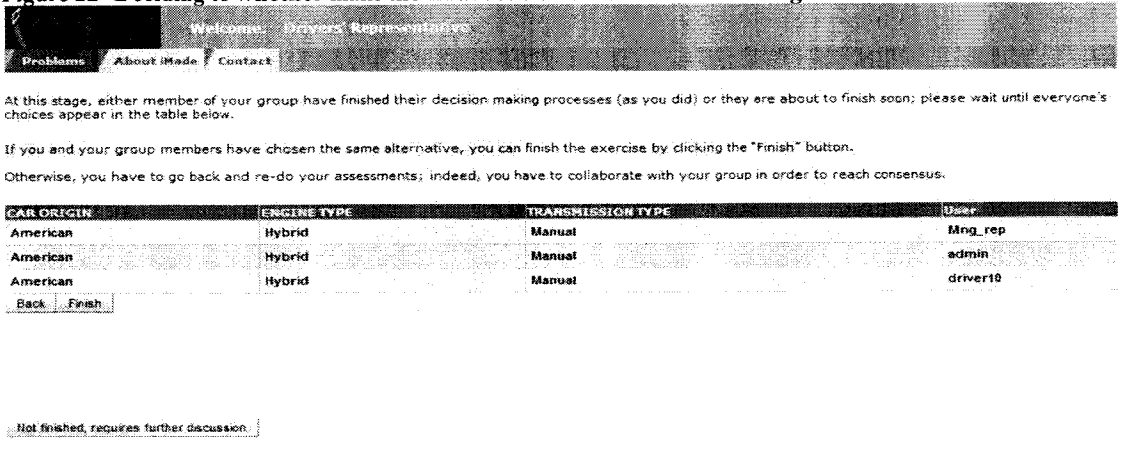
The Final stage of decision making process is when every user has made his own choice and waits for other users to make theirs, as shown in Figure 21.

Figure 21- Waiting for other users to finish their decision making process



Once every user had agreed upon a solution for the problem, the "Finish" button becomes available, and clicking it would save the results in the database and end the exercise. However, if users did not agree on the attributes or did not reach consensus in selecting an alternative, they can press the "Not finished, requires further discussion" button and exit the group decision making process. A screen shot of this is shown in Figure 22.

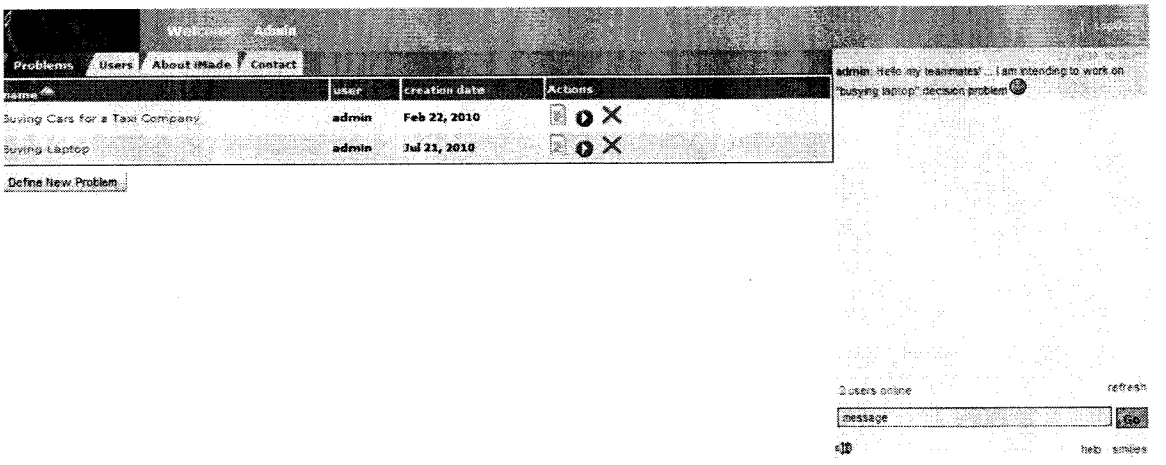
Figure 22- Deciding to whether make the final decision or to continue with negotiation



3.2.1.3 Chat box

In order to provide users the ability to negotiate with one another in real time, a chat box, as illustrated in Figure 23, has been integrated in the iMade interface to let them discuss, in hopes that they will be able to reach a mutually beneficial agreement regarding problem.

Figure 23- Chat box



3.2.2 Adopted Technologies

This project has been implemented as a web application, mainly using Java technologies. In order to enhance the usability of this application, several cutting edge web technologies have been applied to develop such a robust application. This project is a Java EE application (formerly known as J2EE). J2EE is an application development framework developed by Sun Microsystems in order to facilitate developing Enterprise level applications by providing common concerns enterprise applications have including distributed systems, database management, transaction management, and security.

The descriptions of the various technologies and computer languages used over the course of this research are discussed below, in addition to the benefits of using them for this project.

1. Spring

Spring is a framework intended to facilitate developing J2EE applications; indeed, it's a de facto standard which is used by the majority of java developers due to many reasons like simplicity and testability; therefore, wide varieties of applications ranging from small to enterprise levels apply this framework; moreover, using spring framework has enhanced the easiness of accessing to the database, generating dynamic web pages, and implementing business logic. The feature which has mainly contributed to this project is spring's dependency injection which increases the clarity of business logic with lowering the degree of dependencies of the code implementing business logic, to the framework.

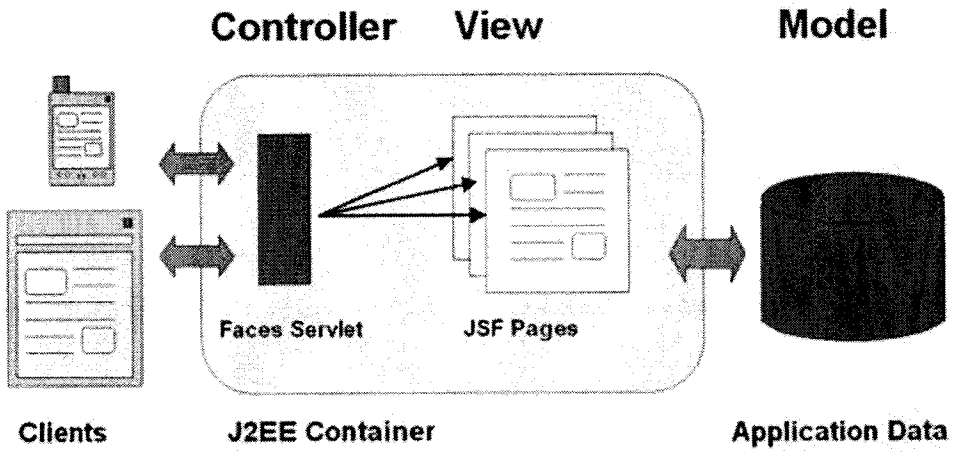
2. Java Server Faces (JSF)

JSF is a specification developed by Sun Microsystems for generating dynamic web pages by applying reusable components. By using a Model-View-Controller design pattern, it provides more efficient approaches for developing dynamic web applications. Since it's a component-based framework, it provides reusability of components developed by 3rd party developers and/or other components in the same project; indeed, this will lead to improve the productivity and consistency of codes.

JSF is just a standard – not an implementation – so an implementation is needed for this specification; currently, there are two major implementations for JSF. One has

been developed by Sun Microsystems and the other one by Apache Foundation called *MyFaces*. In this project, Apache MyFaces is adopted since it has been used by a larger user community which has led to the robustness of this product. In this project, all pages have been generated as JSF pages. Below, the architecture of applications using JSF and the way they interact with clients has been illustrated in Figure 24.

Figure 24- JavaServer faces implementation of MVC (Schalk, 2010)



3. JBoss RichFaces

JSF, since it is a component based framework, it leads to much easier implementation through reusing components and adopting them to JSF based projects.

JBoss RichFaces is a JSF component library which adds *AJAX* features to normal JSF pages. AJAX (Asynchronous JavaScript and XML) is a standard which provides more dynamic web pages by enabling updating of web pages partially. Nowadays, AJAX is used in vast majority of web applications like *Gmail*, *Google Maps,* and *Yahoo Mail.*

Because it enhances the dynamicity of web pages, the web pages which use AJAX are much closer to Rich Desktop Applications, resulting in more user friendly pages. Using AJAX in a web application provides the following achievements:

1. It enhances the usability of a web application comparing to traditional / conventional simple HTML pages
2. Reduces the bandwidth usage of application, which indeed increases the performance of the application in different aspects like reducing the response time and the processing load of the server
3. Improves the user-friendliness of the web page because just modified parts are changing, and the rest remains intact

The below snapshots of the iMade application illustrate the advantages AJAX have brought about in such a way that users can manipulate a dialogue while having the option of observing the remaining parts of the webpage.

For example, when users intend to define various attributes of a problem scenario including categorical and continuous attributes, Ajax assist them to fill out the definition of each attribute without having to navigate into a new page. (Figure 25 and Figure 26)

Figure 25- Modal Panel in RichFaces

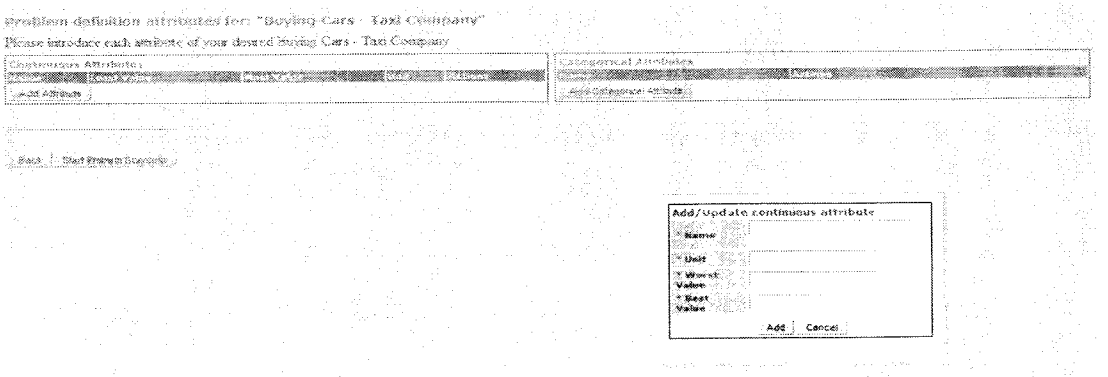
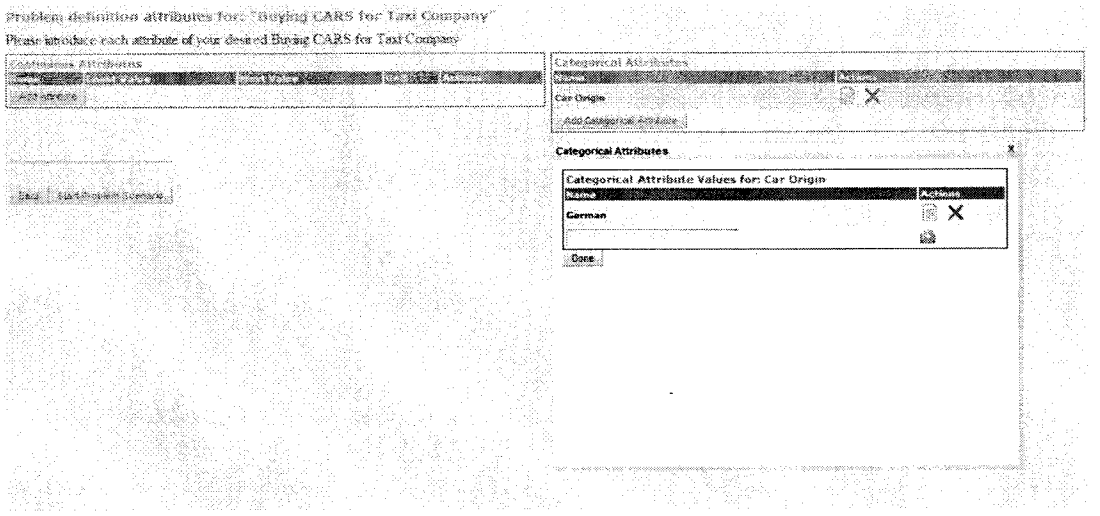


Figure 26- Dynamic Table Record Insertion



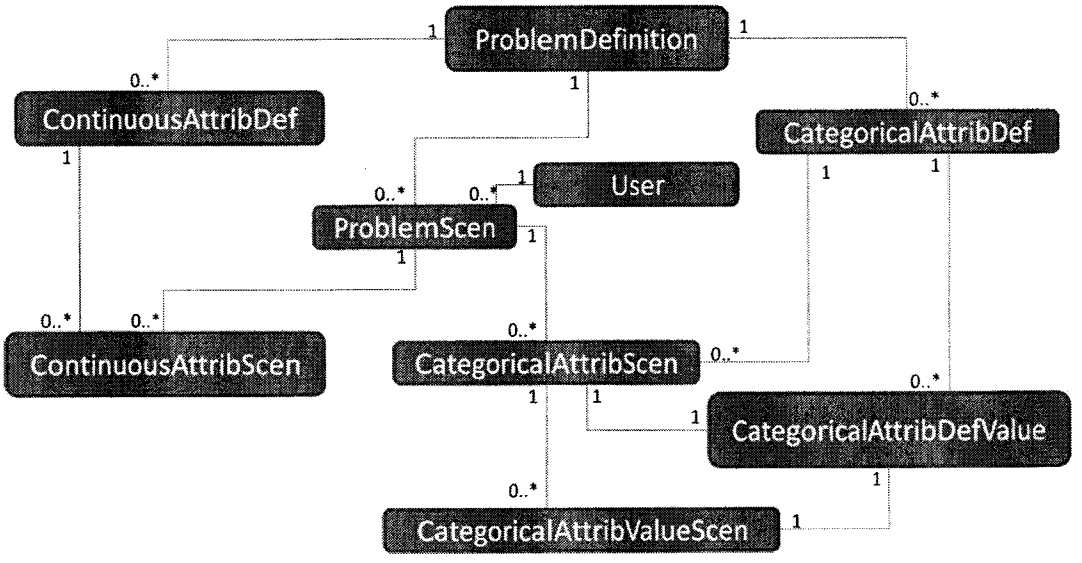
4. Hibernate

Hibernate is a framework that facilitates using databases by adding a layer between business logic and databases. Its main task is to map records in database tables to/from Java classes in the memory. It diminishes the complexities of working with databases including making connections, finding, adding, and removing database records.

Furthermore, as Hibernate is not tightly coupled with any specific database; it means it can be used with almost any commonly used databases.

In Hibernate, the classes which are mapped to database records are called "persistent classes". Each instance of a persistent class is usually mapped to a specific row in a table. The diagram shown in Figure 27 demonstrates the class diagram of persistent classes in this application:

Figure 27- Class Diagram of Persistent Classes



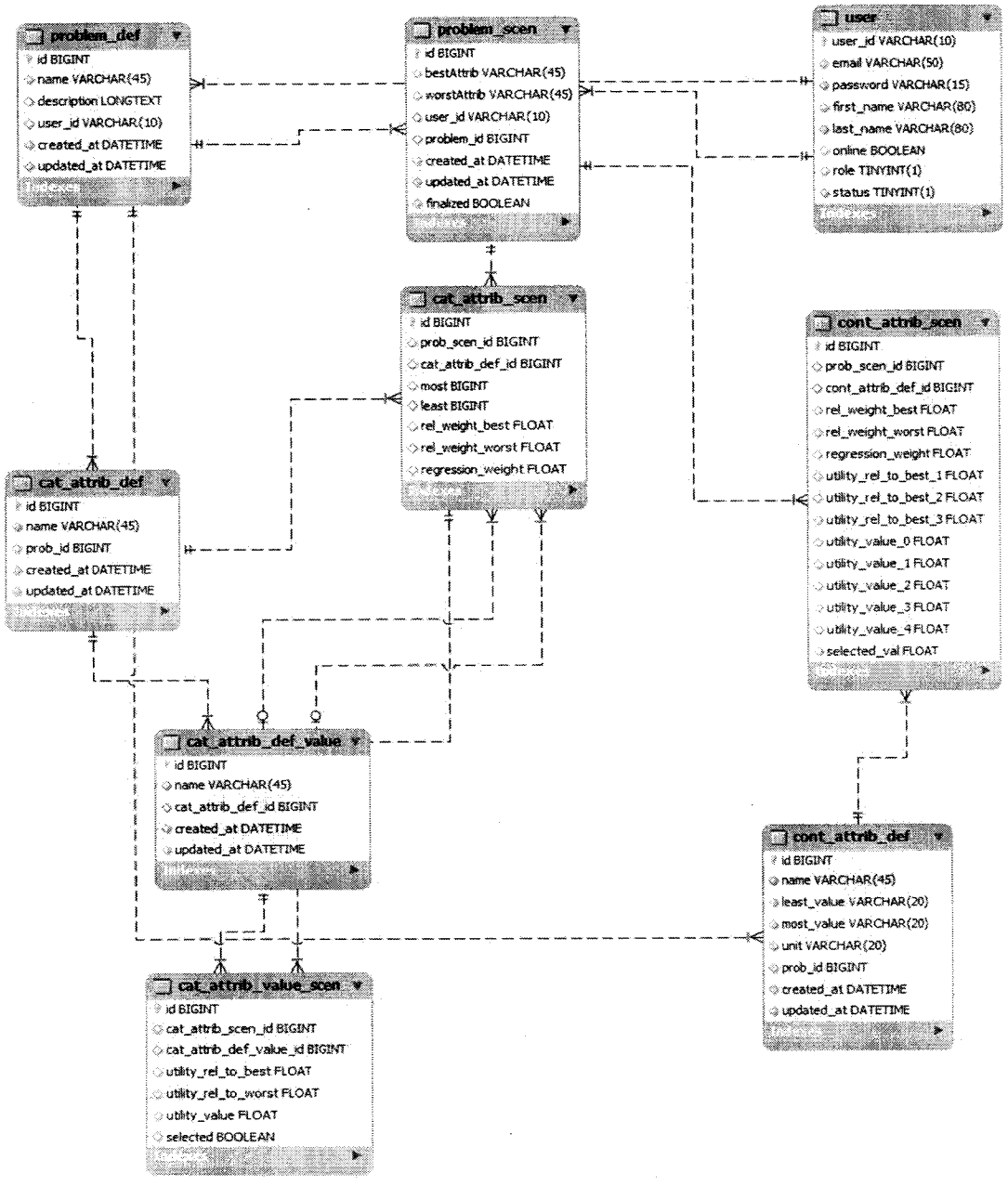
5. Database

In order to be able to keep the users' information, their selected choices and users various rating values, there was a need to adopt a database. In this project, the RDBMS was used to store information. via MySQL 5.0. *MySQL* is a highly regarded, open source database engine that is widely used by such large applications as Wikipedia among others. The entity relationship diagram of database tables is illustrated in Figure 28:

6. Apache Tomcat

Apache Tomcat is a web server which is dominantly used for java web applications. It acts as a server for interpreting and running JSP and Servlet pages; hence, it's capable of showing JavaServer Faces pages. This web server is free and it can be easily used in small to medium size applications.

Figure 28- ERD of Database Tables



7. Java Applet

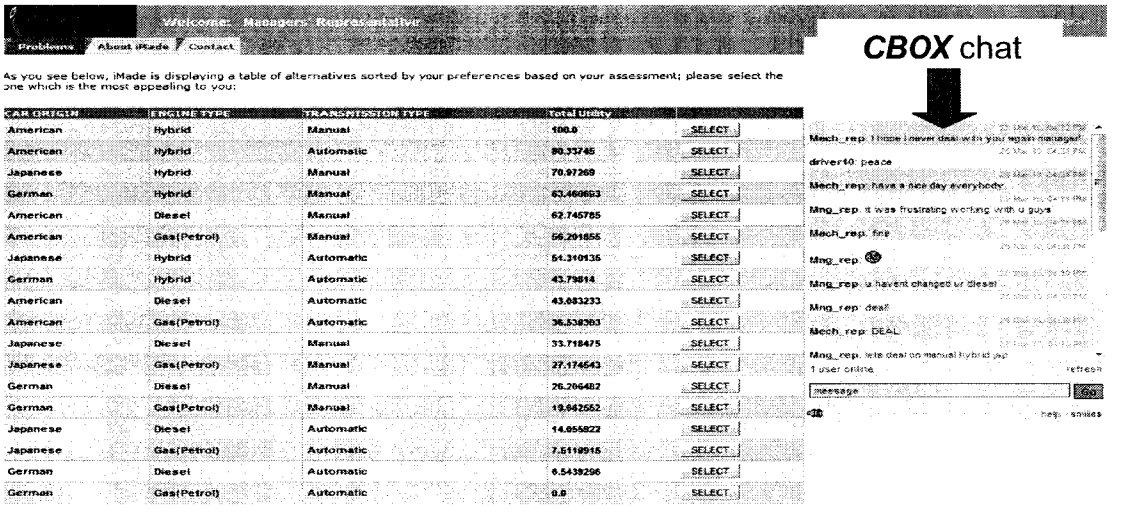
Java Applets are applications which are implemented by Java programming language and can be downloaded and run inside the web browsers. In *iMade,* the diagrams which show the regression weights and utility value have been implemented

through the use of Java Applets. Since these diagrams must be generated at runtime, one of the best methods of doing this is using Java applets. For instance, when a user accomplished his / her assessment for calculating the relative importance of different attributes, an applet would be downloaded into the browser which shows the bar graph of each attributes' relative importance. One of the major contributions of using Java applets in this project was reducing the development time. (Comparing to other solutions for generating graphical information)

8. CBOX – Chat and Messaging Application

In order to provide *iMade* with a group interaction facility, CBOX - which is a ready-to-use chat and messaging application - is embedded into the iMade. A snapshot of this component could be seen in Figure 29. CBOX was chosen over many of the other existing chatting widgets in the market due to based on a variety of areas, these include:

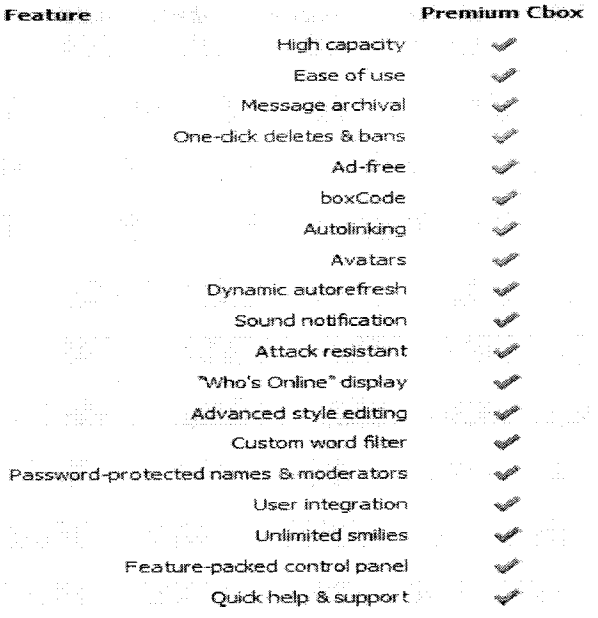
Figure 29- CBOX embedded into iMade



- Perpetual Message History (a backup copy of *every* message / discussions posted)
- Customizability (Colors, Fonts, and many layout options could be modified easily)

- Very easy to use for both users and system developer (integrating user registration of iMade and CBOX was easy, adequate information was provided by CBOX user manual)
- No Java and or flash needed (indeed it requires no plug-ins and it's platform independent)
- Several specific features of CBOX have been listed in Figure 30:

Figure 30- CBOX Features - Adopted from http://cbox.ws/



Feature	Premium Cbox
High capacity	✓
Ease of use	✓
Message archival	✓
One-click deletes & bans	✓
Ad-free	✓
boxCode	✓
Autolinking	✓
Avatars	✓
Dynamic autorefresh	✓
Sound notification	✓
Attack resistant	✓
"Who's Online" display	✓
Advanced style editing	✓
Custom word filter	✓
Password-protected names & moderators	✓
User integration	✓
Unlimited smilies	✓
Feature-packed control panel	✓
Quick help & support	✓

9. R

R (Ihaka and Gentleman 1996) is a free, high quality software environment for statistical computing and graphics. Indeed, R in one of major implementations of the S programming language. However, unlike S-PLUS which is a commercial implementation of S, R is free and supported by contributed packages which are available from the Comprehensive R Archive Network (CRAN) located at http://cran.r-project.org/.

Moreover, R uses a command line interface which is somewhat preferred over GUIs (like SPSS and Minitab) since they are always changing, and of course commands are assumed to be more error-safe. "The basic R system augmented by the contributed packages is arguably the most extensive resource for statistical computing currently available." (Fox and Andersen 2005)

In this project, in order to separate the implementations of statistical algorithms and the coding of web application itself, it was decided that the R software be adopted and embedded into the application. Therefore, since this is an ongoing research, in the future for extending the work in different paths like aggregating group members' preferences (utilities) heuristically, applying non-linear models, etc. there won't be any need for undergoing extensive changes in the application codes. R files will be stored in the library of the application, and by adjusting and facilitating the data transaction between Java and R, the calculated output by R would be accessible effortlessly for further use. In fact, RInterface is a utility java class which takes its input from iMade and passes them through R, and then converts the data which has been assessed by R, and return it back to iMade. In order to make this transaction process feasible, both rJava.dll and r.dll should be placed (copied) into the system32 folder of windows.

In this application, I used R mainly for performing the measurement process for:

- Assessment of relative weight of each attribute with respect to the others [See Appendix 13]
- Assessment of utility (value) of intermediate categories (for categorical attributes); moreover, for continuous variables we measure the utility (values)

for three intermediate points that are between the best and the worst outcomes. [See Appendix 12]

3.2.3 Usability Evaluation

Evaluation of IT-based artefacts is considered as a fundamental component in the design science research process. Hevner and Chatterjee (2010) and Sankar et al. (1995) stated that usability of a decision support system is significantly related to its interface design. iMade was originally developed for assisting people in individual decision making processes; however, after running several preliminary studies with the prior version, it was expanded into a group support system considering applying the required design changes. Before conducting the experimental trials, experts were asked to evaluate the interface of the system at various times during the design process. My expert reviewers consisted of university professors and PhD students, in the field of information systems.

In order to maximize the usability of iMade's interface design for users, several Human Computer Interaction (HCI) methodologies have been followed. Moreover, I have used two usability inspection methods termed "cognitive walkthrough" and "heuristic analysis" in order to evaluate iMade's interface design. Each of these methods is meant to uncover various shortcomings in the system, which combining these two methods of evaluation, has enabled us to minimize the problems and optimize the usability of interface design.

3.2.3.1 Cognitive Walkthrough method

This method is a usability inspection method which evaluates the interface design during the development stage; in fact, walkthrough is really a tool for developing the interface, not for validating it. This evaluation technique focuses mainly on the steps required for a user to perform a task, the decisions a person needs to make at each stage, and the information they need to make each decision properly. In the other word, the designer or other evaluators explore the website themselves (as if users do) in order to identify the existed problems. At the developing stage, by doing cognitive walkthrough analysis, I improved some of shortcomings.

3.2.3.2 Heuristic Analysis method

This method is based on general principles that serve to guide design decisions. In this analysis, "The expert reviewers critique an interface to determine conformance with a short list of design heuristics, such as the eight golden rules." (Shneiderman, 2004) Therefore, I asked several evaluators to evaluate the interface design based on these rules as follows:

The first rule is to provide consistency across several aspects such as: color, fonts, layout, menu formats, clicking buttons, help screens, rating toolbars, and sequence of actions in identical situations. The rule is to optimize the universal usability, so I have considered this system for different categories of people. This system is compatible with different databases, and so on different business areas; thus, the system is meant to fulfill the needs of novice users, knowledgeable intermittent users, and expert frequent users. It must be noted that it is not always possible to satisfy the needs of everyone, however, pains were taken to make it user friendly as possible.

Third, system provides users with informative and constructive feedback. By performing any action, users should see the feedback; for example, by clicking on "Submit" button, users can hear the sound of clicking. Fourth, the interface has been designed in a way not to let users to make errors, and when they mistake, it shows clear error messages; for example, when users want to give rates to the chosen attributes, they cannot enter any number or character in the table. By entering a number or character out of selected range, the system shows the error message mentioning that the entered number should be in a particular range.

The Fifth rule is to provide users with shortcuts in addition to letting them be able to get back to previous pages. To assist with this, the following shortcuts were placed at the top of each page (according to consistency): "Home", "Problems", "Users", "About iMade", "Contact Us", and "Logout". Additionally, one must "Support internal locus of control". Expert users especially, want to have the feeling that they do not only take part as respondents in the system but they also act as initiators. In this system, users will not see too many messages or vague responses, so they can keep up and they can feel themselves in charge of system.

Seventh rule is designing a form of dialogue to show accomplishment of users' tasks; iMade, at its last page, clearly demonstrates a table which has been sorted by high "Utility Value" and mentions that "the items have been sorted based on your preferences". At this page, users can either choose their desired product (based on its utility value) or they can push the "Back" button if they are not satisfied with results. Finally, it is imperative to reduce the short-term memory load of system users, which *iMade* has been designed in a way to fulfill this need as much as possible. As an example,

the beginning of the system presents a range of available features of those particular items. The available products' features have been listed for users, in next pages, in order to prevent them from memorizing or trying to get back to previous pages to remember the provided information.

It must be mentioned that many coding bugs and problematic interface design issues were identified during the system testing period. Many of these have been fixed; however, this application has not reached a stage in its development where it is ready for commercial use. Doing so would require more tests with various problem scenarios should be run on the application to ensure the usability and functionality of the system.

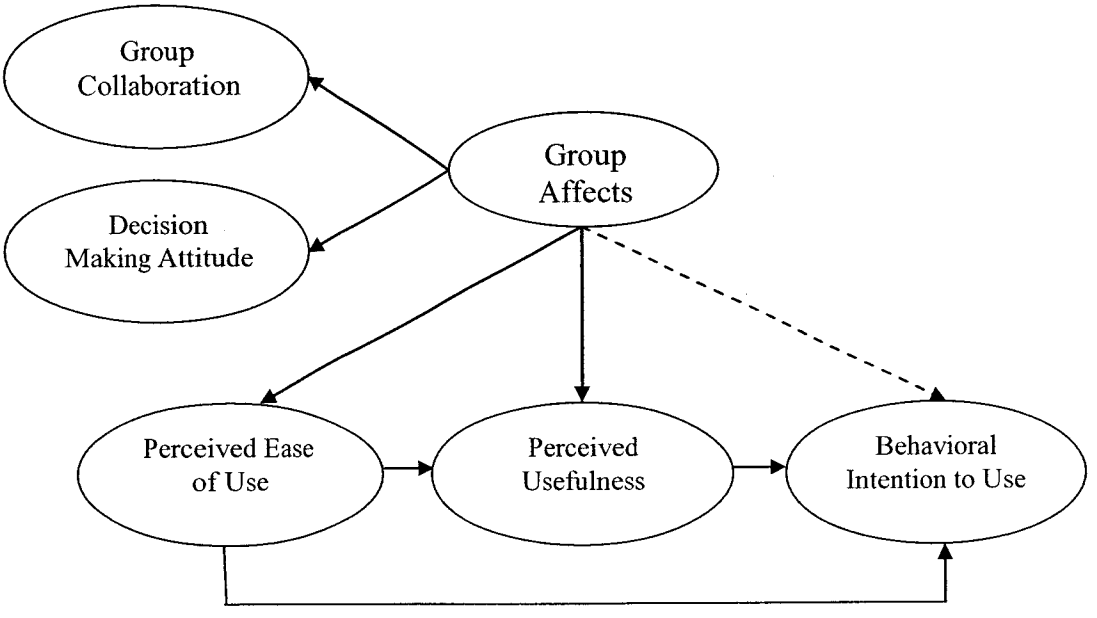
4 Research Methodology

This section provides an overview of the research model and the conducted laboratory experiment for this research. First, research model and hypothesis are elaborated. This section continues with a brief description of the study sample, followed by an explanation of the design of the experiment, the measures used for the assessment of the variables and the procedure for performing data collection. Construct validities and reliabilities are also tested and the results are documented in Table 3:

4.1 Research Model and Hypotheses

The research model of this thesis study is illustrated as below:

Figure 31 - Research Model



This empirical study is to validate following six hypotheses:

Research Hypothesis:

H1: Members of groups receiving negative feelings perceive the system less useful compare to the ones with positive feelings.

H2: Members of groups receiving negative feelings perceive the system less easy compare to the ones with positive feelings.

H3: Members of groups receiving negative feelings intend to use the system in future less than the ones with positive feelings.

H4: Group affects has a positive influence on users assessment of the perceived usefulness of the iMade system.

H5: Group affects has a positive influence on users assessment of perceived ease of use of the iMade.

H6: Group affects has a positive direct influence on users intention to use the iMade system.

4.2 The Sample

The studied sample consisted of 30 undergraduate students from a large Canadian University (17 Female and 13 Male). 76.7% of participants were between the age of 18 to 25(16.7 % between 26 and 30, and 6.7 % were 30+). All but 3 of participants had no prior experience working with decision support systems. However, it must be said that only 10% of subjects admitted that they were truly comfortable with this type of system.

4.3 Experimental Design

Thirty experiments fitting a two-way factorial design were conducted. Each experiment consisted of three people with two of the group members (here called John and Marco) acting as confederates of experimenter. Both (JOHN and MARCO)

participated in each of the 30 experiments. The experimenters were asked to create a positive or negative environment to foster the particular emotional affect depending on whether the participant was in the positive or negative affected group. The way in which they worked towards creating this environment was through the use of certain words or phrases in their communications.[1] The third member was the subject (actual participant) of the experiment who represented randomly one of the three groups of stakeholders pertaining to the scenario (managers, technicians and drivers). The design of the experiment is depicted in Table 2.

Table 2 - Balanced Design of the Experiment

Mood State / Role	Positive	Negative
Manager	John*: Mechanic, Marco**: Driver Users: 1st, 7th, 13th, 19th, 25th	John: Driver, Marco: Mechanic Users:2nd, 8th, 14th, 20th, 26th
Mechanic	John: Manager, Marco: Driver Users: 3rd, 9th, 15th, 21st, 27th	John: Driver, Marco: Manager Users: 4th, 10th, 16th, 22nd, 28th
Driver	John: Manager, Marco: Mechanic Users: 5th, 11th, 17th, 23rd, 29th	John: Mechanic, Marco: Manager Users: 6th, 12th, 18th, 24th, 30th

John: Experimenter 1
Marco: Experimenter 2

4.4 Variables and Measures

All items used to measure the constructs of the model are adopted from previous studies. Some of the measures however were modified and adapted to be appropriate for the special context of my study. All constructs mentioned below are documented in Table 3.

[1] These two experimenters were management graduate students at the John Molson School of Business. Part of their participation in the study consisted of three training sessions, in addition to conducting several preliminary experimental tests.

Perceived Ease of Use **(PEOU)**, in the literature has been defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). The standard items for measuring this construct are adopted from a questionnaire developed by Davis' (1989). Some of the wording was changed to adapt the items to the research context. Upon completion of the experiment the measures' reliabilities were re-tested; the results of these analyses are provided in Table 3.

Perceived Usefulness **(PU)** has been conceptualized as the degree to which the user believes that employing the system enhances his or her performance. (Davis, 1989). Standard items for assessment of this variable were obtained from Venkatesh and Davis (2000) and minor changes were made to adapt to the current experiment. An example of this would be how the original scale would discuss the usefulness of a 'job' which was changed to 'decision making' to fit the current research context.

Behavioral Intention to Use **(PI)** iMade System is defined as the degree to which a person will consider the possibility of using the iMade system in the foreseeable future to aid them in solving problems.(Venkatesh and Davis, 2000) These standard items adopted from Johnson, A. Schwarz, and Chin (2008) and Venkatesh and Davis (2000)
As shown in the research model (Figure 31), the two constructs "*group collaboration*" and "*decision making attitude*", together form the construct of group *affects*, which influences perceived ease of use and perceived usefulness of the system.

Group Affects **(GA)** is conceptualized as the user's experience during the course of the group decision making process (Etezadi-Amoli and Kersten, 2008). Group affects is defined as the positive and negative feelings that a member leaves with as a result of his or her participation in the group.

Group Members Collaboration **(GMC)** defined as the evaluation of group members regarding their collaboration and ***Group Members Decision Making Attitude*** defined as the evaluation of group members regarding their decision making attitude are constructs obtained from Etezadi-Amoli and Kersten (2008). They used these constructs to study the evaluation of the negotiation system influenced by affective aspects of the users' experience with their counterparts in using Inspire which is an electronic negotiation system (Etezadi-Amoli and Kersten, 2008).

Due to having spent tremendous effort in setting up such experiment trials, in addition to the research model constructs, additional data collected for measuring more variables to be used for future research. [See Appendix 2]

4.5 Mood Manipulation

At the beginning of each experiment, one of the two experimenters would begin by making an offer that would best suit their group. An example of this would be automatic transmissions for the driver as they were one of the most important concessions for their group. They would also make sure that they were using as many positive / negative comments as possible towards the other members of the group. This was expected to create either a collaborative or competitive environment while, at the same time, inducing positive or negative feeling about the group members from the standpoint of the subject. By inducing negative mood we simply mean existence of high disagreeableness in the group, selfishness, and absence of team work. The two experimenters would discuss the issue with the subject / participant using some of the already prepared terms when there is a disagreement with the proposed solution.

Table 3 - Research Model Constructs

Construct	Items	Scales
Perceived Ease of Use (Venkatesh and Davis 2000) α =.79	I could clearly interact with the system	1 - Strongly Disagree 7 - Strongly Agree
	Interacting with the system did not require a lot of my mental effort	1 - Strongly Disagree 7 - Strongly Agree
	I found the system to be easy to use	1 - Strongly Disagree 7 - Strongly Agree
	I found it easy to use iMade for group decision	1 - Strongly Disagree 7 - Strongly Agree
	Becoming skillful at using the system was easy	1 - Strongly Disagree 7 - Strongly Agree
Perceived Usefulness (Venkatesh and Davis 2000) α =.78	Using the system improved my performance in making decision	1 - Strongly Disagree 7 - Strongly Agree
	Using the system enabled me to make decision more quickly	1 - Strongly Disagree 7 - Strongly Agree
	Using the system enhanced my effectiveness in making decision	1 - Strongly Disagree 7 - Strongly Agree
	I find the system to be useful in decision making	1 - Strongly Disagree 7 - Strongly Agree
Behavioral Intention to Use iMade (N. Johnson et al., 2008) α =.89	Assuming I have access to the system, I intend to use it in future	1 - Strongly Disagree 7 - Strongly Agree
	If the choice of an online decision support platform were up to me, it would likely be iMade	1 - Strongly Disagree 7 - Strongly Agree
	If I need to make group decisions and the choice was up to me, I would use iMade as a decision system	1 - Strongly Disagree 7 - Strongly Agree
	If asked, I would likely recommend iMade as a decision support system	1 - Strongly Disagree 7 - Strongly Agree
	For future group decision making tasks that are totally within my control, I would probably use iMade as a group decision making system.	1 - Strongly Disagree 7 - Strongly Agree
Group Collaboration (Etezadi and Kersten , 2008) α =.94	Cooperative Vs. Uncooperative (Self Interested)	1 - Cooperative 7 - Self Interested
	Fair Vs. Unfair	1 - Fair 7 - Unfair
	Flexible Vs. Non-Flexible	1 - Flexible 7 - Unflexible
	Kind Vs. Unkind	1 - Kind 7 - Unkind
	Likeable Vs. Unlikable	1 – Likable 7 - Unlikable
	Very Friendly Vs. Very Hostile	1 - Very Friendly 7 - Very Hostile
Decision Making Attitude (Etezadi and Kersten, 2008) α =.89	Irrational Vs. Rational	1 - Irrational 7 - Rational
	Unreliable Vs. Reliable	1 - Unreliable 7 - Reliable
	Untrustworthy Vs. Trustworthy	1 - Untrustworthy 7 - Trustworthy

Note also that such a disagreement and exchange of words might have happened only between the two experimenters. The experimenters derived these positive and negative affect phrases from the same list during each of the discussions. At the end of the experiment and the administration of the questionnaire, the subjects were debriefed and compensated in an effort to make sure that they left the experiment in a positive frame of mind.

4.6 Group decision making task description (Problem Scenario)

To develop a proper problem scenario for the experiment, several decision-making problems are reviewed by experts, from InterNeg Research Center which is specialized in generating problem scenarios and conducting experiments for e-negotiations & group decision support systems.

First, a scenario was generated in order to find the best software solution for a task force in a large hospital composed of doctors, nurses, and administration offices. to automate various activities of the hospital. However, after running a pilot test, we notice that students could not execute the experiment properly because of being unfamiliar with the specific terms in the health care industry.

Afterward, we copnsidered an existing problem scenario in the InterNeg research center on the subject of a famous singer who was reluctantly decided to sign a contract with a major entertainment agency. She was concerned with four major attributes: Number of new songs (introduced and performed each year), Royalties for CDs (in percent), Contract signing bonus (in dollars), and Number of promotional concerts (per

year, for 1,000 or more people each). The major problem with this scenario for fitting into this study was unfeasibility of assigning different roles to the group members.

The major criteria that we considered in choosing the group decision-making task, and generating its specific scenario respectively, are listed below:

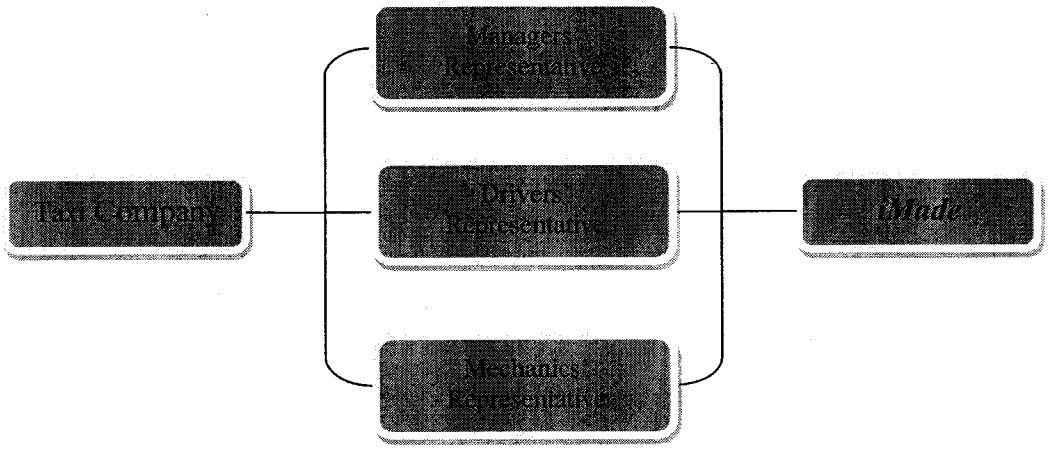
First, generating a simple scenario that is conceivable and doable by undergraduate students. Second, the decision making attributes should have conflicting attributes in a sense that on one hand group members be able to hold a reasonable discussion in negotiation for their preferred choices of attributes and on the other hand, these attributes should not be highly correlated with each other in a fashion that selection of an attribute does not discard selection of any other attribute. And lastly, the importance of assigning specific roles to group members for decision making has been pointed out in the GDSS literature quite a lot.

So in order to study the effect of group interactions and users' behavior toward each other on individuals' perceptions of the system, we generated a problem scenario for buying cars for a Toronto-based taxi company. As part of the scenario, it is assumed that there are three members on the board of a taxi company, each being represented by one of the group members. Participants were then told that the company is intending to buy 500 cars to add to or replace some of Taxi Company's existing fleet. The three groups of stakeholders had to decide together on the type of car to be purchased; of course, each of stakeholders had different interests which made attaining a mutually beneficial outcome difficult. The three positions are as follows:

- *Management representative:* responsible for budgetary planning and getting the best return on investment.

- *Drivers' representative*: concerned with the drivers' desired preferences such as their safety and comfort.
- *Service technicians and mechanics' representative:* concerned with having cars that can be easily fixed and the availability of spare parts in the market.

Figure 32- Taxi Company's Stakeholders using iMade adapted from Bui (1987)



4.7 Procedure

First, participants were provided with a 15 minutes session of training of working with the system as not one participant had any previous experience in working with iMade. Then, all subjects were asked to complete a short questionnaire which is called *problem solving task* (please see appendix 4, 5, and 6). This task consisted of two major areas: a m*ath problem solving section* and an *alphabetizing word sections*. The intention of this task was to neutralize the subject's mood before they participated in the experiment. These exercises are known to be helpful in removing any mood differences among participants resulted by extraneous factors. (Kim, Park, and Schwarz, 2009; Wegener, Petty, and Smith, 1995)

Afterward participants were asked to fill out the pre-questionnaire with some demographic questions and questions pertaining to whether they have prior experience in working with any decision support systems (in general) or not. Upon completion, subjects began using the group decision support system (iMade) in order to identify their most desirable attribute among the three attributes: origin of automobile, transmission and engine type. Each user would rate the importance of their desired attributes regardless of applying and considering other members preferences.

Participants were asked to take part in an initial decision making process where they would decide what they considered to be their best alternatives. After they were finished and they had selecting their most desirable type of the taxi fleet, they were asked to wait for their other two group members to finish their decision making process and begin the negotiation once all three members showed up on the chat screen. At this stage, members were told to discuss their desired preferences with the rest of the group, and trying to persuade each other to reach mutually beneficial outcome.

In order to control better the experiment and increase uniformity in treatment of subjects, the experimenters were each given a package of snapshots pertaining to each stakeholder they had to follow in order to accomplish the decision making process. As such, the experimenters knew, for the most part, what the most likely initial offer would be ahead of time and could adapt their negotiations accordingly. This also served to extend or cut short discussions depending on how the discussions went.

5 Findings

This section describes the results of the data analysis performed on the research's data set.

5.1 Data cleaning

As the initial step in the data analysis process, I first examined the data set to see how respondents filled out the questionnaires. Respondent number 23 did not understand or fallow the procedure properly. His responses were identified as an extreme outlier on a number of measures and were thus removed from the data set. Descriptive analysis of the remaining data set is shown in Table 4.

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5.2 Reliability Results

Although all the measures were adopted from previous studies, I conducted reliability (consistency) tests to ensure that the measures are consistent and reliable in the context of my study. The results are also shown in the Table 3 as follows:

Cronbach's Alpha (Internal Consistency) for "Perceived Ease of Use" = **0.79**

Cronbach's Alpha (Internal Consistency) for "Perceived Usefulness" = **0.78**

Cronbach's Alpha (Internal Consistency) for "Behavioral Intention to Use iMade System" = **0.89**

Cronbach's Alpha (Internal Consistency) for "Decision Making Attitude" = **0.89**

Cronbach's Alpha (Internal Consistency) for "Group Members Collaboration" = **0.94**

Table 4- Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
PUT	29	14.00	28.00	21.8276	3.98272	15.862
PIT	29	16.00	35.00	27.9655	4.93155	24.320
GAT	29	22.00	57.00	40.3448	9.33991	87.234
PEOUT	29	24.00	35.00	30.9310	3.28341	10.781
GMCT	29	11.00	42.00	27.6897	8.62349	74.365
MDMAT	29	8.00	16.00	12.6552	2.05767	4.234
GDMST	29	17.00	35.00	25.5862	5.10264	26.037
EOGT	29	3.00	21.00	15.4828	4.37216	19.116
MOOD_P_T	29	10.00	28.00	19.3103	4.48094	20.079
R_MOOD_N_T	29	16.00	35.00	29.2414	6.11003	37.333
PARTICIPANT_UTILITY	29	7.19	84.14	47.8810	16.97783	288.247
EXP_UTIL_T	29	107.90	176.69	140.8393	15.51640	240.759
Valid N (listwise)	29					

5.3 Results of ANOVA

Table 5 presents the effect of subjects' assumed role and mood on their assessment of perceived usefulness of the system. From this table we note that quality of interaction within the group (positive or negative), create positive or negative feelings in the subjects (mood) that significantly affect their evaluation of the system's usefulness.

The mean score of perceived usefulness for groups that felt negative feelings towards their team members were significantly lower than teams with positive feelings towards their colleagues (19.90 versus 24.14).

Neither the participant's role nor its interaction with group members' feeling state had a significant impact on the users' evaluation of the system's usefulness.

No significant effect, however, was found between the variables of "perceived ease of use" and "intention to use" when they were used as the dependent variables.

Table 5- ANOVA Results

Dependent Variable:PUT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Mood_State (Positive/Negative Affect)	147.968	1	147.968	13.336	.001
Exp_Role	33.112	2	16.556	1.492	.246
Exp_Role * Mood_Stat	11.050	2	5.525	.498	.614
Error	255.200	23	11.096		
Total	14261.000	29			

a. R Squared = .425 (Adjusted R Squared = .300)

5.4 Hypotheses' Results

Figure 33 presents the results derived from a path analysis. Measures of the underlying factors were formed by summing up indicators of the corresponding factors. Indicators of the constructs "group collaboration" and "decision making attitude" were combined together to form the measurement of "group affects".

Using the EQS program, the path from "Group Affects" to both "Perceived Ease of Use" and "Perceived Usefulness" were found to be significant ($\alpha < 0.05$). As expected the paths from "Perceived Usefulness" and "Perceived Ease of Use" to "Intention to Use" were also significant. However, the path from "Perceived Ease of Use" to "Perceived Usefulness" was not found to be significant when the factor "Group Affects" was present in the model. Similar results were garnered when the measures of the two factors "Perceived Ease of Use" and "Perceived Usefulness" were replaced in the model with

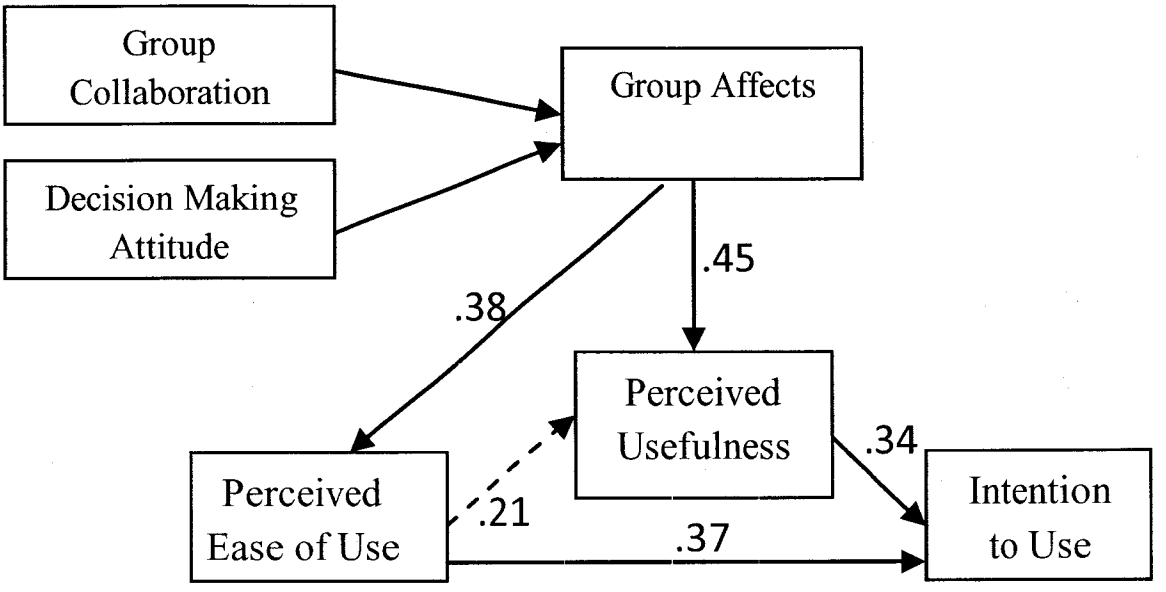
"Ease of Use of General" and "Satisfaction with Outcome" as defined in appendix 2. The standardized path coefficients are reported in figure 33. It is important to note that for the blow path model, nearly 31% of the variation in "Perceived Usefulness" is explained. If the construct of "Group Affects" is removed from this model and fit a basic TAM model, the explained variation in "Perceived Usefulness" will reduce to 14.1%.

It is worth pointing out that we got the similar results with PLS because the analysis was done by measured variables rather than latent variable (see Appendix 21). Indeed, all constructs have been analysed as observed variables however, they are conceptually latent variables

Table 6 - Hypotheses Testing

Hypotheses	**Findings**
H1: Members of groups receiving negative feelings perceive the system less useful compare to the ones with positive feelings.	Supported
H2: Members of groups receiving negative feelings perceive the system less easy compare to the ones with positive feelings.	Not Supported
H3: Members of groups receiving negative feelings intend to use the system in future less than the ones with positive feelings.	Not Supported
H4: Group affects has a positive influence on users assessment of the perceived usefulness of the iMade system.	Supported
H5: Group affects has a positive influence on users assessment of perceived ease of use of the iMade.	Supported
H6: Group affects has a positive direct influence on users intention to use the iMade system.	Not Supported

Figure 33 - Path Analysis



6 Conclusion and Potential Future Research

The results of this study showed affect as a key determinant of user's assessment of a new group decision support system; indeed, our findings have several important theoretical and practical implications.

From a practical point of view, this study has brought about several insightful implications for managers and practitioners in general. Firstly, managers should differentiate among group decision support systems (or negotiation systems) and other expert systems because unlike many other information systems, GDSS and NS have components in social as well as individual interactions. Indeed, in these specific systems, users (employees or members of the board) interact with each other to promote a specific agenda. Sometimes organizations devote tremendous efforts and allocate large amount of budget in adopting very high-end business intelligence or expert systems (like GDSSs, ERPs, etc.), but they neglect such vital social factor.

Second, IT acquirers or IT designers should evaluate information systems (by acquiring different evaluation methods) to enhance ease of use or usability of IT-based artifacts in addition to their usefulness or functionality to assure that technology efficiently carries out what users are aiming for.

From a theoretical point of view, upon final analysis of the experimental data, there is strong support for the proposed model. As such, the importance of affect on assessment of GDSS and its effects on decision-making is clearly demonstrated. The user's assessment of usefulness of a GDSS is highly influenced by the style of interaction demonstrated by other members of the group. When affect is perceived to be positive, demonstrated by member cooperation and relations are perceived to be friendly and

collegial, the user's perceived evaluation of the system usefulness was significantly higher than groups where participants were seen as competitive and unfriendly. Therefore, prior to implementing existing models of acceptance, adoption or use to GDSS, it is important that they are modified to incorporate both cognitive and affective components of the decision-making process. In fact, this study suggests that having such behavioral interaction (among decision makers) under managerial control would shape group members perceptions toward using the system which will result in using the system and possible success of the system.

The results from this thesis introduce many directions for future research. In future studies, partial agreement or partial consensus among group members could be considered as well. In current version, all members should agree on all problem scenarios' attributes in order to accomplish the group decision making process; however, reviewing the transcripts reveals that at some stages during decision making process they had agreed on a portion of attributes but due to the fact that members were supposed to reach consensus eventually, they ended up accomplishing the decision making process without having the attributes agreed initially.

Furthermore, there are many studies which have proposed group utility functions for aggregation of individual preferences; therefore, using R would facilitate applying them into the existing system and it is worth testing the new systems with the proposed research model.

Another potential future research related to this study would be studying the impact of group affect on the decision quality and performance of the group members with using iMade. As already briefly demonstrated in the group decision making

literature review, decision quality, and generally the performance of the process of group decision making have been assessed by different parameters and methods, so the below information that have been extracted from this study can be used for further research; besides, all transcripts of participants in the process of negotiation and decision making task have been recorded which can be reviewed carefully to be used for qualitative studies.

The following appendices contain the additional information collected through conducted experimental trials:

- Appendix 14 displays a table for participants experimental results including their roles, time to decision, agreed alternative, gender, and attained utility.
- Appendix 16demonstrates the regression analysis of the (moderating) effect of gender on the proposed model
- Appendix 17 illustrates the relationship between subjects' gender and the duration (time to decision) of their decision making process
- Appendix 20 demonstrates a table for comparison of representatives of each group (managers, mechanics, and drivers) based on their achieved utility.

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Appendices

Appendix 1 - Experimenters Disagreement Terms

Positive/Neutral (disagree)	Negative (disagree)
Yes, that is a good choice but...	That's not going to happen...
I also like that one but I think/I prefer...	That's totally unacceptable...
That's definitely a possibility...	That's a ridiculous choice...
That's sensible...	That doesn't make any sense...
That's an interesting choice...	That's just stupid...
What about...	Don't be foolish...
That's logical...but,	You obviously haven't considered the options properly...
You've clearly considered the options carefully...but,	No, I don't want/like...

Appendix 2 – Additional Constructs

- ***Mood*** is known as an affective state which is subconscious, enduring, and with a relatively low intensity that has no significant antecedent cause. (Forgas, 2006). Mood was measured using an adapted scale of items from (Yardley and Rice, 1991) who already adapted their measures from the affect scale provided by (Diener and Emmons, 1984). This scale contains 9 items: five negative emotional items (MOOD_N) including: unhappy, frustrated, depressed, angry, and worried/anxious. Moreover, it includes four positive items (MOOD_P): happy, pleased, joyful, and enjoyment/fun.

- ***Group Decision Making Satisfaction*** **(GDMS)** which is indeed indicating group members satisfaction with outcome of group decision making process; the standard items for this construct was also adopted from Etezadi-Amoli and Kersten (2008).
- ***Perceived Ease of Use of General*** **(EOG)** refers to the degree to which that subjects believe that using system features is free of effort; this is based on the study conducted by (Etezadi, G. Kersten, Chen, & Vetschera, n.d.; G. E Kersten, Etezadi, Chen, & Vetschera, 2007) indicating that easiness o using a system can be measured in two major dimensions: analytical and the whole system. The measures for conducting this constructed has been adapted from Etezadi-Amoli and Kersten (2008).

- ***Subject's Utility*** **(Participant_Utility)** refers to subject's total utility (final utility) of the agreed alternative.
- ***Experiment's Utility*** **(EXP_UTIL_T)** refers to total utility obtained by people attending per trial; In other words, it represents subject's total utility of the agreed alternative plus two experimenters' utility.

Appendix 3 - Construct Validity for Additional Variables

Construct	Items	Scales
Ease of use of general (Etezadi and Kersten , 2008) **α =.82**	How easy or difficult was to assign weights to the different attributes?	1 - Extremely easy 7 - Extremely difficult
	How easy or difficult was to exchange messages?	1 - Extremely easy 7 - Extremely difficult
	How easy or difficult was to rate each alternative's utility?	1 - Extremely easy 7 - Extremely difficult
Group Decision Making Satisfaction (Satisfaction with Outcome) (Etezadi-Amoli and Kersten , 2008) **α =.81**	I am quite satisfied with the outcome	1 - Strongly Disagree 7 - Strongly Agree
	The outcome of the decision making process matches my expectation before using the system	1 - Strongly Disagree 7 - Strongly Agree
	How much control did you have over the group decision making process?	1 - Very Much in Control 7 - Not at all in Control
	Did the outcome of the group decision match with your expectation before you began your group discussion?	1 - Completely 7 - Not at all
	How satisfied are you with your performance as a decision-maker in this exercise?	1 - Extremely Satisfied 7 - Extremely Unsatisfied
Positive Mood (Yardley and Rice, 1991) **α =.82**	Indicate to what extent you feel this happy right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much
	Indicate to what extent you feel joyful right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much
	Indicate to what extent you feel pleased right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much
	Indicate to what extent you feel enjoyment / fun right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much
Negative Mood (Yardley and Rice, 1991) **α =.87**	Indicate to what extent you feel depressed right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much
	Indicate to what extent you feel frustrated right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much
	Indicate to what extent you feel unhappy right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much
	Indicate to what extent you feel angry right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much
	Indicate to what extent you feel worried / anxious right now, that is, at the present moment.	1 - Not at all 7 - Extremely Much

Appendix 4 - Problem Scenario for Managers' Representative

A unionized Taxi Company in Toronto is planning to buy 500 cars to add to or replace some of its existing fleet. Three groups of stakeholders shall decide together on the type of car to be purchased.

- **MANAGEMENT REPRESENTATIVE** - mainly responsible on behalf of the union for budgetary planning, financial advice and nontechnical support.
- **DRIVERS' REPRESENTATIVE** – concerned with the drivers' desired preferences such as their safety and comfort.
- **SERVICE TECHNICIANS AND MECHANICS REPRESENTATIVE** - mainly concerned with having cars that can be easily fixed and in the availability of spare parts in the market.

YOUR RESPONSIBILITY

In this experiment, you as a member of this task force are representing "**Managers**". Thus, you are expected to discuss preferences of **managers** with the other members, and come up with the best possible choice of car for **managers**. Your preferences as representative of Managers are very important, but every member has his/her own desired preferences. Thus, you need to work with each other in order to reach a consensus and accomplish this group decision making task.[2] It is important to mention that due to Taxi Company's very large order, the manufacturer may customize the cars.

ATTRIBUTES

The list below describes the three major attributes that need to be discussed. Remember that there should be a trade off in selection of attributes; in fact, because of the company's limited budget, it's impossible to choose all highly priced features at the same time.

---

[2] Group members have no privileges toward each other; indeed, all group members have equal power and right in voting for their desired car. [Everyone is equal!]

CAR ORIGIN

- **German**
  - Expensive by itself also requiring more maintenance than Japanese and American cars and the parts are expensive (Not preferred by management[3]).
- **Japanese**
  - Relatively expensive (May not be preferred by managers).
- **American**
  - American cars are the least expensive; the cheapest to repair and parts are readily available. (Managers love them).

ENGINE TYPE

- **Gas (Petrol)**
  - Gas is expensive and is a pollutant (Not desired by managers).
- **Diesel**
  - Diesel is more fuel efficient, however, diesel engines are more expensive than gas engines (May not be preferred by managers).
- **Hybrid Power**
  - Hybrid cars are environmentally friendly, very fuel efficient and also improving image of the company (Desired by managers).

TRANSMISSION TYPE

- **Manual Transmission**
  - Lower base price, repair, and maintenance costs; besides, cars with manual transmission usually offer higher gas mileage (Desired by managers).
- **Automatic Transmission**
  - Expensive base price (Not desired by managers).

---

[3] Management realizes that the company has to cut costs substantially. This includes getting less expensive cars but also cars that do not break down and do not require much servicing. Indeed, they prefer economical cars.

Summary of Managers' Preferences

Major preferences of your work group have been illustrated as follows:

Attributes / Role	Car Origin			Fuel Type			Transmission Type	
	German	Japanese	American	Gas Petrol	Diesel	Hybrid	Manual	Automatic
Managers			✓			✓	✓	

Appendix 5 - Problem Scenario for Mechanics' Representative

A unionized Taxi Company in Toronto is planning to buy 500 cars to add to or replace some of its existing fleet. Three groups of stakeholders shall decide together on the type of car to be purchased.

- **MANAGEMENT** - mainly responsible on behalf of the union for budgetary planning, financial advice and nontechnical support.
- **DRIVERS** – concerned with the drivers' desired preferences such as their safety and comfort.
- **SERVICE TECHNICIANS AND MECHANICS** - mainly concerned with having cars that can be easily fixed and in the availability of spare parts in the market.

YOUR RESPONSIBILITY

In this experiment, you as a member of this task force are representing "**Mechanics / Technicians**". Thus, you are expected to discuss preferences of **mechanics** with the other members, and come up with the best possible choice of car for **mechanics**. Your preferences as representative of Mechanics are very important, but every member has his/her own desired preferences. Thus, you need to work with each other in order to reach a consensus and accomplish this group decision making task.[4] It is important to mention that due to Taxi Company's very large order, the manufacturer may customize the cars.

ATTRIBUTES

The list below describes the three major attributes that need to be discussed. Remember that there should be a trade off in selection of attributes; in fact, because of the company's limited budget, it's impossible to choose all highly priced features at the same time.

[4] Group members have no privileges toward each other; indeed, all group members have equal power and right in voting for their desired car. [Everyone is equal!]

Car Origin

- **German**
  - German cars are complex in design thus requiring more maintenance than Japanese and American cars (Not preferred by technicians).
- **Japanese**
  - Japanese cars that are produced today are quite reliable, and may cost less to repair than the German cars (Mechanics love them).
- **American**
  - American cars require high maintenance due to frequent breakdowns (May not be preferred by mechanics)

Engine type

- **Gas (Petrol)**
  - These cars require higher maintenance than diesel powered cars (May not be preferred by mechanics).
- **Diesel**
  - Diesel engines do not require spark plugs so it's simpler and more reliable, especially under adverse conditions (Desired by mechanics).
- **Hybrid Power**
  - There are not many skilled hybrid car repair mechanics (Not desired by mechanics).

Transmission Type

- **Manual Transmission**
  - Higher durability (May be preferred by mechanics)
- **Automatic Transmission**
  - Repairing an automatic transmission is much more difficult than working with manual gear boxes. Also, automatic cars have less durability (May not be preferred by mechanics)

SUMMARY OF MECHANICS' PREFERENCES

Major preferences of your work group have been illustrated as follows:

Attributes / Role	Car Origin			Fuel Type			Transmission Type	
	German	Japanese	American	Gas Petrol	Diesel	Hybrid	Manual	Automatic
Mechanics		✓			✓		✓	

Appendix 6 - Problem Scenario for Drivers' Representative

A unionized Taxi Company in Toronto is planning to buy 500 cars to add to or replace some of its existing fleet. Three groups of stakeholders shall decide together on the type of car to be purchased.

- **MANAGEMENT** - mainly responsible on behalf of the union for budgetary planning, financial advice and nontechnical support.
- **DRIVERS** – concerned with the drivers' desired preferences such as their safety and comfort.
- **SERVICE TECHNICIANS AND MECHANICS** - mainly concerned with having cars that can be easily fixed and in the availability of spare parts in the market.

Your Responsibility

In this experiment, you as a member of this task force are representing "**Drivers**". Thus, you are expected to discuss preferences of **drivers** with the other members, and come up with the best possible choice of car for **drivers**. Your preferences as representative of drivers are very important, but every member has his/her own desired preferences. Thus, you need to work with each other in order to reach a consensus and accomplish this group decision making task.[5] It is important to mention that due to Taxi Company's very large order, the manufacturer may customize the cars.

Attributes

The list below describes the 3 major attributes that need to be discussed. Remember that there should be a trade off in selection of attributes; in fact, because of the company's limited budget, it's impossible to choose all highly priced features at the same time.

Car Origin

[5] Group members have no privileges toward each other; indeed, all group members have equal power and right in voting for their desired car. [Everyone is equal!]

- **German**
  - More stylish and have the best driving experience (Drivers love them).
- **Japanese**
  - Efficient and quiet but not very powerful (May not be preferred by drivers).
- **American**
  - Powerful, but not as stylish as German cars (They have frequent breakdowns, so Not desired by drivers because of lost income while under repair).

Engine type

- **Gas (Petrol)**
  - These cars are powerful and have good acceleration (Desired by drivers).
- **Diesel**
  - Finding a neighbourhood service station that sells diesel fuel may be difficult (Not desired by drivers).
- **Hybrid Power**
  - Hybrid cars are very efficient. But, not very powerful. They have high voltage circuitry which causes some drivers to feel unsafe (May not be preferred by drivers).

Transmission Type

- **Manual Transmission**
  - Not very easy to use for novice drivers; furthermore, due to particular characteristics of manual cars, drivers cannot concentrate exclusively on hazards because they should shift gears based on the vehicle's speed.
- **Automatic Transmission**
  - Relatively safer and very easy to use (Desired by drivers).

Summary of Drivers' Preferences

Major preferences of your work group have been illustrated as follows:

Attributes / Role	Car Origin			Fuel Type			Transmission Type	
	German	Japanese	American	Gas Petrol	Diesel	Hybrid	Manual	Automatic
Drivers	✓			✓				✓

Appendix 7 - Problem Solving Task

For survey under development for future use, we are interested in your skill in math problem solving and alphabetizing words. This is not to diagnose your performance or intelligence. Rather, we are interested in knowing how people in your generation engage in such kind of tasks. Do not spend more than two minutes on this task. It is OK if you do not finish all the questions in this section.

Math Problem Solving

Please write down the final answer for each question.

- $117 \div 13 =$
- $\{(12 * 4) - 2\} + (10 * 3) =$
- $\frac{9}{121} \div \frac{3}{11} =$
- $2^6 \div 2^3 =$

	Strongly Disagree						Strongly Agree
1. The above tasks are really easy.	1	2	3	4	5	6	7
2. The above tasks are really enjoyable.	1	2	3	4	5	6	7

Alphabetizing words

Please put the words below in an alphabetical order

Drama	Song	Trial	Neutral	Globe
Piano	Nature	Camp	May	Drive

1)	2)	3)	4)	5)
6)	7)	8)	9)	10)

	Strongly Disagree						Strongly Agree
1. The above tasks are really easy.	1	2	3	4	5	6	7
2. The above tasks are really enjoyable.	1	2	3	4	5	6	7

Appendix 8 - Pre-Questionnaire

Before using the system; please provide us with the following information:

1. Have you ever used any Decision Support System before?

☐Yes ☐No

If 'Yes', please indicate the system(s) or website(s) you have worked with:

2. Highest degree obtained

☐ High School ☐ CEGEP (College) ☐ University (Bachelor and more)

3. Field of Study:

4. Gender

☐Male ☐Female

5. Age Group

☐18-25 ☐26-30 ☐Over 30

Appendix 9 - Post-Questionnaire

This scale consists of nine words that describe different feelings and emotions. Read each item and then mark the appropriate box next to that word. Indicate to what extent you feel this way right now, that is, at the present moment.

(*Your additional comments will be highly appreciated*)

6.	"depressed"?	**Not at all much**	☐	☐	☐	☐	☐	☐	☐	**extremely**
7.	"happy"?	**Not at all much**	☐	☐	☐	☐	☐	☐	☐	**extremely**
8.	"frustrated"?	**Not at all much**	☐	☐	☐	☐	☐	☐	☐	**extremely**
9.	"joyful"?	**Not at all much**	☐	☐	☐	☐	☐	☐	☐	**extremely**
10.	"unhappy"?	**Not at all much**	☐	☐	☐	☐	☐	☐	☐	**extremely**
11.	"pleased"?	**Not at all much**	☐	☐	☐	☐	☐	☐	☐	**extremely**
12.	"angry"?	**Not at all much**	☐	☐	☐	☐	☐	☐	☐	**extremely**

13. "enjoyment / fun"? **Not at all** **extremely much**

☐ ☐ ☐ ☐ ☐ ☐ ☐

14. "worried / anxious"? **Not at all** **extremely much**

☐ ☐ ☐ ☐ ☐ ☐ ☐

Based on your experience with the system, please answer the following questions by circling the appropriate number:

1 = Strongly Disagree
2 = Moderately Disagree
Agree
3 = Somewhat disagree
4 = Neutral (neither disagree nor agree),
5 = Somewhat Agree
6 = Moderately
7 = Strongly Agree

15. I could clearly interact with the system.

Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

16. Using the system improved my performance in making decision.

Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

17. Interacting with the system did not require a lot of my mental effort.

Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

18. Using the system enabled me to make decision more quickly.

Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

19. I found the system to be easy to use.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

20. Assuming I have access to the system, I intend to use it in future.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

21. Using the system enhanced my effectiveness in making decision.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

22. I am quite satisfied with the outcome.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

23. I found it easy to use iMade for group decision.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

24. I find the system to be useful in decision making.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

25. The outcome of the decision making process matches my expectation before using the system.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

26. If the choice of an online decision support platform were up to me, it would likely be iMade

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

27. Becoming skillful at using the system was easy.

Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

28. If I need to make group decisions and the choice was up to me, I would use iMade as a decision system.

Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

29. If asked, I would likely recommend iMade as a decision support sytem.

Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

30. How easy or difficult was to assign weights to the different attributes?

Extremely easy Extremely difficult
1 2 3 4 5 6 7

31. How easy or difficult was to exchange messages?

Extremely easy Extremely difficult
1 2 3 4 5 6 7

32. For future group decision making tasks that are totally within my control, I would probably use iMade as a group decision making system.

Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

33. How easy or difficult was to rate each alternative's utility?

Extremely easy Extremely difficult
1 2 3 4 5 6 7

34. How much control did you have over the group decision making process?

Very much in Control Not at all in control
1 2 3 4 5 6 7

35. Did the outcome of the group decision match with your expectation before you began your group discussion?

Completely Not at all
1 2 3 4 5 6 7

36. How satisfied are you with your performance as a decision-maker in this exercise?

Extremely satisfied						Extremely unsatisfied
1	2	3	4	5	6	7

In this section, you are asked to evaluate your group members:
I found my group members …

37.	Cooperative	1	2	3	4	5	6	7 Self Interested
38.	Fair	1	2	3	4	5	6	7 Unfair
39.	Flexible	1	2	3	4	5	6	7 Rigid
40.	Kind	1	2	3	4	5	6	7 Unkind
41.	Likeable	1	2	3	4	5	6	7 Unlikable
42.	Irrational	1	2	3	4	5	6	7 Rational
43.	Unreliable	1	2	3	4	5	6	7 Reliable
44.	Untrustworthy	1	2	3	4	5	6	7 Trustworthy

45. How friendly would you call your group decision making?

Very Friendly						Very Hostile
1	2	3	4	5	6	7

Thank you very much for participating in the iMade experiment. If you have any comments or suggestions regarding using iMade, please indicate below:

Appendix 10 - Consent form

This form describes the research project that you have been asked to participate in and seeks your consent to do so. Amir Sadaghianizadeh, a graduate student of the department of Decision Science and Management Information Systems, Concordia University, is conducting this study. Amir can be reached via e-mail at:a_sada@jmsb.concordia.ca. Please read the form carefully and feel free to ask any questions that you might have.

First of all, please note that there is no risk in taking part in this experimental exercise; indeed, participants will be rewarded with a cash prize of $18.00 CAD. This experiment involves using a group decision support system, called iMade. Your role will be that of representing _____ in a committee appointed by a co-op taxi company. Your task will be to collaborate with two other committee members and your goal will be to reach a joint decision regarding the purchasing of your desired taxi fleet, using the iMade system.

This exercise will last about **one hour and 30 minutes**. After signing the consent form, you will be asked to answer a pre-questionnaire consisting of six very short questions. Then, you will be instructed on how to use the group decision support system; finally, after finishing the exercise, you will be asked to answer some additional questions regarding your experience with the system. When you have completed the experiment, please ask the facilitator to sign you out, at which time you will receive your cash reward. Please note that if you decide to not complete the experiment and questionnaires, we will not be able to give you your cash reward.

Participation in this experiment is completely **voluntary**. You have the right to refuse to participate or withdraw from this research project at any time. Any information you share about yourself or what you experienced in working with the system will be kept **confidential** and will only be used in a summary format that will not identify who you are. In fact, the data will be kept in strict confidentiality and only researchers involved with the project will ever have access to the recordings. In addition, no names will be used during the experiment to minimize the potential of your identity be discovered. Whoever is interested in the results of this study can contact the researcher by email, and he will provide him / her with the results.

Consent Signature

Having read and understood the above text, I agree that I understand the description of the study and willingly consent to participate in the experiment conducted by Amir Sadaghianizadeh, a graduate student at John Molson School of Business.

Name of participant:

_____

Signature of participant:

_____

Date:

_____

If at any time you have questions about the proposed research, please contact the study's Principal Investigator Dr. Jamshid Etezadi, Department of Decision Sciences and MIS, John Molson School of Business, Concordia University at (514) 848-2424 x3695 or by email at: etezadi@jmsb.concordia.ca

If at any time you have questions about your rights as a research participant, please contact the Research Ethics and Compliance Advisor, Concordia University, Dr. Brigitte Des Rosiers, at (514) 848-2424 x7481 or by email at bdesrosi@alcor.concordia.ca

Appendix 11 - R Packages

Packages in library 'C:\Users\Amir\Documents/R/win-library/2.9':

rJava Low-level R to Java interface

Packages in library 'C:/PROGRA~2/R/R-29~1.2/library':

base	The R Base Package
boot	Bootstrap R (S-Plus) Functions (Canty)
class	Functions for Classification
cluster	Cluster Analysis Extended Rousseeuw et al.
codetools	Code Analysis Tools for R
datasets	The R Datasets Package
foreign	Read Data Stored by Minitab, S, SAS, SPSS, Stata, Systat, dBase, ...
graphics	The R Graphics Package
grDevices	The R Graphics Devices and Support for Colours and Fonts
grid	The Grid Graphics Package
KernSmooth	Functions for kernel smoothing for Wand and Jones (1995)
lattice	Lattice Graphics
MASS	Main Package of Venables and Ripley's MASS
Matrix	Sparse and Dense Matrix Classes and Methods
methods	Formal Methods and Classes
mgcv	GAMs with GCV/AIC/REML smoothness estimation and GAMMs by PQL
nlme	Linear and Nonlinear Mixed Effects Models
nnet	Feed-forward Neural Networks and Multinomial Log-Linear Models
rpart	Recursive Partitioning

spatial	Functions for Kriging and Point Pattern Analysis
splines	Regression Spline Functions and Classes
stats	The R Stats Package
stats4	Statistical Functions using S4 Classes
survival	Survival analysis, including penalised likelihood.
tcltk	Tcl/Tk Interface
tools	Tools for Package Development
utils	The R Utils Package

Appendix 12 - R codes for calculating continuous utility

```
a3= 3

b3<- exp(a3)-1

y <- (exp(a3*x)-1)/b3

##

fn <-function(p) sum((y-(x*(1+p[1]*x+p[2]*x^2)/(1+p[1]+p[2])))^2)

out3 <- nlm(fn,p = c(-1,0.5), hessian = TRUE)

## here we creat a set of x and y based on fitted function to plot

xfit <- seq (0,1, by = .1)

yfit <-

xfit*(1+out3$estimate[1]*xfit+out3$estimate[2]*xfit^2)/(1+out3$estimate[1]+out3$estim

ate[2])
```

Appendix 13 - R codes for calculating Regression Weights

```
nr = 2*(n-1)

nc = n-1

nt =nc*nr

D <- array(rep(0,nt), dim=c(nr,nc))

seq(1, nt, by=(nr+1)) -> i

D[i] <-1

seq((3*nc+1), nt, by=(nr+1)) -> i

D[i] <-1

seq((nc+1), nr) -> i

D[i] <- -1

yl<- log(y)

lm0 <- lm (yl~0+D)

wexp = exp(coef(lm0))

swexp = sum(wexp)

wn=1/(swexp+1)

w = wn*wexp

wfit <-  c(w,wn)
```

Appendix 14 - Participants' experiment results

User	time to decision (discussion)	Agreed Alternative	Gender	Duration (Minutes)	Utility
Manager1	11:15 - 11:58	American, Hybrid, Automatic	female	43	79.94
Manager2	13:01 - 13:18	American, Diesel, Automatic	female	17	50.83
Mechanic1	14:16 - 14:28	Japanese, Diesel, Automatic	male	12	84.14
Mechanic2	15:53 - 16:04	American, Diesel, Automatic	female	11	49.66
Driver1	17:29 - 17:42	Japanese, Gas(Petrol), Manual	male	13	51.74
Driver2	18:33 - 19:01	Japanese, Hybrid, Automatic	female	28	51.85
Manager3	10:38 - 11:00	American, Diesel, Automatic	female	22	52.69
Manager4	11:55 - 12:12	American, Diesel, Automatic	female	17	70.89
Mechanic3	14:59 - 15:25	American, Diesel, Automatic	female	26	52.79
Mechanic4	16:14 - 16:41	American, Diesel, Manual	male	27	66.59
Driver3	17:49 - 18:07	German, Diesel, Manual	male	18	48.47
Driver4	16:31 - 16:52	Japanese, Hybrid, Automatic	female	22	57.48
Manager5	10:52 - 11:14	Japanese, Hybrid, Automatic	male	22	35.77
Manager6	15:01 - 15:21	German, Diesel, Manual	female	20	49.23
Mechanic5	09:04 - 09:16	Japanese, Hybrid, Automatic	male	12	55.44
Mechanic6*	11:28 – 11:48	German, Hybrid, Manual	female	20	46.73
Driver5	12:28 - 12:44	American, Diesel, Automatic	female	16	40.47
Driver6	14:34 – 14:53	Japanese, Hybrid, Automatic	male	19	22.33
Manager7	16:17 – 16:39	Japanese, Diesel, Manual	female	22	46.50
Manager8	14:06 – 14:20	American, Diesel, Automatic	male	14	60.67
Mechanic7	15:03 – 15:23	Japanese, Hybrid, Automatic	female	20	11.04
Mechanic8	16:24 – 16:44	Japanese, Hybrid, Automatic	female	20	41.18
Driver7**	10:49 – 11:20	Japanese, Gas(Petrol), Automatic	male	31	69.00
Driver8	13:29 - 13:38	Japanese, Hybrid, Automatic	female	9	49.42
Manager9	15:36 - 15:45	Japanese, Gas(Petrol), Automatic	male	9	7.19
Manager10	16:20 - 16:59	German, Diesel, Automatic	female	39	45.93
Mechanic9	10:13 - 10:29	Japanese, Hybrid, Automatic	male	16	42.70
Mechanic10	11:27 - 11:56	Japanese, Hybrid, Automatic	female	29	43.29
Driver9	14:36 - 14:53	Japanese, Hybrid, Automatic	male	17	47.49
Driver10	16:09 - 16:32	American, Hybrid, Manual	male	23	26.10

* Due to losing internet connecting, working with the system was interrupted for 5 minutes which should be taken into account for considering the process and discussion time.

** The outlier of the data set (user 23)

Appendix 15 - EQS Analysis

CHI-SQUARE = **.042** BASED ON **1** DEGREES OF FREEDOM

PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS **.83827**

THE NORMAL THEORY RLS CHI-SQUARE FOR THIS ML SOLUTION IS **.042.**

BENTLER-BONETT NORMED FIT INDEX (NFI) = **.998**

COMPARATIVE FIT INDEX (CFI) = **1.000**

JORESKOG-SORBOM'S AGFI FIT INDEX (AGFI) = **.993**

ROOT MEAN-SQUARE ERROR OF APPROXIMATION (RMSEA) = **.000**

PEOUT =V70 = .380*V73 (GAT) + .925 E70 **.145**

PUT =V71 = .206*V70 + .447*V73 (GAT) + .830 E71 **.312**

PIT =V72 = .375*V70 + .341*V71 + .805 E72 **.352`**

Appendix 16 - Effect of gender on the proposed model

Dependent Variable: PUT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	63.104[a]	1	63.104	4.472	.044
Intercept	13725.173	1	13725.173	972.562	.000
Gender	63.104	1	63.104	4.472	**.044**
Error	381.034	27	14.112		
Total	14261.000	29			
Corrected Total	444.138	28			

a. R Squared = .142 (Adjusted R Squared = .110)

PUT

Gender	Mean	N	Std. Deviation
Female	20.5882	17	4.06292
Male	23.5833	12	3.26018
Total	21.8276	29	3.98272

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.094	7.264		.151	.881
	PUT	.577	.221	.466	2.609	.015
	PEOUT	.500	.249	.333	2.009	.055
	Gender	-2.867	1.630	-.291	-1.759	.091

a. Dependent Variable: BIT

Appendix 17 - Relationship between Gender and Decision Making Duration

GAT Mean

P / N Affect	Gender	GAT Mean	N	Std. Deviation
Negative	Female	**35.9091**	11	8.65395
	Male	33.0000	4	10.39230
	Total	35.1333	15	8.85492
Positive	Female	45.0000	6	6.44981
	Male	**46.6250**	8	6.36817
	Total	45.9286	14	6.20749

Time_to_Decision

Gender	Mean	N	Std. Deviation
Female	22.4118	17	8.73255
Male	16.8333	12	5.27142
Total	20.1034	29	7.89369

Time_to_Decision

P / N Affect	Gender	Duration Mean	N	Std. Deviation
Negative	Femle	21.0909	11	8.46705
	Male	20.7500	4	5.56028
	Total	21.0000	15	7.60639
Positive	Femle	24.8333	6	9.47453
	Male	14.8750	8	4.15546
	Total	19.1429	14	8.36529

Appendix 18 - An extreme outlier

Data provided by *user 23* demonstrates the following results:

He accomplished the exercise with the total utility of 69 (Percentile: 90)

Experimenter1: 10.56
Experimenter2: 42.25

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PARTICIPANT_UTILITY	30	7.19	84.14	48.5849	17.12233
Valid N (listwise)	30				

Final Selected Alternative: Japanese, **gas**, **automatic**

PU: 3.25 out of 7(Percentile: 3.3)

PEOU: 7 out of 7

BI: 6.6 out of 7(Percentile: 83.3)

GA: 6.08 (Percentile: 80)

The data analysis reveals that he has filled out the post-questionnaire carelessly or irrationally. Although he experienced positive affect from group decision making process and correspondingly he was intending tremendously to use the system for future use,

Although he wasn't in the negative mood, but meanwhile his score in positive mood implies that his mood at the experiment time didn't show any positivity too.

R_N_Mood: 6.5: **Not at all** in the negative mood

P_Mood: 4: Neutral

Appendix 19 - Participants Comments about the iMade System

- It would be interesting to see other members' final utility. [The utility each group member gains]
- It would be interesting if system could interfere in the conflict situations.
- Larger chat box
- Some of group members might not let others to give their point of view effortlessly
    - Especially in the sessions that experimenters would induce negative affect
- 10% of participants stated that although they found the iMade very interesting to use, they believe that face to face group decision making would be more efficient.

Appendix 20 - Comparison of Participants Utility Based on Their Roles

Report

PARTICIPANT_UTILITY

Exp_Role	Mean	N	Std. Deviation
1.00	49.9649	10	19.77359
2.00	49.3548	10	18.79462
3.00	43.9279	9	12.07803
Total	47.8810	29	16.97783

By comparing means of achieved utility by three groups (Managers, Mechanics, and Drivers), it's revealed that participants representing the management stakeholders hold higher utilities.

An example of transcript extracted from members communication as follows:

Managers' representatives

- "as I said, I am the one who should fund this and I only am willing to pay for American cars!"
- "I say it for the last time, IT IS MY MONEY!! I DECIDE WHAT WE DO!!"
- "I am SURE I will find drivers who are not ONLY thinking about themselves"
- "YOU HAVE TO CONCEDE ME EITHER THE ORIGIN (AMERICAN) OR THE ENGINE TYPE (HYBRID)..OTHERWISE WE CANT DO ANYTHING"
- It is a TAXI business not fashion industry (In response to The Driver Representative)

Driver Representative who is discussing with the Manager Representative about novice drivers difficulty in learning Manual: if you promise to train them that would be ok. I think it's better to finish this decision making so we can get back to our work in the company.

Appendix 21 - PLS Path Modeling