Smart Support

Design and implementation of a man-machine interaction to increase group collaboration and decision making for marketers in the energy sector.

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Student number 4420861

Graduation report

MSc Science Education and Communication

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Part 1

Introduction of research project

Context and problem description/motivation

The need to improve group decision making is of longstanding concern to organizational researchers. The same holds for communication and marketing professionals who have to make decisions in highly complex, dynamic and uncertain contexts. The energy market and the high-tech developments such as smart energy meters combine the uncertain and highly complex context of strategic communication management in energy providers [21]. Therefore, there is a growing interest in group decision support systems (GDSS) which combine communication, computer and decision technologies to support problem formulation and solution in group meetings of marketers [1].

All over the world, people in organizations spend much time in meetings and group decision making. Even though much about meetings can be predictable, the diversity of the group members, the different opinions and ideas generated can influence the process of decision making. Sometimes a decision might have more chances to be made just by knowing who dominates the discussion. The organizational status of the members shows who might dominate [2]. In fact, when aggregating the opinions of individual members, it is natural to have members with more influence than others i.e. users who have authority, more expertise or are more trusted. Members with more influence must be treated differently (e.g. give more weight to their opinion or cover their identity under anonymity) in order to improve the group decision-making process [3]. As prior group collaboration research has shown that the performance of each individual group member is an important contributor to success, the effects of various factors such as feedback, social comparison and grading have been extensively studied [4]. Also professional learning has always been a popular topic in literature but its focus was mainly on schools and teachers. However, there are many points that are useful and could be translated and used in an organizational environment such a group meeting of marketers. [18] Professional learning is defined as changes in an individual's knowledge, skills and way of thinking. If this is done effectively then it increases not only the learning curve of the individual but also the chances for long-lasting changes in practice.
However, literature lacks information according to the way factors that will enhance group collaboration, could match with the factors of decision making and how these could be implemented in a GDSS in order to result into improved quality of the decisions made. To be able to test that a GDSS is needed to be designed.

Because of the need to research which factors that enhance group collaboration could match with decision making factors, the main task of such a tool will be to simulate different marketing scenarios and get insight in whether the decisions made are actually optimized through group collaboration which will be stimulated by the design of the GDSS. The case considered for the scenarios will be the introduction of smart energy meters to households. Overall this is part of the energy transition that has created an emerging market and because of that there is no clear knowledge for marketing professionals on how to proceed with the right decisions for their marketing plan.

Besides this though, designing such decision making tool, is influenced also by my personal interest in decision making tools and also my professional career at Cisco, specializing in collaboration solutions. This entails the constant research of problems that organizations

are dealing with, in the context of working more efficiently both internally and externally and eventually driving better results.

Aim of research project

This project is based on previous research. As seen in [21] an agent-based model was created to describe a simulated population which has a behavioral intent to adopt a technology. The aim of this research project is to develop a group decision support system (GDSS) that is integrated with the agent-based model, to be used by a group of marketers that will help them maximize the quality of the decisions they make upon marketing strategies through enhanced collaboration. The theoretical research of this project is based on the literature mentioned in the 'Literature study' chapter but also on the use of a Proof of Concept that took place at the university. The proof of concept consisted of a session during which students used for a meeting on a self-made scenario.

Question introduction

Research Question

How can we design a man-machine interaction to improve group collaboration and decision making for marketers in the energy sector?

Sub-questions

How can the GDSS trigger marketers to elaborate on their ideas from a theoretical perspective?

What are the impacts of the GDSS on the marketers?

To what extent does the design eliminate bias, support openness and decrease uncertainty?

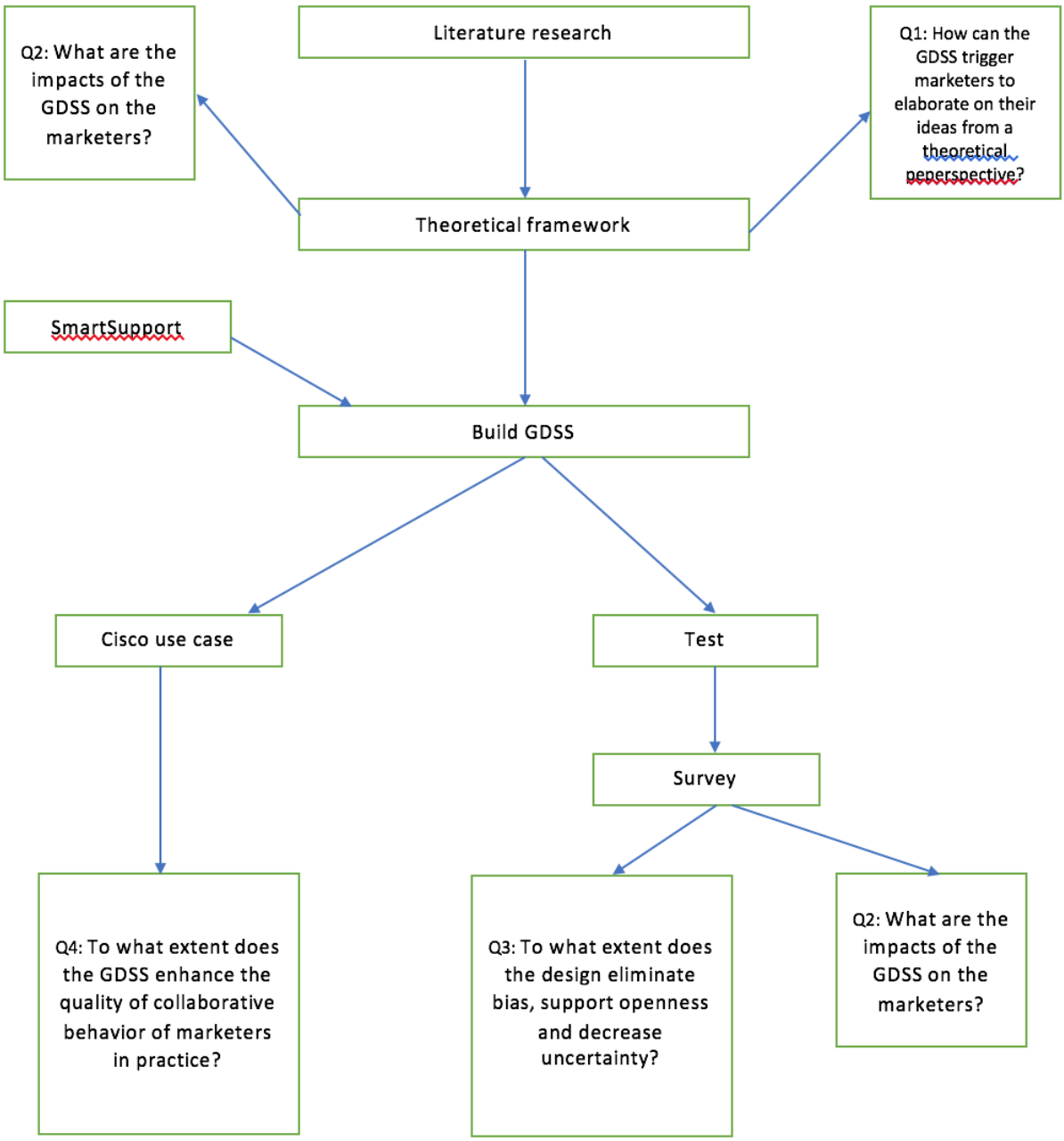
To what extent does the GDSS enhance the quality of collaborative behavior of marketers in practice?

By answering the sub-questions as ordered above, a clear conclusion will be extracted of how marketers could be supported to make better group decisions. The results will be added to the literature and according to positive or negative outcome, will be a starting point for further decisions, changes or adjustments on the GDSS.

Methods

Study design, data collection, analysis and interpretation

First of all, we will conduct a systematic literature study about decision making & tools, collaboration, professional learning, man-machine interaction and also marketing planning and strategy. Based on insights from the literature the main part of my research was focused on creating a decision making tool that would help enhance collaboration among professionals in group meetings. From insights from literature [1],[2],[3],[4] I realized that there were plenty of tools created from time to time but none of these would cover all the drawbacks of the others. For example, one GDSS would not include the function of giving feedback or another one would need a human facilitator to manage the session but it would have the feedback function. So the main focus of my research was to try to create an as much as possible flawless decision making tool. Second, we will re-design Smart Support which is an existing tool and create the tool which will be based on our literature study findings. In order to test our tool we will invite three sustainable energy MSc students from TU Delft and we will ask them to use the tool. To do that we will need to book a room with enough space, three computers that will be connected in the local network of TU Delft and will have the tool installed. Also, someone who is not directly involved in the project will need to facilitate this whole process. After the students use the tool, a survey will be handed out. This survey will contain questions about the tool and its usefulness concerning decision making and collaboration. Then we will analyze the collected data from the survey in order to understand the advantages or disadvantages of the tool and make a clear conclusion about the usefulness of such decision making tools for marketers and further development of the tool. Below can be found a diagram of how the methodology helped me answer all research questions and also shows the procedure of completing my research.


Literature research
Q2: What are the impacts of the GDSS on the marketers?
Q1: How can the GDSS trigger marketers to elaborate on their ideas from a theoretical peerspective?
Theoretical framework
SmartSupport
Build GDSS
Cisco use case
Test
Survey
Q4: To what extent does the GDSS enhance the quality of collaborative behavior of marketers in practice?
Q3: To what extent does the design eliminate bias, support openness and decrease uncertainty?
Q2: What are the impacts of the GDSS on the marketers?

Reliability, validity and ethics

This research is to be seen as further proof of principle based on validated software and well researched constraints of collaboration. The reliability of the data collection and analysis is ensured first of all by using a paper survey and a predefined sample group (i.e. 3 MSc students). Secondly, by using explicit definitions for all questions needed to be answered and what the procedure will look like. Furthermore, the internal validity is safeguarded by conducting a true experiment. At last, all participants will be experienced students in sustainable energy. They will not be asked questions that might cause loss of self-esteem or stress, neither any religious, sexual or private information will be asked. All descriptions about the research and participation will be clear and the privacy of the information will be ensured by using an anonymity algorithm that will encode and encrypt all sensitive data such as names, age or experience.

Relevance

Anticipated results and scientific relevance

The projected outcomes of this project are directly scientifically relevant because of the research in the implementation of collaboration and decision making factors but also since there is a new tool introduced by the SEC-Delft research team. The outcomes will help the SEC-Delft research team to identify whether there is a need or not, of using the new tool in group decision making processes. The theoretical useful outcomes are anticipated to show if actually the combination of tools and different collaboration factors will enhance collaboration and effectiveness in making decisions. Practically, the technical outcome of this thesis could probably be integrated in the main collaboration tool of Cisco systems. Cisco Spark is the main collaboration tool for virtual meetings, connecting conference rooms all around the world for the largest enterprises in the world but also for small/medium business.

Social / practical relevance and valorization

The projected outcomes of this project could be translated into practice in two ways. If the outcomes are positive and show the usefulness of such a GDSS in the decision making process, then the optimization process and use will be able to start. If the outcomes are negative, then further changes and research will be able to be made to the GDSS in order to fit and satisfy the needs of the business development professionals.

Context of energy transition

As described in [12] the number of domestic energy users who become domestic energy producers is increasing. One drawback of this is that it is often not demand driven like the large scale generation plants and also it is difficult to predict the production when it is based on sustainable resources such as sun and wind. The energy market is currently changing since energy produced by fossil fuels is getting more expensive and new sustainable energy technologies like solar panels are becoming cheaper. This results into domestic consumers adopting more and more solar panels. So, if households are able to match the locally produced energy with their own energy consumption it means that solar electricity is likely

to be used more efficiently and sustainably. [12] Besides that, the EU stimulates energy savings from a climate target perspective and all EU members are forced to reduce emissions through international agreements such as the Kyoto protocol.

Marketers and big data

[23] Big data are large data sets that may be analyzed computationally to reveal patterns, trends, and associations, especially relating to human behavior and interactions. Big data is on the agenda of each organization's marketing director. But what could be done with that? Sophisticated big data analytics tools allow marketers to identify the key marketing imperatives and produce impressive results, such as successful marketing campaigns that will lead to increased sales. Such tools are able to transform traditional marketing and improve the execution of essential marketing functions because they provide a bias-free environment combined with real behavioral analysis. Marketers collect live data produced by customers and create a bigger picture of their behavior. That means they are able to understand what motivates the end customers and see different factors they hadn't thought of before. The analysis of this data allows marketers to customize customer segmentation models and with the use of the insights to develop customer engagement strategies. Big data offers marketers the opportunity to provide highly personalized experience and also maximize the return of investment of marketing. In long-term, this will allow marketers to use their insights for new product developments or product pricing. Collaborative groups are important for marketers in order to build the right strategy on which a company will base the launch and success of a product. Besides that, collaboration among marketers and other corporate stakeholders is very important since the decisions taken in marketing meetings are affecting directly the success of the strategy of other stakeholders [23].

Part 2

Systematic Literature Study

Methodology

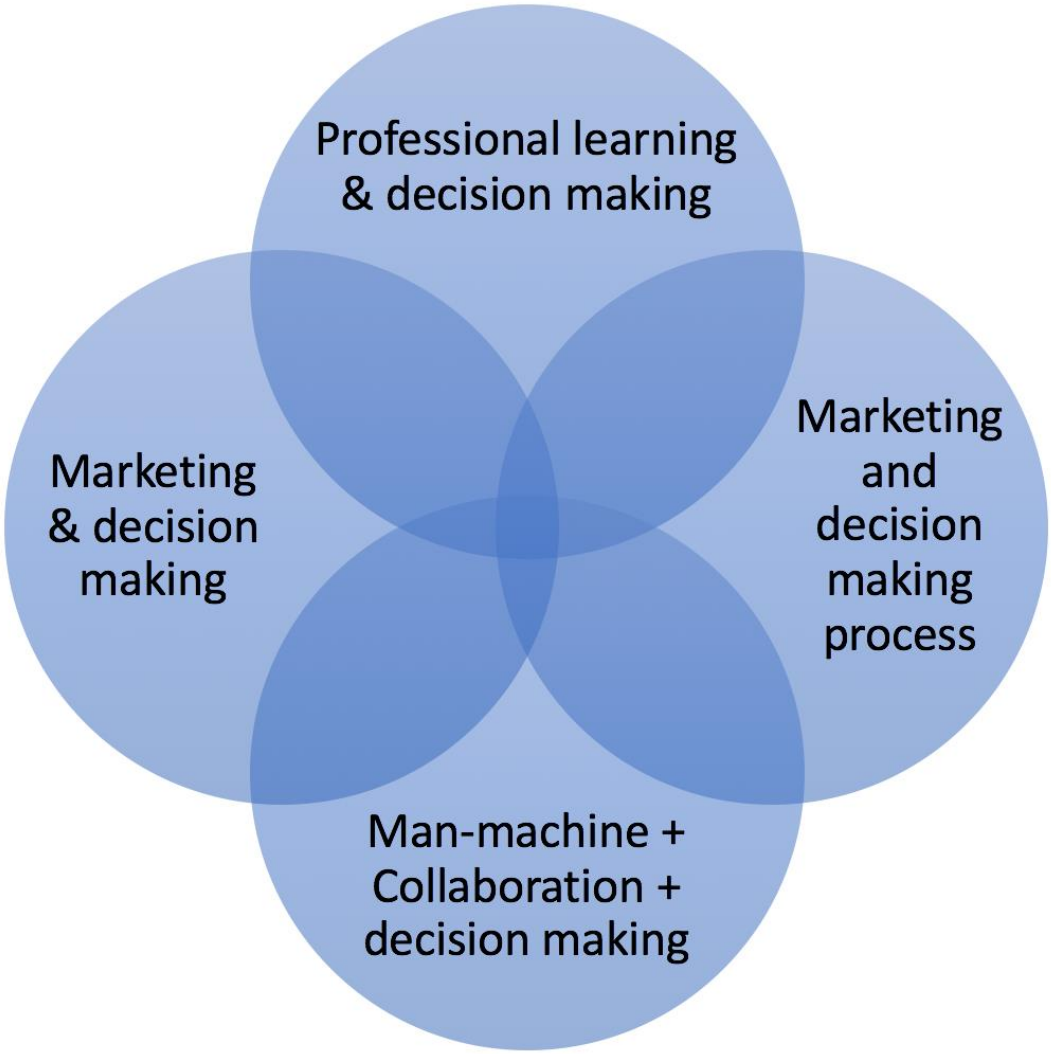
The systematic literature research that was carried out with the help of the database “Web of Knowledge”, consists of many parts from different scientific fields. The first step was to search about group decision support systems and how these are being used in an organizational environment. This gave insight in the broad study of decision support tools. Below there can be found the keywords used in order to minimize the results found on the database “Web of Science” but more importantly to make the results more specific to the researched topic. Reflecting on the results we identified that there was not as much relevant literature as expected. The choice after minimizing the results was based on the topic and its relevancy.

Keywords	**Web of science**
	topic/title
Marketing AND decision	38,305/1,404
Marketing AND "decision making"	11,232/316
Marketing AND decision AND planning	1400/6
Marketing AND "decision making" AND plan AND collaboration AND decision	15/0
Marketers AND "decision making"	299/5
marketers AND mindset	12/2
"marketing decision making process"	7/0
marketers AND "decision support system"	6/0
Sales AND "decision"	3,364/
Sales AND "decision support system"	175/18
sales AND "decision" AND collaboration	63/0
"professional learning"	570/182
"professional learning" AND decision	27/1,0
"professional learning" AND marketing	12/0
"professional learning" AND "decision making"	21/1,0

"professional learning" AND "decision making" AND marketing	1/0
decision AND "man machine"	44/1
"decision making" AND "man machine"	20/1,0
"man machine" AND collaboration AND decision	2/0

Something I found interesting while going through the literature is the very small amount of papers found on specific topics. As it can also be clearly seen in the literature research tree above, when combining keywords such as "man machine" AND collaboration AND decision, the results returned are only two papers that mention these in general but none in the title. Same happens for other major topic keyword combinations. From this we are able to understand that there hasn't been almost any research in the combination of these different fields and there are many possibilities for further research. Below can be found the list of literature papers that I eventually chose to use during this research study. Each individual paper was chosen for different reasons. In Appendix A and under each paper I provide a small insight of what intrigued me to use it and why.

In the following Venn diagram we see the intersection of the four main areas I researched in and we can see also from the table above that there is very little research done.


Professional learning & decision making
Marketing & decision making
Marketing and decision making process
Man-machine + Collaboration + decision making

Group Decision Making

[3] It is widely known that people in organizations spend a lot of time in meetings. Even though most of these meetings are not taking place for decision making, our goal is to focus on decision making groups and the collaboration process. Based on personal experience, meetings in general are important for stakeholders within organizations to understand the goals and mindsets of each other in order to proceed to aligned actions that will profit the organization.

[3] A decision making group consists of two or more people who get together to discuss a problem, find possible solutions and evaluate them in order to choose the solution to be implemented. The members of a group need to be aware of their role as part of the group but they don't need to be physically present in the same location as the other members. Decision making groups are brought together to solve issues that are thought to be too significant for individuals. Discussion between the group members aims to bring up ideas by each member to the meeting and motivate everyone to find a solution for the problem that will be accepted by the whole group for implementation. An individual decision support system functions mainly on knowledge and mathematical formulas which are used to evaluate the inputs of the user which are based on the user's analytical skills and provide information on how the user should decide. Though the main advantage of GDSS is that it can be adapted to any situation and also the decision factors that will affect the final decision are formed by the users. The improvement that Smart Support brings is that it combines the possibility of effectively collaborating based on the analysis of data collected from end customers. It actually takes the most out of each participant's individual skills and uses collaboration to share and fulfill the gaps of the skills of other participants.

Smart Support v. 1.0

[12] In the beginning of this project the goal was to take an existing tool that would analyze data from surveys and export charts with the possibilities of adoption of smart energy meters by consumers. However, this tool did not have an interface so that it could be used easily by others than the creators. The idea was to actually build an interface for it in the context of a decision making tool that would be used by marketers in the energy sector. That is how Smart Support was created in the form that it is presented in Chapter 3 later on. During the literature study, all factors and theories used will be described as found in theory and also the way they are used in Smart Support v. 2.0, starting with one of the core theories which is decision making behavior in the following section.

Decision making behaviour

[20] The decision making behaviour is directly influenced by the dynamic tasks of the tool such as the change of the interface and the transition to the next round. In Smart Support the change of interface is achieved by the simplicity of the design, allowing the participants to understand their tasks immediately. For example, in a dynamic environment that is constantly changing the user needs to take time into consideration. The user needs to decide under pressure which information to select and how to integrate it and this may result into negative outcomes when time is inefficiently used. To overcome that constraint, time needs to be spread into different decision rounds and also information processing

speed needs to be increased. In Smart Support this has been achieved by giving a certain time limit to each round while simplifying many parts of the information process, giving the opportunity to the user to focus on the important information. Furthermore, the user can use feedback in providing information in order to elaborate on the strategies discussed to be used for the decision problem while also a trade-off needs to be made between the cost of each action and the risk of not taking any actions when dealing with uncertainty. In Smart Support we use feedback as a basic feature during the decision making process in order not only to improve collaboration but also the quality of the decision.

Collaboration

[8] It is generally believed that a good way to enhance collaboration in a group of professionals as well as for marketers is to create a sense of a community among the members which in this case it is a corporate meeting of marketers in the energy sector. However, in order to achieve that it would be useful to use a set of activities throughout the meeting process to establish a climate of cooperation and trust which could not be very strong in teams. In this section several components and activities to achieve a climate of trust and cooperation are being described. These components were chosen throughout several other components described in literature due to their effectiveness in group meetings [9, 10, 11, 17] and their suitability for the purpose of creating the tool. These are:

- Feedback of other participants on each idea generated
- Social comparison between the ideas of participants
- Anonymity of all participants
- Uncertainty management of untrusted information

Feedback

[10] In group meetings it is really important to give feedback since group members are getting motivated to participate more when they have the ability to compare their work to standards of excellence. As a result, the competence of each individual will increase when they see through the feedback they receive that their efforts are really helping the group to achieve their goal.

[10] Informational feedback and controlling feedback are the two categories identified and discussed in this chapter. Informational feedback allows the participants to monitor their progress towards the group's goal but it also makes them feel emotionally safe which increases their perceived competence. For example, informational feedback should let the receivers know the good parts of their ideas but also suggest ways or give ideas on how to improve their ideas even more. On the other hand though we have controlling feedback which is more judgmental on the participant's performance in an attempt to steer people towards achieving the group's target. Controlling feedback in some way forces participants to use the feedback received and this is likely to cause stress and anxiety to them which leads to lower levels of perceived competence. For example, controlling feedback would tell the receiver strictly what to do without suggesting options. However, this is not always wrong and it depends on how challenging a particular target of the group is. An example for the participant's emotional safety that was mentioned before, if the individuals are not feeling challenged by the target of the meeting then informational feedback will not have any effect on them and as a result they won't put much effort in reaching their target.

Controlling feedback though will encourage participants to continuously put more effort and try to achieve higher levels of performance.
Nevertheless, as proposed by [8], even though it might be useful to use probes such as to generate reactions and motivate users to participate more, they have to do it in a way that others will not feel offended. For example in Smart Support we support that feedback should be given in a positive way like "I like your idea but I would like you to…." which actually combines these two types of feedback since it tries to motivate users to use the feedback in a positive way without causing stress due to the factor of social comparison that I will explain in detail in the following paragraph. This phrase is suggested in Smart Support in the instructions section during the feedback round.

Social comparison

[9] Upward social comparison refers to when individuals compare themselves to more elite or superior people and highlight their similarities while in the case of downward comparison people tend to compare themselves to the less proficient. It is believed that upward social comparison provides inspiration for improvement and they are made to improve yourself hoping that self-enhancement will also occur. This section is not directly connected to collaboration since group participants do not consciously understand that they are collaborating in one way with the rest of the group. However, without knowing it everyone is helping increase the group's performance.
Social comparison theory suggests that upward comparison might lead to increased effort and as a result increase performance. The positive effect of upward comparison is explained by the amount of attention given by an individual to the ideas of the others. In Smart Support this is achieved by exposing all ideas to every participant allowing participants to look at ideas of other more elite or hierarchically superior participants and compare their ideas, even though they don't know which idea belongs to who.

Anonymity

As researched in corporate environment [11] there are several factors in a group meeting that might affect the decision making process. It is observed in some cases that the group members are likely to follow the first idea thrown on the table. In a group there might be also individuals with more experience or authority than others who as a result will have more influence on other members or who might be more trusted. [8] Providing anonymity during the whole meeting can increase participation, openness and also equity since the ideas are measured based on their quality and not the person itself.
[17] In an organizational environment it is difficult to achieve and maintain anonymity. During a decision making meeting there are three stages at which anonymity might be lost.

- The a priori lack of anonymity:
  The issue in this phase is that many groups have a long time relationship which means that individuals will be aware of how the other individuals behave and think and will know their biases. This means that the identity of a user might be exposed through the way an idea is described.

- The loss of anonymity during the meeting

  Even though a GDSS is designed in a way to protect the anonymity of the participants, there are still ways to challenge anonymity. One way is that a person with authority will just decide to discard the anonymity offered by the tool. Another possible way is to challenge another participant to react. For example, someone could write something rude about someone which would make him or her react and expose their identity [17].

- The post priori loss of anonymity

  This case fits mostly in decision making meetings where the tool is used for brainstorming through the use of short sentences. When that happens, it might be possible that someone's idea will need further explanation if it is not set in the correct way. So, then if someone asks all participants for further explanations, it is mostly likely that the owner of the idea will be the one who will try to explain. This means that it might be possible to link the idea to the owner and not only because of that but also from the body language, voice inflection and personal feelings on the topic if there has been a vote before [17].

However, out of these three phases it is believed by [17] that it is most likely for a user to lose his/her anonymity at the end or after the end of the meeting than at the beginning or during the meeting. This means that there is a possibility for a participant to react directly with the other participants because of for example something that someone said in an impolite way about an idea of his/her. This observation is important for Smart Support since it covers completely the anonymity from the point the meeting starts up until the end of it but can't avoid possible interactions of the participants after the meeting has come to an end.

As researched by [9] the quality of the ideas generated increased when the participants were able to look at other ideas while writing their own idea and that helped them to think more openly and put more effort in their ideas. In Smart Support anonymity is being assured by encrypting the details of all participants and without exposing them to other users or to the administrator of the database. The point I want to make is that sharing the context of the ideas of the participants is a very important part of Smart Support but always respecting the privacy of the participant. This also helps deal with the different uncertainty management levels explained next. But what if participants open up at the end? Based on personal experience from a few tests with teams at Cisco, participants do not tend to open up but even if they do and claim the winning idea, it is difficult to convince the rest of the participants.

Uncertainty management

In the context of marketing professionals, uncertainty is a situation where information can be inexact, unreliable or close to ignorance. Yet, uncertainty can be categorized as uncertainty due to lack of knowledge or due to the variability of the system. As explained by [12],[15],[20] uncertainty has three dimensions. The location of the uncertainty refers mainly to where the uncertainty is found in a range from an unachievable ideal to total ignorance. The nature of uncertainty consists of either epistemic uncertainty where the

problem is the lack of knowledge or variability uncertainty which refers to inherent variability.

More specifically, as mentioned by [15] uncertainty can be attributed to one of the following categories:

- To the individual

Uncertainty is caused by the absence of the required knowledge, rules or skills needed to solve the problem at hand

- To the social context

Uncertainty is caused by the absence of necessary information exchange when working in a group. In this case, uncertainty is connected to issues like trust and shared understanding

- To the task

Uncertainty is caused by the complexity of the task given and the process that is appropriate to follow in order to solve the problem

[15] In decision making this means that the participant will feel not comfortable and safe enough to express in an open and creative way. However, in Smart Support uncertainty to the task is eliminated by providing clear instructions at all levels of the decision making process and through the simplicity of the tasks which do not require a certain level of expertise. As for uncertainty to the individual and the social context, these two are eliminated by the use of anonymous feedback and content sharing.
A very important factor of providing the clear instructions mentioned before is giving the basic guidelines of what is required for a successful marketing plan. In the following chapter this chosen guideline is being explained in more detail.

Marketing plan

As stated by [22], a company decides through strategic planning what it wants to do in short or long term period. Marketing planning involves choosing marketing strategies to help the organization reach its goals. A marketing plan could have many different forms and structures. However, a typical marketing plan, in one form or another it contains or it is being built on the following major sections. More specifically, this outline is used mainly for product or brand marketing planning which is also relevant to our tool. Later on (page 57), it is been shown how this structure is being used in helping the users of the tool in grading the ideas of the others.

Executive Summary: Presents a brief summary of the main goals and recommendations of the plan for management review, helping top management find the plan's major points quickly

Current marketing situation: Describes the target market and the company's position in it, including information about the market, product performance, competition and distribution.
This section includes the following:

- A market description that defines the market and major segments and then reviews customer needs and factors in the marketing environment that may affect customer purchasing.
- A product review that shows sales, prices and gross margins of the major products in the product line.
- A review of competition that identifies major competitors and assesses their market positions and strategies for product quality, pricing, distribution and promotion.
- A review of distribution that evaluates recent sales trends and other developments in major distributions channels.

Threats and opportunities analysis: Assesses major threats and opportunities that the product might face, helping management to anticipate important positive or negative developments that might have an impact on the firm and its strategies.

Objectives and issues: States the marketing objectives that the company would like to attain during the plan's term and discusses key issues that will affect their attainment.

Marketing strategy: Outlines the broad marketing logic by which the business unit hopes to create customer value and relationships and the specifics of target markets, positioning and marketing expenditure levels.
Action programs: Spells out how marketing strategies will be turned into specific action programs that answer the following questions: What will be done? When will it be done? Who will do it? How much will it cost?

Budgets: Details a supporting marketing budget that is essentially a projected profit-and-loss statement. It shows expected revenues and expected costs of production, distribution and marketing. The difference is the projected profit. The budget becomes the basis for materials buying, production scheduling, personnel planning and marketing operations.

Controls: Outlines the controls that will be used to monitor progress, allow management to review implementation results and spot products that are not meeting their goals.

What is a GDSS

[2] A group decision support system is a computer-based system that provides solutions to unstructured problems through the interaction of decision makers who work in a group. There are four basic components that are used to support groups of people in the context of a meeting and these are the hardware, the software, the participants and the processes.
The most important characteristics of a GDSS could be described briefly as:

1) A GDSS is a system designed especially for its purposes and it is not a setup of already existing systems.
2) It is designed to support decision makers in a meeting setting. It should help them improve their decision making process and outcomes in comparison to when the GDSS is not being used.
3) The way it is designed enables the user to easily understand how it works. It gives the ability to all kind of users with any computer based knowledge to use it.

4) It can be focused on only one very specific target group of users or it can be adjusted for all kind user groups
5) The way the GDSS is built does not encourage the development of negative behaviors or miscommunication.

As we understand a GDSS can be built for a really broad variety of decision making groups like committees, task forces, board meetings or remote workers. The setting in which a GDSS is used can vary too. It can be used in one single location such as a marketing meeting for defining a marketing plan or remotely with the use of telecommunication channels for recruiting future employees or product selling. Because of the broad possibilities a GDSS offers, we should focus on the group activities it supports and the collaboration among participants. The group activities that usually occur and the GDSS actually takes over are three:

1) **Information retrieval**
   This function includes the selection of existing data values (e.g. numerical) or general information (e.g. feedback) from a database.

2) **Information sharing**
   This activity is responsible for displaying the data to the group members on a shared screen or on the computer screen of selected users in the group.

3) **Information use**
   This function refers to the technology of the tool, the processes and techniques used by the group in order to help them reach a decision.

The technology of the GDSS

[2] Below a typical structure of a GDSS can be seen. This figure is a generalized representation where the group members have access to a database a model base and a GDSS software. This involves at least one computer, one device for input and output and a viewing screen. The facilitator is responsible for the correct use of the technology by the group with also a user friendly interface. Even though from one GDSS to another there are various configurations provided, the basic components they share are the hardware, the software, the users and the processes as they are described in detail later on.

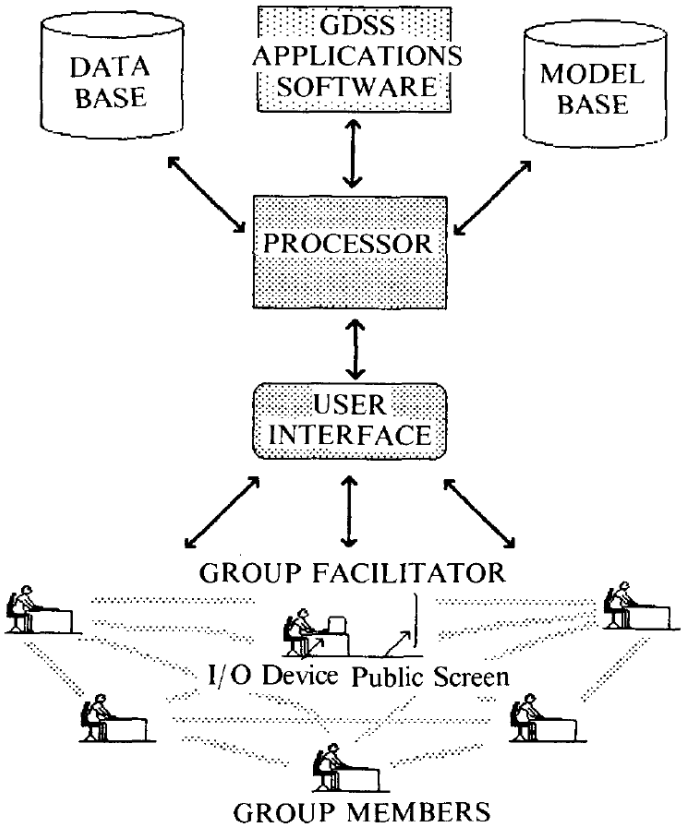


Figure 1: Generalized structure of a GDSS [2]

The hardware

[2] The possibility to have access to a computer and an information display is the same for all kinds of decision situations. The minimal requirements are: input/output device, a computer processor, a communication line between the processor and the input/output device and shared or individual monitor for displaying the information. The use of personal desktop computers, several processors and monitor and distance communication equipment are used in more sophisticated systems. The most preferred systems though is the one that will allow the user to work alone, publicly demonstrate personal work and see the work of other users. Also it is preferable if the monitors are able to display colors and graphics.

The processing power needed to support the processes of a GDSS depends clearly on the software used and the number of the participants. In case the users are using personal desktop computers then the central processing can be used to facilitate the communications between the users, the database and software applications. In the context of a traditional meeting room linking all the hardware mentioned until now might be the only thing necessary. In case of dispersed groups, the users might need a local area network, telephone lines or satellite communications in order to communicate.

The software

[2] Components such as the database, the model base, external specialized programs that are used by the group and the user friendly interface are defining the software of a GDSS. Even though some systems might not need to include a database, the most advanced and preferred systems actually do use one. The technological part that is used the most is the software application that support the group in decision making. The basic features that are mainly included in such applications are:

- The ability to create, modify and store text and data files
- The ability of training instructions for amateur users
- The ability of providing help instructions when needed
- The ability to use tools that will display text and graphs
- The ability to manage a database in a way that it will handle queries correctly and control accessibility

Besides these basic and mostly individual features there are also group features that are widely used:

- The ability to represent a summary of ideas, votes, numerical and graphical data provided by the group
- Instructions that motivate to provide text, data and votes input
- The ability to support group processes such as the calculation of weight factors, ensure anonymity of the users when sharing ideas or voting rounds
- The ability to analyze past interaction patterns of the group
- The ability to transfer text and numerical data among the group members and the central processing unit.

The users

The human component of the GDSS consists of the group members and the group's facilitator. The facilitator is able to be or not physically present during the meeting and is responsible for offering a smooth experience to the users. In the beginning the facilitator is more needed to help the users become familiar with the technology but as time passes the role of the facilitator decreases.

The processes

This component consists of various factors that enable the ease of use and effectiveness of operations. Besides the technological aspect, the processes might also include rules such as not allowing verbal interactions between the users or various rules to ensure the continuous flow of the meeting. However, a GDSS could be specifically designed to serve specific decision making techniques such as the Delphi method or social judgement analysis.

GDSS Scenarios

[2] As mentioned briefly before, a GDSS could be designed to host meetings with specific requirements. In this section 4 scenarios based on factors such as duration and physical attendance of the users are being analyzed both visually and in text.

1) Scenario 1: The decision room
   This scenario could be seen as the electronic version of the traditional meeting room. Everything is set up in a room and the participants are seated behind a desk

facing a big screen and the only person interacting directly with the computer processor is the facilitator. A more advanced version would be to also have screens in front of each individual with the public screen to be used only for presenting ideas and analyzed data. As mentioned in [2] a good way to think of this is scenario is a group of high-level managers who must decide on a marketing mix for the year to come. The process would mainly involve the facilitation of idea generation and evaluation by the GDSS and also present the current situation of the markets and the economy. The users are able to communicate both verbally face to face and through the network. A number of marketing strategies are modeled and tested before making the final decision.

2) Scenario 2: The local decision network
   In this scenario the GDSS receives a different configuration since the setting concerns a group of people who are located close to each other (same floor or building) and have to deal with problems on a regular basis. Instead of developing a fixed decision room like in the first scenario, the local decision network supports decision makers while they are working at their individual offices. Each user would have a workstation on their desk and all GDSS software would be stored on a central processor. All communications between members and the central processor will be facilitated by a local area network. Exchanging messages between the users is available also together with having access to private and public databases. An example used by [2] and that could be considered is the headquarters of an insurance company where decision making is ongoing. Financial managers, investment managers and analysts are connected to each other in a continuous and interactive mode. This enables the group members to receive information on what the others are doing.

3) Scenario 3: Teleconferencing
   The target group of this scenario is group members that are geographically distant but still need to “come together” and make a decision. In this scenario two or more connected decision rooms are needed. If for example an international company has offices in Amsterdam and in London, then meetings could be arranged without members being all together in one single location. The advantage of teleconferencing are the reduced time and costs.

4) Scenario 4: Remote decision making
   The fourth scenario could be considered as an optimized combination of scenarios 2 and 3. The scheduling and coordination of meetings is considered a drawback in scenario 3 which is removed in this one. For example if a member needs help he or she can send a notification requesting a meeting (e.g. in 10 minutes) and that will appear on the workstations of the other group members. Everyone is then informed about the problem and the decisions to be made.

Ideally I would prefer the fourth scenario of remote decision making. Smart Support is currently developed based on the second scenario of local decision network but after the integration with Cisco Spark it will fully support scenario number four.

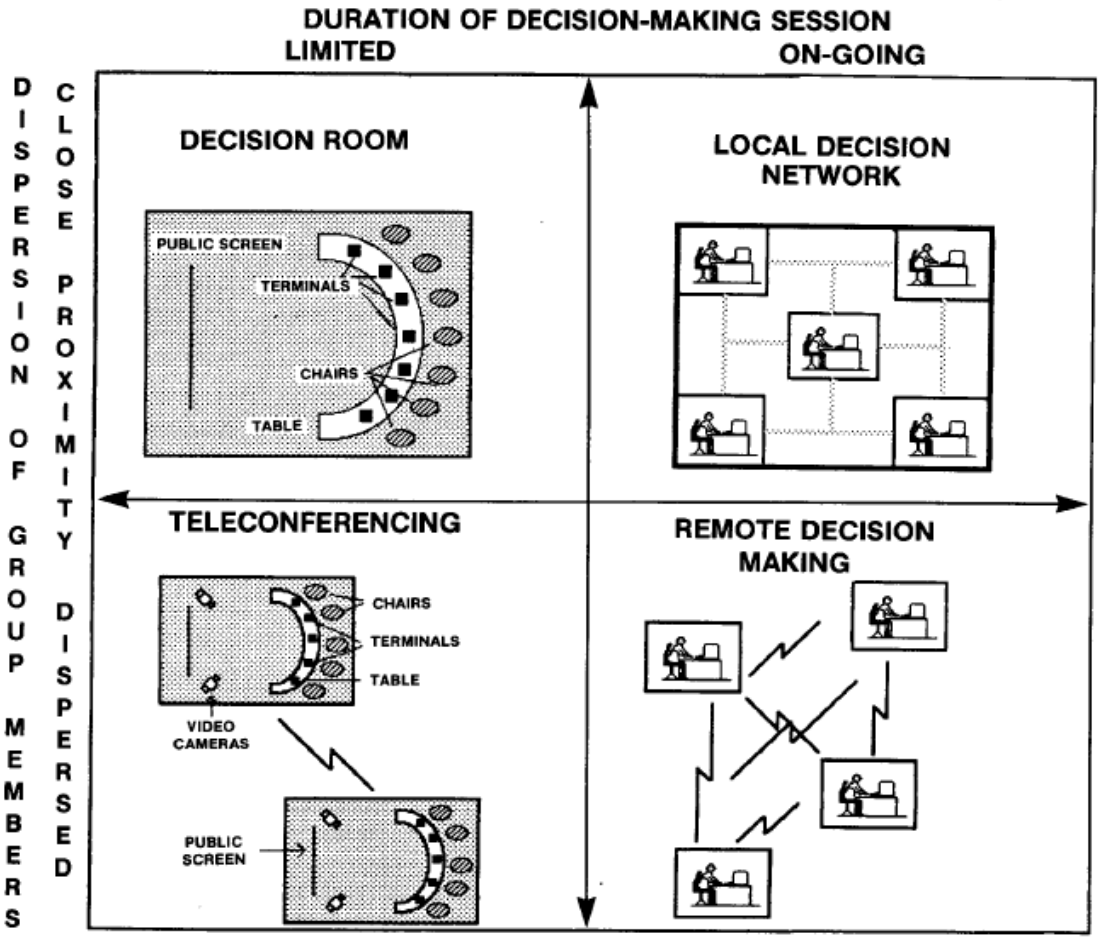


Figure 2: Visual representation of the 4 GDSS scenarios [2]

Impact of GDSS

GDSS from the point of view of information exchange

[3] One of the main goals of the tools supporting group decision making is to optimize the collaboration among group members while they proceed through the problem solving process. Our tool is envisioned to optimize collaboration by motivating the group members to participate more through anonymous interaction. Besides that, the users will get all the tools to enhance their idea generation and through feedback, grading and dealing their ideas the final decision will include parts from the idea of each group member. If the GDSS only automates the processes as they would without it then the impact of the tool is very small. However, if the system defines processes such as the user, the order and the time limit of speaking then the impact increases dramatically. By taking such initiatives the system aims to improve the outcome of the meetings and alter the structure of interpersonal exchange.

Patterns of information exchange

[3] In the process of a meeting it has been observed that interactions constantly change. The only consistent interactions observed are two that dominate during the meeting. The first one is seen as task oriented which means that the participants just want to make a

decision and finish the meeting and the second one is oriented towards social needs such as agree/disagree or solidarity/antagonism which are also the most possible interactions during a meeting. The level of emphasis on these two interactions changes while the meeting progresses and the participants are trying to balance between getting the job done but also keeping the group consistent.
In Smart Support this balance is provided by the tool itself and the participants do not have to put any effort in that. Smart Support actually helps the participants to keep performing on the same level by not allowing them to proceed faster in the meeting and skip rounds quickly while motivating them to collaborate by giving them the possibility to fulfill their social needs by giving them the opportunity to agree or disagree with other participants through the process of feedback or to compete with them based on scores of their ideas and also express themselves freely with the safety of anonymity.

Relationship between psychological climate and work performance

[5] In this section different psychological states such as safety, meaningfulness and goal clarity and their connection to the work performance of individuals and the group is being analyzed. These states were chosen because they have been shown to explain effort and performance of work groups but also of individuals participating in group meetings.

Safety

[5] When the environment provided by the GDSS seems secure, predictable and trustworthy then the users also feel psychologically safe. This allows them to try to operate more and feel safer that if they fail there won't be any consequences. Work motivation and better performance are being increased by this sense of security and flexibility but also the group members feel more committed to the team and try to accomplish the meeting's task. This leads to better and closer collaboration among the group members in order to find a solution upon which almost everyone will agree. In Smart Support the feeling of safety is provided through anonymity and also clear instructions by the facilitation.

Meaningfulness

[5] Psychological meaningfulness is the state when people believe that they are valued by the other group members and also make the difference in the group. This reflects the amount of effort people invest in tasks based on their interests, needs and expectations. However, these underlie the need of people for power and influence in the group. In a GDSS this perception allows users to believe that their input will affect the decision making process and this eventually increases their involvement in the processes. As a result, users with higher psychological meaningfulness will have a higher task performance and the group will perform better. This makes the feedback function of Smart Support that consists of giving feedback to each idea based on the marketing criteria mentioned before and that is described later in that chapter, a very important part of the meeting process.

Goal clarity

[5] It is generally supported by the Action Regulation Theory that the work behavior is mainly goal directed and influenced by the internal goals set by each individual. This determines the actions of the users since their attention and effort are guided towards the desired goal. However, in order for this to happen the goals should be clear and specific. This means that if the task-goals are clear to the user and these are close to the individual's personal goals then there is a possibility that the user will put more effort and complete the

tasks successfully. As a result, this increases the user's commitment and sets goal clarity as a very important variable in a GDSS. The importance of goal clarity and defining the goals of the group and how these will be achieved, leads us to the theory of Adaptive structuration explained next and which focuses on the importance of being able to restructure and adapt the GDSS based on the needs of the team.

Adaptive structuration theory (AST)

[6] The term of AST refers to the process during which a group of people adopt a new technology like a GDSS or any other technology used by a group and is used to explain that a group might restructure a GDSS in order to fit its needs. Being actually the evolution of social practice it implies that the possibility of failure to re-structure might be bigger if the group does not have the appropriate decision structures. As a result, in order to reach better outcomes the use of a facilitator in the group can help guide the group to successfully adopt the GDSS technology. The use of AST is important to explain the process of technology appropriation, the how and why facilitation might impact the decision outcomes.

Decisional guidance

One of the key factors for the successful use of a GDSS is to use a facilitator. A facilitator carries out several activities in order to help the meeting group to successfully use the GDSS and these are separated in pre-meeting, during the meeting and post-meeting actions as described in detail below [6] [7].

Pre-meeting

i) The facilitator introduces the GDSS to the group members
ii) The facilitator defines the agenda of the meeting with the topics and activities of the meeting
iii) The facilitator defines the roles of the participants during the meeting
iv) The facilitator has to identify and formulate the problem that will be discussed during the meeting
v) The facilitator defines the rules of the process
vi) The facilitator is responsible to define the time limits of the meeting

During the meeting

i) The facilitator needs to manage the processes in a way that will promote effective task behaviors
ii) The facilitator is responsible to keep the participants focused on the agenda and guide them toward the desired outcomes by helping them execute the agenda successfully to accomplish the task outcomes
iii) The facilitator needs to define the list of criteria to be used by the group and clarify the meaning of each one of them
iv) The facilitator is responsible for the transition to the evaluation stage
v) The facilitator is responsible to explain the scoring process and make all the required calculations based on the criteria defined
vi) The facilitator is responsible to identify the final group decision

Post-meeting

i) The facilitator is responsible to wrap-up the meeting
ii) The facilitator is responsible to present the results that led to the final decision
iii) The facilitator is responsible to generate post-meeting reports

However, human facilitation consists of a set of reflections on the personal and professional experience of the facilitator and this makes it even more difficult to train one. Based on this, a software facilitator (decision guidance) seems to be a better choice to guide the users towards the successful structuring and execution of the meeting. So, as mentioned before, facilitation is a key to unlock the participative spirit of the GDSS and shape the appropriation of the technology.
Based on that, Smart Support uses a built-in facilitator to coordinate the meeting. By doing that, Smart Support reassures the flow and continuity of the meeting and that marketers will only focus on their tasks. However, there are different types of facilitation. These differences are based on how much the work of a participant depends on the work of another participant. These types are explained next in the theory of Interdependence.

Interdependence

[16] In the past there has been a lot of research on interdependence and three types have been included in theory: pooled is the type of loose collaboration where each unit performs separate functions, sequential is the type where the outcome of one unit is needed for the functions of the other unit and reciprocal is the type where the outcome of one unit becomes the input of another. These three types might be a good fit for man-machine design but they are not sufficient for covering the details of close collaboration between man and machine and their joint task work. This joint activity is described as when the actions of an individual depend on the actions of another individual. Then we say that the individuals are interdependent. Yet, we need to predict the individual's behavior and this is best done with the help of agent-based models.

Agent-based models

[12] The main function of an agent based model is to model specific behaviors of individuals or groups and analyze the outcomes on a system level. In capturing socio-technical systems, an agent based model is suitable for flexible and autonomous action. In detail, such models allow the simulation of different scenarios in order to understand how people act based on the decision rules established by them or their environment. [21] In this research project, each household is modelled as an agent with its own characteristics and opinion. An agent's opinion is being formed based on the satisfaction with a smart-energy meter and decides whether or not they would like to purchase one. [21] The decision making process is modelled according to the structural equation model calibrated with the survey data, using the set of coefficients for the various factors as weights. This means the simulation model takes the data from the survey as input and uses a behavioral model to predict the response of each individual. Then you are allowed through smart support to change variables and observe the impact on the individual's decisions.

Man-Machine interaction

[13] Humans and machines have a relationship of completing each other. On one hand humans are restricted by their limited capacity in the information they are able to process but they are superior in spatial, heuristic and analogical reasoning. Also, typically, the working memory of a human can hold approximately seven elements for a few seconds and process simultaneously two or three elements. On the other hand, machines are able to continuously gain expertise and get problem solving knowledge from humans to improve their performance. [14] As a result we understand that by allocating functions reasonably between man and machine with the appropriate automation level we will realize not only the human's advantages like intuition, experience and initiative but also these of the machine like high processing speed and accuracy when combined all together.

Advantages of the man	**Advantages of the machine**
The ability of being creative, flexible and adaptable in solving problems	The ability to visualize data
The ability of learning and collecting experience	The ability to store and manage large quantities of data
The ability to predict accidents	The ability to function continuously for a long time
The ability to communicate complex information in various ways	The ability to deal with complex mathematical operation continuously for a long time
The ability to make decisions in shorter time due to experience, intuition or instinct	The ability of high computational speed
The ability to control errors	The ability to make highly accurate calculations
The ability to perceive external environment as a whole	High cost-effectiveness ratio
The ability to describe and classify	The ability to work under harsh conditions
The ability to know when a satisfactory decision has been made and stop the process resulting into saving computational resources	The ability to make better predictions due to the procedure set

[14] It is generally argued that man and machine are of cooperative relationship. Functions might not be completed by the man or the machine individual but only through their cooperation. This relationship can be described by different levels of automation, ranging from fully manual to fully automated. In between, the level of automation is being increased gradually as described below:

1) The system does not provide any assistance and the users need to complete everything on their own
2) The system defines the decision making plan
3) The system narrows the scheme selection
4) The system makes a proposal

5) The system executes the plan after the users have agreed
6) The system implements automatically if it is not necessary to notice the users
7) The system decides if the users need to be noticed before acting
8) The system decides on its own and blocks any intervention from the users

The way Smart Support is designed right now would fit better in the second level of automation where it actually defines the process and the steps to be taken. Nevertheless, Smart Support is built in such a way that it could easily be upgraded to any of the levels mentioned above.

Coactive design

[16] Coactive design is a new way to approach man-machine relationship and which takes interdependence as the core principle of this interaction. The goal of the coactive design is to support designers to identify all the interdependence relationships in order to help them design systems to fulfill the objectives of coordination, collaboration and teamwork. Coactive design brings to the surface three new requirements that need to be fulfilled by the designer: observability, predictability and directability.

- Observability

This requirement is about making aspects of the knowledge of individuals in the team, observable to the others. This allows also individuals to interpret the signals received.

- Predictability

This requirement is considered to be one of the most important facets in human-agent interactions and is about making the actions of each user predictable so that other users will feel safe to rely their own actions on them.

- Directability

This requirement is about directing someone's behavior and at the same time being directed by the behavior of others. Allocating tasks, assigning roles, giving guidance or warnings are some of the ways directability is being implemented.

These three requirements consist the OPD (Observability, Predictability, Directability) framework which is used to help designers answer questions such as "What information need to be shared?" or "Who needs to share with whom?". The goal of the OPD framework is actually to help the designer support interdependence.

The design of Smart Support is based on this principal of coactive design. In Smart Support we see that the actions of each marketer participating in the meeting depend on the actions of the others. All three aspects of the OPD framework were taken under consideration during the design. Observability is fulfilled by sharing the ideas and the feedback among the group while predictability and directability are provided through the facilitation of the meeting by providing warnings and instructions throughout the whole process. The marketers have exactly the same tasks so they know what to expect from the other group members and at the same time they direct each other to the final decision.

Professional learning

Professional learning has always been a popular topic in literature but its focus was mainly on schools and teachers. However, there are many points that are useful and could be translated and used in an organizational environment such a group meeting of marketers.

[18] Professional learning is defined as changes in an individual's knowledge, skills and way of thinking. If this is done effectively then it increases not only the learning curve of the individual but also the chances for long-lasting changes in practice. Besides that, it is suggested that if the individuals work together then it is more likely that they will implement changes in practice and also collaborative work builds trust among professionals. As supported by [18], professional learning does not need to come from experts but from individuals with a level of expertise since it is observed that professional learning can also come from professionals who are just willing to learn more by using data.

For marketers with the help of Smart Support this means that through effective collaboration their learning curve will increase including knowledge, skills and way of thinking which will result in enhanced decision making process. Smart Support will enhance all these through its supported features. All the individual participants during the meeting, work and collaborate together. By allowing them to share ideas and knowledge but also form their own ideas based on the knowledge and ideas of their peers, the individuals increase their knowledge, collaboration skills and also enhance their way of thinking.

Part 3

GENERAL INFORMATION OF SMART SUPPORT

GENERAL INFORMATION OF SMART SUPPORT

System Overview

Smart Support is a computer-based group decision support system designed to enhance collaboration between marketing professionals. Its purpose is to host meetings and help marketers be more open and creative. The tool allows the participating marketers to gain inspiration from their colleagues, elaborate more on their ideas and also motivates them to help each other. The main purpose of this section is to explain in general terms the system and the purpose for which it is intended. The description shall include:

- **Major functions performed by the system**

  Facilitation

  Smart Support is built in such way that no external human support (facilitator) is needed to use it. More simply, the role of the facilitator is taken over by the computer itself. It is responsible to explain the rules and give guidelines to the participants. Yet, the most important part is that it is completely automatized which means that it takes the participants from one phase to another without requiring any additional actions from them. Furthermore, the tool itself informs the participants about the remaining time for each round/phase.

  Interactions/Knowledge sharing/Feedback

  The interface of the tool allows all participants to share their ideas and knowledge with each other. The system behind the interface is responsible to collect these, store them and know where to send each one of them. Except from ideas, the tool is also responsible for collecting and storing the feedback given for these ideas and make all the needed connections.

  Agent based modelling with the use of Repast

  An agent based modeler is used to describe a system. The system consists of various individual actors whose behavior is represented by an agent. That behavior is being observed on a system level but it could also be observed on an individual level. The agent is being situated in some environment in which he can be flexible and autonomous. This approach is suitable to be used for observing socio-technical systems. In our case we use scenarios to model and observe the behavior of agents and not the outcome of their actions.

  Data collection

  Through the tool's interface, the participants are able to evaluate the ideas of their colleagues by grading specific aspects of their ideas. The grades given are collected and stored by the system. The system itself is responsible to know which grades are connected to which user and which idea.

Calculations

After all the data needed has been collected, the system is responsible to know when to use them in order to announce the winning idea and user. The system that runs behind the interface is responsible to calculate the sum and the average of the grades collected not only for the whole group but also for each participant individually.

- **Description of the architecture of the system in non-technical terms**

The architecture of the system is pretty simple and it consists of:

The database

A database is being used to store and manage all the data given by the participants during the meeting process. The database is connected with the computers of the users.

The server

The database mentioned before is functioning on a server. The server is responsible for the connectivity of the database with all the computers using the tool during the meeting but also for the two-ways communication. Besides that the server allows the meeting to take place with distributed participants. In our case , the server connects marketers who are allowed to be distributed in a small area but still only through the local area network (LAN). A small area could be rooms next to each other, different floors in the same building or even different buildings in the same campus but not for participants in located in different cities or countries because then we need a wide area network connection (WAN).

The interface

The graphical user interface is the medium that allows the participants to communicate with each other through the server. Its role is actually to translate the commands given by the users in language understandable by the computer, the server and the database. The interface is at the same time also the facilitator of the meeting since it provides information, instructions and help at any stage.

The agent based modeler

Smart Support is combined with an ABM. This allows the participant to model data from real surveys and generate graphical illustrations representing their behavior in three different scenarios.

- **Responsible organization**

  Smart Support was built as part of a graduation project supervised by Maarten van der Sanden from the Science Communication department at the Technical University of Delft and Koen van Dam who is a fellow researcher at the Imperial College of London.

- **System name or title**

  The name given to the tool is “Smart Support”

- **System code**

  The main program languages used for the development of Smart Support are Java and SQL. Java has been used for the creation of the graphical environment and the agent based model. In order to achieve the communication between the database and the interface SQL language was used. SQL was also used to develop the database. The connection of the tool with the server is being done with the use of Java language and the use of the local IP address of the local area network the computers are connected to. In the APPENDIX is given the code used together with implemented alternatives that could be changed to serve the needs of the participants in case the present graphical environment is not preferred. These alternatives can be found in the form of comments.

- **System category**

  Smart Support belong to the category of the major applications since it performs clearly defined functions for which there is a readily identifiable security consideration and need

- **Operational status**

  Operational beta version. The tool has been completely developed and it is operating as a beta version.

- **System environment or special conditions**

  The only special condition that should be taken under consideration when using Smart Support is that due to a minor incompatibility between the versions of development of the agent based model and the graphical interface is that when the agent based model is being opened automatically by the tool, it should not be closed by the users because this command will terminate the whole process. So, as it is being explained later on visually the user should not only execute the program and just follow the automated process without closing any of the frames opened.

Points of Contact

In this section a list of the points of organizational contact (POCs) that may be needed by the document user for informational and troubleshooting purposes.

Information & Troubleshooting
Type of contact: Administrator
Contact name: Christos Tsiourakis
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Type of contact: Administrator
Contact name: Maarten van der Sanden
Department: TU Delft Science Communication
Telephone number: 0031 15 27 83055
E-mail address: M.C.A.vanderSanden@tudelft.nlmailto:M.C.A.vanderSanden@tudelft.nl
mailto:M.C.A.vanderSanden@tudelft.nl
Type of contact: Administrator
Contact name: Koen van Dam
Department: Imperial College London
E-mail address: k.van-dam@imperial.ac.ukmailto:k.van-dam@imperial.ac.uk
mailto:k.van-dam@imperial.ac.uk

Acronyms and Abbreviations

GDSS: Group Decision Support System
ABM: Agent based model
LAN: Local Area Network

SYSTEM SUMMARY

SYSTEM SUMMARY

The purpose of this section is to present a general overview of the system and outline the uses of the system in supporting the activities of the user and staff.

Smart Support was created to support marketing professionals in the energy industry to collaborate more and efficiently in order to make better decisions in this period of energy transition. For the tool to be able to do that successfully, the following technical components were combined and used:

A database is being used to store and manage all the data given by the participants during the meeting process. The database is connected with the computers of the users. The users write with the use of the keyboard on their computers and the tool automatically saves and updates their input in the database. Furthermore, when the participants are grading the ideas of their colleagues they do not have to keep track of the grades they give or calculate anything. All calculation are being done automatically by the database.

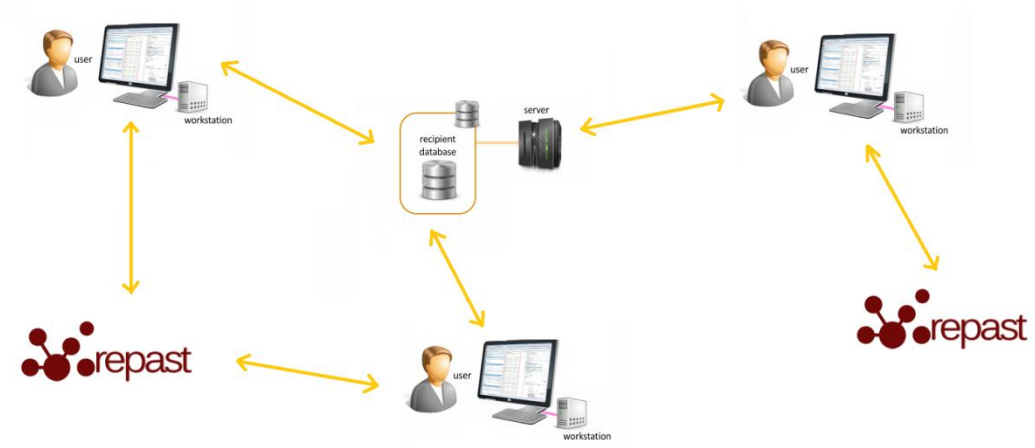
The database is hosted on a server. The server is responsible for the connectivity of the database with all the computers using the tool during the meeting but also for the two-ways communication. Besides that the server allows the meeting to take place with distributed participants connected on local area networks (LAN).

An agent based modeler called Repast is being used to simulate the roll-out of smart meters to households based on surveys answered by people. The participant is able to model the behavior of agents (e.g. clients) in different scenarios in the Repast interface.

The graphical user interface is the medium that allows the participants to communicate with each other through the server. Its role is actually to translate the commands given by the users in language understandable by the computer, the server and the database. The interface is at the same time also the facilitator of the meeting since it provides information, instructions and help at any stage.

System Configuration

In this section the equipment, communications, and networks used by the system are graphically depicted



Data Flows

The first data given by the user is the login name and the password. These are confirmed with the database which then sends back to the user a confirmation or rejection message. Later on, the user receives some headlines from the database based on which he/she has to develop the idea. The same time the user is able to send data for each scenario of the agent based model. The agent based model then makes the calculations based on the factors given and returns generated graphs. Then the ideas of the other users which are stored/saved are generated one by one. For each one of the headlines given before a grade is given but also a general feedback on the idea. These are sent to the database for calculation. Then the grade received, the average grade of the group and the feedback received are sent back to the user and displayed on the screen. After that a loop process begins by displaying all data displayed until now on the user's screen in order to proceed.

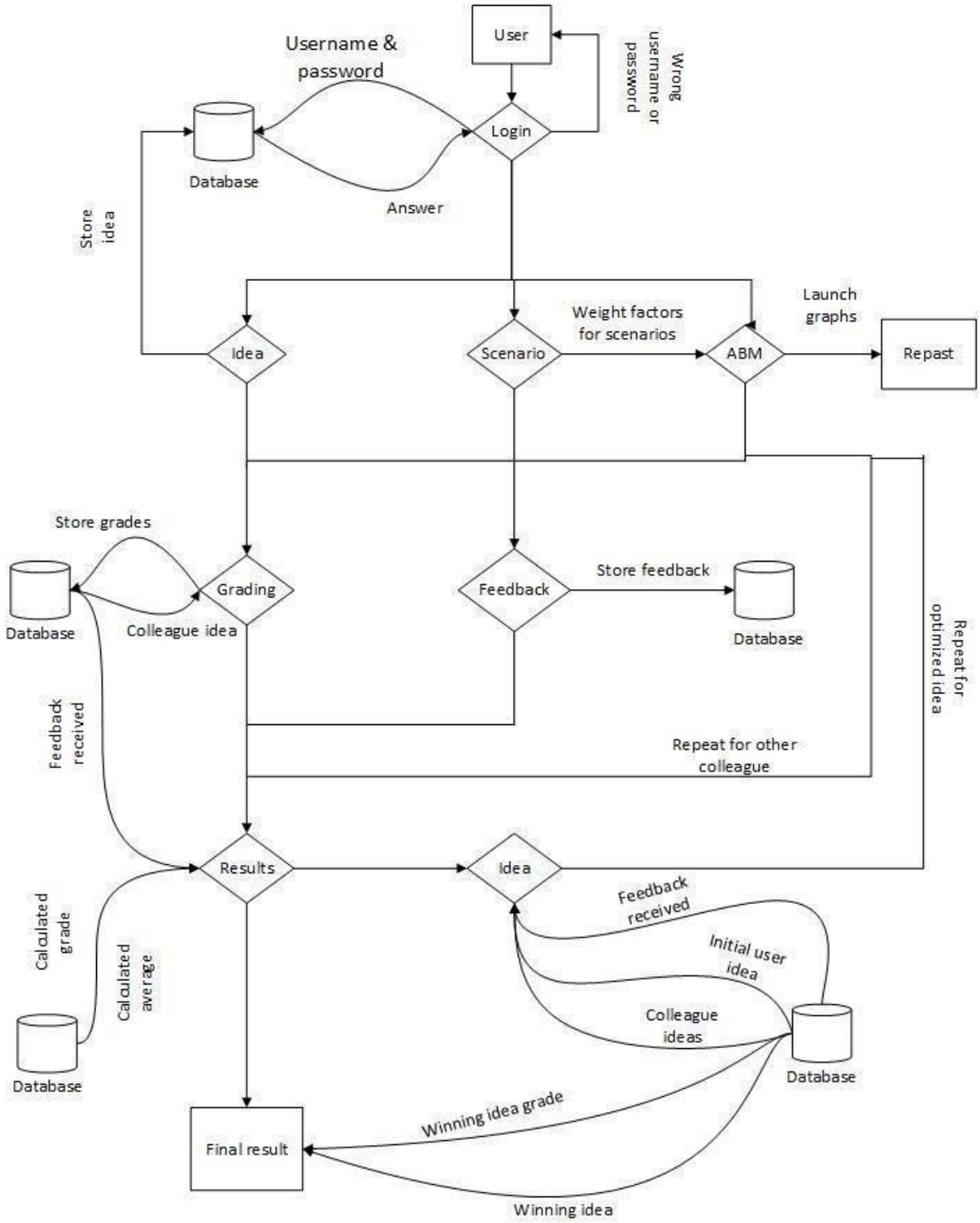


Figure 1 Data flow chart

User Access Levels

Smart Support is designed for marketing professionals so the users will be marketers from the energy sector. The users have direct access only to the graphical interface. The system behind the interface that consists of the database, the server and the agent based model is accessible only by the facilitator.

The user is able to give grades and feedback only to the ideas generated by other group members. The possibility to grade his personal idea has been blocked. Until the last round when the winning idea and the grade received for that idea are being announced to all participants, the user is not able to see the grades neither the feedback given to the other participants, only the average group grade.

The last and most important restriction is that the tool provides full anonymity. The user is not able to see which idea or feedback belongs to which participant. The automated process of the tool that guides the user through the meeting eliminates also any possibility of knowing which idea belongs to which user by looking at who is typing on the computer and who is not.

Contingencies and Alternate Modes of Operation

When Smart Support is being used, the continuity of operations in the event of emergency, disaster, or accident is assured. The reason of choosing to use a database on a server to store the data is the security and safety. In any case that the meeting is disrupted by either internal or external factors, the participants will not lose any data. The reason for that is that during the meeting after the end of each round the data is automatically saved to the database. Something like a checkpoint. So, in case of emergency no data is being lost. However, the participants in order to continue their meeting will have to start the tool from the beginning and let the timer get them to the moment when the meeting stopped.

Overview of the translation of collaboration aspects into design requirements for Smart Support 2.0

Feedback of other participants on each idea generated	The design requirement for this aspect is translated in a text box where the participant gives feedback to the presented ideas. Details can be found in Part 3,Round 2
Social comparison between the ideas of participants	The design requirement for this aspect is translated in two text boxes where the participants are able to optimize their ideas while looking at other ideas. Details can be found in Part 3, Round 5
Anonymity of all participants	The design requirement for this aspect is translated in a randomly given username. Details can be found in Part 3, Round 1
Marketing plan	The design requirement for this aspect is translated in a text box where the participant is able to answer the pre-specified questions. Details can be found in Part 3, Round 1
Uncertainty management of the task	The design requirement for this aspect is translated in a text box where the participant is able to read step by step instructions about the process of Smart Support. Details can be found in Part 3, Introduction

GETTING STARTED

GETTING STARTED

This section provides a general walkthrough of the system from initiation through exit. The logical arrangement of the information shall enable the users to understand the process of the system. Throughout this section print screens will be used to support visually the description. For better understanding the walkthrough is being done through the eyes of 'user1' in a meeting of 3 users.

Login

When Smart Support is launched the first screen appearing is the Login form requesting a username and a password. In the case we are going to test the tool, the username and password are already assigned for various users. After these fields are filled in the user will have to press 'Enter' in order to access the tool and start the automated process.

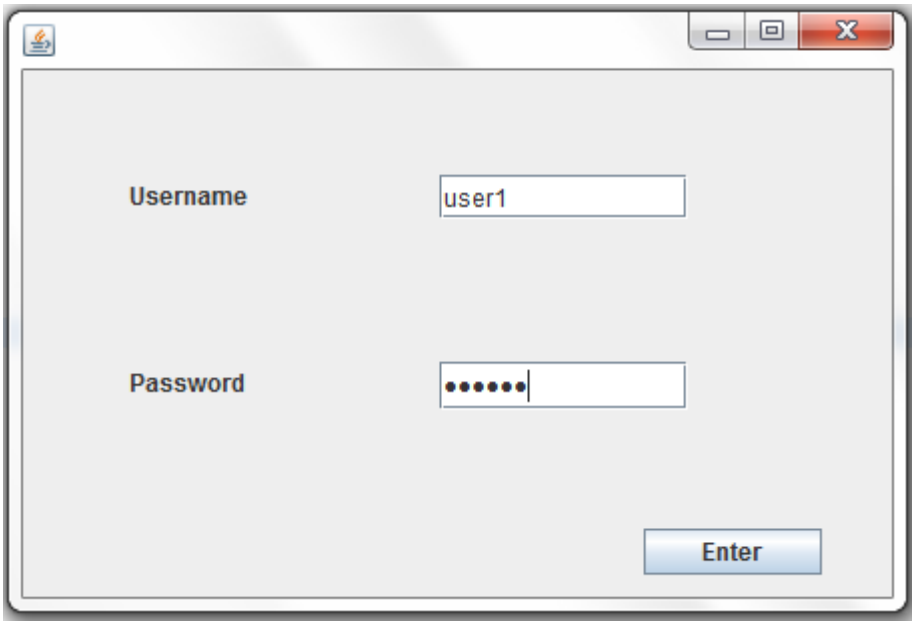


Figure 2 Screen shot of login interface

In case one or both of the fields have an incorrect input then the user receives a message "Wrong username or password. Try again!".

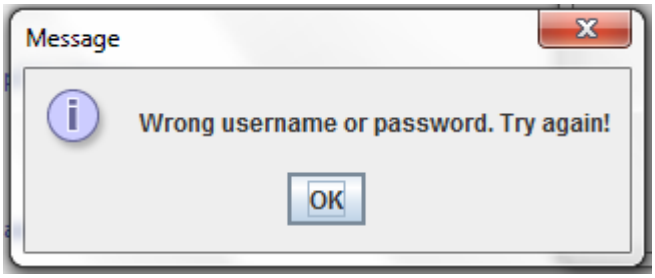


Figure 3 Screen shot of error message

System Menu

The purpose of this part is to present a detailed walkthrough guide through all the functions of the tool and prepare the user about what to expect.

Introduction

When the user has successfully logged in the tool the first screen appearing is the Introduction screen. The purpose of this function is to provide the user with a text explaining the basic functions and actions that he will have to do at each round of the meeting process. On the upper right side of the frame there is a clock counting down. For each round the starting time of the clock is different due to the difference in actions needed for each round. In each round when the countdown reaches the time limit of two [2] minutes then it turns red in order to warn the users that the time for that round is running out. This is critical for the users since the transition to the next round is being automatically done without any additional warning. For this specific round the time given is six (6) minutes, which is enough for the participant to read the instructions carefully.

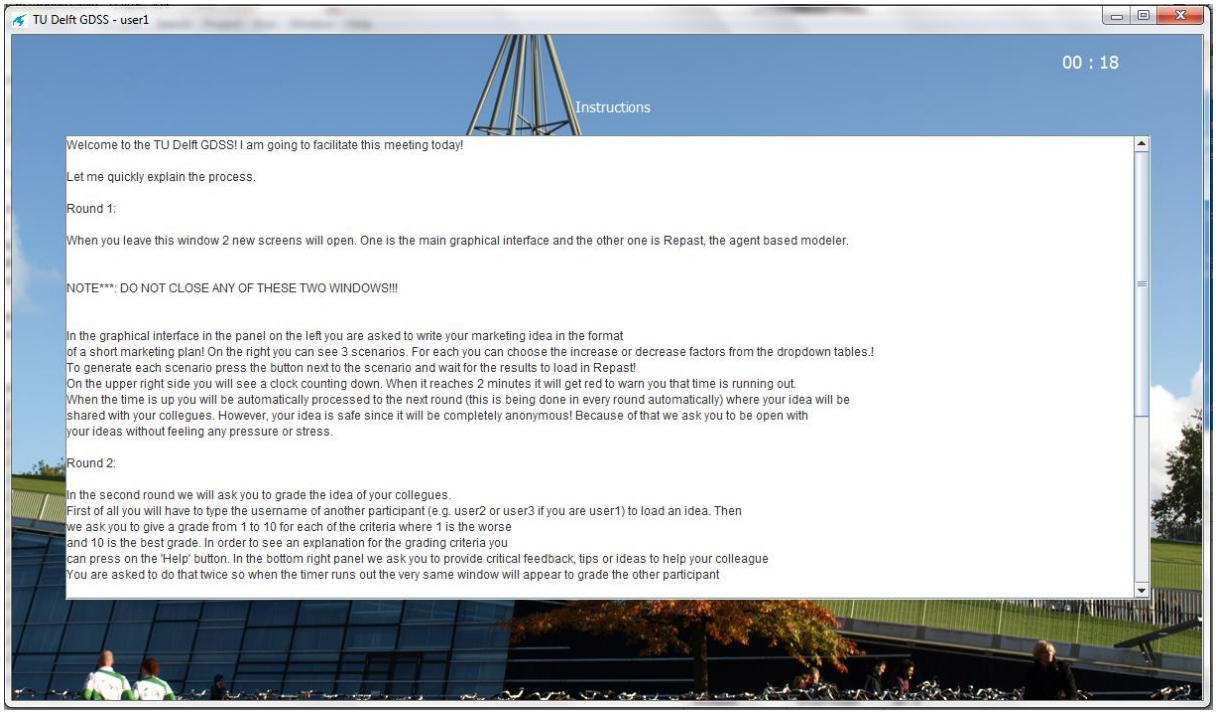


Figure 4 Screen shot of introduction

Round 1

After reading the instructions the first round will begin and two new frames will appear on the user's computer screen. The first one is the main graphical interface the marketer is using. On the left side of that screen there is a panel containing 8 headlines. These are the main factors that are taken under consideration by marketers during a meeting. Based on these the participating marketer is asked to write a marketing plan or idea but it is not compulsory to focus on these. On the right side of the screen the user will see 3 scenarios: 1) Increase Appreciation 2) Increase Financial Stimulus 3) Decrease Financial stimulus and increase sustainability. For the first two scenarios there is one drop down table for each and

for the third one there are two drop down tables. The values for all the drop down tables are the same and have a range from 5%, 10%, 20% and the values increase with the same rate up until 150%. For each scenario there is a 'Generate' button. Every time the user makes a change in the values of the scenario he will have to click on that button in order to see the new results. The results are shown on Repast, which is the second screen opened in the beginning of this round. Once again in this round and like in every round we have a clock counting down and the transition to the next round is being done automatically by the tool when the time runs out. For this round the time given is 20 minutes.

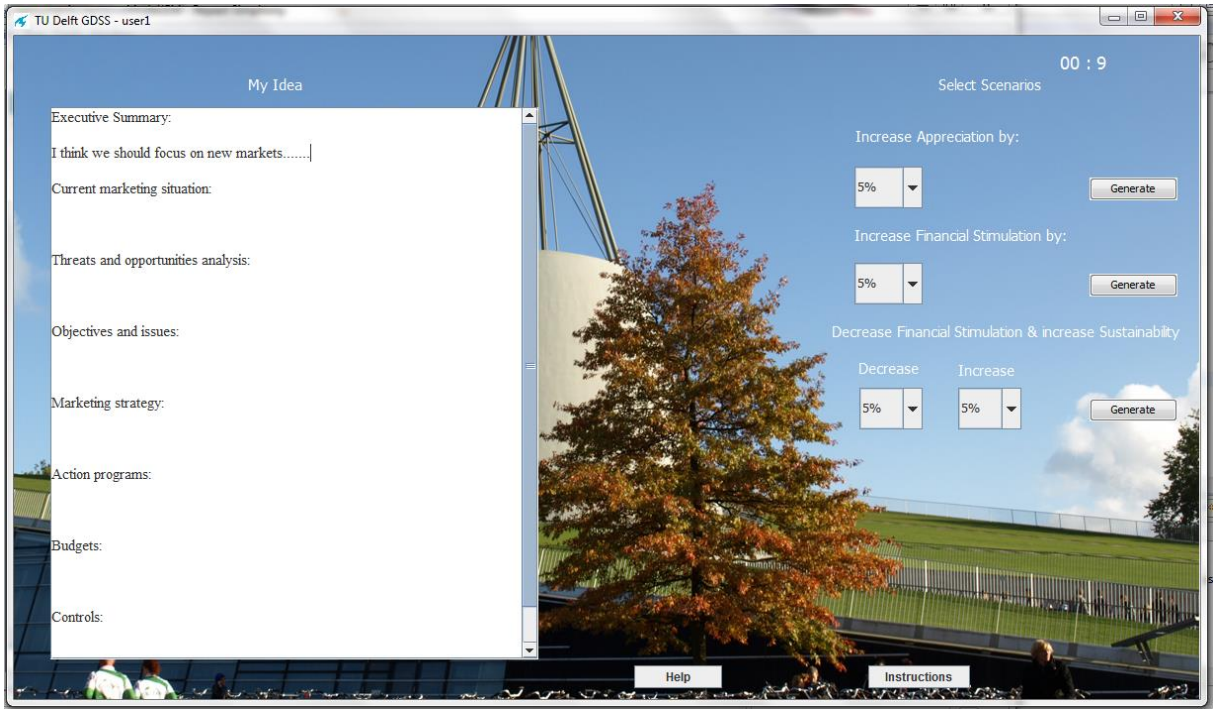


Figure 5 Screen shot of marketing plan generation interface and Repast control buttons

At the bottom of the screen we have two more buttons. The one is 'Instructions' and when the user clicks on it an extra screen open with the instructions given in the introduction of the tool. The purpose of that is on one hand to prevent the user from stressing out in case of forgetting something and on the other hand to give a continuous flow in the experience of the tool by the user. This button will be available at any moment during the meeting.

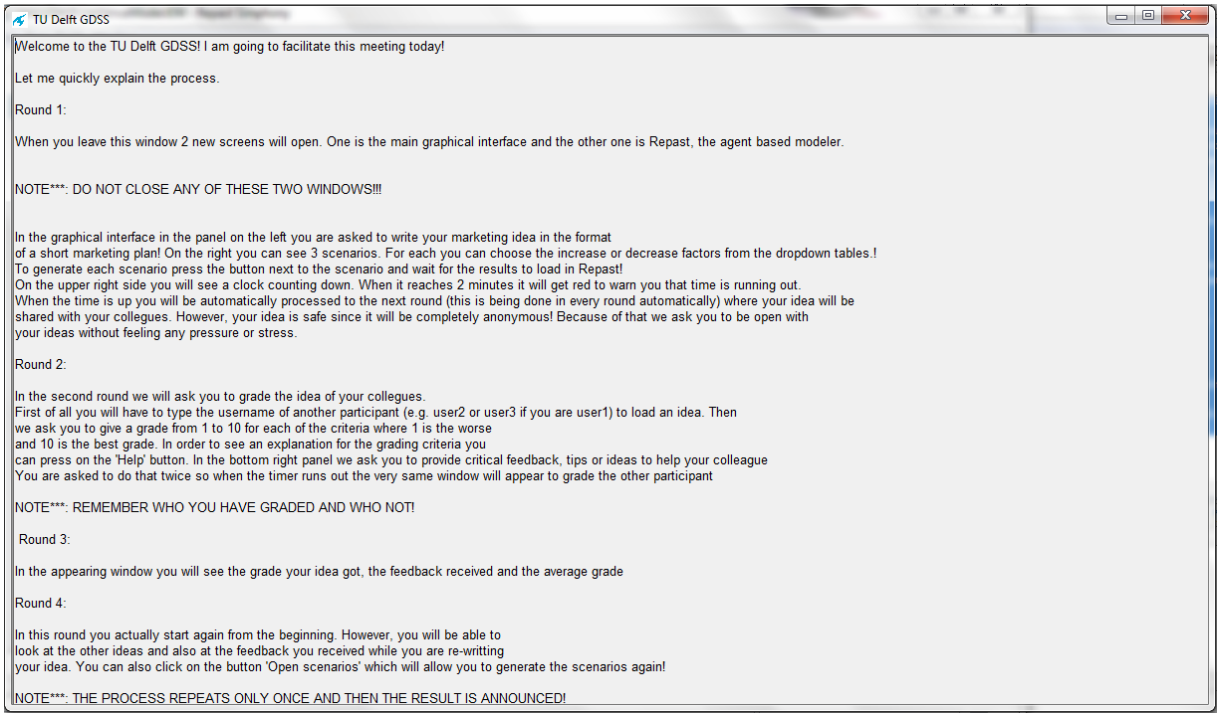


Figure 6 Screen shot of instructions pop-up window

The other button is ‘Help’ and this one will be provided to the user only when needed. Just like the ‘Instructions’ button, when the user clicks on it an additional screen appears with detailed explanation for each of the marketing factors based on which the marketer builds the marketing plan or idea.

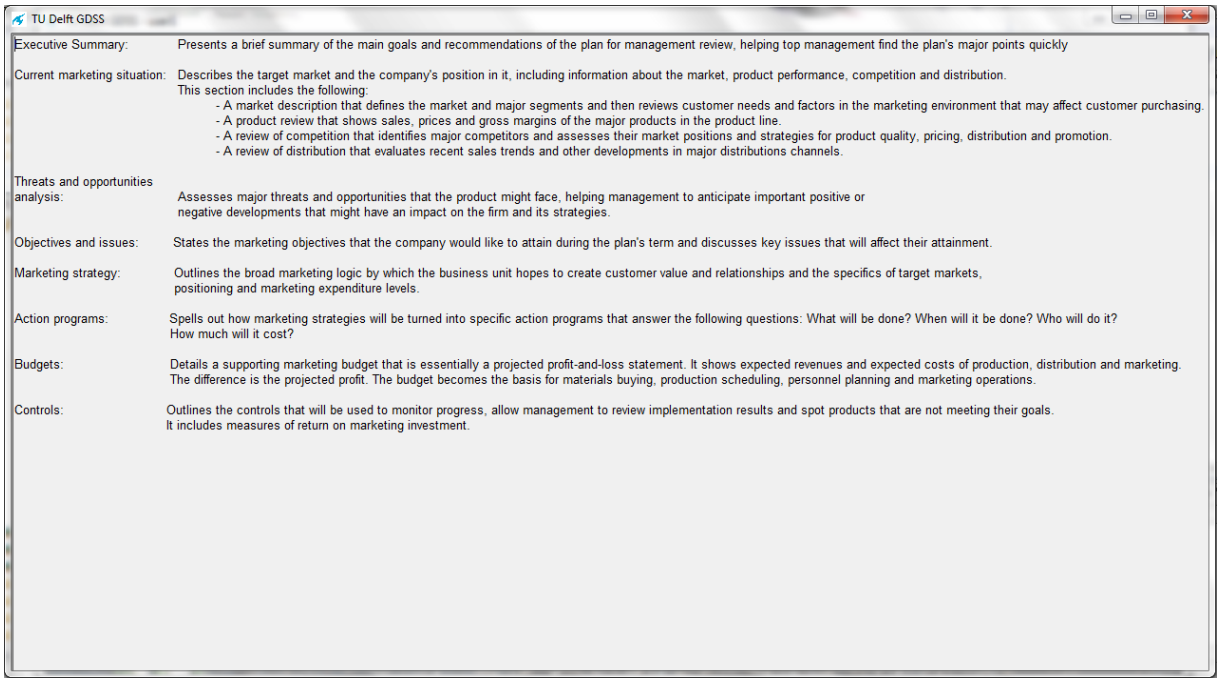


Figure 7 Screen shot of marketing objectives instructions

Scenarios

The following scenarios are being compiled based on data collected about the intention of adopting smart energy meters, smart plugs and smart thermostats. The main constructs used are:

i) Increase Appreciation

ii) Increase Financial stimulus

This scenario refers to the degree to which one wants to act more sustainable to: “save money” and “keep control of my energy bill”

iii) Decrease Financial stimulus and Increase Sustainability

Repast

Repast is the program used to develop the agent-based model mentioned in the beginning. [21] In Repast each household is modelled as an agent with its own characteristics and opinion. An agent’s opinion is being formed based on the satisfaction with a smart-energy meter and decides whether or not they would like to purchase one. [21] The decision making process is modelled according to the structural equation model calibrated with the survey data, using the set of coefficients for the various factors as weights. This means the simulation model takes the data from the survey as input and uses a behavioral model to predict the response of each individual. Then you are allowed through smart support to change variables and observe the impact on the individual’s decisions. [21] Even though the survey questions used a 5-point scale, a 10-point scale is being used in Repast for the predicted behavioral intent. In that scale it is assumed that a value of 6.0 or higher represents a positive attitude towards adoption of the technology. In this section are explained the most useful tabs the user will have to look at while generating scenarios in Repast. The results shown below are totally random.

Routine use from model

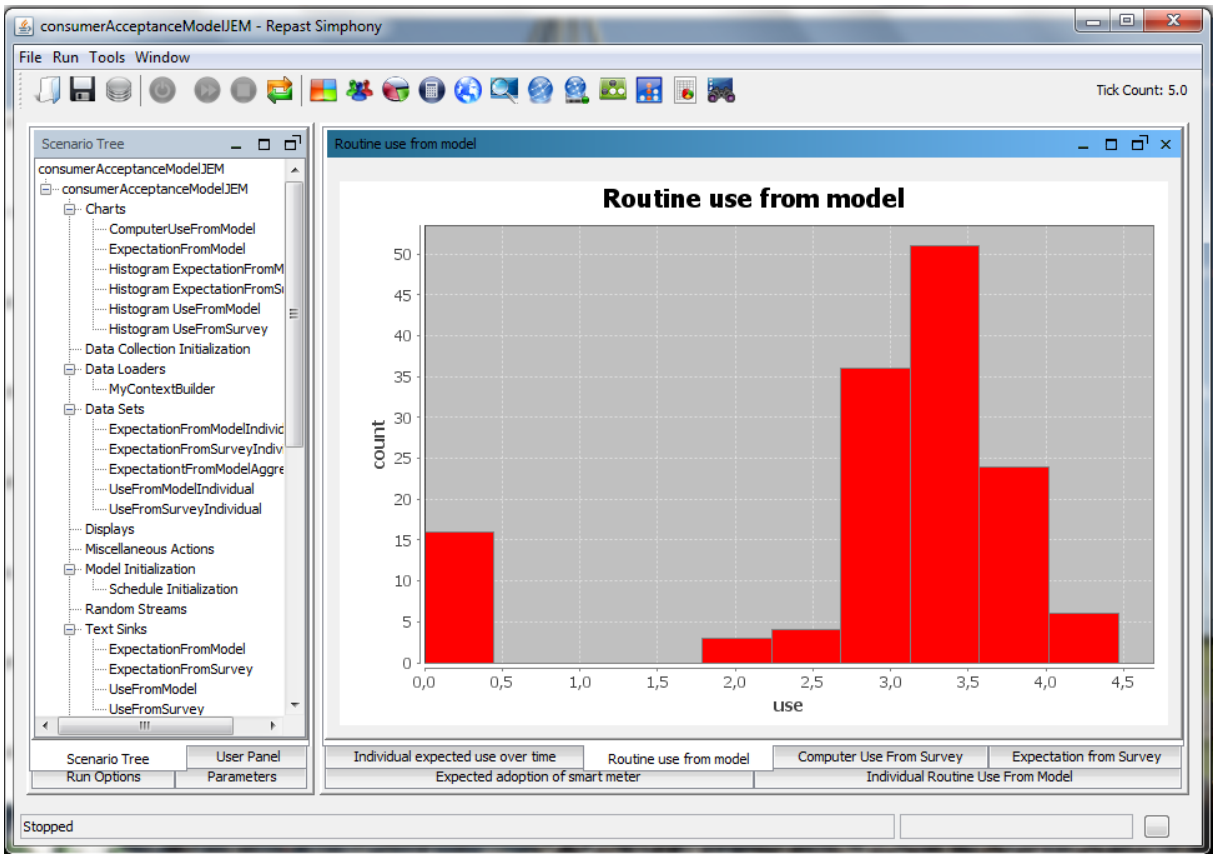


Figure 8 Screen shot of Repast generated graphs

Expected adoption of smart meter

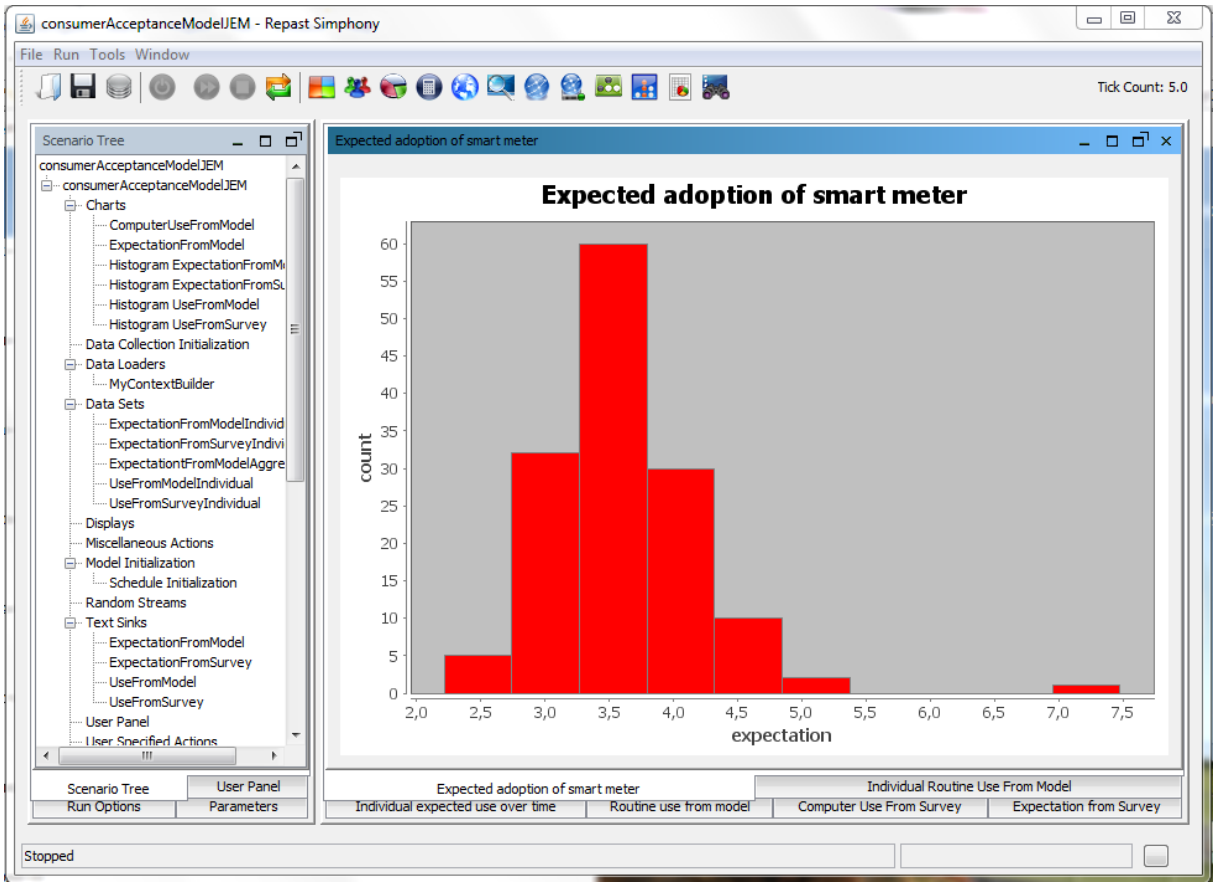


Figure 9 Screen shot of Repast generated graphs

Expectation from survey

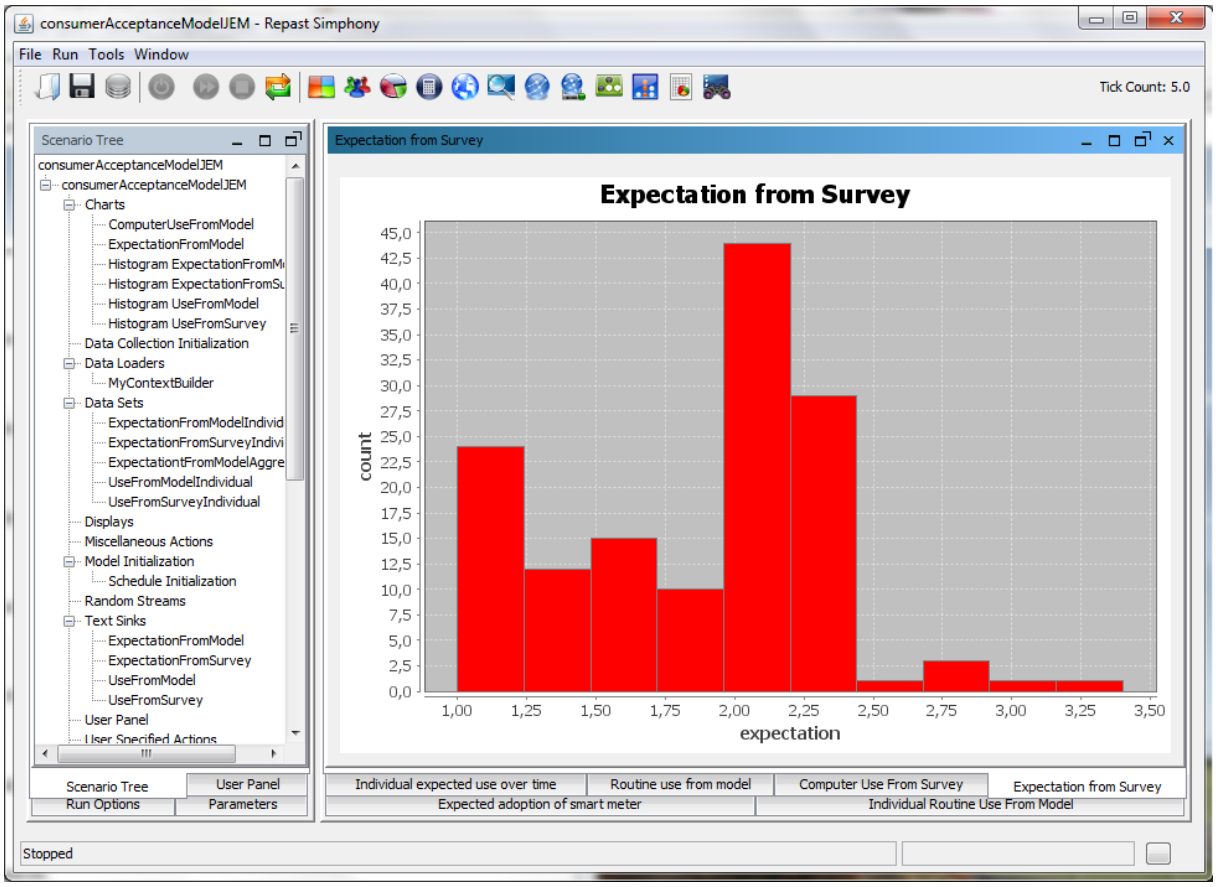


Figure 10 Screen shot of Repast generated graphs

Individual expected use over time

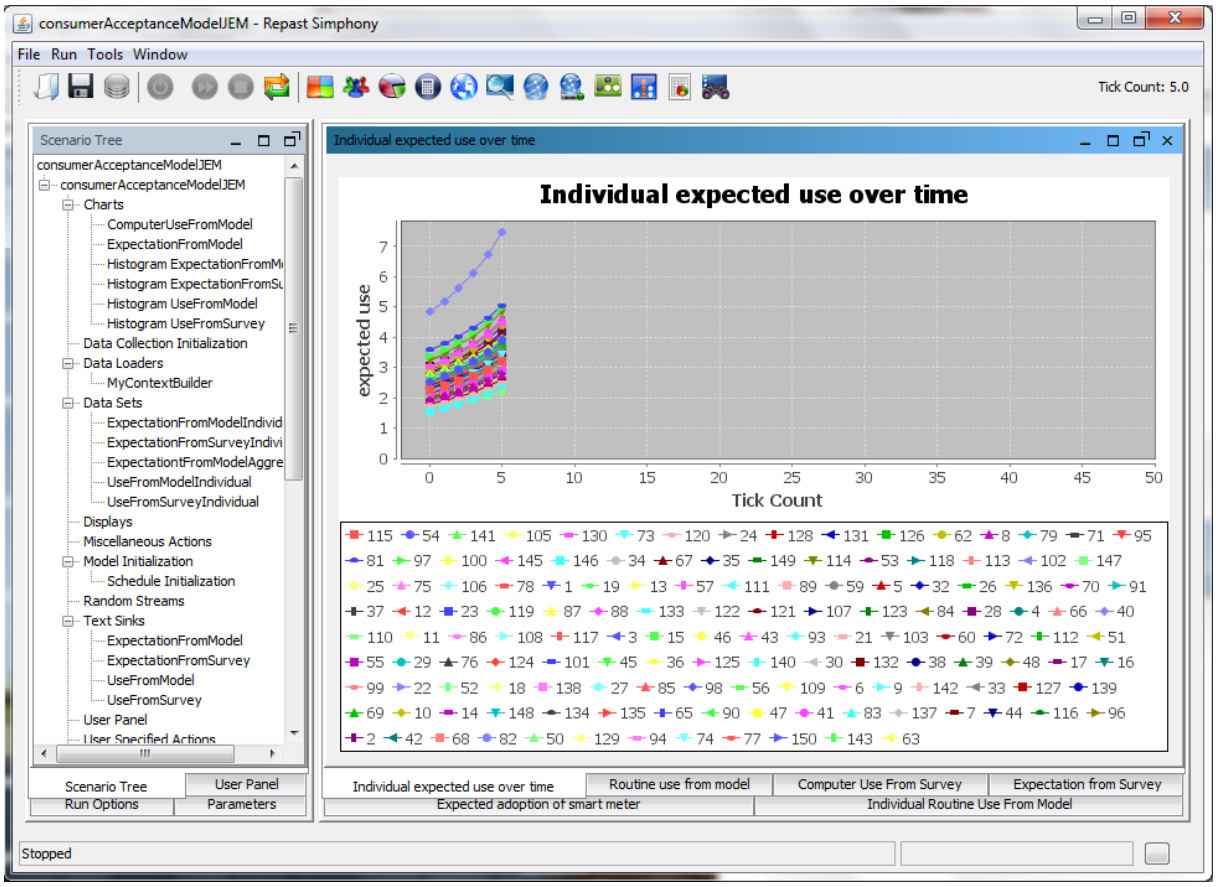


Figure 11 Screen shot of Repast generated graphs

Round 2

Once the time is up and the idea of the user is submitted then the grading phase starts. The screen that appears contains on that search field, the marketing factors with a text field next to each one of them and two empty panels. The most important part is the search field. The user will have to type the username of one of the other two participants. Once this is done automatically one of the two empty panels and specifically the upper right one get filled with text. That text is the plan or idea submitted by that user. The user then will have to read it carefully and type a grade for each of the marketing factors. The possible given grades from 1, 2, 3…until 10 with one [1] being the lowest and ten (10) the highest score. Besides the grades, the user is asked to also submit personal feedback in text. The purpose of this feedback is to encourage the fellow participant to elaborate more on his idea. This can be done by providing ideas, tips or advice on how to optimize the idea in the next round. The user is asked to do that by starting with the phrase “I like your idea but for the next round please pay more attention on the following”. ‘Instructions’ and ‘Help’ buttons are also provided here. The user is asked to complete these tasks in 12 minutes before being redirected to the next round.

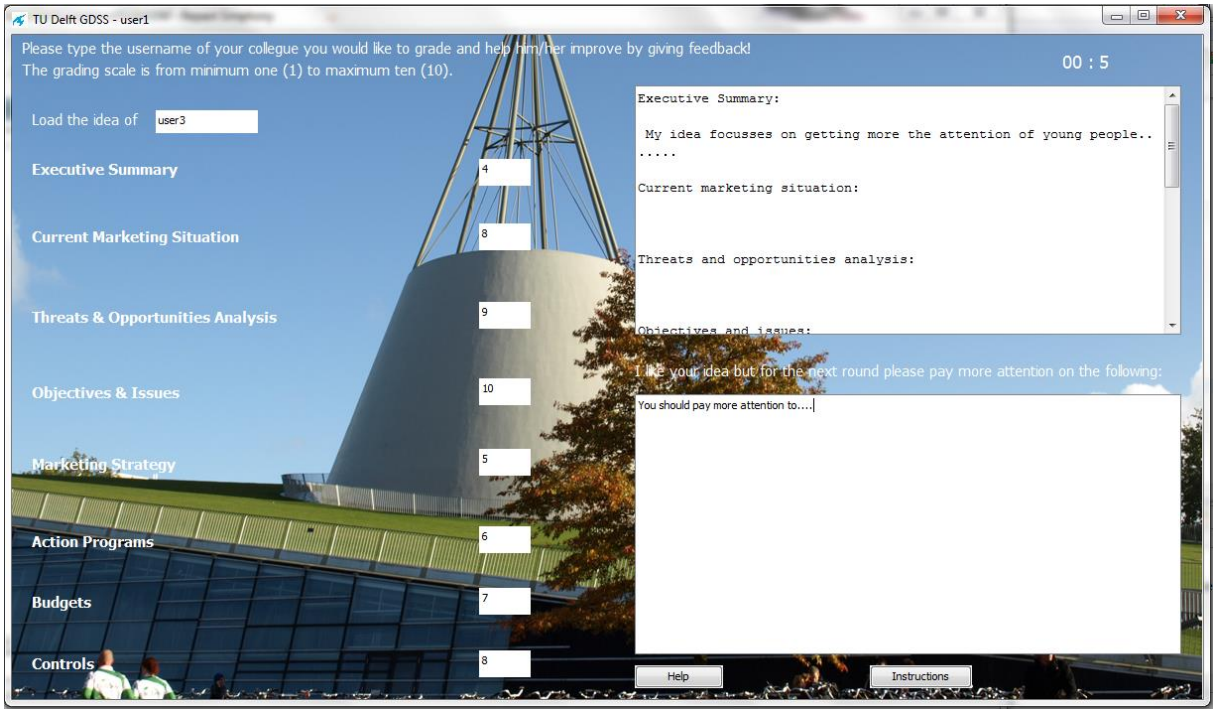


Figure 12 Screen shot of grading and feedback interface

Round 3

This round is identical to the previous one. This time though the user will have to 'load' the idea of another colleague different from the previous one.

Round 4

When the user reaches this point, the first phase has been officially completed. A new frame appears and it automatically loads the grade the user received and the average grade of the group meeting. On the screen also appear two large panels which show the feedback given by the other participants. When all these happen, based on the group performance and also the individual performance a message appears on the screen. If the user has scored better than the average group grade then the message appearing is "You are doing great! Keep up with the good work!. If the individual performance is worse the user get the message "Don't worry! Use the feedback given and you will score higher on the next round!" For this round the estimated time needed is three [3] minutes.

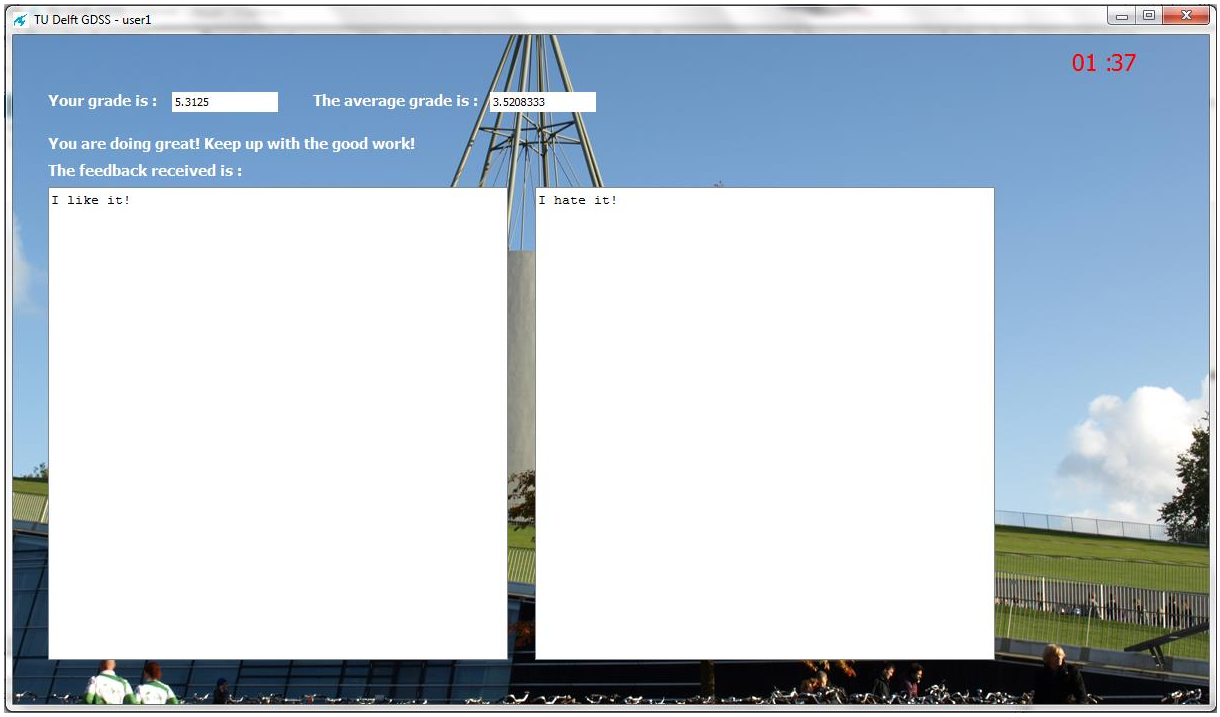


Figure 13 Screen shot of participant's grade

Round 5

This is the most critical moment. When this round starts and the new screen appears the second and last phase starts. The participants should focus and use everything they can in order to optimize their plan or idea. It is up to them to do that since the tool provides everything at this round. On the left of the screen there are two [2] panels showing the initial ideas of the other participants. In the middle there is a large panel with the user's initial idea, ready to be updated and optimized or even erased and written all over again. On the right side there again two [2] panels with the feedback received during the previous rounds. In this round the 'Instruction' and 'Help' buttons appear again to support the user and the meeting when needed. The estimated time needed for this round is 25 minutes.

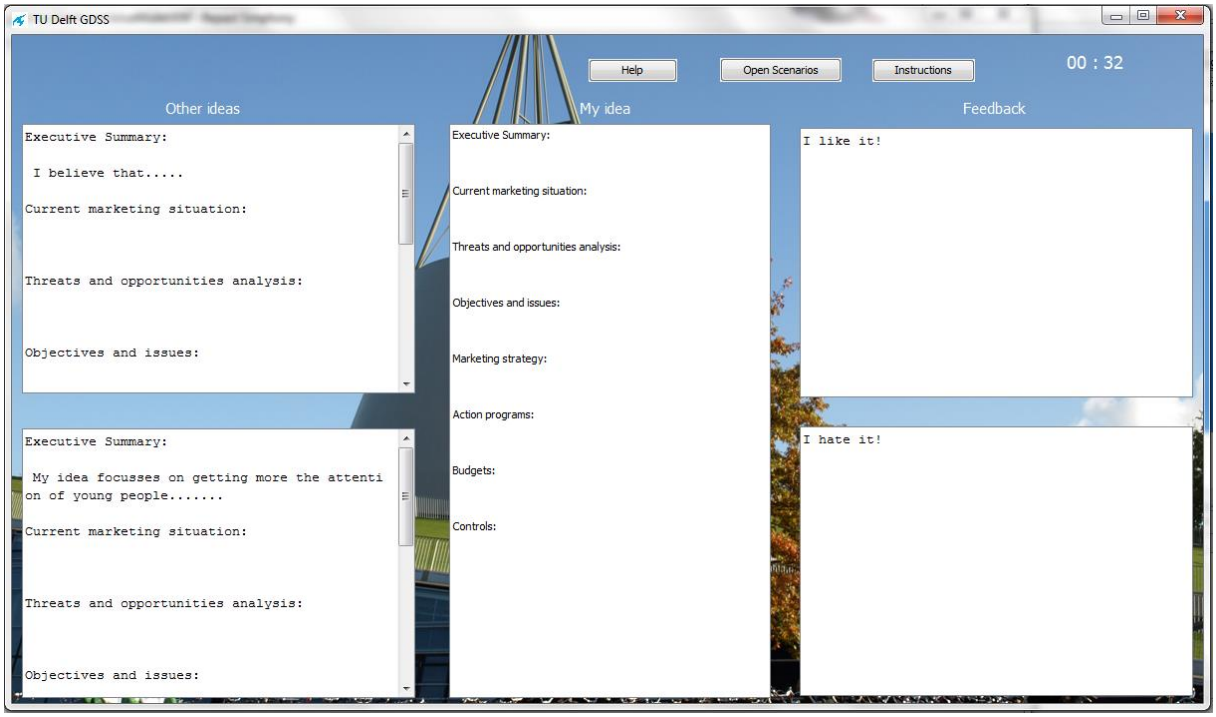


Figure 14 Screen shot of assembled ideas and feedback received for further idea improvement

In this round there is also one extra button called ‘Open scenarios’. While Repast stays open during the whole meeting the user is not able to simulate the scenarios at any time. Here the user is able to click on that button as many times as needed in order to simulate the scenarios in Repast and use the results in the plan or idea.

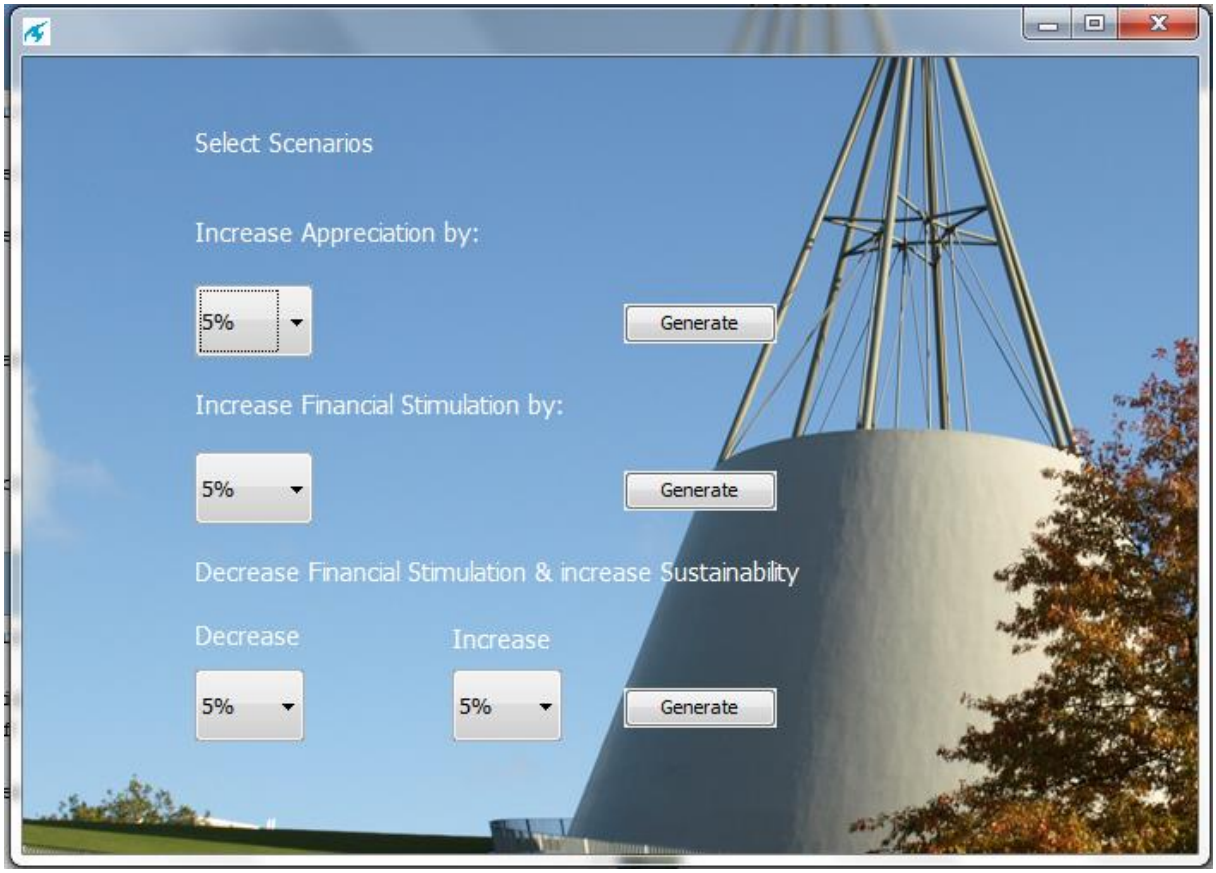


Figure 15 Screen shot of Repast control interface

Round 6

When Round 5 finishes then the user is asked to repeat the exact same steps as in Round 2 and Round 3.

Round 7

Just before the finish line the user gets the opportunity to receive the new grade and feedback received for the second phase of the meeting. After three [3] minutes the users are sent to the next round.

Round 8

All users get to see the same for the first time during this long but productive meeting. Decision is made! On the new frame that appears the users get to see the winning idea and the grade that gave the first place to this idea. In this round there are no time limits. The users are able to stay as long as they want and discuss further steps of this idea.

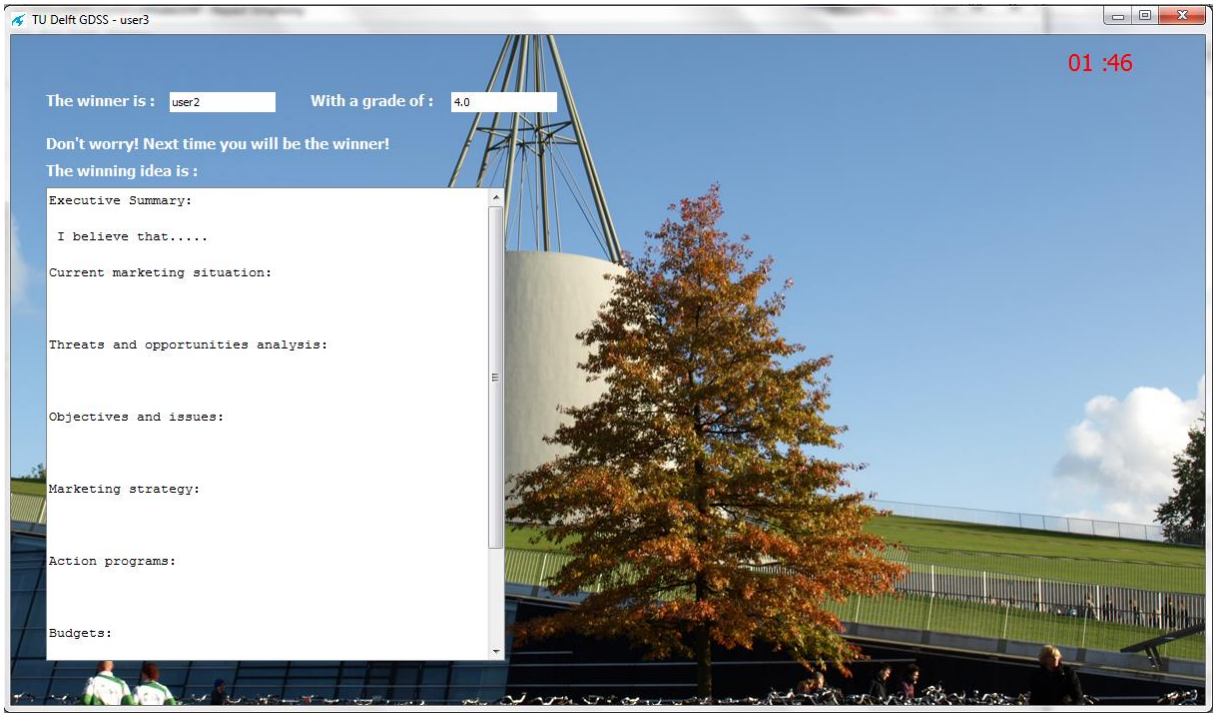


Figure 16 Screen shot of winning idea

Things to be careful with

This particular section is very important for the meeting to have a continuous flow. As already mentioned, two screen will be open during the whole process. The one is the main graphical interface which changes automatically and the other one is the screen of Repast which is the agent based modeler. The user should never close any of these two screens because this will terminate the user's process and it will also cause problems to the other participants. The only screen the user will be able to close manually the screens opened by clicking on the following buttons: 'Instructions', 'Help' and 'Open Scenarios'.

Exit System

The user will not have to do anything specific before exiting Smart Support. All data is being saved automatically by the tool itself. In Round 8 when the winner is being announced the users can stay and discuss as much as they want about the result and its future development. In order to exit the tool they just have to close the graphical interface and Repast.

QUERYING

QUERYING

This section describes the querying and retrieval capabilities (how the systems know which idea, grade or feedback is from/for who) of the system. The process necessary for recognition, preparation, and processing of a query applicable to a database is being explained in detail.

Query Capabilities & Procedures

The storage, management and retrieval of all the data inserted by the user are being done through SQL queries. These queries are used in the Java code in order to enable the communication of the tool with the database.

MySQL connection

For the tool to connect with the database we use the help of the JDBC connector. The tool can either connect on a localhost or through a local area network. The queries used for each case are:

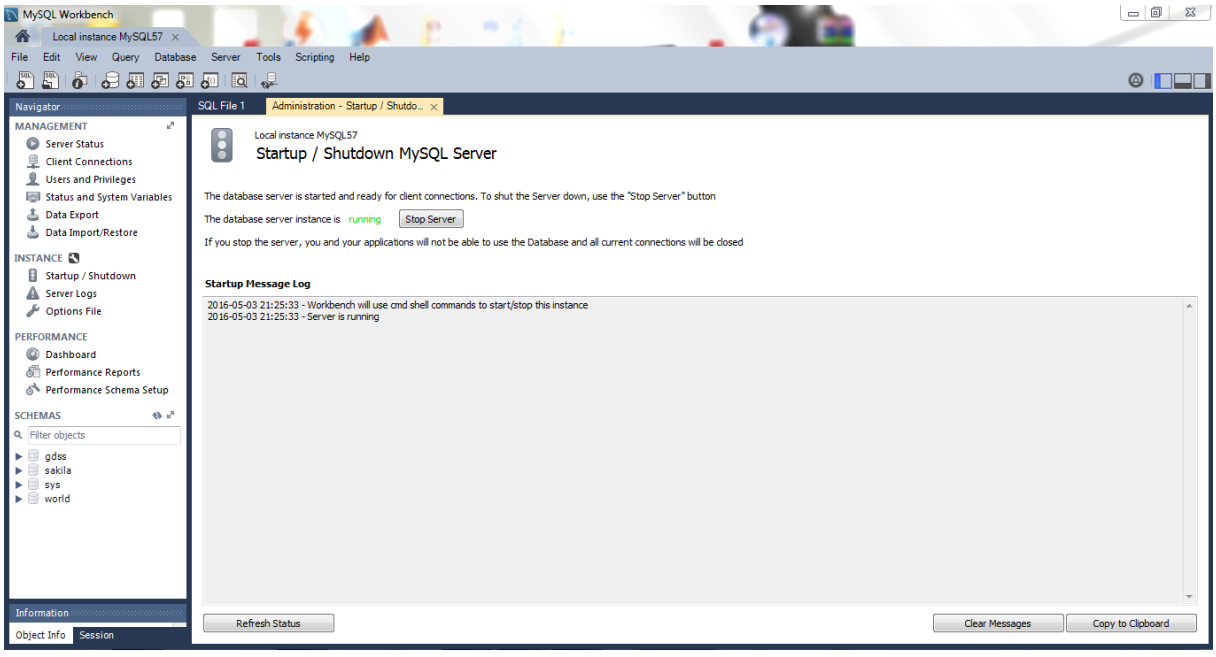
Localhost: "jdbc:mysql://localhost/database_name","root","database_password"

LAN: "jdbc:mysql://local_ip_address/ database_name ","root"," database_password"

Above, some details are hidden due to security reasons and data protection.

Login

In our case and for the ease of use of the tool we have pre-stored usernames and passwords in the database and also all the tables needed are not created through the Java code but are already created through the MySQL workbench.



When the users wants to login the tool checks in the database the given data and specifically in the table “user”. Below you can see the structure of the table in the database and the query used for authentication.

query="SELECT * FROM user WHERE username=? AND password=?"

username	password
user1	admin1
user2	admin2
user3	admin3
NULL	NULL

Round 1

In this round where the user is submitting an idea the data used are the text containing the idea and the username of the user in the table called “idea”. Below you can see the structure of the table in the database and the query used.

query="INSERT INTO idea (FromUser,Text) values (?,?)"

FromUser	Text
user1	Executive Summary: Current marketin…
user2	Executive Summary: I believe that….. …
user3	Executive Summary: My idea focusses o…
NULL	NULL

Round 2

In this round the user will have to type the username of another marketer in order to load an idea for grading. When the user has done that, the query sent to the database is show below.

query="SELECT Text FROM idea WHERE FromUser=?"

The grades given by the user, the calculated total, the username of the user to whom the grades are given and the feedback are stored in the table “gradesfirst”. Below you can see the structure of the table in the database and the query used.

query="INSERT INTO gradesfirst
(FromUser,ToUser,grade1,grade2,grade3,grade4,grade5,grade6,grade7,grade8,total, Text)
values (?,?,?,?,?,?,?,?,?,?,?,?)"

id	FromUser	ToUser	grade1	grade2	grade3	grade4	grade5	grade6	grade7	grade8	total	Text
1	user2	user1	1	2	3	4	5	6	7	8	36	I like it!
2	user3	user1	3	3	3	6	7	8	9	10	49	I hate it!
3	user1	user3	4	5	7	8	9	10	9	0	52	xalia!
4	user1	user2	2	2	2	2	2	2	2	2	16	Wonderful!
5	user3	user2	2	2	2	2	2	2	2	2	16	You need to pay more attention in the budget n...
6	user1	user2	5	5	5	5	5	5	5	5	40	You should improve the budget....
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Round 3

Here the exact same queries are used as in Round 2

Round 4

In this round multiple queries are being used for the functions of the tool to be successfully completed. To get the grade of the user from the database and show it the query below is used:

query="SELECT SUM(total) FROM gradesfirst WHERE ToUser=?"

In order to get and show the average grade of the group the query below is used:

query="SELECT SUM(total) FROM gradesfirst"

To select the feedback provided by each participant the following two queries are being used in the database:

query="SELECT Text FROM gradesfirst WHERE ToUser=? ORDER BY FromUser DESC"

query="SELECT Text FROM gradesfirst WHERE ToUser=? ORDER BY FromUser ASC"

Round 5

In this round actually all previous queries are used with some small differences as seen below.

query="SELECT Text FROM gradesfirst WHERE ToUser=? ORDER BY FromUser DESC"

query="SELECT Text FROM gradesfirst WHERE ToUser=? ORDER BY FromUser ASC"

query="SELECT Text FROM idea WHERE FromUser<>? ORDER BY FromUser DESC"

query="SELECT Text FROM idea WHERE FromUser<>? ORDER BY FromUser ASC"

query="SELECT Text FROM idea WHERE FromUser=?"

The one query that is new in this round is the following:

query="UPDATE idea set FromUser='"+UserName+"', Text='"+textFieldMyIdea.getText()+"' WHERE FromUser='"+UserName+"'"

This query prevents from creating a new table and so it gives the ability to the database to overwrite the new idea in the table “idea”.

Round 6

Here the exact same queries are used as in Round 2. The only difference though is that the grades are stored in a new table with the name “gradesecond”

id	FromUser	ToUser	grade1	grade2	grade3	grade4	grade5	grade6	grade7	grade8	total	Text
7	user1	user2	8	8	8	8	8	8	8	8	64	ytgytrerterterte
8	user1	user3	1	2	3	3	2	1	1	1	14	iuiouiouiyu
9	user2	user1	9	9	9	9	9	9	9	9	72	vbcvbv
10	user2	user3	2	2	2	1	1	1	2	1	12	popopopopopo
11	user3	user1	8	9	9	9	9	9	9	9	71	vcvcvcvcfgvdsrewteryiuoiu
12	user3	user2	2	3	3	2	2	2	2	1	17	rewerefdcwqwertrews
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Round 7

In this round the very same queries are used as in Round 4. The only difference though is that the grades are retrieved from the new table with the name “gradesecond”.

Besides that a new query is used for a new table called “gradesfinal” as seen below:

query="INSERT INTO gradesfinal (WinnerUser, total) values (?,?)"

In this table are the final totals and the usernames stored.

WinnerUser	total
user1	0
user2	64
user3	26
NULL	NULL

Round 8

For this round the queries used to retrieve the winner, winning idea and grade from the table “gradesfinal” are shown below:

query="SELECT WinnerUser,total FROM gradesfinal ORDER BY total ASC"

query="SELECT Text FROM idea WHERE FromUser=?"

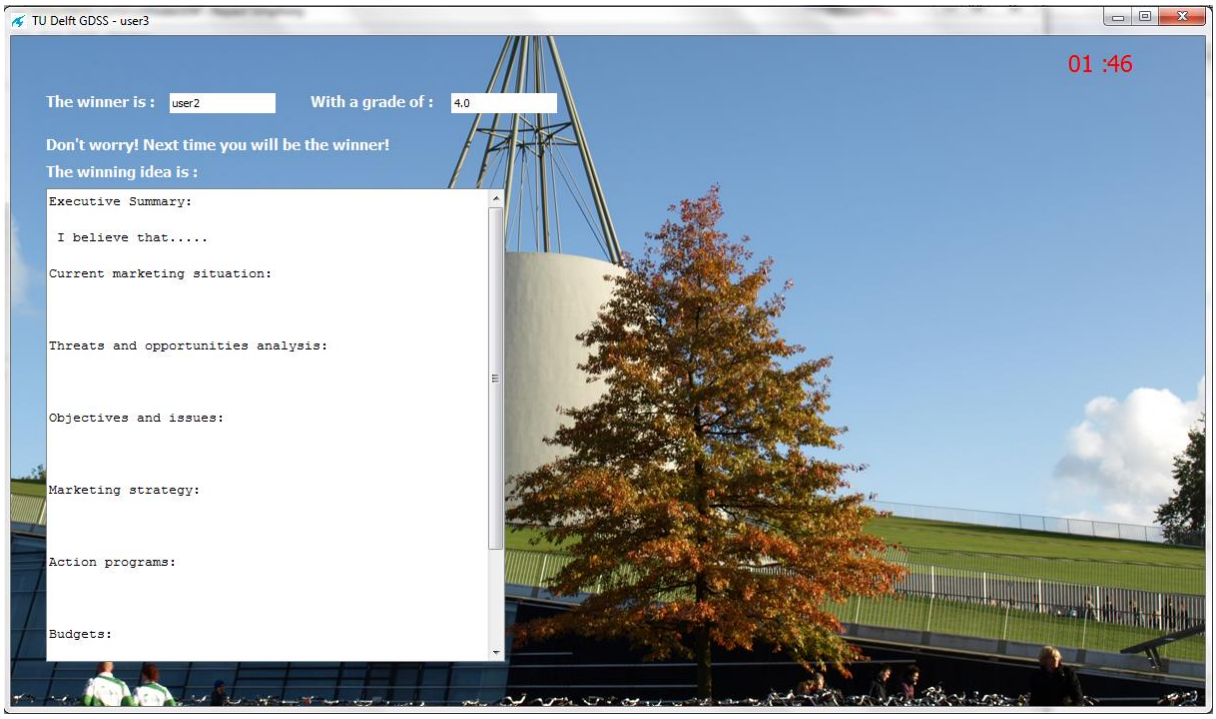
REPORTING

REPORTING

The purpose of this section is to depict the report capabilities provided by the tool to the participants.

Report Capabilities

At this first version of Smart Support the user does not have the ability yet to generate a report. However, an internal report is provided to the user during the last round of the tool where the winner, the winning idea and the grade of that idea are provided to everyone.



Report Procedures

The internal report is being generated automatically by the tool. The result of the report remains stored on the database and is able to be retrieved at any time.

Part 4

Prototype

A prototype is defined to be the first version of something that could be used in the real world. The principle of purpose of a prototype is to identify things that might go wrong during the process of using Smart Support 2.0 during a meeting. A prototype should have almost all the functionality of the final product, but it still might not be as efficient or aesthetically pleasing.
The point to which Smart Support is developed at the moment allows us to consider it as a prototype since it could easily support a marketing meeting in the real world.

Test setting

The testing of Smart Support took place in a group of three TU Delft MSc. Students (under my supervision) who all have been or are currently involved in the energy sector so their knowledge and experience is related to the discussed topic. The idea behind this was to see how three individuals with different experience levels will collaborate or interact on a topic of the same importance and interest for all of them. Besides that, the idea was to see if they felt more creative during a meeting like that instead of the traditional setting of a meeting.
The meeting took place in a computer room in the TNW faculty of TU Delft in which each user sat in front of a personal computer which were all connected to the local area network of the university. The participants were provided with the scenario of the meeting, based on which they should use the tool. After the end of the meeting each individual was provided with an evaluation questionnaire to fill in.

Scenario for the test

You are three marketers in the company called Energa which is one of the biggest energy providers in the Netherlands. The CEO and the board of directors has decided to change the company's strategy and introduce smart energy meters in the Dutch market and that's why they have sent you the following email.
"Hello team,
As you might already know, we recently decided to make a big step into the energy market by introducing smart meters. So let us give you a small update on this exciting topic!

Smart energy meters

[12] The energy market is currently changing because the price of energy produced by fossil fuels is increasing and the same time the price of new energy technologies like solar panels is decreasing. This means that domestic consumers are adopting such technologies very fast.
In Europe, smart grids are being defined as electricity networks that can intelligently integrate the behavior and actions of all users connected to it in order to provide sustainable, cheap and secure electricity supplies. Besides that they are expected to handle market participants in real time, while creating more complex interaction behavior with intelligent devices and communication tools.
Smart grids include also the installation of smart energy meters in houses. Smart meters are being defined as electronic meters that can measure energy consumption and transmit data by using a form of electronic communication including also feedback. Smart meters actually give real time insights about the network to the energy grid managers and help them to

decide and act properly. Smart meters also help energy companies to manage better their man-power since they do not have to send employees out to collect all that data.

We would like to ask you to come up with a marketing plan that will help us define our strategy better. The question to be answered by the marketing plan is the following:
'How will we help electricity consumers make the most of their smart meter, without running an extremely expensive and long-term campaign?'
In order to get a head start you can use Smart Support where you will be able to also generate data from surveys based on the expected adoption of smart meters from consumers, based on different factors.
We are looking forward to see your presentation with your ideas and marketing plan!
Kind regards,
The board of Energa"

Evaluation

[19] The purpose of evaluation is to assess the value of a system. There are many different types of evaluations but to serve our purposes we used an overall-effectiveness evaluation which means we assess to what extend Smart Support effectively assists organizations to reach its goals. The reason for doing that is because an organization will decide to invest in a GDSS based on the premise that the tool will help the organization improve its performance. The approach of the evaluation of a GDSS should cover technical, empirical and subjective aspects. The technical evaluation refers to system verification and the empirical one refers to validation. Below, the questionnaire that was based on the three aspects mentioned above, can be found.

Questionnaire

	Strongly disagree	Disagree	Uncertain/ Not applicable	Agree	Strongly agree
Planning/Preparation					
1.The purpose of this meeting was clear	1	2	3	4	5
2.The computer facilitator helped the meeting to process correctly	1	2	3	4	5
3.Sufficient and clear instructions for the use of the tool were provided by the facilitator	1	2	3	4	5
Effectiveness of the tool/Satisfaction with the process					
4. The tool accomplished its purpose	1	2	3	4	5
5. The tool reduced uncertainty by sharing the correct information within the group members	1	2	3	4	5
6. The process and functions of the tool motivated me to participate more	1	2	3	4	5
7. The tool helped me feel more certain about my ideas than in a regular meeting	1	2	3	4	5
8. The anonymity provided by the tool helped me be more open and participate more.	1	2	3	4	5
9. I participated more in this meeting than in a regular meeting	1	2	3	4	5
10.The tool helped me feel more certain about my strategic thinking skills	1	2	3	4	5
Satisfaction with the results					
11. Even if my idea did not win, the result reflects my inputs more than in regular meetings	1	2	3	4	5
12. I feel very uncertain about the outcome of the meeting	1	2	3	4	5
Satisfaction with software					
13. The program was difficult to understand and use	1	2	3	4	5
14. Collaboration in this meeting was enhanced	1	2	3	4	5

by software support					
15. The design of the tool helped me feel more certain about my tasks	1	2	3	4	5
Future use of the tool					
16. I am willing to replace regular meetings with this tool	1	2	3	4	5
17. I am willing to use this tool as part of my decision making process	1	2	3	4	5

Data analysis

Right after the test scenario was completed the questionnaire was handed to the participants in paper format. In general, all three participants agreed in most of the questions but there are some significant differences.

Planning/Preparation

In this part of the questionnaire all participants agreed that they understood the purpose of the meeting by the sufficient instructions given by the facilitator of the meeting.

Effectiveness of the tool/Satisfaction with the process

In this set of questions we see differences between all participants. One participant feels uncertain about the level on which the tool helped to reduce uncertainty by sharing information during the meeting. Same is true for another participant who felt uncertain to answer if the tool helped to feel more certain about his ideas than in a regular meeting. The third participant in contradiction to the other two, felt uncertain to answer whether the tool helped him to participate more in the meeting and feel more certain about his strategic thinking skills.

Satisfaction with the results

In this part we identify that two out of three participants felt certain about the outcomes of the meeting while at the same time the same two felt uncertain to answer whether the result reflected their own input more than in regular meetings.

Satisfaction with software

In this part we identify only one difference where one participant felt uncertain to answer whether the tool helped him to feel more certain about his tasks.

Future use of the tool

Like in the previous part only one difference was spotted among the participants, with one of them declaring his uncertainty in replacing regular meetings with this tool. This means that probably it will take some time to convince all people about the usefulness of Smart Support, based mostly on their previous experience and how keen they are to technology. Those people would more likely see Smart Support as a side tool that can be used instead of a complete replacement of traditional meetings.

Results analysis

Diving deeper into our findings we can define that besides some differences mentioned our findings are that all participants agree that the tool enhanced collaboration in the meeting by helping and motivating them to be more open with their ideas and participate more in the meeting. This was mainly achieved by the anonymity provided by the tool and also the evaluation of the ideas as stated by one of the participants “Anonymity is a big advantage of the tool as it takes away the usual stress of regular meetings and increases creativity. Evaluation in multiple stages from team-mates allows you to build on your idea and improve your flaws”. About reducing uncertainty, we found out that in general the tool helped the participants in different aspects such as strategic thinking skills and task understanding to reduce their uncertainty or make them feel even more certain about their ideas. Furthermore, we found the impact of the tool on the participants which made them feel safe through the anonymity but also helped them through the facilitation and the instructions to gain very good goal clarity. Yet, we identify uncertainty whether the participants got the impact of meaningfulness and identify clearly their contribution in the outcome.

Discussion

During the literature research, it was difficult to find very specific literature for our purpose. Yet, in this study there have been used review studies from several papers such as [3], [6] and [19]. This means that there has been used literature from many sources that are accredited. On the other hand though, due to time pressure there was organized only one meeting session to test the tool and with only three participants. This is a very small group of participants in order to have accurate insights. However, there are enough to understand how people react while using and which things should be changed in the future.

Throughout this thesis, existing theory helped me mostly in gaining ideas for the technical implementation, of what has already been created and how it was implemented. Even though I didn't use something exactly as found in literature, I used the identified drawbacks they mentioned for each technique and come up with ideas on how to overcome them, such as for example automating the facilitation. I also used existing literature to support the success of the chose techniques. For example, to support that when participants are able to look at the ideas of other people then they use these to improve their own ideas. Or that anonymity eliminates bias or allows participants to be more creative during the meeting. In a few words, literature helped me justify my decisions when using the basic idea from existing decision making tools and evolving them in better versions to use them for the Smart Support interface.

The scientific relevance of the project is that by creating a tool from the combination of tools and different collaboration factors managed to enhance collaboration and effectiveness in making decisions. The tool created has given the opportunity to the existing agent based modeler to have an interface and to be easily used as part of a meeting through a decision making tool. This adds a lot to the practice of marketers. First of all and most important, it gives them an insight in how the end consumer might behave. This makes their practices more focused and less unpredictable. The interface gives them the ease of use of the agent based modeler by adjusting the factors that influence the decisions of consumers through the interface it is connected to. Based on that the marketers are able to share more focused marketing strategies and as a result more successful.

Last but not least there are technical improvements that could make Smart Support more efficient. The most important one would be to make Smart Support available for use also through a Wide Area Network (WAN) and enable marketers to participate from different long-distance locations. Since it is a prototype there are many opportunities in making the design of the interface more user-friendly and efficient. Another possible improvement would be to allow marketers to log in to Smart Support when they have time without demanding the whole group to be available the same time. This could help to bring together in a meeting, marketers from different time zones. Besides these, the time limits of each round in Smart Support should be redefined based on the needs of the marketers and the topic to be discussed each time.

The interface of Smart Support is a huge step forward and provides all the ease of use to the marketers. It also gives the opportunity to use the agent-based modeler and extract results and use them during the meeting. The style of the interface is very basic but easy to understand when looking at everything for the first time. Of course, the graphics and the features could be more elegant but I did what was possible with free libraries provided by the Eclipse IDE. Besides that, the windows could be less busy for the eye but then it should be organized differently to be able to see and understand everything at once. From a man-machine interaction point-of-view I would extend the rounds and automate facilitation even

more by providing an instructions video in the beginning of the session, showing exactly what the participants should expect and which actions they should take.
Furthermore, Smart Support could be more intelligent in a way which will allow the system to analyze the input, compare it to older decisions stored in a database and propose the best solution or even make a decision on its own by just providing the marketing plan it "thinks" is the best, without allowing the users to act.

The way Smart Support is built at the moment enables it to grow greatly. As mentioned in the beginning of this project, my constant interest into developing tools like Smart Support has created opportunities to develop it even further and apply it in practice in the future. Momentarily, the future of Smart Support is already taking shape. The plan is to integrate Smart Support with Cisco Spark, the collaboration software of Cisco systems. Spark offers the ability to host virtual/remote meetings from all the world. The plan is to create an intelligent bot. When the meeting starts the bot will be called and it will create Spark rooms with itself and each participant. The idea then is that the bot will help the participant with brainstorming and also will help when it takes him/her a lot of time to contribute by giving tips or possible ideas. The agent-based modeler will be running in the cloud giving the option for large group meetings while providing faster performance to the participants. Based on that there are some possible use cases:

Use case 1: Cisco Global Service Providers system engineers team
The GSP team consists of system engineers, sales experts and marketing professionals with different levels of experience or different hierarchical positions but also located all over the world. This makes meetings not only difficult but also very time consuming until a decision can finally be made. With Smart Support integrated into Cisco Spark they will be able to define a topic and then from any device (laptop, phone or tablet) to participate in the meeting and make a decision. A possible topic could be "How should we push X new SP switch to the SP market"

Use case 2: Business Unit for Energy Management Service
The BU located in San Jose which consists of technical marketers could use Smart Support in the same way as in Use case 1. There the problem it will solve is not really the distance between the participants but the insights it will provide through the ABM about the likeliness of end customers to adopt energy management products. A possible topic could be "We know that Energy Management is ideal for green field deployments (this means when there is no network yet) but how could be possibly increase our sales rates in brown field deployments (this means there is already a preinstalled network)?"

For the field of Science Communication, the outcome of the project allows to gain insights on how a GDSS in combination with the agent-based model can reduce the decision making complexity that exists in marketer meetings in the energy market. Science communication will be able to understand how participants interpret real data generated by Repast and make use of these in the idea generation process. Also, SC will be able to figure out in the future, based on the success of marketing plans generated with the help of Smart Support and used in real marketing strategies, if this form of collaboration enhanced decision making quality.

Conclusion

The study was set to explore how we could design a man-machine interaction to increase group collaboration and decision making for marketers in the energy sector. In order to answer this question, we had to research a few sub-questions such as the impacts of such group decision making systems on marketers, the elements that can be used to trigger marketers to elaborate more, the functions to be used to decrease biases, support openness and decrease uncertainty and also the ways a group decision support system would be able to enhance the quality of collaboration among marketers in a meeting setting.

Smart Support proves the way such a man-machine interaction can be designed. The first sub-question we tried to answer is "How can the GDSS trigger marketers to elaborate on their ideas from a theoretical perspective?" Based on what we found in literature there are factors such as feedback, anonymity, social comparison and uncertainty management that are effective in increasing collaboration in group meetings. Anonymity and uncertainty management help the participants feel safe by encrypting their personal details but also by providing simple tasks and clear instructions about these during every stage of the meeting. Even though through the survey the anonymity is being admired by all the participants for allowing openness and creativity in a safe environment, not all participants felt certain or safe about the outcome of the meeting. Back to literature, feedback and social comparison are proposed mainly as ways of increasing the perceived competence of the participants and also increasing the value of their ideas. Survey participants now come to agree that getting feedback from other participants and looking at their ideas helped them to develop and improve their own ideas. So, Smart Support was able to trigger marketers to elaborate more on their ideas through the anonymity it provided and the different functions in the evaluation stages such as feedback and grades which motivated and inspired the participants to build on their ideas.

The second sub-question we tried to answer is "What are the impacts of the GDSS on the marketers?" Based on what we found in literature there are different psychological states such as safety, meaningfulness and goal clarity. Safety refers to the sense of security and flexibility that help work motivation and performance increase during the meeting. Furthermore, meaningfulness is referring to the sense of the participants being valued for their input by others and also goal clarity helps them to put more effort based on the goals of each individual. Looking at the survey results of the test conducted at TU Delft we identify that they all agree it was useful to understand at any stage their tasks and goals and this helped them to proceed in the meeting process without uncertainty about what will happen, which made them more creative.

The other two sub-questions we tried to answer are "To what extent does the design eliminate bias, support openness and decrease uncertainty?" and "To what extent does the GDSS enhance the quality of collaborative behavior of marketers in practice?" Based on literature the design of a decision making tool that would allow anonymity would eliminate also biases and support openness by making participants feel more safe. As we saw from the survey, Smart Support helped the participants to understand clearly the goal of the meeting. Furthermore, anonymity motivated participants to be more open and collaborate more in the meeting while feeling more certain about their ideas, their strategic thinking skills and what they had to do during the meeting. Additionally, Smart Support by offering

functions such as feedback and access to the ideas of other participants which enhanced collaboration throughout the group meeting. In practice, what I experienced at Cisco is that participants enjoyed the openness of the process, not only during the idea generation process but even more during the feedback process, where they felt free to express their honest opinion. This showed enhanced quality of collaboration, in comparison to traditional meetings. Throughout this project and by answering all the research sub-questions, we can conclude that the way Smart Support 2.0 is designed and built it represents a man-machine interaction that improves group collaboration and decision making for marketers in the energy sector. This is achieved through the simplified and easily understandable interface followed by the automated facilitation of the meeting, which combined with the features of anonymity, feedback and social comparison improves the quality of collaboration and enhances the decision making process among participants.

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[1] Huber, G. P. (1984). Issues in the design of group decision support sytems. *MIS quarterly*, 195-204.

[2] DeSanctis, G., & Gallupe, B. (1984). Group decision support systems: a new frontier. ACM SIGMIS Database, 16(2), 3-10.

[3] Desanctis, G., & Gallupe, R. B. (1987). A foundation for the study of group decision support systems. *Management science*, *33*(5), 589-609.

[4] Kiesler, S., & Sproull, L. (1992). Group decision making and communication technology. *Organizational behavior and human decision processes*, *52*(1), 96-123.

[5] Barkhi, R., & Kao, Y. C. (2011). Psychological climate and decision-making performance in a GDSS context. *Information & Management*, *48*(4), 125-134.

[6] Limayem, M., Banerjee, P., & Ma, L. (2006). Impact of GDSS: Opening the black box. *Decision Support Systems*, *42*(2), 945-957.

[7] Adla, A., Zarate, P., & Soubie, J. L. (2011). A proposal of toolkit for GDSS facilitators. *Group Decision and Negotiation*, *20*(1), 57-77.

[8] Salter, G., Nanlohy, P., & Hansen, S. (2000). Online discussion groups: Strategies to enhance participation and collaboration. In *L. Richardson and J. Lidstone (Eds), Flexible Learning for a Flexible Society, 618-623. Proceedings of ASET-HERDSA 2000 Conference, 2-5 July*.

[9] Michinov, N., Jamet, E., Métayer, N., & Le Hénaff, B. (2015). The eyes of creativity: Impact of social comparison and individual creativity on performance and attention to others' ideas during electronic brainstorming. *Computers in Human Behavior*, *42*, 57-67.

[10] Wang, X., Schneider, C., & Valacich, J. S. (2015). Enhancing creativity in group collaboration: How performance targets and feedback shape perceptions and idea generation performance. *Computers in Human Behavior*, *42*, 187-195.

[11] Mengash, H., & Brodsky, A. (2015). A group package recommender based on learning group preferences, multi-criteria decision analysis, and voting. *EURO Journal on Decision Processes*, *3*(3-4), 275-304.

[12] Yu, L., & Lai, K. K. (2011). A distance-based group decision-making methodology for multi-person multi-criteria emergency decision support. *Decision Support Systems*, *51*(2), 307-315.

[13] Fan, X., & Yen, J. (2011). Modeling cognitive loads for evolving shared mental models in human–agent collaboration. *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)*, *41*(2), 354-367.

[14] Zhang, A., Zhili, T., & Zhang, C. (2011). Man-machine function allocation based on uncertain linguistic multiple attribute decision making. *Chinese Journal of Aeronautics*, *24*(6), 816-822.

[15] Pahl, G., & Beitz, W. (2013). *Engineering design: a systematic approach*. Springer Science & Business Media.

[16] Johnson, M., Bradshaw, J. M., Feltovich, P. J., Jonker, C. M., Van Riemsdijk, M. B., & Sierhuis, M. (2014). Coactive design: Designing support for interdependence in joint activity. *Journal of Human-Robot Interaction*, *3*(1), 43-69.

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[19] Pick, R. A., & Weatherholt, N. (2013). A Review On Evaluation And Benefits Of Decision Support Systems. *The Review of Business Information Systems (Online)*, *17*(1), 7.

[20] Kerstholt, J. (1994). The effect of time pressure on decision-making behaviour in a dynamic task environment. *Acta Psychologica*, *86*(1), 89-104.

[21] CA Van Der Sanden, M., Van Dam, K. H., Stragier, J., & Kobus, C. (2013). Simulation based decision support for strategic communication and marketing management concerning the consumer introduction of smart energy meters.

[22] Kotler, P., & Armstrong, G. (2010). *Principles of marketing*. Pearson education.

[23] Boyd, D., & Crawford, K. (2012). Critical questions for big data: Provocations for a cultural, technological, and scholarly phenomenon. Information, communication & society, 15(5), 662-679.

Appendix A

[1] **Huber, G. P. (1984). Issues in the design of group decision support systems. *MIS quarterly*, 195-204.**

This 678 times cited paper was from the beginning of my research the fundamental of what has already been done in group decision support systems and what has been going wrong. This helped me think one step further. For example, when mentioning the use of a facilitator in older GDSSs, I thought of automating the whole procedure and building the facilitator in the system. Besides that helped me understand what should be for sure included and what not.

[2] **DeSanctis, G., & Gallupe, B. (1984). Group decision support systems: a new frontier. ACM SIGMIS Database, 16(2), 3-10.**

This paper was used more to get an overview of the different types of GDSS and the scenarios in which each type could be used. Besides that it helped understand the hardware, software and procedures taking place until in a traditional GDSS.

[3] **Desanctis, G., & Gallupe, R. B. (1987). A foundation for the study of group decision support systems. *Management science*, *33*(5), 589-609.**

In this paper it was interesting to read about the patterns of information exchange in GDSS and how this changes during the meeting based on the way participants interact or interpret information.

[4] **Kiesler, S., & Sproull, L. (1992). Group decision making and communication technology. *Organizational behavior and human decision processes*, *52*(1), 96-123.**

Part of this paper helped me get the insight that there were plenty of tools created from time to time but none of these would cover all the drawbacks of the others. This helped me figure out the strong parts of each and combine them, while minimizing the drawbacks.

[5] **Barkhi, R., & Kao, Y. C. (2011). Psychological climate and decision-making performance in a GDSS context. *Information & Management*, *48*(4), 125-134.**

In this paper I found interesting the importance of the psychological climate and psychological safety the tool should be able to offer.

[6] **Limayem, M., Banerjee, P., & Ma, L. (2006). Impact of GDSS: Opening the black box. *Decision Support Systems*, *42*(2), 945-957.**

This paper was one of the most interesting ones for me during my research. It helped me understand the importance of certain elements such us anonymity, facilitation in the process but also giving decision guidance and the need to re-structure technology until it fits the needs.

[7] **Adla, A., Zarate, P., & Soubie, J. L. (2011). A proposal of toolkit for GDSS facilitators. *Group Decision and Negotiation*, *20*(1), 57-77.**

In this paper I found really useful the guideline of the three different meeting phases (pre, during and post meeting) that should be controlled by the facilitator in order to get the best result from a smooth process.

[8] **Salter, G., Nanlohy, P., & Hansen, S. (2000). Online discussion groups: Strategies to enhance participation and collaboration. In *L. Richardson and J. Lidstone (Eds), Flexible***

***Learning for a Flexible Society, 618-623. Proceedings of ASET-HERDSA 2000 Conference, 2-5 July*.**
From this paper I got more inspiration on how people should provide feedback to their peers during the meeting in order to minimize the stress factor and motivate each other.

[9] **Michinov, N., Jamet, E., Métayer, N., & Le Hénaff, B. (2015). The eyes of creativity: Impact of social comparison and individual creativity on performance and attention to others' ideas during electronic brainstorming. *Computers in Human Behavior*, *42*, 57-67.**
From this study I read the fascinating results of people being triggered by the ideas of other people and making them gain inspiration from this and improve their own ideas. This gave me the idea of sharing ideas during the meeting in order to increase motivation and decrease uncertainty through increased collaboration.

[10] **Wang, X., Schneider, C., & Valacich, J. S. (2015). Enhancing creativity in group collaboration: How performance targets and feedback shape perceptions and idea generation performance. *Computers in Human Behavior*, *42*, 187-195.**
In this paper is being mentioned how feedback improves creativity and idea generation. This helped me understand the importance of using feedback as one of the core factors in the tool.

[11] **Mengash, H., & Brodsky, A. (2015). A group package recommender based on learning group preferences, multi-criteria decision analysis, and voting. *EURO Journal on Decision Processes*, *3*(3-4), 275-304.**
In this paper is being mentioned the use of a voting procedure in the decision making process. This helped me come up with the idea of grading specific fields of the idea and getting the average grade for the whole idea.

[12] **Yu, L., & Lai, K. K. (2011). A distance-based group decision-making methodology for multi-person multi-criteria emergency decision support. *Decision Support Systems*, *51*(2), 307-315.**
From this paper I gained inspiration and insight from the general framework provided, for multi-person multi-criteria group decision making methodology. This paper actually helped me define the structure of the tool.

[13] **Fan, X., & Yen, J. (2011). Modeling cognitive loads for evolving shared mental models in human–agent collaboration. *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)*, *41*(2), 354-367.**
From this paper I understood the importance of making the process easier for all the participants and reducing cognitive load from their decision making process. This allowed me to consider the use of a storing database that would actually handle all the memory and calculation workload.

[14] **Zhang, A., Zhili, T., & Zhang, C. (2011). Man-machine function allocation based on uncertain linguistic multiple attribute decision making. *Chinese Journal of Aeronautics*, *24*(6), 816-822.**
The interesting information I gained from this paper is the tables with the advantages of machines and humans in a decision making process but also the different levels of automation of the process. This allowed me to design the tool on the right level of automation and make use of the right advantages of the machine and the humans participating.

15] **Pahl, G., & Beitz, W. (2013). *Engineering design: a systematic approach*. Springer Science & Business Media.**
From this book I gained insight about the uncertainty created among the participants about the task but also the social context.

[16] **Johnson, M., Bradshaw, J. M., Feltovich, P. J., Jonker, C. M., Van Riemsdijk, M. B., & Sierhuis, M. (2014). Coactive design: Designing support for interdependence in joint activity. *Journal of Human-Robot Interaction*, *3*(1), 43-69.**
This paper helped gain inspiration about the design of interactions between the machine and the human and how these could increase collaboration through a more intelligent machine.

[17] **RAO, V. S. C. (1992). Group Support Systems in Organizations: The Potential Effects of Anonymity. *Journal of Information Technology Management*, *3*(2), 29.**
This paper gives more insight about the benefits of anonymity in group collaboration.

[18] **Wayman, J. C., Jimerson, J. B., & Cho, V. (2012). Organizational considerations in establishing the data-informed district. *School Effectiveness and School Improvement*, *23*(2), 159-178.**
From this paper I used insights about professional learning and the importance of having participants with certain level of expertise during a meeting.

[19] **Pick, R. A., & Weatherholt, N. (2013). A Review On Evaluation And Benefits Of Decision Support Systems. *The Review of Business Information Systems (Online)*, *17*(1), 7.**
This paper was used to understand the way the final version of the tool should be evaluated by the sample group. This was important in order to correctly evaluate the tool.

[20] **Kerstholt, J. (1994). The effect of time pressure on decision-making behaviour in a dynamic task environment. *Acta Psychologica*, *86*(1), 89-104.**
This paper helped me support my idea of using timers for each round in order to apply some positive pressure to the participants.

[21] **CA Van Der Sanden, M., Van Dam, K. H., Stragier, J., & Kobus, C. (2013). Simulation based decision support for strategic communication and marketing management concerning the consumer introduction of smart energy meters.**
From this paper I got to understand the actual problem in the energy market and the uncertainty created among marketing and communication professionals during the decision making process for their marketing plan.

[22] **Kotler, P., & Armstrong, G. (2010). *Principles of marketing*. pearson education.**
From this book, I gained insight on what are the worldwide most followed guidelines during the creation of a marketing plan. This helped me structure the process and make the task of the meeting more specific, helping the participants to focus more and reduce their uncertainty.

[23] **Boyd, D., & Crawford, K. (2012). Critical questions for big data: Provocations for a cultural, technological, and scholarly phenomenon. Information, communication & society, 15(5), 662-679.**