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Individual Definition of Multi-Criteria Problems in Ubiquitous GDSS

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Abstract. The process to support the decision-making in ubiquitous contexts is very complex but no less relevant. Mechanisms such as automatic negotiation can be used in order to aid parties to reach decisions with quality. However, most of the intelligence that could be generated in the real decision-making process is forgotten. Besides that, if on one hand many group decision support systems force the user with overly complex, demanding and slow configurations, on the other hand experience the lack of essential information that could be used to enhance the intelligence of the decision. In this work we (1) propose a set of points related to the decision-making process whose associated knowledge we think to be fundamental to provide more intelligent decisions and with higher quality, (2) a way in which these points can be implemented that will result in a fast, perceptible and usable configuration for the decision-maker and that will also provide reliable information. We have developed a prototype where we present a template with all the points that were considered. Throughout this paper we present a selection of images related with that scheme that exemplify in practice the implementation of each point.

Keywords: Ubiquitous Group Decision Support Systems, Multi-Criteria Problems, Affective Computing, Multi-Agent Systems, Problem Definition.

1 Introduction

Ubiquitous computing has become a necessity while developing Group Decision Support Systems (GDSS) [1, 2]. The problem of group decision-making brought new issues such as how to effectively improve the interaction between all the participants involved in the decision-making process and at the same time "deal with uncertainty, ambiguous problem definitions, and rapidly changing information" [3]. Ubiquitous computing provides answers to these issues by improving the way information flows through all the distributed environments [4] and how it allows every participant to exchange knowledge regardless of time or location constraints [1]. However, many existing Ubiquitous Group Decision Support Systems (UbiGDSS) seem to forget about these principles and force the user with either overly complex and slow config-

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urations [1] which no decision-maker with a tight schedule will bother to fill accurately or they do not convey the decision-maker opinion properly into the system resulting in a loss of valuable intelligence [5].

In this work, we propose a set of points which we think that should be considered when modelling multi-criteria problems, and that will ultimately allow the system to take advantage of more intelligent mechanisms by dealing with all the information (both subjective and objective) that affects the decision-making process. Besides that we also think that these points are fundamental to obtain a huge amount of information, not only directly (through their configuration) but also indirectly by how they relate to each other and how they affect the decision-making process which will lead to more intelligent and closer to real decisions. We then propose a template that provides the decision-maker with a simple and perceptible configuration, which will allow him to understand the problem more quickly and at the end will enhance the usability of any system that follows this template.

The rest of the paper is organized as follows: in the next section is presented our methods, where we: identify three different sections that are relevant to our context; present each one of the sections, describing every point and correlating it with the proposed template. Finally, some conclusions are taken in section 3, along with the work to be done hereafter.

2 Methods

Defining a configuration environment in which the decision makers could model a multi-criteria problem is a complex process. Whenever it is planned and designed something with the sole purpose to be used by the type of end users considered in this work (executives and top managers), there should be considered some necessary factors for the UbiGDSS to succeed: non-mandatory configurations, usability, problem data always accessible, allow the decision-maker to model its opinion truthfully, and be complex enough whenever it is necessary.

We have grouped the necessities and the several points that should be presented in a configuration template in three sections: Problem Data, Personal Configuration and Problem Configuration. The Problem Data should always be available and accessible throughout each configuration step in order to allow the decision-maker to consult any necessary information as much as he needs.

2.1 Problem Data

In this section, it is presented problem specific information that is a result of several brainstorming sessions. This information has to be organized, cleaned and structured before the decision-maker performs the problem configuration. In its composition, a problem includes a number of criteria as well as a number of alternatives which are different instantiations of all the considered criteria. Both criteria and alternatives are topics to be discussed by decision-makers and are essential to try to reach a decision

to solve the problem. Besides alternatives and criteria it should also be inserted all the information that is relevant to reflect about the problem, such as: historical data, financial and cultural issues, etc.

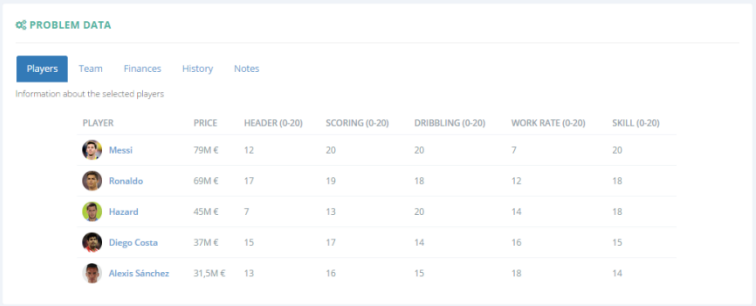

Fig. 1. Problem Data

In our example (**Fig. 1**) we deal with a scenario of a football technical team that has to decide about which football player (from a range of five options) that should be acquired at the start of the next transfer market. Our Problem Data includes all the information about: each one of the five players, the current football team data (which player plays in the current team, statistics etc), financial issues, historical data, and other important notes about the problem. All the information is organized and can be consulted by the decision-maker in a very clear and accessible way.

2.2 Personal Configuration

This section is related with how the decision-maker can model its own personal attributes as well as other decision-makers' attributes. In most of automatic negotiation models, the decision-maker's opinion is considered throughout the entire process in the same way. This means that for those models, the opinion from a decision-maker who does not hold any sort of knowledge towards a topic and still makes a problem configuration will have the same weight as the opinion of an expert in that matter. Another example is the level of interest shown by the decision-maker in the topic that is not considered. In most of the models it is impossible to know the interest or the commitment level that a decision-maker plans to bring to the decision-making process. Because of these factors, most models are not able to properly generate intelligence, and end up generating garbage instead of valuable information.

The points that we propose to be modelled in Personal Configuration will allow a much easier and intuitive configuration, not forgetting that none of them are mandatory. The proposed points are: Expertise Level, Conflict Style, Credibility and Notes. As can be seen in **Fig. 2**, this type of configuration can be easily done using a mouse, keyboard or a touchscreen, and should take no longer than 1 minute. Besides that, these points will allow to obtain a huge amount of direct and indirect information.

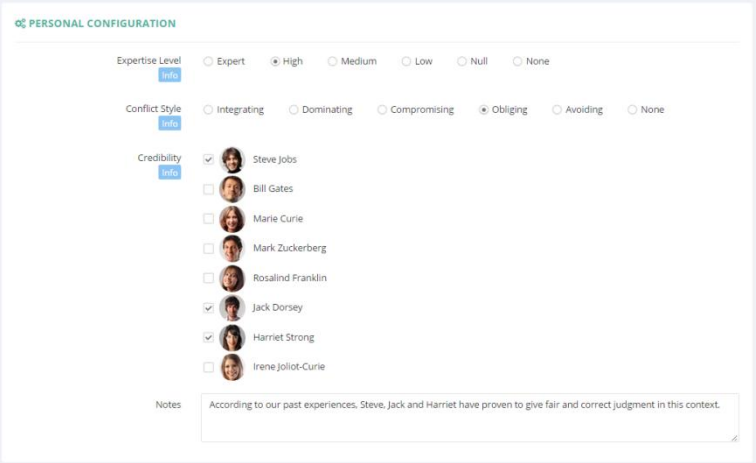

Fig. 2. Personal Configuration

Expertise Level. As can be seen later in this paper, expertise is considered as one of the credibility dimensions (affected by objective components). Our objective in this point is to allow the decision-maker to make a self-evaluation about his expertise level for the topic at hand. We have considered the existence of five different expertise levels: Expert, High, Medium, Low and Null.

Why is this information relevant and how can it be used? This kind of information can have many applications. One could be to use it to compare the self-evaluation made by the decision-maker for its expertise level with its credibility which is recognized by other decision-makers, allowing further conclusions to be made. This information can also be used to compare the self-evaluation with the chosen conflict style.

Conflict Style. For this proposal we have followed our previous studies [6] where we identified 5 conflict styles: Dominating, Integrating, Compromising, Obliging and Avoiding. These styles differentiate from each other by what we think that are 4 essential dimensions for this context:

- Concern for Self – This dimension is related to the individual's concern for his own opinion above the others since he is likely to adapt a more one-sided attitude during the decision-making process by making statements, questions and requests that detail that opinion;
- Concern for others – This dimension relates to the individual's concern for other individuals' opinion. He adapts a more altruist attitude during the decision-making process, trying to understand other opinions and making an effort to reach a decision that benefits or pleases most of the participants;
- Activity – This dimension relates to the effort put into the decision-making process by the individual, meaning that the more active an individual is, the more questions and statements and requests he is likely to make;

- Resistance to change – This dimension relates to how hard or easy it is for an individual to accept other opinions.

Table 1. Conflict styles and corresponding dimensions, adapted from [6]

Conflict Style	Concern for Self	Concern for Others	Activity	Resistance to Change
Dominating	High	Low	High	High
Integrating	High	High	High	High
Compromising	Moderate	Moderate	Moderate	Moderate
Obliging	Low	High	Low	Low
Avoiding	Low	Low	Low	Low

In **Table 1**, we describe each conflict style by providing a value for every dimension mentioned before.

Credibility. There is not a universally accepted definition for credibility. Besides that, the study of credibility is highly multi-disciplinary and some of the suggested definitions are related to their area of operation [7]. In our work we consider the definition proposed by Flanegin and Metzger when they say that "the overarching view is that credibility is the believability of a source or message, which is made up of two primary dimensions: trustworthiness and expertise" [7]. Trustworthiness is related with subjective components while expertise is related with more objective components. The notion of credibility is related with many other concepts including trust, reliability, accuracy, quality, authority, reputation, competence, etc [7]. In our work the decision-maker can select which other decision-makers he considers to be credible towards a certain topic. This credibility evaluation is related with the concepts mentioned above and will be the reason why a decision-maker may consider another decision-maker to be credible for a topic and not for a different topic (for example, with the related expertise level recognized for that decision-maker), and also why a decision-maker may consider another decision-maker always credible despite of the topic's difference (for example, due to reasons such as authority, reputation, etc.).

Notes. We have considered important to include something that allows the decision-maker to express openly his opinion towards its Personal Configuration. For instance, in our experiment, one participant wrote in Personal Configuration: "According to our past experiences, Steve, Jack and Harriet have proven to give fair and correct judgment in this context".

2.3 Problem Configuration

This section is related with how problem-specific attributes are modelled. The decision-maker may select: the preference chosen towards each one of the available alternatives; the importance given for each criterion; alternatives and criteria without opin-

ion, alternatives or criteria with private opinion; and finally notes. In this section, the configuration can also be done very quickly and intuitively. Besides that, it allows to specify the opinion unconsciously according to natural comparison that exists between the given alternatives, which is done by the human being (for more information, see [8]).

Alternatives Classification. The method to classify alternatives, as can be seen in **Fig. 3**, has been adapted from the Visual Analogue Scale (VAS) because we think that this scale is the most appropriate for our problem. This scale is appropriate for values that cannot be directly measured and that way allow the decision-maker to level his opinion in a range of values instead of writing down a specific value. Besides that, many studies have proven that VAS allows obtaining information more quickly and assertively [9]. In our context it is also important to refer that this facilitates the configuration, improving how the system could be used in many electronic devices. Another advantage from this model is that it improves the way the decision-maker evaluates all the suggested alternatives and its comparison since, as he starts selecting new values for each alternative, he will inevitably look at what he selected before and also judge his opinion according to that. Because of this we believe that the decision-maker will find the criterion preference configuration process perceptible and easy to use.

Criteria Classification. The same process was applied to the criteria classification where the decision-maker can scale his opinion for each criterion, due to the reasons mentioned before.

Notes. The purpose of this point is exactly the same as the notes described in the section of Personal Configuration. For instance, in our experiment, one participant wrote in Problem Configuration: "I have discussed this topic with Steve Jobs and we both agree that price is fundamental to control our financial plan for the next season".

No Opinion. Looking at **Fig. 3** it is possible to verify that the decision-maker can select the "No Opinion" option for any alternative or criterion. This means that even if the decision-maker wants, for example, to configure the entire problem and if he does not have a formulated opinion for a criterion or an alternative, he is not forced to invent just to configure everything. This can result in relevant information about how the agent should act on behalf of the decision-maker

Private Information. Similarly, the decision-maker may opt to select the opinion about a given alternative or criterion as "Private" (**Fig. 3**) whenever he intends to not share that knowledge. This may happen, for instance, due to strategical reasons. This information will also be relevant to define how the agent should act.

Fig. 3. Problem Configuration

3 Conclusions and Future Work

Defining a balance between the amount of information that needs to be configured by the decision-maker and at the same time assure usability, quickness and perceptibility is not an easy task. However it is important to notice that due to its context, if this task is not properly executed, it can affect the system's viability. The work presented in this paper is a result of several years of study in the area of Group Decision Support Systems and even if we consider that there is a lot of brilliant work in this area, there are still problems that need to be addressed that we think that may be responsible to destroy what could be the success of UbiGDSS.

This work had the main goal to define a set of points which will allow to obtain, infer and create intelligence about "every" question that affects the group decision-making process. These points are divided in three sections: Problem Data, Personal Configuration and Problem Configuration. Furthermore, we propose a template as an example that shows how these points could be implemented, and at the same time assure the usability and simplicity of the configuration for any kind of electronic device.

As future work we intend to produce a case of study to evaluate the usability (already ongoing), simplicity and comprehension for the proposed template. We will also analyze how much time the user needs to properly configure the problem. Besides that we will also perform a study that will tell us which information the decision-maker considers as relevant and that should be presented at each iteration in the group decision-making process. As future work we also want to establish in literature a reference standard for this type of context.

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