DECISION SUPPORT ON THE MOVE
Mobile Decision Making for Triage Management

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Keywords: Mobile Decision Support, Multicriteria Decision Analysis.

Abstract: This paper describes research investigating ways in which a mobile decision support system might be implemented. Our view is that the mobile decision maker will be better supported if he/she is aware of the Quality of the Data (QoD) used in deriving a decision, and how QoD improves or deteriorates while he/she is on the move. We propose a QoD model that takes into account static and dynamic properties of the mobile decision making environment, uses multicriteria decision analysis to represent the user's decision model and to derive a single QoD parameter, and investigates the use of powerful graphics to relay information to the user.

1 INTRODUCTION

In this paper, we address the concept of mobile decision support. The aim of developing a mobile decision support system is to provide on the spot assistance to a mobile decision maker who is forced to make decisions on the move. Potentially, the decision maker is away from his desktop PC / office environment where information might usually reside which would help in the decision making. The prototype developed uses multicriteria decision analysis (MCDA) to model the decision problem, scenario reasoning to evaluate the alternative options, and calculation of Quality of Data (QoD) to indicate the reliability of a recommended solution. Although the use of mobile computing is not new, we believe the use of MCDA and mobile decision support has been little researched. Further details of comparative studies are provided in Cowie and Burstein (2006).

Although applicable to many domains (San Pedro et al., 2004; Hodgkin et al., 2004), we have chosen to focus the use of the tool on triage management to illustrate its potential use and benefits. In this environment, quick and accurate decisions are imperative. It is hoped that this mobile decision support tool can aid in achieving this aim.

We begin by providing a brief overview of multicriteria decision making, explaining the method and its potential use. In Section 3 we discuss some of the main features of mobile decision making, in particular the concept of static and dynamic decisions. The measure by which we measure the quality of the data relayed to the mobile decision maker is discussed in Section 4. In Section 5 we detail the prototype developed, discussing use of the tool in a triage setting. The paper concludes by examining potential avenues for future work.

2 MULTICRITERIA DECISION ANALYSIS

Multicriteria Decision Analysis (MCDA) solves a decision problem by evaluating and comparing a number of alternatives against several, possibly conflicting, criteria and proposes the best alternatives based on some aggregation of these evaluations and comparisons. In a mobile decision making context, this MCDA model can assist a triage worker to understand the best course of action to take in an emergency situation. By facilitating real-time connectivity to live data, the decision maker will be able to access crucial information to aid, for example, in deciding which Accident and Emergency (A&E) department a casualty should be sent to, the best mode of transport to use in transiting patients, or estimating travel time.

Cowie J. and Godley P. (2006).
DECISION SUPPORT ON THE MOVE - Mobile Decision Making for Triage Management.
In *Proceedings of the Eighth International Conference on Enterprise Information Systems - AIDSS*, pages 296-299
DOI: 10.5220/0002441902960299

3 STATIC AND DYNAMIC DECISION MAKING

Much of our previous work using MCDA has adopted the approach in static decision making. In static decision making, we can assume that the evaluation of alternatives with respect to criteria is constant (over a given period of time), and evaluations will not fluctuate according to some external factor. For example, in assessing a suitable location to conduct a conference, criteria such as size of rooms, facilities available, and accommodation costs will have scores that are unlikely to change from one minute to the next, one day to the next, or even one week to the next.

There are however some genres of problems which encompass dynamic as well as static criteria. For example, suppose we are considering the best mode of transport to our work place. Travel time is a very dynamic attribute in that it can change frequently. We may have an idea of approximate travel times for different modes of transport (e.g. train, bus, car), however, this information may change after listening to travel reports on the radio prior to setting off for work, causing us to re-rank which mode of transport will get us to work in the shortest time. This scenario is still not static, as 5 minutes into our journey the travel situation may change again, such that perhaps a different mode of transport would have been preferable. In such situations, it is important to have some indication of how static or dynamic our decision is, and some estimation of the time period over which the stability of the data is likely to be maintained. So for example, if we choose to travel by train as it is currently the best option, is it likely that this will remain the optimum option for a given time period, say 30 minutes. It is here we see the need to not only provide decision support in the more traditional sense as seen with static decisions, but also to give some indication of the quality of the decision or quality of data being received.

4 QUALITY OF DATA

Our measure of quality is not reflective of the standard of the information received, but of the robustness, recency, and stability of the data. Recent research defines QoD as a score that allows the user to appreciate the uncertainties inherent to a mobile computing environment (Mihaila et al, 2000). By using QoD, appropriate sensitivity analysis can be performed and results used to better inform the user as to the suitability of choices. This additional information allows the decision maker to make their decision with confidence as not only are they presented with the pertinent data, they are also aware of changes in the environment and the potential impact this could have on the decisions made.

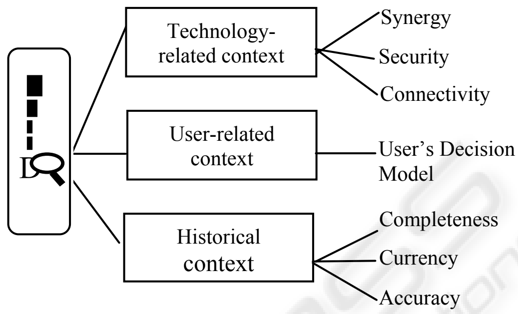

Figure 1: Quality of Data Model.

In Figure 1 we illustrate how QoD can be represented as an aggregate measure of technology-related parameters (e.g., synergy, security and connectivity), user-related parameters (e.g., stability of scores in user's decision model), and data quality parameters that are related to historical context (e.g., completeness, currency and accuracy of historical data). This aggregate measure can be represented as a weighted sum, to allow the decision maker to choose the importance associated with the various quality measures. Further details of the QoD measure can be found in Cowie and Burstein (2006).

5 THE PROTOTYPE

5.1 Setting Up the Model

The prototype was developed using an Object Oriented (OO) methodology, where unified modelling language (UML) was used to assist in conceptualising the design of the prototype. Although the Decision Support System (DSS) proposed is designed to operate on a number of mobile devices, this initial design is for use on a PDA. The technologies used comprised of Java ME, Java SE, Excel, MySQL and the multicriteria decision analysis software V•I•S•A.

In order to use the prototype, an appropriate MCDA model must be created and imported onto the mobile decision device (such as a PDA). Through access to the web, the PDA can then keep the decision maker up-to-date with the latest information pertinent to the problem domain being addressed.

5.2 Use of the Model-Triage

Initial real-time assessment of emergency situations (triage) has to be accurate and quick. Triage is used in a variety of different scenarios: on the battlefield, at disaster sites, and in hospital emergency rooms when limited medical resources must be allocated. There is an obvious need to optimise the triage process and outcomes in order to satisfy the demands for high quality and responsiveness of contingency management.

In order to demonstrate the potential of the mobile decision support system, we use the example of a triage decision maker who is first on the scene to an accident. In such a scenario, various criteria would need to be considered in assessing what the appropriate course of action would be. For example, supposing the triage worker has to choose between the following options: Calling for an ambulance, calling for an airlift, calling for both ambulance and airlift, and treating injured parties on-site. Factors that he/she may consider could include time: both time taken to administer treatment to an individual, and how critical this time is; also, number of casualties: where the triage worker needs to assess the collective number of casualties and differentiate between the number of major and minor injured parties.

Assuming the triage accident model is already in existence, the decision maker at the scene of the accident would select the "accident model" on his mobile decision device to aid them in assessing the most appropriate course of action. The mobile support system will have been accessing appropriate websites for up-to-date information pertaining to accident scenarios over a given time period. The information collated is assessed and results relayed back to the mobile decision maker. A typical screen from the model is depicted in Figure 2a.

Figure 2a and 2b: Example of Weights.

It is clear to see from the figure that alternative C (in our example, "Treat Onsite") is currently the best option. However, it is also crucial that the decision maker (DM) takes into account the QoD score (top left Figure 2a) and the predicted QoD score over time (top right Figure 2a). The current QoD indicates that the quality of the data is quite high. However the QoD score over time shows that the quality of the data is likely to deteriorate. Should the DM wish to find out more about the QoD score, by clicking on the QoD info button they are taken to the screen depicted in Figure 2b. This screen allows the DM to analyse the quality of the data concerning the main three criteria used in constructing the QoD score (as shown in Figure 1). From Figure 2b we can clearly see that it is the technology-related issues that have poor quality (so for example, perhaps we are unable to connect to the specified URLs as frequently as requested due to poor network connection). The user also has the ability to drill down further and analyse the factors contributing to the QoD scores for user-related, technology-related, and historical contexts.

Figures 3a and 3b: Further Data Analysis.

By clicking on any of the score bars associated with an alternative (shown in Figure 2a) the decision maker can view information relating to the stability of the scores of the alternative. In Figure 3a we see the stability scores for the "Treat Onsite" option. Currently, the interface shows the previous scores (shown in pink) achieved by the option at five minute intervals. It is evident from Figure 3a that "Treat Onsite" appears to be a consistently high scoring option. This may help the decision maker in deciding whether the option is suitable. Had the score for "Treat Onsite" been less stable, the decision maker may feel more cautious about choosing an option which scores well at the current time, but may score badly in the next five minutes. The interface also shows a blue dot which depicts the predicted score of the alternative in the next five minutes. A simple forecasting technique is used to achieve this value. This predicted score value provides additional information to enable the decision maker to assess the stability of the alternative by the decision maker.

A further results screen available to the decision maker is to view comparative scores for each alternative over a given time period. This is depicted in Figure 3b. Again the scores are shown at intervals of 5 minutes. This allows the decision maker to assess the stability of each option, and how the ranking of options changes over time. Again, it is evident that “TreatOnsite” is consistently the best alternative. Option “Airlifting” the casualties and “calling for ambulance and airlift” remain fairly stable options over the displayed time period, ranked 3rd and 2nd respectively. “Calling the ambulance only” in this scenario is consistently the lowest ranked option, and over time the suitability of this option deteriorates.

6 FUTURE WORK

6.1 Evaluation of System

Current work is focused on evaluating the usefulness of the tool developed. Initial research has indicated that mobile decision support is of use to decision makers on the go (Cowie and Burstein, 2006), however more rigorous evaluation is due to begin investigating how such a system is used in different application areas. In addition, we hope to identify whether such a mobile device is restricted to only certain types of decisions, and whether there are some areas where the quality of a decision made in this way is degraded. For example, it could be the case that facilitating mobile decision making encourages rushed, ill-thought out decisions. Such a finding would impact greatly on the potential use of the tool in areas such as triage management, where the quality of the decision made is paramount.

6.2 Interface Improvements

The current interface, although facilitating mobile decision support, is undergoing continual improvement. We hope to run some evaluation workshops in the near future with potential users of the system. These workshops will allow us to assess the usefulness of the tool and the usability of the interface.

6.3 Prediction Capabilities

One facility that is regarded as highly important when trying to assess the suitability and stability of an option is forecasting. Currently, the tool uses a very simple weighted averages approach to predict the next score value for an alternative. We hope to incorporate more sophisticated techniques to enable a greater amount of prediction ability for future score values.

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