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# Learning How to Make Optimal Decisions in Design and Selection of Post-Disaster Shelters

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**ABSTRACT**
Optimal choice of shelter solutions in post-disaster emergency situations depends on deep understanding of needs, context of needs, up to date knowledge of the available solutions and smart strategies to connect the two optimally.
Evidence of needs can be submitted both by the beneficiaries and relief specialists as NGO's and the UN. The solutions can be entered by local or international suppliers. Post-disaster emergency shelter designers are as any other designer concerned with the ecological, social, cultural and spatial application of technologies to meet specific human needs after each disaster and in each location. The choice for an on-demand designed post-disaster shelter contributes to optimal post-disaster shelter relief process and sustainable post-disaster emergency shelters. The need for qualified engineers who can translate their technical know-how into tailored solutions is eminent.
In this article we describe a research project that develops and tests a tool for design and selection of on-demand post-disaster emergency shelters, a Decision Support System (DSS). The tool can be used by the beneficiaries, relief specialists and politicians. The questions asked by the DSS for gathering evidence on needs and solutions, can be adapted to each type of user. In addition to assisting relief specialists in decision making, the DSS can be used as training tool for relief specialists in the field and educating engineers in their thinking.
***Keywords***: Design, disaster, needs, learning, post-disaster, innovation, Post-disaster shelter**,** technology, research projects.

## I. INTRODUCTION

The UN and relief organizations as the IFRC acknowledge that adequate shelters are vital for saving thousands of lives at risk. The available budget is often decisive for the quality and quantity of the available shelters. However the understanding of local culture, knowledge of available solutions, and the usage of the available technology, to access information about the disaster, local climate and conditions can contribute to more efficiency and reduce costs.

Cases as Pakistan, Tsunami in Indonesia or the recent Haiti post-disaster shelter aid where not rain resistant shelters were provided shortly before the rain season, demonstrate that decision making in post disaster shelter aid does not lead to tailored shelter solutions for each situation.

Relief organizations are mandated to provide optimal aid after a disaster. Spite extreme efforts to provide optimal shelter aid however, the shelters often do not meet the requirements. Lack of proper instruments, lack of professionalism, shortcomings of relief specialists in decision making positions, in terms of experience, training, insight or conflict of interests are possible reasons for the ongoing failure in providing optimal shelter aid.

Training a shelter relief specialist can cost up to €7800, which is mostly not affordable for the volunteers or the NGOs. The shortcomings as a result of lack of training for example can partly be reduced by using a proper tool as a decision making aid tool that has access to the needed knowledge in the field, a Decision Support System (DSS). This tool can function as training tool as well.

## II. HEADINGS

The **headings** and **subheadings**, starting with "**1. Introduction**", appear in upper and lower case letters and should be **set in bold and aligned flush left**. All headings from the Introduction to Acknowledgements are numbered sequentially using 1, 2, 3, etc. Subheadings are numbered 1.1, 1.2, etc. If a subsection must be further divided, the **2 DECISION SUPPORT SYSTEM FOR ON-DEMANS POST-DISASTER EMERGENCY SHELTERS**

The application of technologies to meet specific human needs in case of post- disaster emergency shelters, leads to finding the optimal solutions in as short as possible time. The UNDRO (United Nations Disaster Coordinator, now called OCHA) has been offering post- disaster planning and relief coordination since 1972. Although significant aspects have been changed in the quality of post- disaster emergency shelter aid since, the offered aid does not meet the needs of the beneficiaries and the requirements completely [1].

Post-disaster shelter relief specialists have to deal with decision making under time pressure and in a hectic and chaotic post- disaster environment and are expected to think of various parameters simultaneously.

In addition to human factors as altruism, emotions and stress, the chance of human errors or overseeing essential factors under high pressure of time and in a hectic environment is more present when optimal training is lacking.

Preparedness has been recognized as a key factor by post-disaster relief specialists. Preparedness includes educating engineers in their design thinking and training the relief specialists who operate in the field. A tool, a Decision Support System (DSS), that does not feel the pressure and has the knowledge of the needs, solutions and the rules to connect the two can be of assistance to the relief specialists, can be of assistance in the field and in training.

## III. The Structure Of Decision Support System Architecture

To formulate the characteristics for such a tool, we develop and test a prototype DSS. The Decision Support System consists of two essential parts:

Input: Collect variables in user screens; set up data structures to store information about disaster; set up data structures to store information about Location; set up data structures to store information about Situation; Set up data structures to store information about Materials/Techniques; record Shelter with variables information; set up admin functionality to maintain data (user administration; shelter data)

Output: Set up calculations; generate report present conclusions.

System specifications, system structure and system rules make the final decision making process possible. Technical specifications for the DSS for post- disaster emergency shelters are standard specifications: ICT specialists, tailored physical infrastructure (web browser, server, and engine), database, data security and data storage.

The system is rule based and makes decisions based on the disaster and location data. Behind the scene, the disaster workflow will be activated.

To provide on-demand shelter advice, the DSS needs, a logistics module, water and sanitation module, a design module, energy module, waste module and a rubble module can be implemented in the DSS.

The performance based decision making in the DSS results in the need for additional matching with the current product standards as the sphere [6] and shelter standard. The optimal situation is when performance standards are applied by all decision makers or a DSS that checks the compliance with various standards.

The DSS asks a range of questions related to the disaster, location and solutions, according to the shelter workflow to provide a list of the most optimal shelter/shelter items. Fig.1 is an example how the workflow structures the steps that are taken by the DSS. In this example, the logistics workflow, once the disaster location is defined and the most suitable shelters are identified, stock location and the package size will be determined. This information will be used by the DSS to define the optimal logistics for the distribution of the shelter. The final step of this process is to confirm the shelter and producing a final report. The user can decide to end the process or add more Auxiliary materials.

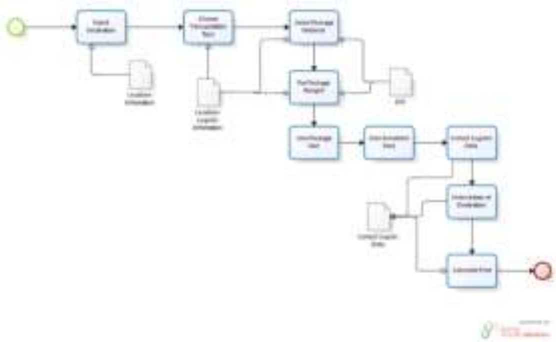

Fig.1

The DSS can be divided in three sections: Users, data and rules. Rules and data are not visible to the users. The DSS knows four levels of users: Administrator, data manager, disaster manager and shelter manager. The administrator has access to the whole system, including the engine and the rules. Data manager is responsible for data gathering in the system, service calls and master data. Disaster manager enters and the disaster data can be a beneficiary, a relief specialist or a politician for example. Shelter manager is the representative of a manufacturer, can enter shelter data and has only access to his/ her own shelter data.

Regarding data gathering; data storage and data connectivity, data security is the key element in post-disaster relief process. Relief organizations have pointed out that certain data needs not to be saved or archived due to safety measurements.

The strategy in decision making that combines the demand side of the infrastructure to the solution side, needs to have the capacity to cope with diversity of supply, in a broad crosscutting environment. System and data security are in addition to infrastructure capacity primary requirements for an optimal functioning of the DSS.

Two ways of defining the on-demand optimal shelter can be followed: the optimal shelter regarding absolute functionalities and performance and the optimal shelter including extra parameters as recycling; delivery time and local economy parameters. The latter provides the overview that we need for long-term effects of the shelter.

To meet the needs of the beneficiaries and provide an integral on-demand shelter solution, a logistics module, water and sanitation module, a design module, an energy module, a waste module and a rubble module are to be included in the DSS.

### 3.1 Data connection-Entity Relation Diagram

To create a prototype DSS, first we create an Entity-Relationship Diagram (ERD), the blueprint that explains motivation for the advices that the decision support system suggests. This step is essential in creating a functional knowledge management system. Fig.2 illustrates an example of the diagrams.

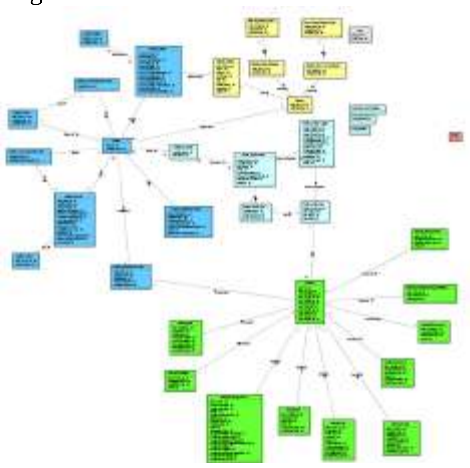

Fig. 2

The table "Location" refers to all geographic information, the user can decide how detailed the data need to be. The tables "Location Small Scale Information" and "Large scale information" can be used for implementation of GPS functions or other links with usable data in the DSS. In case of location data the data concern master data, available directly at any time while using the DSS,.

The section "Disaster" refers to the information regarding the disaster. The database distinguishes between "natural" and "man- made" disasters. Relief organizations participating in relief activities are in most cases defined by the type of disaster: Man-made disasters are mostly handled by the UNHCR as the IFRC mostly is involved in natural disasters. In addition the knowledge of the kind of disaster assists the DSS to provide tailored advice concerning the "After- Disaster-Effects".

Data about the beneficiaries is gathered in the table called "Disaster_Beneficiary".

The solutions are structured in solution tables. The shelters will be registered with all the relevant technical specifications. On the level of shelter parts and materials the material specifications is gathered. Local (construction-) materials, shelter items are available via table local materials.

The steps in the current DSS are as follows:

Step 1: Logging in, step 2: Entering data, step 3: Selecting continent and disaster type, step 4: Selecting location and disaster, step 5: Confirming the selection, step 6: Entering disaster specifications, step 7: Producing report, step 8: Selecting desired solutions, Step 9: Shelter choice, step 10: Final report.

### 3.2 Requirements for a DSS for post- disaster shelter relief

The basic needs for a DSS are the correct engine, working infrastructure and computational environment including connection to the infrastructure. When the correct engine is chosen, the DSS needs data; structured information on the needs and the solutions and a set of Decision criteria and rules to decide by. Location data, disaster data and solution data are the sources that are consulted by the DSS. A profound maintenance of the system and the accessibility of the DSS for the users are the key elements for trust and acceptance of the DSS as a tool by the users. This includes internet connection and a reliable infrastructure. In this case, clear rules that connect the needs and the solutions together and performance standards are crucial for the DSS to provide tailored, uniform on-demand post-disaster shelter advice.

In this research project we develop and test a prototype DSS.

## IV. TESTING THE PROTOTYPE DSS

To learn from the developed prototype DSS, we test the tool and formulate the characteristics for the DSS that can bring the needs and the solutions in post-disaster shelter aid optimally together.

In the test, in a role-play, three groups of students provide shelter advice for the selected test locations. We choose to perform the test with students as test panel, as although students are no authority in the field of shelter relief, they are more objective in this matter. Relief specialists would be testing their own previous performances or their own way of operating versus a tool.

As students have no interests in the field of post-disaster shelter relief or have to consider the consequences of their answers, they will provide uninfluenced, neutral results.

Twelve students in three groups of four, each with a specific role, test the DSS for three locations. Two groups have one extra member as beneficiaries.

These students tested the DSS within their study program. Each location is provided with shelter aid by two groups of test panel members. One group has access to the DSS and the second group will provide shelter aid as currently the shelter specialists do. In this test we will refer to the decision making without using the DSS as "the paper-run". Both groups have access to the same disaster- and location parameters and both can choose the optimal shelter solution from a list of forty five shelters, specially formulated for this test. By comparing the results, we can discover the characteristics of a DSS that leads to a tailored, uniform and optimal shelter choice in post- disaster situations. With the aid of the test results we can formulate the characteristics for a DSS for post-disaster emergency shelter relief that can effectively connect the needs for post-disaster emergency shelters in a specific situation with the available shelter solutions.

Each group provides shelter solutions for two locations, one location with the aid of the DSS and for one location, implementing the Paper-Run method. This results in two shelter advices for each location; one advice provided implementing the DSS and one advice implementing the 'Paper-run' method (without the aid of the DSS). We compare the provided advice and the needed time for decision making and we investigate the findings of the panel members.

Disaster data and shelter data are available in the test documentation. The location data for paper-run is available in the project documentation. The DSS test panel has access to location data via the master data; however they do not need to access this data when using the DSS. For the test using the DSS, each group of students fill in the location and disaster parameters or fill in shelter/shelter item data and consult the prototype DSS for one disaster.

The panel members have specific roles as actor in post- disaster shelter relief. The roles are: Shelter relief specialist, Local Mayor of the disaster location, Minister of foreign affairs of a donor country and Beneficiary. Each panel member has a public and a hidden agenda.

The test panel members are monitored in their communication and interaction with one another, while performing the test. Each panel member has specific goals defined by his/her role and the hidden agenda that is to be realized. The panel members need to discuss the requirements related to their role with the other panel members in the group. One shelter type is to be chosen by each group while each group members individually try to realize their hidden agendas.

In this test we provide pre-assembled shelters in fictive designs that can be advised by the DSS.

### 4.1 Test criteria for a DSS for post- disaster shelter relief

The first test is performed in a controlled environment where the questions over the location and disaster parameters are specifically defined for the test. The location and kind of disaster are actual cases where the disaster has occurred in the past. To create a measurable test environment, the disaster parameters including the amount of beneficiary is for all the locations identical in the test. The shelters (solutions) are specially created with each one differing characteristic (shelters for the test) to create a controlled test environment. The prototype DSS will be tested on her contribution to uniformity in decision-making. For the test performed by shelter experts and non-expert individuals, the test panel uses the DSS according to the available test manual. As the current DSS is a prototype, the data on the locations and shelters are limited.

We test the performance of the prototype DSS for on-demand post-disaster shelter advice, according to the criterion of providing tailored, uniform solutions regardless external influences.

In the test, shelter choice, made by the prototype DSS will be compared to the shelter choice, made without the assistance of the DSS. We test if arbitrarily and non-objective decision making can be eliminated by the implementation of the DSS and then we formulate the characteristics needed for a DSS that can achieve this performance.

The test conditions include extreme factors that can occur and can lead to less optimal solutions. The parameters in the test panel members' hidden agenda for example do not implement that per definition these scenarios will indeed happen. These are extreme test conditions.

Theoretically the DSS can be tested in any location. Data on the ten locations are currently available in the DSS. We test three locations, Haiti, Japan and the United States of America. The disasters are man -made and natural disasters.

Disaster locations are locations where previously disasters have occurred. However disaster data and shelter solution data are fictive and specifically prepared for this test to create controlled measurable results for objective comparison.

The advice that the test panel provide in each case, will be compared one to another. The panel members are provided with the information and instructions. The test panel members will answer the questions as formulated in the manual. Disaster data are equal for all test panel members. The test panels are:

1 Member of a donor government/minister (Donor) | User level: Disaster manager

Aim: A: To provide as much shelter aid as possible/high quality/fast; to meet the needs of the beneficiaries; as he/she is accountable towards the taxpayers: see to that the taxpayer's money has to be spent on shelter products; to lose as little time as possible for making the decisions (To make fast decisions).

B: To make sure that his country's economy can profit from this shelter relief; to bring at least 10% of the shelter orders to his shelter manufacturers; to get logistics realized by a his country's logistics company; to convince the voters that their tax money is spent optimally; to present his country to the world as a nation that makes significant contributions to relief activities.

2 Shelter technical advisor international relief organization. | User level: Disaster manager

Aim: A: To provide as much shelter aid as possible/high quality/fast; to meet the needs of the beneficiaries; to have an overview of the donated items /the costs; to purchase as many shelters with each euro he/she has.

B: To be the first organization that provides shelters to the beneficiaries; to be on the news as active and efficient organization that is doing all the work; to buy the shelters from a friend; to get an order for an innovative manufacturer that is trying to use the innovative material XT in his shelters in order to help him innovate further.

3 Local relief organizations | User level: Disaster manager

A: To provide as much shelter aid as possible/high quality/fast; to meet the needs of the beneficiaries; to find structural solutions for the future disasters.

B: To get 10% of the donations.

4 Beneficiary User level: Disaster manager

Aim A: To secure shelter for himself and his family fast; to survive.

B: To provide shelter for not-affected poor family members.

In this test, the available time to choose a shelter solution and produce a report is max 20 minutes. The test panel with the DSS has access to the location data via the master data, as the Paper-run group is provided with documents including location data. Location data are retrieved from Google- earth. Both the DSS group and the paper-run group can choose to investigate the location data on the internet. Both groups have access to the list of 45 shelters. As the shelter specifications are specially prepared for this test, they are fictive products. Each shelter has one parameter that is different from the other shelters. A uniform and comprehendible data matrix is then realized. We compare the provided advices. Finally we gather the suggestions how the DSS can be improved.

### 4.2 Test results

The test results are summarized in the table 7. As the table shows, three members of group three did not finish any part of the test, due to system failure (DSS) and shortage of time (paper-run). Two groups had two beneficiaries, to test the effect of presence and democratic choices. The effect of extra panel members on the outcome appeared not to be significant. Location Fukushima was chosen as the only location where the shelters were to be situated inside. The shelters did not need to meet the local climate conditions. The test panel group three members, who did finish the test did make the error of ignoring this fact in the paper- run, the DSS users in all groups chose automatically for shelters suitable for being places in covered areas. Human error was prevented by the DSS.

Table1- test results

| Test panel | Test | DSS Locatio | Shelte | Amou | Price | Paper-run Locatio | Shelter | Amount | Price |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | Port-au- | F shelter | 22550 | 6765000 | New | B Shelter | Incomplete | Incomplete |
| | 2 | Port-au- | F shelter | 16005 | 4801530 | New | B Shelter | Incomplete | Incomplete |
| | 3 | Port-au- | F shelter | 16005 | 4801530 | New | B Shelter | Incomplete | Incomplete |
| | 4 | Port-au- | F shelter | 35000 | 1050000 | New | B Shelter | Incomplete | Incomplete |
| | 5 | | | | | | | | |
| | 6 | Fukushim | AO Shelt | 6447 | 1934100 | Port-au- | H Shelter | 50000 | 15000000 |
| | 7 | Fukushim | Z shelter | 35000 | 1050000 | Port-au- | H Shelter | 50000 | 15000000 |
| | 8 | Fukushim | AO Shelt | 71629 | 2148870 | Port-au- | H Shelter | 50000 | 15000000 |
| | 9 | Fukushim | Z shelter | 35000 | 1050000 | Port-au- | H Shelter | 50000 | 15000000 |
| | 10 | Fukushim | Z shelte | 25000 | 7500000 | Port-au- | H Shelter | 50000 | 16000000 |
| | 11 | New | E shelte | Incom | Incomple | Fukushima | E Shelter | Incomplete | Incomplete |
| | 12 | New | Incomplete | Incom | Incomple | Fukushima | E Shelter | 27500 | 8250000 |
| | | | E shelte 2 | 26150 (E) | 8075000 | | | | |
| | 14 | New | Incomplete | Incom | Incomple | Fukushima | Incomplete | Incomplete | Incomplete |
| | 15 | New | Ze FS | Ze FS | Ze FS | Fukushima | E Shelter | 27500 | 8250000 |

Test panel group one did not succeed to complete the selection in the paper-run due to time limitations. Regarding amount of shelters and the total price, the group could not reach an agreement in the available time. The differences in the hidden agendas lead to discussions which was not the case when the group used the DSS. The choice of the shelter for location New Orleans was made based on permanency (B shelter), however in New Orleans permanent shelters were not required in this test. The duration of shelter aid is three Q (9 months). Fast delivery and price were disregarded by the group members.

In case of New Orleans, in paper-run version, the hidden agenda of the minister was crucial for choosing a shelter fabricated in his country (B shelter). The fastest shelter would have been the E shelter located in Laplace USA.

As the beneficiaries claimed more shelters than needed due to their hidden agenda the group could not agree on the amount of shelters in the paper-run. In the DSS version , the official amount of needed shelters, was higher than defined in the test manual as well.

In the DSS version the test panel group one, choose the F shelter, located in Port Au prince Haiti

which is the fastest shelter as the prices were equal, this is the optimal choice.

Test panel group two had a discussion during the test with the DSS about the choice of the Z shelter from Tokyo that would be the fastest shelter according to the current DSS or the AO shelter that had to provide shelter fast, however as the choice for the cheapest or the fastest was possible, a number of panel members did choose for the fastest shelter (the assignment). This resulted in non-uniform advice from the DSS. This step in the DSS leaves space for discussion.

The discussions for the choice of the most optimal shelter indicate that without the DSS there is more opportunity for choosing non optimal solutions: Test Panel Three (Paper-run) succeeded to convince his group to buy shelter 945 (the B shelter) as he was friends with the manufacturer. And in case of Fukushima the paper run panel members ignored the fact that the shelter was situated inside.

When using the DSS the discussion was possible when the system capacity was not sufficient (system crashed) and when the fastest and cheapest shelters were to be selected manually in the last step.

The panel members of test group three could not finish the DSS as the system failure caused by infrastructure capacity limitations and the panel members started to fill in the amount of needed shelters manually at the last interface page.

Regarding data entry, the amount of beneficiary that was to be filled in equally for all the situations, was filled according to the hidden agendas of the test panel members. As the panel members did not follow the test manual structures when filling in the amount of beneficiaries, to achieve their hidden goals the amount of needed shelters vary. Data gathering in case of disaster data depends on the information that the users provide to the DSS in the current situation.

In the Paper-Run test, the panel members could not choose a shelter in the limited time of the test. A shelter choice was too complicated to perform in this short time. The average time spend to discuss a shelter choice in a group in this test was 7,75 minutes for the DSS users and 14,23 minutes for the Paper-Run group.

## V. Charachteristics Of A Decision Support System For On-Demand Post-Disaster Shelters

The test results can be summarized in a set of characteristics for a Decision Support System for post- disaster emergency shelter aid. The DSS breaks the complex variables in post- disaster emergency shelters down into simple rules, and is able to combine the results into complex decision advice that is needed to provide a tailored solution for each disaster. In order to provide optimal advice detailed and sophisticated data gathering.

The DSS for post- disaster emergency shelters has the ability to provide tailored and uniform on-demand shelter advice by means of elimination of arbitrary choice of shelter / shelter parts, involvement of the users, and a comprehensive structure. The characteristics of such a DSS can be summarized as:

- The DSS has access to the infrastructure, technical capacity in the web browser, server, the engine to process and store the needed data on and provide data security ;
- The DSS has up to date knowledge of the needs and/ or has the flexibility and the ability to gather data on the needs fast (reliable assessments).
- The DSS has up to date knowledge of the solutions (local –traditional-innovative) / or has the flexibility and the ability to gather data on the solutions fast, via links and other engines
- The DSS is transparent, the prices and the stock are available on line
- The DSS is accessible to all (the beneficiaries; donors and relief specialists) and can be expanded to the level of policymaking, medical aid, and can provide advice in long-term shelter and urban design activities.
- The DSS is reliable while being used by the involved parties as relief specialists, the beneficiaries and the manufacturers: objectivity, system stability and data security.
- The DSS has the knowledge of the local and international standards.
- The DSS is flexible in programming.
- The DSS is user-friendly.
- The DSS learns from the earlier events, provided shelters/ evaluations.
- The DSS needs limited maintenance.
- The DSS provides a sector memory, has a record of lessons learned from the past disasters, learns from the earlier experiences and provides advice based on this memory.
- The DSS has a cross- sector character (interconnectivity) and has sections as energy, waste, rubble, water, sanitation, nutrition, medical advice.
- The DSS has access to inclusive, structured data.

## VI. CONCLUSIONS AND RECOMMANDATIONS

As the recent cases show [2], applying innovative technology in post-disaster emergency operations, including shelter aid, is already a fact. SMS is for instance used broadly to provide information for the beneficiaries or to locate the missing persons. The task is to implement innovative technologies in an appropriate way.

The various available artificial intelligent systems and the applicability of each system in different situations have been structured in many publications [3]. In case of design tools, the necessity of efficient communication among various disciplines in collaborative (design)- teams has resulted in development of tools as SCAFFOLD. The conclusion of developing and testing this tool was that the implementation of computational tools can contribute to more efficiency in communication and more transparency in the architectural design process [4].

In decision making (when choosing post-disaster shelter items), as well as designing post-disaster shelters, a more integral viewpoint and constantly tuned data, technology and information until valid and usable results are obtained, results in better decisions or designs [5] In the specific case of post-disaster emergency shelters, an integral approach from clothing and sanitation to water, energy and construction results in more tailored solutions, that can save time, costs and as a result save more lives. As for instance in cold climates providing hats/winter-caps can result in less need for heating in the shelter. The first step in shelter relief is to design an integral combination of the available preferably local solutions.

This research project can be summarized in a set of characteristics for a Decision Support System for post- disaster emergency shelter aid. The optimal DSS for post- disaster emergency shelters has the ability to provide uniform advice.

The test in this research project indicates that users including relief specialists, the beneficiaries and designers need to trust the DSS and to believe in accuracy and reliability of the advice provided. In addition to participation of the users in the creation of the DSS, a DSS that will be used by the involved parties needs a flexible framework and a reliable and secure infrastructure.

An adaptive way of thinking by the relief specialists is needed to provide on-demand post-disaster shelters. The pipelines that are currently set up and are seen as a routine are to be re-thinked. In addition relief specialists may need time to get used to a new approach. This can be seen as a reason why this approach may have little chance of being implemented as a Decision Support Tool. The tool as a training tool may have a chance, as the DSS can make a selection from the existing solutions.

A different approach for the DSS to be more accepted can be to make a selection of existing shelters based on relevance to the situation: ranking in the needed specifications, the priorities of the users as indicated in earlier steps, Fig. 3. From the most suitable shelters the cheapest or the fastest options can be selected. The cheapest and the fastest solutions will be specified by the amount of time and the difference in price. The user can choose the desired balance between time saving and optimal pricing using this information.

A set of rules has to be created in addition to the current rules. The system has to check the percentage of requirements that a shelter meets according to the selection rules. If a shelter fits for 99%, and if no solution fits for the full 100%, or if the shelter is significantly cheaper than the one with the full 100% then the shelter will appear in the solutions screen. When the user places the cursor over the percentage, the requirements that cannot be met are displayed. The user can decide whether these are too important to ignore or to accept the shortcomings of a certain shelter. Figure 3 illustrates an example of how the ranking system operates. As the system provides the possibility to return to earlier steps, the user can choose to return to step 8 and adjust the needed shelter specifications or continue and follow the advice provided by ranking.

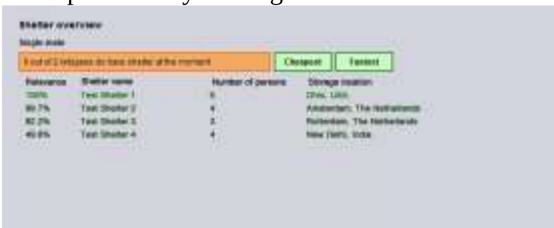


Fig.3

In both cases of choosing from the existing solutions or designing on-demand shelters, The DSS needs the trust of the users in terms of data accuracy, data security, securing objectivity and transparency as well as infrastructure reliability and accessibility.

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