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ICT for Social Networking in Flood Risk and Knowledge Management Strategies- An MCDA Approach

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***Abstract*—**This paper discusses the role and importance of Information and Communication Technologies (ICT) and social Networking (SN) in the process of decision making for Flood Risk and Knowledge Management Strategies. We use Mozambique Red Cross (CVM) as the case study and further more we address scenarios for flood risk management strategies, using earlier warning and social networking and we argue that a sustainable desirable stage of life can be achieved by developing scenario strategic planning based on backcasting.

***Keywords*—**ICT, KM, scenario planning, backcasting and flood risk management.

I. Introduction

MOZAMBIQUE is located in Southern Africa between 10°27'S and 26°52'S Latitude and 30°51'E and 40°51'E Longitude and has a total area of 799,380 km^2 [3]. This geographical location provides a unique economic strategic opportunity in one hand, but on another one it creates a vulnerable situation given the magnitude of exposure to natural hazards. According to Mavume [1] in the National Institute for Disaster Management, INGC [3], "*the country, lying at the offshore warm-waters of the Mozambique current, it is simultaneously situated near the path of tropical cyclones that propagate across the African continent stretching mostly from the north to the south of the country*", and from a total number of 128 districts of Mozambique, 57 are subjected either to drought, flooding or to both hazards, what motivates the progressive learning process of national institutions to deal with natural hazards.

Statistics show that in overall, 48.2% of the population of Mozambique is vulnerable either floods and droughts and synergic efforts are always put in place to deal with these events whenever they occur. The process of natural disaster risk management is lead by a national Center, an organic unit belonging to INGC called "***Centro Nacional Operativo de Emergência - CENOE***", that is responsible for coordination and decision making on technical and multisectoral issues before, during and after a disaster occur [1]. Historically, in 51 years, for the period between 1957 and 2008 the country registered 62 major events and this can be illustrated respectively on Table I and Fig. 1 respectively from [3] and [4].

TABLE I
Summary of the Impacts of Natural Disasters (Period 1956-2008)

Nº	Disaster type	# of Events	Total Killed	Total Affected
1	Drought	10	100,200	16,444,000
2	Flood	20	1,921	9,039,251
3	Tropical Cyclone	13	697	2,997,300
4	Epidemic	18	2,446	314,056
5	Windstorm	5	20	5,100
6	Earthquake	1	4	1,440

The 2000 year floods in Southern Mozambique are the worst in the country's history that still in the memory. Figures from both the Government of Mozambique and International Financial Institutions such as the International Monetary Fund (IMF) and World Bank highlight the magnitude of economic and social assets. "The World Bank estimated that losses, damage, and reconstruction costs from cyclone Eline were equivalent to 20% of the Mozambique Gross National Product (GDP)" [3].

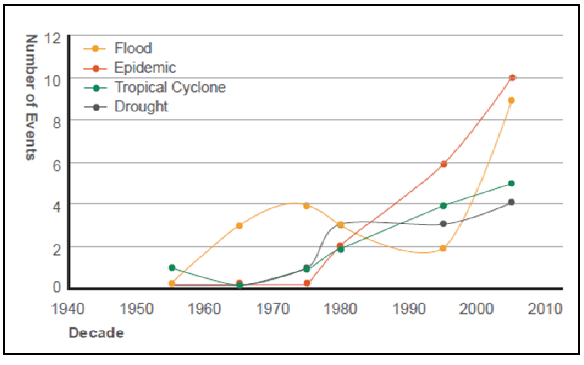

Fig. 1 Number of natural disasters in Mozambique (period 1956-2008)

CENOE is a result of historical process on risk assessment and risk management within the country where it has been

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undertaken by several organizations and institutions, and as a consequence the current situation is not really known. This handicapping situation has led to the implementation of a systematic inventory and evaluation of risk assessments. The inventory and evaluation of risk assessments were carried out under the SIERA (Systematic Inventory and Evaluation of Risk Assessments) project and one of the major output is the application of Information and Communication Technology the so called Risk Information Portal (RIP) "Contextual Framework" .

The SIERA Project, provide online access to the information on the status, issues and challenges, strengths and weaknesses of risk assessment in Mozambique [3] and it illustrates practical application of ICT on natural disaster risk management.

A. Purpose and Motivation

The application of Knowledge Management within social networking has shown to be key element for the success of many Information and Communication Technologies for the world development and particularly in the field of risk management where extensive applications are discussed within field literature.

The main purpose of this paper is to emphasize the importance of ICTs and social networks within knowledge management for flood risk management strategies in particular and for risk management in general. "Mozambique's major need is information about disaster risk – about probabilities of alternative consequences of different management actions – that is to use in various applications including planning, decision-making, mitigation and adaptation" [3]. *By carrying out this research we aim to contribute by providing different approaches that can be combined namely from knowledge management, scenario planning for strategic thinking toward decision making process, through social networks and application of ICTs for natural disasters and foster the country's capacity to deal with these events.*

"Social networking is the grouping of individuals into specific groups, like small rural communities or a neighborhood subdivision, if you will. Although social networking is possible in person, especially in the workplace, universities, and high schools, it is most popular online". *Our motivation for this research is based on above definition [5] and based on humanitarian interest we have chosen the Mozambique Red Cross as the social network for this study, given its importance and the large network of volunteers well distributed across the country.*

II. Objectives

The main objective of this paper is to provide the reader with different approaches that ICTs enable human in the process of Multicriteria Decision Analysis (MCDA) through Scenario planning for strategic decision thinking in the field of natural disasters in general, and, particularly taking the Mozambique Red Cross as the learning organization for their application toward:

1. Development of social networking in the process of Multicriteria Decision Analysis "Making" MCDA"M"
2. Development of knowledge management for both social networking and application of ICTs
3. Importance of both social network and knowledge management for flood risk management strategies and decision process analysis

III. Methodology

The methodology applied in this paper is a combination of both grounded theory and a framework rather hypothetical deductive, which means that the architecture will be proposed and tested through the development of specific outcomes based on a combination of case study analysis with scenario planning for strategic decision making theory approaches. The organization under consideration is the Mozambique Red Cross (CVM), a humanitarian society established on July 10th 1981 with the main objective to support the humanitarian agenda countrywide. The impact of knowledge management within CVM, based on the extensive network of volunteers is the key for success of institutional strategic and operational management. A combination of both ICT and human networking provide the communication and information system of CVM all over the country.

Mozambique Red Cross represented by a "RED CROSS SYMBOL" (see Fig. 2 A) is largely supported by a strong network of members and volunteers who subscribe their membership under a symbolic annual fee and are differentiated by categories and the selection criteria are namely individuals and organizations (Fig. 2 D), where a member becomes certified by a specific ID card.

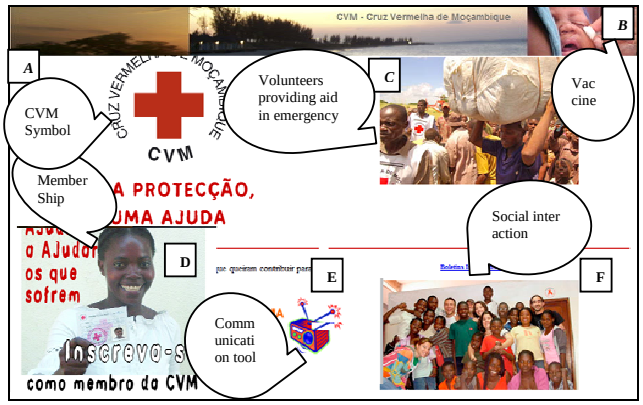

Fig. 2 CVM 6 steps Simplified Rich Picture, Source: [2]

Fig. 2 above illustrates 6 main steps that constitute some key elements of CVM daily activities, whose scope is widely supported by a human active network, therefore the focuses of this paper on social networking and knowledge management, which is built up by a chain of about 70 thousands members, 4.4 thousands young volunteers spread in 95 districts out of 128 existing all over the country [9].

Disaster risk management in Mozambique is an issue under the management of Government of Mozambique (GoM)

represented by CENOE within INGC, whose role is to coordinate and lead the natural disaster all over the country.

The CVM has been complementing the efforts of the GoM in humanitarian operations, by working closely with the INGC [2]. Nevertheless the leading role of INGC, CVM has been a pulling and learning organization where knowledge management, Fig. 2 above and plays a decisive role when comes to natural disasters management. CVM operates at three main levels namely at national, provincial and district levels and its intervention can be simulated on ICT based software shown in Fig. 3 below, plotted at 0.333% weight each.

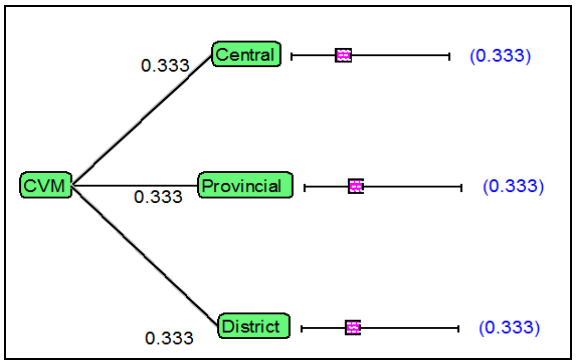

Fig. 3 CVM Resource Management Tree using VISA Software

Given the large social network and decades of experience in emergency and post disaster intervention, CVM has been country's key player when comes to deal with hazards and it has shown its added value in the major events such as the 2000 floods Limpopo and 2001, 2007 Zambeze floods, the February 2008 and September 2010 social riots in Maputo and the break of military weapon warehouse just to mention a few.

	Central	Provincial	District
Resource Ger	73	73	89
Human Resou	92	89	55
Assets and m	81	45	62
Financial Mani	100	67	34
Project Manag	56	98	28
Volunteers	11	78	98

Fig. 4 Score profile across the tree based on VISA Software

Figs. 4 and 5 illustrate the output of CVM intervention and the impact of Volunteers as part of social knowledge management in the field, what constitute the organizational key success factors.

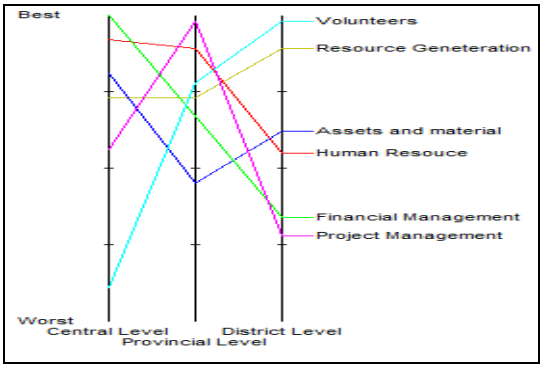

Fig. 5 Alternative weight for CVM based on VISA Software

IV. Social Networking a and Knowledge Management

Knowledge Management (KM), according to [10] has two main distinguishable branches that are widely accepted: explicit and tacit knowledge. Explicit knowledge is structured and can be verbalized, it is the structured and objective part of knowledge, it can be stored in documents and computational systems, while Tacit knowledge is inherent to people; in other words, it is the abilities they possess [10]. Tacit knowledge it is seems like being non-structured part of knowledge that cannot be recorded and or easily transmitted to others.

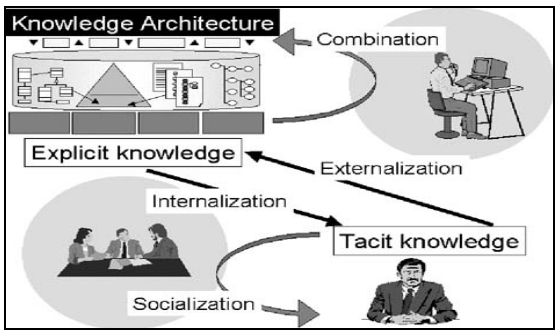

Fig. 6 (a) Knowledge Architecture and Management [10]

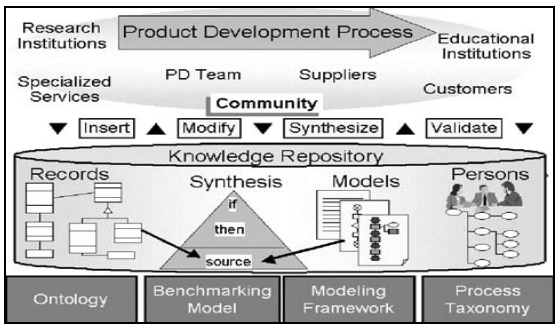

Fig. 6 (b) Management as Key Success Factor [10]

Despite the strong of social network that CVM possesses countrywide, the key success factor for its continuous involvement in preventive and coping operations is based on knowledge management, where both scientific and local knowledge are combined to strategize the operational elements

in the field of disaster risk management, taking into account the cultural and ethical issues, as illustrated on Figs. 6 (a) & (b).

Figs. 6 (a) and (b) above elicit the role of ICT in the process of Knowledge management, where the combination of IT, human facilities and culture can bridge the ICT application within social networking toward flood risk management strategies. Many ICT applications have been put in place in the role of flood risk management and (RIP) concept developed in chapter I is an example how multi-stakeholders can share values in the process of "flood risk management" by accessing the risk Information portal.

Apart from humanitarian aspects CVM also relay on technical aspects to reinforce its Information and Communication Systems (IFSs) based on traditional radio, satellite vehicle mobile based communication radio, telex for and fax facilities, land line facilities, mobile and internet. This set of ICT tools combined with cultural and ethical habits and principle constitute the beam of strength that support most of operations in the disaster front line for CVM.

Nevertheless, the success of CVM operation is based on a combination of both social and technical aspects based on the wide spectrum of knowledge management that has been put in place for the decades of its existence. Figs. 2 C, E, and F, illustrate the basic tool of communication applied by CVM to fulfill its mission, whose combination establish the bridging process of social networking toward knowledge management in the process of multi objective decision making [7] for hazard risk management strategies, particularly floods.

The social purpose of flood risk management is to reduce flood damages. Since flood risk management strategies can require a significant diversion of resources from other purposes, it is desirable to determine whether the reduction in flood damages justifies the resources so spent. Equally, only if we were in a position to evaluate alternative intervention strategies in terms of their relative benefits and costs we are able to make better choices and introduce more effective flood risk management strategies [8]. Nowadays the usage of social networking within natural disaster risk management goes beyond borders thanks to the ICT facilities worldwide and the application of smart phones and open access facilities. The internet has changed the world and widely influences the behavior of the humanity in general and particularly the way the decisions are made.

V. Technology Description and Developments

The role of ICT within the field of natural disasters has been of special importance in the last decades, especially in the process of decision making. GIS applications in Multcriteria decision making, earlier warning systems and storms tracker processes are just few of ICT application particularly within flood risk management strategies, Fig. 7.

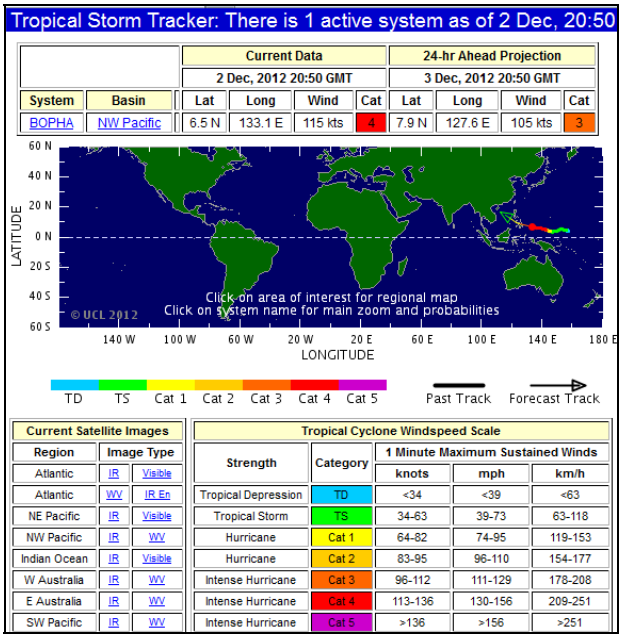

Fig. 7 Tropical Storm Tracker [6]

Fig. 7 provides an illustration of web based tropical storm tracker [6] that CVM has a link on its webpage, which provides information to any citizens who access it. The social networks where human capital exercise their knowledge such as radio, TV, mobile phone, internet applications like Facebook, Twitter, "People Net" in China, Wikis are among those ICT tools that if well managed can provide communication facilities before, during and after a disaster occurs and in the specific case of Mozambique, CVM has used them successfully, particularly, in the field of flood risk management strategies.

VI. Social Networks, KM and MCDA

This section discusses the importance of ICTs in the process of strategic decision thinking, particularly, in the field of flood risk management. We use the performance measurement to simulate the impact of social networks for knowledge management taking into account five main attributes, namely:

- Knowledge share with all stakeholders
- Attention to issues such as culture and ethic
- Building of existing system
- Social networks knowledge management context
- Building and positioning in as the more reliable tool for support and connect people

The above attributes are simulated based on the principle of pairwise comparison, using a Multicriteria Decision Analysis tool, the Analytical Hierarchical Process, (AHP), in Fig. 8. Three main stages, principle, are considered within the application of AHP [11]. The first principle is the decomposition which requires the decision problem to be detailed into a hierarchy that captures the essential elements of the issue. The second principle deals with the comparison of the elements under consideration. Here resides the importance

of AHP, when the pairwise analysis takes place within a certain level of branching, taking into consideration the parents and children of a given hierarchy. Lastly we have the principle of synthesis, where the relative weights from the second step are aggregated and composed.

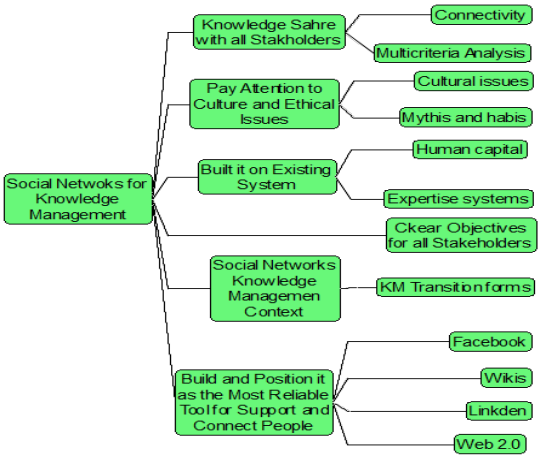

Fig. 8 Performance Measure's Tree for KM & MCDA

In this paper we reinforce the role of ICT in the MCDA strategic decision thinking, by developing a scenario planning and analysis, using 4 alternatives that can taken in case of floods, bearing in mind the reaction of those whom are impacted and have direct influence on social networks for knowledge management:

- A1; Stay indifferent
- A2: Wait to certify
- A3: Evacuate by own means
- A4:Evacuate in emergency

Each alternative is subject to influence the behavior of the stakeholders involved in the process of flood risk management and strategic thinking since any scenario that is strategically developed aims to ensure future actions from now [12]. Scenario planning was first used in World War II (WWII), aiming to defeat the enemy [13] and they result from the strategic complexity to predict the future. Shoemaker [14] stresses the importance of scenario planning by compensating for two common errors in the process of decision making: first error comes from an underestimation of the process while the second one, derives from the overestimation, where the first case is the most common within organization in the process of strategic planning. Stevenson [15] within IPCC Special report [16] brings disaster risk planning and climate change adaptation within planning issues for an uncertain future, such as a process of combining people's aspirations both personal and collective with perspectives on what is about to be achieved. Both Robison [17] and the IPCC stress long term sustainable planning that consider poverty, inequality and injustice as incompatible to such vision to be covered by specific techniques, with which the most likely might not be the most desired. Backcasting techniques close the gap that predictive scenarios and risk approaches, exploratory and normative and normative approaches do not fill. "Participatory backcasting, which involves local stakeholders in visionary activities related to sustainable development, can also open deliberative opportunities and inclusiveness in decision framing and making" argue the IPCC [16].

Being backcasting an organizational learning act of setting up how one frames the desired sustainable future; we can summarize this process as part of a dynamic planning with which we integrate all strategic decisions. Based on such approach we depict a desirable visioning stage, Fig. 9, where we need ICT to contribute for our social networking on flood risk management strategies.

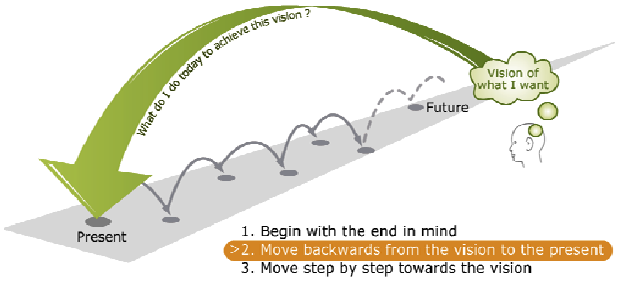

Fig. 9 The Backcasting process for scenario planning [18]

Fig. 9, from [18] illustrates the backcasting method from scenarios for organizational sustainable development. This process starts with the definition of a visionary point where the strategic planners set up the desirable sustainable future, based on what is called the end mind visioning. Then a backward process the vision to present is developed and this is designated Backcasting [18]. Then there is a complementing process from the present that fills the gaps, step by step, toward the end mind point.

We can exercise this as the process taken as an output of different possible combination of the outputs depicted in both Figs. 5 and 6 in order to built the sustainable scenario. The weaken side of this combination is that if we involve many stakeholders as well as if we depict many variants we might become inadequate to manage the process. In Fig 5 our approach will be how can ICT enhance the strategic planning toward a sustainable social networking for knowledge management so that CVM have all 6 alternative well manageable at all three operating levels, while Fig. 11 can help us to ask a question such "how can ICT can contribute to social networking for knowledge management so that people best manage the given four alternative for their surviving in case of emergency". As we argue in section IV, knowledge management the ICT plays a major role to bridge the IT and human behavior and culture in the process of social networking. Bessis and Asimakopoulou [19] have published an extensive collection of ICT research paper for disaster and threat detection, which extensively address important topics on the subject.

Decision support systems (DSS), particularly the ICT, provide techniques that help the human being to model its

future. Fig. 7 from Tropical storms trackers provides different scenarios about stage of tropical storms. V.I.S.A. the software that generated Figs. 3-5, 8, 10 and 11 is one of the many (DSS) with scenario planning applications. Both tropical storms trackers and V.I.S.A. provide scenarios, which constitute "*hypothetical sequences of events constructed for the purpose of focusing attention on causal process and decision points*" [20], while the World Health Organization glossary define "*backcasting as a step-wise back in time that must be taken at critical points if the scenario is to be a*chieved" [20]. The ICT within backcasting must play a role of decision support in ensuring a long term strategic vision, 25-50years, c.f. [18]-[21].

Robert [2] discusses the role of Information Technology within backcasting to enhance the sustainable transportation system, whereas we should borrow the same concept of applying ICT together with human behaviour to shape the sustainable flood risk management strategy. The complexity of ordinary scenario planning such as the ones depicted on Figs. 5 and 11 might be suppressed by using backcasting principles widely discussed in [18], which is not part of the present paper.

Kupuswamy [22] discusses ICT approaches in Disaster Management with focuses on public awareness, education and training, community resilience in India, while Reyes and Beard [23] highlights a systemic approach to manage natural disasters. The authors address similar approaches of ICT applications within communities to those of Millennium Village within Mondlane [24] where ICT play a pooling role for the change and systemic management. Early warning systems and alert technology if applied like advised by [25] in different categories we can cover both forecasting and backcasting scenario planning, bearing in mind that developing world such as Mozambique lack structural decision making frameworks. Multicriteria Decision Making is part of the strategies we could address as part of multiple stakeholders and multiple objective decision process, where the ICT have their strategic role.

VII. Results

An analysis from the previous paragraphs and Figs. 3-8, 10 and 11 show that the application of ICT within the field of scenario planning for natural disaster risk in general and particularly for flood risk management constitute a strong tool that enable social networks if positively the knowledge management is put in place; Fig. 9 emphasizes the role of backcasting in scenario planning and sustainability. Knowledge management and social networking appear to be two face of the same coin that can be reinforced by ICT, and hence strength the role of decision makers in the field of flood risks management strategies with long term visioning. Figs. 4, 7 and 8 show how the multicriteria decision making can be aided by ICTs as result of specific decision making Software, while Fig. 4 and 6 highlight the role of ICT in the process of knowledge management.

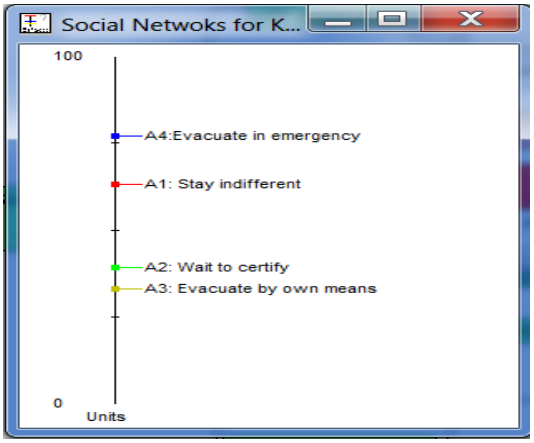

Fig. 10 The Thermometer, alternatives raking using VISA

Particularly, Figs. 10 and 11 show how ICT can provide multiple choices provided that the stakeholders have different objectives and options in the process of flood risk management, where alternative 1 appears to be the one with best expected value.

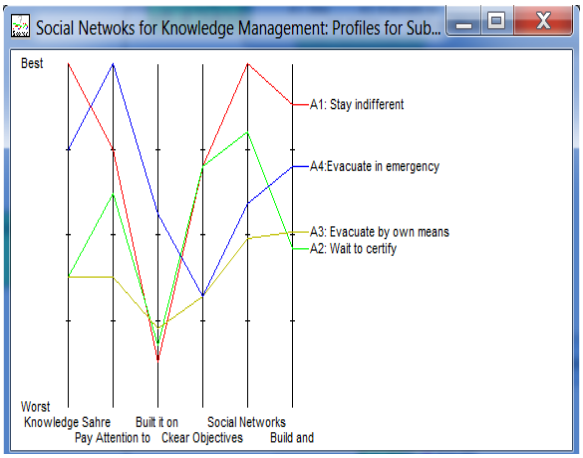

Fig. 11 MCDA Scenario analysis comparison based on VISTA

VIII. Business Benefits

The role of ICT for Flood Risk Management Strategies is of extreme importance and the application of social networks and knowledge management are added value. MCDA process can be reinforced as strategic planning tool through scenario planning for strategic decision thinking, based on different ICT applications.

IX. Conclusions

This research has shown how ICT can contribute in the process of decision making particularly if one is provided with different courses of choices and tradeoffs to make. Social networks and knowledge management can be combined toward decision making process what can contribute to minimize the waste of resources and prevent loss of both

social and economic assets at long run through backcasting process.

Decision making process is a complex issue, therefore when dealing with multi attribute is where the ICT play its contribution by providing the decision maker with tools that simplify the all process. Scenario planning is one of the most recommended tools that can help the decision makers to define and evaluate their strategic decision thinking. For this precise paper we can evaluate scenarios like the one shown in Figs. 8, 10 and 11, then decide what course of action we should take in case of possible floods. The scope of this work was to illustrate the role of ICTs within flood risk management strategies by combining social networking and knowledge management, which is a large topic and the authors, are aware of the limitations and uncertainty that encountered, hence further work still to be developed in the future.

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