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The Decisional Visualized Toolkit for Crises Management Based on Information Visualization

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Abstract: The changes related to intervention dynamics and the effects of extreme events and the complications involved have encouraged researchers to discover innovative ways to handle the decision making processes of crisis management. The issues related to these decisions are usually complex and need robust and usually creative, support tools. On occasion, time pressure, the complexity of the event, how quickly the event or disaster situation changes, the fact that surrounding environments can be chaotic and human behaviors are important when considering critical situations. This study offers an in-depth examination of commonly used crises management software from across the world. In turn, the organization of critical services necessary for continued and organized crises management is built through a literature review and the researchers communication with a number of stakeholders. The current study employs advanced information visualization schemes for the early warning system of a decision, thus, assisting in crises prevention and recovery thereafter. It puts forward a visualized toolbox for CDSS which uses crises management and dynamic information visualization under the scope of enterprise functionality. Lastly, this study establishes the potential for using this type of toolbox and offers concluding remarks.

Key words: Crises management, crowed management, IOT, VCDT, enterprise functionality, concluding remarks

INTRODUCTION

A crisis is considered to be a situation with a strong level of threat and time pressure. In most cases, the actions taken and solutions provided to neutralize these dangers are based on the level and duration of the crisis. Crisis management is the term used for a collection of actions or operations intended to pinpoint, examine and predict crisis situations and establish specific methods to allow an organization to handle a crisis or stop it from happening (McClure *et al*., 1999).

Crisis management is tied to the handling of threats prior to at the time of and following the crisis. In this regard, it comes under the context of management, made up of skills and methods used to evaluate, comprehend and manage a serious situation and particularly from the time it happens until the recovery procedures begin. Prior to categorizing the processes involved in a possible crisis, a structure would be established to allow for efficient standardization through numerous platforms. It is recommended that the procedures required for evaluating and handling the crisis are pinpointed and implemented as they are required (Birch, 1994).

The response involves crisis prevention, crisis assessment, crisis handling and crisis termination. Crisis management intends to provide a basis for adequate preparation, quick and sufficient reactions to the crisis, creating paths for the reporting and communication of a crisis event and setting rules regarding crisis termination.

Crisis management is made up of a number of elements such as methods employed to react to the actual reality and understanding of crises, setting metrics to describe the scenarios that make up a crisis and then in turn bring about the required response mechanisms and the communication that happens during the response phase of emergency-management situations.

When reacting to crises in a time-sensitive way, the chances of death and injuries are reduced, together with fewer economic impacts (Nouali *et al*., 2009). With this in mind, accessing up to date geo-tagged situational data regarding the crises-affected locations can allow for efficient decisions being made and crisis responses being organized effectively. On the other hand, crises management activities are not restricted to post-crises

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relief and rescue activities. Prevention, mitigation and preparedness are steps taken prior to a crisis in order to limit the human and property damage from these hazards, while response, recovery and reconstruction are the post-crises measures resulting from crises aiming to facilitate timely recovery and rehabilitation of victims and communities impacted.

Crisis management is critical when it comes to limiting these unpredicted situations. A number of systems were created or are in the process of development which can bring about crisis management support for communication and decision making.

The decision making related to crises management usually happens in a dynamic, rapidly evolving and unstable environment. For this study, the benefits of crisis management tools are examined regarding crisis decision makers using them when timely data is offered which can boost the effective management of a crisis. Additionally, there is data supporting a crisis management support system offering a universal interface for a number of user applications (Jungert and Hallberg, 2009) to facilitate greater application. The majority of crisis situations are tied with chaotic situations needing clear communication and rapid decisions (Andrienk and Andrienko, 2007). An organized decision support system based on actual data is necessary for crisis handling (Franke, 2011) to help the crisis management personnel involved, who are under great pressure to offer guidance when dealing with unusual circumstances.

An information system for crisis management is aimed to help with the organisation of crisis response activities (Endsley *et al*., 2003) situation awareness (Iannella and Henricksen, 2007) time-critical decision making or the visualization of crisis related information (Franke, 2011). These aspects are universally time-sensitive and an issue that arises is how to handle these different time aspects when building an interface for a crisis management information system.

Ways to deal with time-related elements in the planning of interfaces which facilitate crisis management were put forward and this study attempts to evaluate and boost the design of these interfaces. The aim of intelligent visualization is to allow all individuals to have access to the appropriate data at the suitable time points to maximise the benefit. A decision maker must have their pertinent data offered in a timely manner, through a user friendly GUI (Franke *et al*., 2011).

The Internet of Things (IOT) based solutions can assist in being prepared for an emergency, like first-aid assistance, early warning and navigational guidance for shelters close by in pre-crisis times and during the incidents. Four key areas were pinpoint during crises and post-crises scenarios, where Internet of Things (IOT) enabled solutions could provide strong advantages. These include robust, interoperable and priority sensitive communication for individuals involved at different levels (such as field workers, volunteers and remote officials at Emergency Control Centers). superior understanding of a situation, the creation of a common operating idea of resource and services required, together with the resources and services accessible in the areas affected and finally, superior decision support, resource tracking and allocating system. Other than these benefits, certain unique services such as area-wise online lists of victims can assist in missing individuals finding their families again.

In the modern era, smartphones are widely employed for numerous functions such as messaging, social networking, calendar functions and contact management, together with location or context-based applications. The universality of handheld computing technology is seen to have extensive benefits to crises management and relief operations, along with the mitigation, preparedness and response stages (Shih *et al*., 2013).

Crises management activities including co-coordinating relief operations, establishing shelters, reporting structural damages, evaluating the requirements of the impacted regions and managing volunteers create an extensive amount of data. This situational data is gathered from the impacted locations and shared with smartphones that the volunteers have on their person as well as victims and other stakeholders taking part in the disaster management process. In turn, the data offered by different groups across locations must be pooled to offer an in-depth comprehension of the overall conditions and offer valuable information to the relevant authorities to more effectively make their decisions (Shih *et al*., 2013). An in-depth situational overview can become accessible for the agencies included in the disaster management operations via interactive, map-based web interfaces in order for the following actions to be effectively planned. Being able to use this type of integrated situational view, damage and need assessment reports with smartphones and laptops allow the volunteers and authorities to pinpoint the resources that can be used to meet the demands of various sectors, taking into account poor access and thus control resource distribution. As a result, a cooperative framework can be set up with ICT-enabled solutions to provide efficient disaster management in the pre, during and post stages.

Crisis Wall (Groeve *et al*., 2013) created by the Global Security and Crisis Management Unit (GlobeSec) is a multi-device, multi-system crisis management piece of software that aims to meet the needs of the primary emergency management tasks across a national or international crisis room such as situation surveillance (a general look at the world events with instant alerts and attention management) activation (analytical tasks used for these emergency situations such as operational coordination and collaborative analysis) and presentation (situation analysis, strategic data as well as public data).

The Global Disaster Alert and Coordination System (GDACS) is a cooperation framework that exists amongst the United Nations, the European Commission and disaster managers across the glove to boost alerts, provide information exchange and coordination in the first parts of disasters (Stollberg and Groeve, 2012).

To this end, the Joint Research Centre (JRC) of the European Commission began to investigate how social media is employed to gather important disaster response data. JRC created a Twitter account and a Facebook page for the circulation of GDACS alerts (in cases of earthquakes, tsunamis, tropical cyclones, floods and volcanoes) while a Twitter parser allows for information monitoring and a mobile application offers information exchange. This additionally provides a web-based platform which merges current web-based disaster information management systems. Furthermore, GDACS can be used throughout the research community to examine disaster impact and response activities to boost global disaster management approaches.

KoBo Toolbox is an open source and free mobile application used to gather data in challenging situations. The use of the KoBo Toolbox for humanitarian purposes was facilitated by OCHA, Harvard Humanitarian Initiative (HHI) and the International Rescue Committee (IRC). KoBo provides a flexible form builder joined with a Question library to make survey design more straight forward where users and organizations will then be able to access and use questions.

As a result, prepared questions are able to be quickly pinpointed and used in a form as planned. KoBo provides Android or browser-based data gathering functions, offline and online. The data management feature of KoBo facilitates the aggregation, editing and annotation of information gathered directly in the platform, together with mapping the geo-referenced data and photo display. Data is able to be collected in numerous formats and is able to be processed through Excel, SPSS or other statistical packages. User access control processes mean that this downloaded data does not have universally open access to it.

A general integrated framework that covers the required services mentioned above is not currently available. Other than the research activities of certain European nations, there is a limited number of isolated applications employed, particularly in developed countries which are primarily web-based or mobile applications, concentrating on offering specific support such as Google maps and SMS-based pre-disaster alert generation as well as disaster tracking and updates through geo-tagged situational information, offering a map of shelters available, emergency preparedness and first-aid assistance, volunteer and resource tracking and so on. This software is beneficial due to its inclusive, flexible and reliable platform with both mobile and web application, allowing for greater preparedness, response, and consequence management of natural and manmade disasters, through providing access to useful data in a timely manner.

The primary goal of this study was to complete a survey on current crises management applications in order to determine the services they provide. These applications have been split up through features and applicability across various crises stages.

Flexible visualization can be employed to create an interactive display to facilitate the operations of an analyst, planner or decision maker and create an information base for a particular recipient.

Modern crises have shown that visualization tools are required to uphold time-sensitive cooperation, analytical reasoning, problem solving and decision making under the scope of analysis, planning and time-sensitive response activities (Belardo and Pazer, 1995).

Whether the cause was natural or technology-based, crises have three key properties which are frequency of occurrence, scope of impact and time pressure. Crises by their nature are in fact, not frequent occurrences. Thus, those involved with crises do not often have extensive experience to relate the current situation with (Basu *et al*., 2016).

Crisis response and crisis management are ways to facilitate naturalistic decision making conditions which are defined by time pressure, risk, uncertainty, numerous evolving aims and a number of organizations. Managers and politicians often appear in favor of computerized decision support to assist in the planning for and response to crises.

Throughout this study, numerous information visualization works are looked into (Shannon *et al*., 2010; Shneiderman, 1994). Extensive research undertakings concentrate on the way to change business data to shape while decision makers must deal with problems surrounding the comprehension of the fundamental outcomes and the way crises management can come as a result. As a result a visualized interface must facilitate and offer advantages for crises management phases, instead of simply for data transformation. The majority of current

Table 1: Comparative study between crises management software tools

	Crisis management software tools								
Features	Emergeo	CoBRA	Crisis360	ArcGIS	Crisis track	FCEMHS	Crisis commander	Crisis works	Ushahidi
Access from a mobile phone?	√	√	√	√	√	√			√
Support a standard web browser?	√	√	√	√	√	√	√	√	√
Interface user friendly?	√	√	√	√	√	√	√	√	√
Support alert notification?	√	√	√	√					√
Support different types of incidents?	√	√	√	√	√			√	√
Provide templates for various incidents?	√				√				√
Collect predictive data for damage assessment?			√	√		√	√		
Generate alert deactivation warning?	√								√
Provide alert in local languages?					√				√
Through crowdsourcing using app/SMS?	√	√			√				√
Provide integration with various sensors?	√	√							√
Provide damage prediction module?		√						√	

decision support systems for crises management and simulation systems integrate certain functions without being able to handle environment changes or offer potential for negotiation.

An in-depth discourse on service gaps which exist and limit the extensive use of current software in crises management has been presented. As a result an integrated system framework which can provide sufficient disaster management services with both the services in place and those needing integration. This study deals with certain restrictions and attempts to deal with these DSS shortcomings. VCDT is a key concern for this research stdy. Primarily, this stems from concentrating on user-specific requirements. As a result, the first function of the toolbox is to offer visualizations in a clearly comprehensible manner for the decision maker.

These fresh dynamics and the substantial effect of extreme events (natural hazards, terrorism, technological accidents, and economic/financial crises) as well as the complications involved in related interventions have encouraged the scientific community to establish efficient solutions to be used in the decision making process, which are focused on crisis management, particularly when it comes to resolving matters of time urgency, complexity of event, volatility and changeability of the crises situations, the chaotic surrounding environment aspect, human behavior in critical situations (e.g., emotional stress) the outcomes of decision failure, limited data and numerous interruptions to the decision making processes.

This study looks into different applications for explorative analysis, concentrating on advanced interactive graph visualizations instead of hard graphs produced from the query responses. This type of VCDT problem is related to the adaptability and applicability in a number of issues, and can be applied to numerous businesses as a workable version.

LITERATURE REVIEW: CRISIS MANAGEMENT SOFTWARE (CMS)

Several Emergency and Crisis Management Software (ECMS) can be used to help the Emergency Management Agencies (EMA's) when it comes to contrasting and examining the different micro-level data available and offer decisions based on the simulated results of the different incidental models established before. ECMS is usually situated in Emergency Operation Centers to oversee the government and various NGO's to create plans and transfer resources during a crisis or emergency.

The Emergency and Crisis Management Software used is a key component of the integrated Incident Management System (IMS) which involves numerous technologies such as mobile phones, sensors, cameras and radios, operating on a common web based or standalone platform. Contrasting available ECMS products is undertaken using specific parameters such as available modules for managing emergencies and alert deactivation warnings as presented in Table 1. The majority of these products use a web browser based dashboard involving crucial raw data and different analytics findings. In most cases, this interface is linked with the internet, allowing for information to be pooled amongst different agencies tied to emergency management.

EmerGeo (Anonymous, 2007) provide two products, Fusion point and EmerGeo mapping to allow users to oversee disasters and plan response activities. Emergency managers are able to look at information gathered from different sources in organized table and there are facilities which allow for email alerts with no user intervention. Map based visualization of critical situations and subsequently rapid decisions can be made through live data gathered from the disaster zone.

CoBRA (Anonymous, 2016) offers a cloud-based approach for use in emergency response and information management. A map-based view of the incident provides users with access to crucial incident data quickly and allows them to make decisions regarding the emergency through the use of live data gathered from different sources.

Additionally, common operating pictures are created, and this means that data synchronization, sharing and backup is facilitated. Knowledge Center is entirely web-based, involving GIS Mapping and real-time weather data, offering up to date information in order to establish a pooled operating picture during emergency events.

Crisis360 (Anonymous, 2015) allows the Command Center to make effective decisions regarding resources, via a web-enabled dashboard in emergency conditions. Mobile apps can additionally record response and map-based visualization in order to create a deeper comprehension.

Crisis track undertakes damage assessment using the captured photos of the location of the crisis via. the mobile application. This offers in-depth search and rescue software which offer practical benefits for search area planning and team organisation. Crisis track can operate online as well as offline, allowing for the evaluations and images to be uploaded to a server, available to the Emergency Operation Centre. In situations without Internet connectivity, Crisis track stores the data on the local device and the data is sent to the servers at a point where connectivity is restored.

Franklin Country Management and Homeland Security (FCEMHS) (Anonymous, 2013) constitutes a warning and notification system created to make sure residents know about crisis situations. This offers vital data straight to them through text message or email on a cell phone. Additionally, this keeps a pool of data used to pinpoint resources which can help first responders. This sends the first damage assessment reports to Ohio EMA in <12 h from the time of the emergency. MetricStream offers a Governance, Risk and Compliance (GRC) App. which moves data to the cloud directly from the location of the event.

Crisis Commander (Anonymous, 2003) offers a schema and communications framework which can be used to produce a notification and is mobilized with beneficial pre-identified resources. Acting as a web-based incident management system, it can produce reports regarding an event from the location of the incident and then group these according to incident type and their nature, deciding on the most suitable individuals to be involved in the subsequent investigation and tracking.

CrisisWorks is a cloud-based tool used in emergency management situations which offers awareness, communication and organisation during emergency situations. It is able to handle numerous incidents at the same time and is able to be accessed from any web enabled device (e.g., mobiles). It is created in order to oversee and manage emergencies from an operations center. It provides instant reporting on the effects and damages occurring through mobile devices.

An open source platform (Anonymous, 2008) provides users with way to transfer data regarding a crisis from the location of occurrence to the control station through a mobile device with a crowdsourcing function. This offers ways to gather data, achieve visualization and data analysis in a structured manner, allowing for more successful decision making. Additionally, automatic alerts are produced about the event, forwarded to a pre-set group of users. A feature based comparative study of various emergency and crisis management software tools is in Table 1.

ANALYSIS OF EXISTING SOFTWARE FOR CRISES MANAGEMENT

The requirement for a crisis management support system to be in place is because of the time and stress restrictions in place when decisions must be taken without much time to spare, at the time of a crisis. On a technical basis, an effectively organized knowledge based decision support system in the context of crisis handling is beneficial when it comes to restoring functions to their normal levels and appraises the future response research (Franke, 2011). Information systems that need to be created must be straightforward enough for crisis management experts to easily use.

Numerous systems exist or are in the development stage that brings about crisis management support for communication and decision making. This study looks into the effectiveness of certain crisis management tools when it comes to crisis decision makers being benefitted through time-sensitive data provision to boost the outcomes of their crisis management efforts. In addition, there are findings supporting the idea that crisis management support system to offer a uniform interface throughout numerous user applications to bring about a more widespread application (Jungert and Hallberg, 2009). The majority of crisis situations present chaotic scenes that necessitate communication and decisions made rapidly (Andrienk and Andrienko, 2007). A structured knowledge based decision support system for crisis handling is necessary in resolving these situations in which crisis management personnel come under great pressure when it comes to offering help in dealing with these rare events (Franke, 2011).

Taking decisions in these unique circumstances is complicated in the extreme, due to the systems being complex and the dynamics incomprehensible so adaptability is highly necessary. Technologies employed to deal with the crisis situation and other high risk occurrences have progressed substantially with certain underlying issues being in place to make the high risk prevention and multiple crisis response more troublesome. Poor communication amongst the various actors and levels, relatively insufficient data fusion, selection, filtering and standardization for the impacted information database, challenges related to keeping data up to date regarding the development of extreme risk (victims damages, rescue team technologies, specific data and access to databases and plans already in place are potential hazards (Andre *et al.*, 2007).

With regards to crisis management, the definition of "Showtime" is a visualization technique under which dynamic networks are animated over time (Lettieri *et al.*, 2009). In these situations, users can oversee the animation's speed in different manners, meaning there is a greater comprehension of the data shown to them. For certain researchers, the key focal point is the visualization of time (Franke *et al.*, 2011; Allen, 1991). Earlier studies concentrating on crisis management primarily look at technical issues regarding how temporality is shown.

Detailed research into current software has shown that, even though there is plenty of text, video and visual feedback from victims and volunteers, together with social media activity (including Facebook and Twitter) there are important elements which affect the benefits authorities gain from this input. For example, crowds sourced geo-tagged situational feedback lack structure and are provided through a web portal with no strong validation in place, leading to the possibility of rumors. This data is sporadic and there is no ability to form a full and reliable picture of the impacted areas with no procedure being in place to analyze this data in greater depth in order to ascertain location-specific requirements and impacts.

Because of these disadvantages, crowd sourced data cannot be considered appropriate for taking decisions regarding damage and needs evaluations. This, it is challenging for the authorities to decide what tasks are most suitable and assign appropriate priorities from this wide range of unprocessed crowd sourced data. Other than this, the alert generation process does not have any ability to keep the community in question up to date with crisis news, including that the crisis has finished (de-alerting). In many cases, the "available resource view" feature in current software is affected by out of date information because of irregular updates.

Recent literature has shown a number of applications, processes and actions that can be taken to predict, prepare for, stop or limit various risks and hazards related to crisis categories with a small number of integrated frameworks being in place to handle visualized crises data. Here, decision makers require substantial technical support prior to at the time of and following their decisions being made relating to a crisis.

VCDT problem: Numerous authors have pinpointed three key steps in the Crisis Management Model 1 (Li and Kraak, 2008). These are prevention (mitigation) preparedness and recovery. They have shown that crisis prevention includes actions such as monitoring, predictions and pre-emptive actions which can help predict a crisis. Prevention presents greater challenges and costs for low probability events. Crisis prevention actions are able to limit threats. For crisis preparedness, efforts are made to limit the negative effects a crisis has in the eventuality that it happens. Critically, weaknesses and crisis scenarios must be pinpointed. Planners must find the potential downfalls and what the outcomes are in case the worst predicted event happens. Crisis recovery covers damage evaluation as well as the accounting, reporting, and sharing of resources. Crisis recovery additionally provides a chance to find ways to react to future crises with superior results.

Even though information visualization has progressed and there are now new technological problems, the main issue is upholding end-user comprehension and close involvement. This problem is significant as it allows decision makers to examine substantial amounts of data quickly, boosting the rapid comprehension of the data spread and patterns being recognized quickly. VCDT can help users come to more rapid and more educated informing crisis decisions by examining business matters and possibilities in a way that is timely and easily comprehended.

Key aspects of the VCDT issue is the time stress of the decision and the vagueness related to decision processes that cannot be repeated. Information visualization offers a robust way to communicate and

Table 2: VCDT summative focused-group

	Involvers				
Most data source	Mgt levels	No.	Needed response of VCDT	Decision style	How do they see VCDT look like
Data Base (DB)	High	5	Slow monitoring	Heuristic	Simple indicator
Data warehouse	Tactical	11	Slow interactive	Analytical	Interactive GUI
Direct injecting DB	Operational	7	Fast reaction	Model-base	Smart auto-reaction

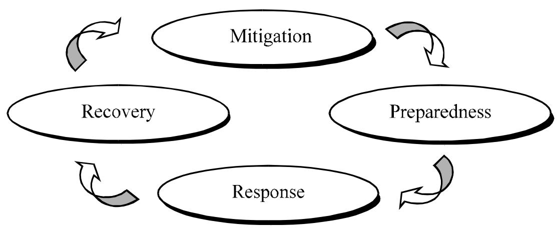


Fig. 1: Crises management cycle

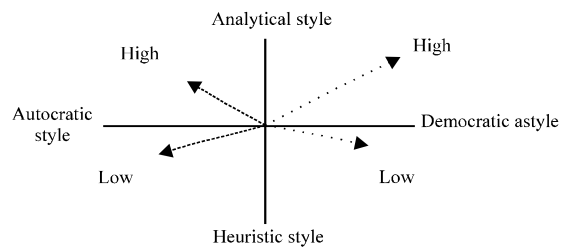


Fig. 2: Decision style

handle the intelligent visualization processes findings. Five key elements exist within information visualization in a crisis management system (Turban and Aronson, 2007) (Fig.1):

- Alert by bringing attention to a potential threat or similar
- Inform: providing data on the situation
- Suggest: putting forward potential actions
- Enable: examining and making decisions or planning
- Explain or justify a suggested solution or decision made

This study displays the way that Visualized Crises Decision Toolkit (VCDT) components are used for decision makers.

Field study summary: When pinpointing the decision-involvers needs, Joint Application Development (JAD) methodology and a focus group were involved in finding the exact needs of decision-involvers. The gathered data is beneficial to the VCDT prototype. The focus group consisted of 27 respondents out of 67 acquired users. Table 2 offers a summary of the field study.

Decision taker's styles became more close to the fact represented in Fig. 2. This field analysis examined the following process of architecting VCDT as shown in Fig. 3.

VCDT ARCHITECTURE AND FUNCTIONALITY

VCDT is made up of three sections which are discribed as:

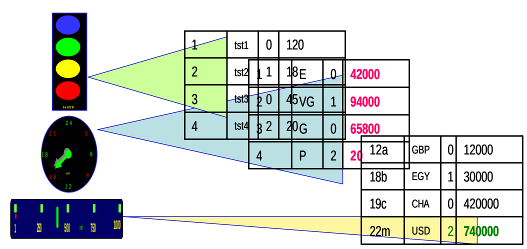
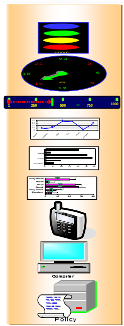


Fig. 3: On-the-spot monitoring set

On-the-spot component: This is a collection of indicators that instantly present the underlying databa's status. This oversees the decision variables from the database which assist in preventing certain crisis events by offering this monitoring ability with the collection, grouping and discussing the status of the incident indicators. Through the input collected during the monitoring stage, suitable actions are taken to get ready for any crisis event as well as pre-emptive activities which can help avoid a crisis. Crisis prevention activities are able to limit threats. Figure 3 shows that, this collection is made up of three programmable controls: blue, green, yellow and red which are each related to the strength of light value (fuzzy light), a two-direction counter that is able to show the flow volume of a particular property and Progress of x-y scale to let the user know of cross border boundaries.

Simulated shapes component: This is a collection of simulated shapes which are able to interact and model the underlying data warehouse (cube). The main function here is to assist with what-if scenarios from the decision variables stemming from the data cube. Crisis preparedness is tied with the steps taken to limit the effect and damage of a crisis and whether it happens at all. This is crucial in pinpointing vulnerabilities and crisis

Table 3: Crises decision maker toolbox

Control shape	Control description
	Blue, green, yellow and red ON/OFF lights. They contain light and light degree due to decision maker request (fuzzy light)
	Two-direction O'clock indicator
	Scaled x-y progress indicator
	Simulated curve
	Simulated bar
	Simulated time-line
	Do-mobile action
	Do-remote computer action
	Do-remoter deriver action

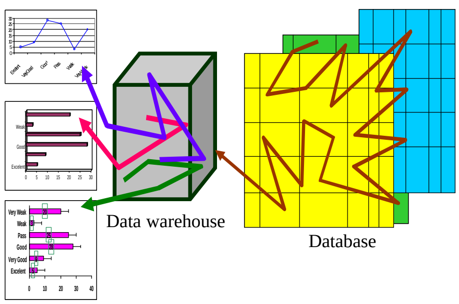


Fig. 4: Simulated shapes

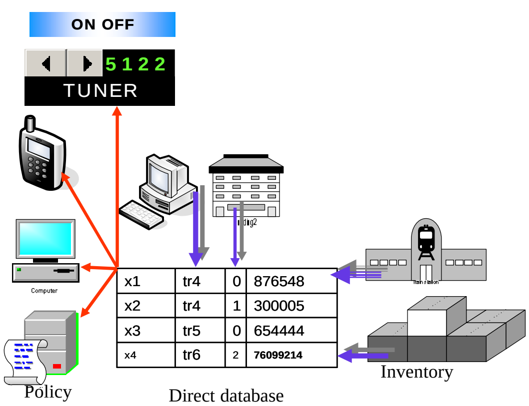


Fig. 5: Action-decision shapes

scenarios. Planners must highlight what could happen and the impacts of the worst case scenario. Figure 4 shows this component which is made up of the line, Bar and time-line programmable controls.

Action-decision shapes component: This is a collection of controls which can bring on a specific action based on the cause-action attribute value of the underlying direct-database with the aim of being able to make intelligent decisions as the user-agent with other environment smart-drivers. This component is shown in Fig. 5 and is made up of four programmable controls: the tuner to make changes to database values such as account transfer or closing a dormant account. Send-to-mobile control such as send massage, control a remote-computer-resources control such as shutting down a computer, make an order for a different business, such as reordering or stopping a stolen credit card.

VCDT: HAJJ CROWDED MANAGEMENT CASE STUDY

The Hajj is a yearly pilgrimage by Muslims to Makkah, Saudi Arabia and is one of the most extensive annual pilgrimages worldwide. Until now, roughly three million pilgrims take part in the event. For this event, crowd-control techniques are crucial with the possibility of more effective crowd control systems being explored constantly.

Information from the RFID readers are forwarded to a VCDT which can save, process and show real-time data on the pilgri's location. Pilgrims who have RFID tags with mobile smartphones can make use of a mobile app in order to use various location based services. For example, they can pinpoint where family and friends are inside the Hajj region, send emergency requests, be alerted by the system and be provided with a searchable mapped Hajj area including the critical areas and facilities. The mobile user sends out their location with the mobile app switched on which can help with the real-time tracking and position reliability of a mobile user pilgrim. The data from the transmission and receiving across different mobile users is handled by VCDT (Fig. 6).

VCDT will be made up of numerous features. Firstly, they can see the position of pilgrims (RFID/Mobile) on a map. Secondly, they can find the location of a pilgrim on the map, using their profile (e.g., nationality, blood type). Thirdly they can be provided with emergency requests from the pilgrims who use the app. and these will appear on the map. VCDT will transmit notifications and alerts to mobile app users. Fourthly, each pilgrim will have a user profile which contains their name, family emergency contact, email, blood type, nationality, age, passport No./National ID card No., address, phone number international and local Saudi number if applicable. Background on the location of pilgrims is saved for the whole duration of the Hajj. This is helpful for the Hajj ministr's analysis and research activities. The map is a useful tool and important locations shown include the Hajj places, facilities, RFID reader locations, hospitals, bathrooms, bus stops and train stations. These areas are seen through the mobile App. additionally, there is the facility to setup and maintain the RFID readers. VCDT is able to concentrate on the way crowd surveillance can be achieved in a crisis zone and gather data regarding their location, movement and condition. The main aim is to gather up to the date information regarding threats, pinpoint threat patterns, find crowd locations related to hazard sources and then put this data to use to make decisions for navigation in an emergency evacuation. The VCDT approach appears to offer many benefits to this end.

CONCLUSION

For this study a Visualized Crises Decision Toolkit (VCDT) is produced for the Decision Maker. VCDT needs evaluation uses the JAD methodology and a focus group in order to find the precise requirements of decision involvers. The gathered data can assist in creating the VCDT prototype. The differences seen in the services in place currently and those desired were the reason behind the comprehensive crises management Toolbox plan, which establishes the basis for more research and development.

The provided VCDT is examined and had success, as it can make use of the modern capabilities of object oriented programming instead of the previous click-and-drop static graphs. It has the benefit of being extended without great difficulty and can be integrated by extending the tools menu of the main window.

VCDT is able to handle the progression involved in the user's cognitive needs and the modern visualization's computing power. This takes into account the time needed by decision makers through using inference logic along with related option-base visualization which has the ability to interactively boost a decision process. There are however, certain limitations to this research.

Validation for the suggested toolbox was used on a case work situation so internal validity is greater, without necessary the same for external validity and other crises. On the other hand, the airplane hijacking crisis used, holding a high ranking when comparing national crises, was acceptable for a test of the validity of the conceptual design. Even with these restrictions, the study shows that the suggested design of the VCDT can be followed up on successfully. Using the conceptual design with a test of validity and appraisal can mean that the study has offered critical data for future work to use. This study is a direct response for the decision making style and user satisfaction involved and stands as a stepping stone for VCDT effectiveness to rise with regards to implementation and popularity.

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