Disaster Management: A Model Approach to an Integrated Real-Time Computer Mediated Information Network System *(D2MINS)* through Wireless & Mobile Networking as Enabling Technologies

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Abstract

Disaster Management remains an area which has immense scope for improvisations and that, in the context of distinct practices and methodologies adopted across different areas, regions, countries, etc, gains significance. Each type of disaster has its own set of inherent characteristics, however, on a broad level, the critical strategies for its management remain more or less similar and hence therein lies the scope for a standardized solution approach: A *quasi*-intelligent approach that builds more upon the management aspects rather than the usually adopted technological ones and that is also adaptive in nature with respect to any type of disaster. In the present study context, the Disaster Management phenomenon is being defined within the confines of three approaches: *Management approach* where the immediate focus is on ubiquitous resource matching *(available resources to those who need it at that point of time)* by clearly capturing the critical existing grass-root setups, the stake holders and the critical entities; the *Technology Management approach* which focuses on the streamlining and standardization of unstructured information flows through data mining validations and; the *Technology approach* which focuses on enabling the last mile through a rapidly deployable network architecture along with effective communication strategies enabled through Adhoc networking schemas. The

research further assumes significance in the light of it getting verified and validated through a five country primary research (*India, Bangladesh, Thailand, Sri Lanka and Nepal)*. Effective Disaster Management would result when the resource matching is done through effective coordination and that could be achieved through efficient information & communication strategies. This research contributes to all such fronts with deliberations on the research gaps and the feasibility of ICT in the heterogeneous environment as discussed in detail.

The research is introduced while taking through a unique proposed concept of governance/government, viz., 'Mobile Governance' *(mGov)* [Scalem & Bandyopadhyay, 2002] wherein the model focuses on facilitating the enhanced technologies incorporating new management propositions including inherent aspects like effective real-time information sharing, transparency, security, implementation through wireless/mobile/Adhoc/Distributed networking schemas. Disaster Management is introduced in steps through the mGov concept followed by details on our research model approach in subsequent sections. The background discussions on the Research methodology, Conceptual framework and IT enabled Disaster Management approaches are also presented.

The primary research was carried out in 5 select developing countries, viz., India, Bangladesh, Sri Lanka, Nepal and Thailand with the focus to create case studies capturing the disaster management status and practices adopted/adapted therein. These sample countries were selected given their extensive exposure to natural disasters and their elaborate learning curves, if any. The present study incorporated the methodology as a mix of structured questionnaires, unstructured interviews, country case studies, regional case studies and interactive discussions with the stakeholders. The results are validated through direct feedback from respondents *(stakeholders)*. Sampling is done as per standard approaches with the sample questionnaire forming the backdrop of collating common relevant related information thereof. The validation process continued throughout the circle. Analyses are carried out through the common parameters of study across the sample countries with the objective of focusing upon the real grass root practices and their scope, as they exist on field. Examples of some select country disaster management information systems are also taken through secondary research so as to capture the field dynamics, as they exist.

The term Information Communication Technology *(ICT)* encompasses computing & telecommunication technologies and the associated know-how to apply them in different fields of organizational activity and the last two decades have seen a rapid evolution of ICT capabilities in homogeneous context. While till now both the practitioners and academics have mostly been concerned with how the penetration of ICT into organizations can be explained or understood, its effects as also its implementation feasibility in a heterogeneous environment still remain to be researched upon in detail. The term 'Homogeneous Environment' signifies the sample space being a close group of individuals/entities/nodes/etc having identical work environment, chosen common technology adaptive constituents and being run by a common code of conduct *(Examples: Organization/Company/Plant/etc)*. The term 'Heterogeneous Environment', on the other hand, signifies the sample space being an open group of individuals, undefined work environment, diverse

technology adaptive constituents and mostly don't have any common codes of conduct *(Examples: Organization/Company/Plant/etc)*. The term 'Heterogeneous Environment', on the other hand, signifies the sample space being an open group of individuals, undefined work environment, diverse technology adaptive constituents and mostly doesn't have any common codes of conduct *(Examples: Village/City/Any Geographic Area/Societies/etc)*. This study covers the attempt to present the existing scenario and propose the strategic intent of the heterogeneous context by way of the example of the proposed mGov *(Mobile Governance)*, eDM *(e-Enabled Disaster Management)* and D2MINS *(Distributed Decentralized Disaster Management Information Network System)*. As per the literature survey carried out, there is no well-established model/framework on Disaster Management and hence a strategic framework is being proposed which is of techno-management nature.

As could be pointed out, the existence of the wireless communication infrastructure alone does not ensure an efficient and effective disaster management. The existing Disaster Management *(DM)* approaches are quite unstructured and are usually centralized in nature with the instructions following some sort of fixed hierarchy. This results in the poor resource management and hence causes inefficiency.   Since disasters themselves are unstructured in scope and hence can't be managed centrally, there is a need for a demand-driven, user centric, decentralized, hierarchy independent information-exchange approach wherein even the end user is empowered accordingly for quick and effective decision-making thereby promoting an efficient resource sharing [Scalem et al., 2004]. Introduction to D2MINS is undertaken while covering the topics of interest in three distinct issues of classification: Management, Techno-Management and Technology. Concepts like FMEA, Process Modeling, ETVX, *d*-ERP, MIS Design, MIS Architecture, Field Network Strategy, etc are also presented in detail to showcase the inherent strategy involved.

At the Ground Zero, Information Management gains the highest priority and significance. The topic of 'critical' information assumes super importance, as it is this that should be identified, modeled, structured, decentralized, made to follow some standard format, and customized for best results. It has been proved by researches [Wenger, 1986] that one of the most consistent observations point out to the fact that at the level ground, communication is inadequate and that it is also a continuing problem. The emphasis on the word 'information' couldn't be underestimated as definitions of 'adequate communication' greatly vary in absence of any standardized MIS framework. While the Information System would take care of static coverage and updates thereof, it is the Information Network that would enable the end users to interact and share information on real-time platforms. How to design such a system from a grass-root level, what to include while designing, how to go about while conceptualizing the most effective solution, how to model it, etc are some of the areas that the subsequent sections of the study cover. Discussion on model architectures, use case scenarios, domain models, flowcharts, Data Flow Diagrams *(DFDs)* also ensue.

The issue of efficient communication management strategies is contributed upon by introducing a novel content-based query support schema for handling resources in fully distributed Adhoc wireless networks in the context of Disaster Management *(DM)*. In a typical DM scenario, the most common

problem is the inefficient management of resources *(like food, drinking water, medicine, etc)* due to poor co-ordination and lack of communication among the heterogeneous groups participating in relief operations. A proper approach, thus, needs to be adopted for efficient management of relief operations. This should be capable of assimilating the information regarding inventory of resources from different participating groups and disseminate it over the distributed network in a fully decentralized manner. Concepts like a novel two-layered *content-based searching* approach using *narrow-casting* schema superimposed over a broadcasted *information-fading* layer are detailed through examples. The objective of information-fading is to make a node aware of information content of other nodes in the network through broadcast-based multi-hop percolation of information. However the preciseness of knowledge about a node decreases or fades away with hop-distance, thus reducing the information overhead. The term fading of information actually implies propagation of progressively summarized information based on a semantic classification of information. In such a knowledge network, our novel content-based query retrieval process becomes quite effective and uses narrow casting to access the prospective destination through the relevant set of nodes only. Thus we have developed an intelligent multi-hop information retrieval system where the query itself will lead the search process to get the proper information from the nearest available destination. The novel proposition of MMAS *(Multi Mobile Agent System)* in the context of D2MINS is also included as one of the main communication management strategies. At the end, a summary is undertaken while focusing on the further research scope and roadmaps ahead.

Key Words: DM *(Disaster Management)*, D2MINS *(Distributed Decentralized Disaster Management Information Network System)*, mGov *(Mobile Governance/Government)*, eGov *(Electronic Governance/Government)*, Environment Matrix *(Heterogeneous/Homogeneous)*, MMAS *(Multi Mobile Agent System)*, d-ERP *(Distributed ERP)*, Six-Entity-Critical-Disaster-Management-Model *(6ECDM2)*, Adhoc Networking & Routing, *Content-Based* Search, *Information-Fading* Approach, *Narrow-Casting* Schema, Query Support, Information Hierarchy, eDM *(Electronically Enabled Disaster Management)*, DMIS *(Disaster Management Information System)*.

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