"Communication Systems of Civil Emergencies and Its Challenges"AnIntrospective Literature Review

Mr. Ghanshyam Purswani Dr. Girish Parmar Dr. Lokesh Tharani

Abstract-- Introspectively undertaken literature review of existing communication systems of civil emergenciesobjectivelycontemplative its pertaining challenges.Literature review's extended aim is to understand need and designingholistic framework using innovative technologies which can eradicate challenges of all uniform and non-uniform stakeholders.
Natural, manmade are two kinds of disasters. Manmade disasters are well proactively controllable; whereas natural disasters being more technology dependent found to be bit difficult to predict &control spontaneously.Impact of disasters on mankind, society, property& its economic losses are tremendous and irrecoverable.
Survey reveals multiple public safety organizations while undertaking rescue operations experiences difficulties in making critical decisions for wants of non-availability of real time situational awareness and holistic information based interoperable communication systems.
Deep review recognizes uncovered areas, impacting factors, insight how to undertake further innovative, constructive and holistic integration of people, processes and technologies (PPT) along with proactive preparedness and quality of response in minimizing the impact of disasters. Natural disasters to the greater extent found to be averted by ensuring proactively integrating new learning and PPT as solution components.
9/11's critical appraisal revealshow process re-engineering, holistic ICT enabled services; technology awareness, implementation techniques and integrated participation of all stake holders can avert civil emergencies.
Assessment of study provides understanding of technologies & what and how holistic communication system can be put into use?
Evaluating existing civil emergencies communication systems' (CECS) characteristics, features, and challenges of rescue operations (ROps) provides innovative step towards need of designing novel frame work communication architecture of emergency operations and command control communication center EOAC4.

Key words – Civil Emergencies (CEs), Critical Infrastructure System (CIS), Civil Emergencies Communication Systems' (CECS),Emergency Fighters (EF),Emergency Operations and Command Control Communication Center (EOAC4),First Responders (FRs),Geography Of Operations (GOO), Information Communication Technology (ICT), Incident Management System(IMS), Proactive Robust Early Warning System (PREWS),Rescue Operations (ROPs), Place Of Occurrence (POO),.

1. APPROACH

Literature review of about 140 papers covering period from 1970 onwardsundertaken with an aim to understand the extent of impact of various disasters on the mankind and society and to get the insight of the existing communicationsystems with its characteristics & features in disaster and civil emergencies, the challenges being faced by the first responder while mitigating the risk during civil emergencies.
Objective is to understand the solution components considerations with benchmarking techniques having emphasis on aspects of geographical and environmental conditions for risk mitigating communication systems for the public safety and first responders.

The basis of search of papers in international journals were undertaken on the key words Civil Emergencies, Natural Disasters, Disaster communication systems, First responders, Incident management systems, Emergency Operation System, Critical Infrastructure System, Civil emergencies communication systems, Rescue Operations, Policy documents of various governments on disaster preparedness etc. Industrial approaches and technology developments' through search was conducted,

The most relevant about 50 papers have been considered in the review study which provides us better clarity of the aim and objectives of study in understanding existing disaster communication systems along with its characteristics & features. Out of 50 the most subject linked papers 15 papers has been considered in this review study in references which provides us the base to understand the disaster communication systems' characteristics and challenges also lead us towards the need for an innovative solution and its components and the frame work design. In addition to these papers various Nation's and states policy preparedness documents were also reviewed helps us to

- *Author Ghanshyam Purswani is currently a Research Scholar pursuingPhD degree program in electric and communication engineering in Rajasthan Technical University , Kota, PH-+919868482378. E-mail: ghanshyam.purswani@gmail.com*
- *Co-Authors are currently Associate Professors in Department of Electronics & Communication Rajasthan Technical University Kota – Rajasthan - India- Pin 324 010, Fax +91-744-2473040*

1. *Dr, Girish Parmar, PH-+91-9950680322. E-mail: girish_parmar2002@yahoo.com*
2. *Dr, Lokesh Tharani, PH- +91- 9414238103. E-mail: tharani123@gmail.com*

see through the integration of PPT, implementation and risk mitigation proactively.

EM-DAT: The OFDA / CRED – International Database has been extensively used to understand the impact of disasters on mankind and society. Few details and charts on occurrences of natural disasters period from 2005-2015 are mentioned below in tables and charts for better clarity.

Subsequent 29 Papers provides us the different technologies solutions in existence and their silo usages help us in designing the frame work solution.

More than 18 papers provide insight on integration and interoperability technologies in designing the holistic systems. All are being referred in subsequent paragraphs.

2. PURPOSE

Natural disasters remind us the nature's power and the relationship of mankind with environment.During the civil emergencies GSM communication systems especially the wired and wireless services like GSM are affected first and the most. During recent Tsunami in Thailand and floods in J&K India found the communications was severely hit. Undertaking Literature Review of papers [1] etc. with an aimtounderstand the scene of disaster, the impact of damages its effects on the society. The mechanism for civil emergency systems and its preparedness, implementation methodology, disaster management's general guidelines, vision and policies etc. lead to understand the challenges, features, characteristics, technologies, deployed specific solution components, role of all stake holders, impact of environmental and geographical dependencyissuesetc.in existing civil emergencies management communication systems for first responders'(FRs) in various situations / civil emergencies.

Prevailing components in existing FR's communication systems shown in Fig 1 are heterogeneous, ad-hoc and of silo in nature with lot of limitations, hiccups like last mile connectivity and reliability etc. provides the insight for further studies.

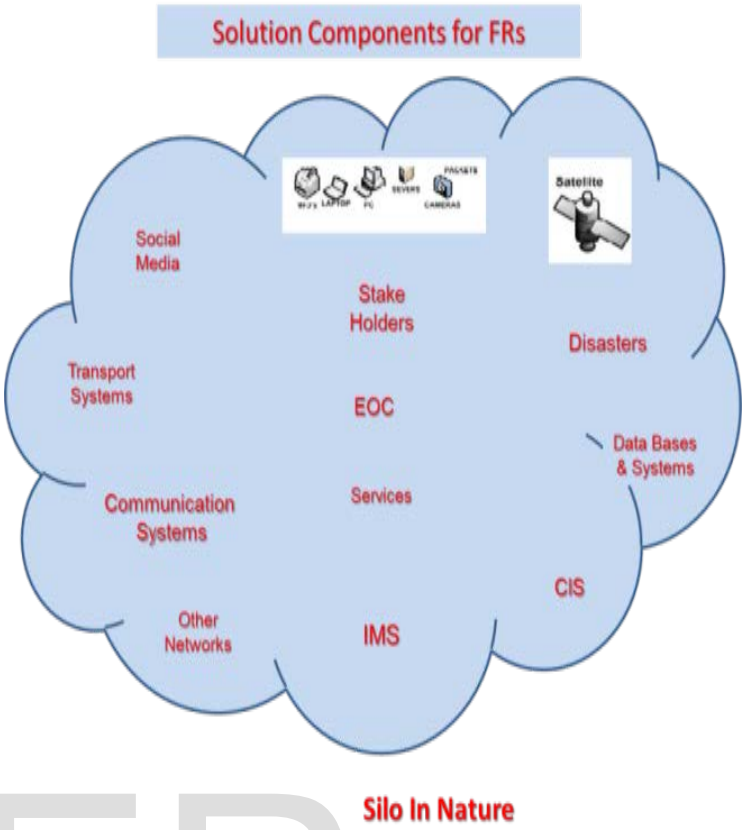


Fig 1 FRs' Mesh Of Various Silo systems / Components

3. INTRODUCTION

Communication systems are critical and crucial to effective incident and disaster response. Lack of communications and the short sighted situational awareness are the key factors that hamper Public Safety's and first responders' ability in making critical decisions.

Government agencies, system integrators, manufactures, solution providers across the globe found has provided a silo operated systems as a short lived ad-hoc solution.

Better co-ordination and understanding of different technologies from the perspective of emergency management by all the stake holders such as civil protection teams / preventing organizations, security forces including uniform & non-uniform emergency fighters and community while

A successful rescue operation is directly dependent on external assistance like technology advancement, awareness and participation by all stake holders found to be the critical factors in managing the response process during the civil emergencies. 9/11 terrorist attack on the world trade center twin towers in New York, USA has taught us means of technology advancement, awareness and participation of all stake holders, process re-

engineering to processes mature enough. Study of data sorted from EM-DAT shown in tables, Pie charts and diagram provides the trends of the magnitude of losses with its impact on society & lives.
http://www.emdat.be/disaster_profiles/index.html

Summary of data reflects the worst picture of irrecoverable losses occurred to the property, peoples & society.

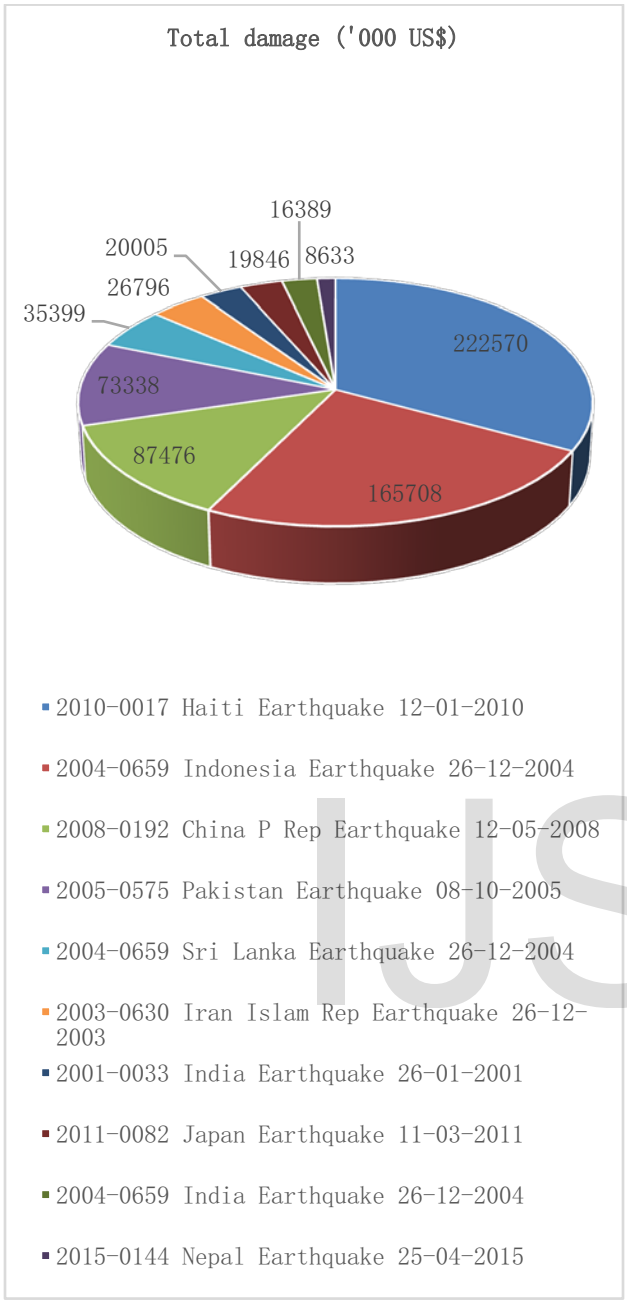
Table 1 Earthquake Country wise 2001-2015 Source EM-DAT: The OFDA / CRED – International Database

.Disaster No	Country	Type	Date	Total damage ('000 US$)
2010-0017	Haiti	Earthquake	12-01-2010	222570
2004-0659	Indonesia	Earthquake	26-12-2004	165708
2008-0192	China P Rep	Earthquake	12-05-2008	87476
2005-0575	Pakistan	Earthquake	08-10-2005	73338
2004-0659	Sri Lanka	Earthquake	26-12-2004	35399
2003-0630	Iran Islam Rep	Earthquake	26-12-2003	26796
2001-0033	India	Earthquake	26-01-2001	20005
2011-0082	Japan	Earthquake	11-03-2011	19846
2004-0659	India	Earthquake	26-12-2004	16389
2015-0144	Nepal	Earthquake	25-04-2015	8633

Table 2 Earth Quake disasters 2001-2015
(Continent wise losses reported in 000 USD)

Continent	Disaster type	Disaster subtype	Events count	Total deaths	Total affected
Africa	Earthquake	Ground movement	23	3030	289259
Africa	Earthquake	Tsunami	4	312	109913
Americas	Earthquake	Ground movement	66	225261	11554666
Asia	Earthquake	--	2	78	14726
Asia	Earthquake	Ground movement	280	235925	94617794
Asia	Earthquake	Tsunami	13	247276	2763341
Europe	Earthquake	Ground movement	32	388	269434
Oceania	Earthquake	Ground movement	12	190	628687
Oceania	Earthquake	Tsunami	5	248	14305

Diagram 1 Pie Chart
Total damage in Thousands USD



http://www.emdat.be/disaster_trends/index.html

Diagram 2Pie Chart

Occurrence of Natural disasters 2005-2016 Drought, Earthquake, Epidemic, Extreme temperature, Flood, Landslide, Storm, Volcanic activity, Wildfire and data

4. Study Outcome

The analysis of above mentioned tables and graphical data Pie Chart 1 & 2spells out the degree of damages and losses to the mankind and society, review of guidelines and national policies force us to re-think for a radical approach and need to design an intelligent holistic innovativeinteroperable, reliable holistic technologies enabled cost effective user friendlynovel architecture for

effective communication system for civil emergencies which can supplement in reducing the impact of damages and losses to mankind.

Civil emergencies communication systems' (CECS) characteristics, features, challenges of rescue operations (ROPS): Papers' review highlights available solution for CECS that security forces and civil administration are operating with limited resources and ad-hoc means of non-collaborative civil safety communications, sharing of information found to be limited. The existing information systemsare to the great extent non-scalable, non-flexible, non-interoperable [2] and fulfilling the short duration non-holistically immediate requirements. Availability of short livednon-easily transportablewith no minimal set up timings systemswith hardly any last mile connectivity, limited mobility and mobile process management systemare in place.

For the first responder technologies likeinformation fusion, intelligent fusion framework [7],Software based centralized integrated command and control having information sharing and real time intelligence analysis [11] etc. not able to provide data and in-depth information insight.

Impact of incident and geography of operations (GOO) i.e. plain, hilly, jungle, urban, rural, deserts, seashore, governmental policies, localized crime pattern, local law and order situation etc. are the major key factors missing in available silo system and solutions.

Unfortunately, none of these solutions including "3S" technique (i.e. GIS, GPS and RS) used in intelligent digital system for urban natural hazard mitigation [8] neither met the users' / public's full expectations norstands as a proven flexible, accurate, scalable or unobtrusive solution as whole.

CECS systems' characteristics visualized aresolution integrity, security, information assurance, collaborative scalable mobility ICT enabled localized communication (tetra), Knowledge Management (KM),integrated command center(ICS) etc. are in a position to ensure effectiveness of risk mitigation which is fully dependent on availability of the unified holistic integrated communication systems at POO as abest achievablesystem for first responders (FRs).

The gap between theory and reality has been filled by Hudson Valley transportation management center by undertaking training of personnel for incident & emergency management and FR's.Other key features like reusability with modularity, fusion technology [7], systems' solution andintegration techniques amongsecurity forces-civil military operations CMOS [3] and its characteristicscan be the basis for designing the novel architecture frame work.

5. Solution Components - A New Learning

The basic solution for civil protection emergencies [1] provides us a short lived limited area rescue operation system. The German government funded project SPIDER [2] (Security System for Public Institutions in Disastrous Emergency scenaRios) having limited capability providing XML based interface for a service oriented interoperability architecture with insight for secure collaboration and enabling components required for critical networks of disasters. Integration tool during emergency response operations [3] for the civil and military service cooperation with its concept and emergency management operations control system [4] both enables the insight of the solution learning. Navigation In Case of Emergency (NICE) [5] An Integrated NAV/COM Technology for Emergency Management on experimental basis has been successfully demonstrated. Improving emergency responder situational awareness for Incident command systems (ICS)[6] using critical information management, simulation, and analysisalong with "Real-time data fusion and visualization [7] in support of emergency response operations. Device independent information sharing during incident response [8]a useful concept and identifying End-User requirements for communication systems in disadvantaged environments [15] are light throwing facts as a step forward to design and develop an architecture frame-work.

Next generation priority services for emergency preparedness and national security communicationsystems supporting information sharing for situational understanding and command coordination in emergency management and disaster response[9][10] are well explained. Requirements and system architecture design consideration for first responder systems [11]. Lincoln Lab MIT [12] with ERS community have demonstrated a prototype net-centric system architecture integrated sensing and command and control system enables shared situational awareness and collaboration during response operations.

Civil information management semantic technologies [13]while in situation of complex emergencies providing analytical investigations for the encountered technical challenges. Public safety mobile system for disconnected, interrupted, low and wide area bandwidth communication system [14] operating in different environmental conditions provide us input how to establish grounds for designing connected, uninterrupted communication system capable of reshaping the telecommunication world for civil emergencies.

6. Benchmarking Techniques

In the light of recent natural and man-made disasters, terrorist events, technology, processes and human resource challenges of traditional disaster recovery approaches for disaster preparedness have beentreated andoutlinedby Lawler, C.M.; LLC Irving, Chad; Szygenda, S.A. with emphasis on the components of disaster tolerant computing and communications in the present situation.The relationship between disaster tolerant systems (DTS),Information Technology application availability (ITAA) and executive level management visibility have becomenecessary for successful system operations in the event of a catastrophic disaster. A general approach for disaster tolerance which mitigates unplanned downtime through a disciplined approach of IT infrastructure's designs based on redundancy and distributed components with special attention to the ability of executive level management to comprehend the value of uptime of an application and to make appropriate capital investment was visualized [1].Humanity is one of the high dependent key factors hence benchmarking must take care of the needs of such complex systems.

7. Conclusion

Natural disasters cannot be averted. Its impact andminimizing losses can be achieved by the degree of preparedness, quality of responsesto the situation. Powerful effective management plans with engineeringefforts and expert enforcement can maintain and provide an evenly balanced partnership with stakeholders. To have out of the box solution with ahigh-performance, reliable communication information management network and a fault tolerant advanced technology enabled transportation management system havingfeatures of ICS,cost effective modular, user friendly simple interoperable, reusable, with mobility (agile and mobile), last mile connectivity and fusion etc. thecharacteristics for (terrain based (CIS) critical infrastructure systems)disasters' controls in multi environment as well as under developed / rural areas operations support for all stake holders in accordance to the national polices of respective Disaster Management Authoritiesacross the world over.

End Note: In broad perspective, disaster preparedness must ensure an efficient, effective and holistic emergency response system (ERS) for the first responders as a proactive robust early warning system (PREWS). This paper highlights the review of existing and ongoing research on the "Communication System for civil emergencies". We recognize that there are many factors, uncovered areas that can provide the insight to undertake the further innovative and constructive studies as an outcome of literature survey of this paper.

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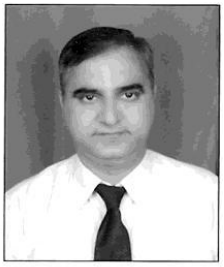
Web sites: Nation's vision document @ their respective web sites

In addition to the above mentioned references the web sites of the various developed, developing and under developed countries like USA, Europe, Fiji, India, Botswana etc. has been referred to understand their policies and vision pertaining to the management of civil emergencies.

In addition to the above mentioned references the web sites of the various disaster management authorities nation's(developed, developing and under developed countries) like USA, Europe, Fiji, India, Botswana etc. and various nation's vision document at their respective web sites & EM-DAT- OFDA/CRED – International Database site last viewed 31 Dec, 2015 has been considered and reviewedto understandtheir policies and vision pertaining to the management of civil emergencies.

9. Biographies

9.1 Biography: Ghanshyam Purswani



An Alumni of Rajasthan University, GJU Hissar, IIPA New Delhi & Symbiosis Pune. Having done M.Sc. (Physics with Micro wave electronics), M. Tech (CSE), MBA, PGD- ITM, Served the Border Security Force – MHA GOI as Technical (ICT) Officer from Asst. Commandant to Commandant in various rolls by holding prestigious appointments in the areas of ICT, Techno- administrative functions and Borders' Security all along the frontiers from East to West and North to South. Raised and Commanded NDRF Bn. Served UN Civpol monitor at Mozambique operation ONUMOZ where worked with 30 countries' police forces in the multicultural international environment. After serving for 23+ years took Vol. retirement and joined Indian MNCs and working as Domain Expert – HLS, Security solution Architecture security systems.

9.2 Biography : Dr. Lokesh Tharani

Dr. Lokesh Tharani has done B.E. from Govt. Engineering College Kota (Now University College of Engineering, Rajasthan Technical University) in 1999 and received M.Tech. in Electronics & Communication Engineering from Malaviya National Institute of Technology (MNIT), Jaipur in 2003. He is also obtained his Ph.D. in Multiuser Detection in CDMA technology from MNIT, Jaipur in 2011. He has a teaching experience of more than 15 years and has published several papers in National & International Journals, symposiums and conferences. He is also co-author of book "Wireless Communication". He is life member of Institution of Electronics & Telecommunication Engineering (IETE), New Delhi. He also served as Principal of JaganNath Gupta Institute of Engineering &Technology, Jaipur from 2011-13. Presently he is working as Associate Professor in the Department of Electronics and Communication Engineering, University College of Engineering, Rajasthan Technical University (RTU), Kota, Rajasthan, India since June 2013.

9.3 Biography: Dr. Girish Parmar

Dr. Girish Parmar was born in Bikaner (Rajasthan), India, in 1975. He received B.Tech. in Instrumentation and Control Engineering from National Institute of Technology, Jalandhar in 1997 and M.E. Electrical **(Gold Medalist)** with specialization in Measurement and Instrumentation from Indian Institute of Technology, Roorkee, in 1999. He obtained his Ph.D. in Electrical Engineering in 2007 from Indian Institute of Technology, Roorkee. He is life member of Systems Society of India (LMSSI) and Associate member of Institution of Engineers, India (AMIE). He has published more than 80 research papers in various International/National Journals and Conferences. He is author of several technical books. He was working as Assistant Professor in Department of Electronics Engineering at Rajasthan Technical University, Kota from 1999-2011. He also served as Principal of Modi Institute of Technology, Kota from 2011-13. His research interests are in the area of Process Instrumentation & Control, Optimization, Signal Processing, System Engineering, Watermarking and Model Order Reduction of Large scale systems. Presently, he is working as Associate Professor in the Department of Electronics Engineering at Rajasthan Technical University, Kota since 2013.

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