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Anthropogenic hazard and disaster relief operations: A case study of GAIL pipeline blaze in east Godavari of A.P

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Abstract

Disasters are of two type's natural and anthropogenic hazard or man-made hazards. A natural disaster is a major adverse geologic process resulting as floods, earth quakes, tsunamis which cause severe damage of life, property and environment. While the anthropogenic hazard results in the form of human intent, negligence, human error and involving a failure of man-made system. The Nagaram gas leaking from GAIL pipeline fire explosion took 23 lives in the early hours of 27th June 2014. This explosion occurred close to the ONGC's Tatipaka mini-refinery and a gas collecting station began leaking the day before the accident and spread over the area and caught fire when the tea vendor lit a stove. The impact was devastating as the flames spread over a 1 km radius, catching people in the vicinity unawares.

The major cause for this mishap is apathy towards the haul of surveillance and hovered district administration. The state government has announced ex-gratia of 50,000 rupees and GAIL has announced an ex-gratia of 25 lakh to the next kin of those who died, and 5 lakh to those who suffered permanent disability as a medical aid. The paper aims to question the governments' ex-gratia over decimation, despite additional surveillance based on an empirical work in support of disaster relief operations over this anthropogenic hazard of GAIL pipeline disaster. This paper provides an overview of this hazard in victim's family/kin perspective, which is aggravated significantly by the vulnerability of people's vicinity, and the findings of the study will be useful to improve the effectiveness and efficiency of disaster relief operations in order to assist in the aftermath of future anthropogenic disasters.

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Keywords: Anthropogenic hazard; Humanitarian Logistics; Disaster Relief Operations; GAIL

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1. Introduction

An Anthropogenic hazard or Man-made disasters cover a wide range of events created largely due to accidents, negligence or sometimes even by human design, which result in huge loss of lives and property every year. These include road, rail, river, marine and aviation accidents, oil spill, building and Bridge collapse, bomb blast, industrial and chemical accidents etc. These also include the threats of nuclear, biological and chemical disasters. India has experienced several man-made disasters. One among them is the 'Bhopal Gas Tragedy' it happened in the early morning hours of December 3, 1984, a highly toxic cloud of methyl isocyanate leaked from Tank – E610 engulfing the city of Bhopal resulting as many as 10,000 deaths . In the state of Andhra Pradesh, there was a massive gas well blow-out that had occurred on January 8, 1995, at Pasarlapudi, of East Godavari District, it is also popularly known as the second biggest blow-out in the world. It stretched the resources of the ONGC to the limit and after two months of struggle, by using a specially designed machine called a Halliburton sand cutter, which sprays silica and water with tremendous force, it was brought under control.

In Andhra Pradesh, the blow-outs occurred in 1993, 1995, 2005 and 2014. This study focused on the recent Nagaram GAIL blast that which had occurred in the early morning hours of June 27th 2014. This massive GAIL pipeline blaze took the lives of 23 people in which 6 children were also burned alive in the sleep and 16 others got severe burns at Nagaram village of Mamidikuduru mandal of East Godavari District in the state of Andhra Pradesh. The leaking GAIL gas pipeline spread over 1 kilometer radius, and villagers woke up to deafening noise and huge flames after the pipeline belonging to Gas Authority of India Limited (GAIL) suddenly caught fire near an ONGC connecting station. The villagers are running in panic and wailing for help as huge flames engulfed an entire village trapping about 30 people, and burning hundreds of tall coconut trees and reducing about 50 houses and shops, 16 vehicles to ashes. Dead bodies of humans and animals scattered around the blast area, the smell of burning bodies lingered in the air. According to the media report, 23 people burnt alive, 16 people seriously injured, 167 birds, 2 domestic animals, 1145 coconut trees, 13 electrical wires were feared burnt in the mishap as flames rose to as high as 250 meters and 150 meters away from GAIL station. The district administration rushed to the spot and started immediate rescue operations with the help of fire engine department and utilized the other medical logistics from the hospitals of KIMS- Amalapuram, Apollo and Trust of Kakinada and Rajahmundry and the government assured better medical treatment to the severely injured.

The relief announced by the Prime Minister is in addition to the relief assistance given by the Petroleum Ministry and GAIL. He has announced ex-gratia relief of Rs. 2 lakh from PMRF, for the next of kin of those who have lost their lives in the GAIL pipeline fire. The state government has announced an ex-gratia relief of Rs. 50,000 has also been sanctioned for those who were seriously injured in the incident. The GAIL has announced an ex-gratia of 25 lakh to the next kin of those who died, and 5 lakh to those who suffered permanent disability as a medical aid. This remains the highest ex-gratia for the deaths of GAIL disaster in the Indian disaster history.

The Gas Authority of India Limited (GAIL) the country's largest state-owned natural gas processing and distribution company did not make any efforts to replace an already corroded gas pipeline. The blast occurred in the pipeline carrying gas to Lanco power station. The villagers allege negligence on the part of officials as the pipeline developed rust and authorities failed to replace it. Around 7-8 leakage incidents have taken place in the natural gas pipeline (5.8 km from GAIL, Tatipaka) including a few in March this year. The villagers said their lives were endangered by laying the pipeline through the residential area. The villagers claimed that the smell of gas being felt in the village but the officials did not look into the possibility of leakage and there was no further action taken place towards disaster identification. They alleged that the officials did not take measures for their safety despite several complaints to the GAIL about the pipeline leakages several times and reminding the warning of an impending disaster went unheeded for a long time.

The locals recalled the massive fire blowout in a gas well at Pasarlapudi village in East Godavari district in 1995 which could not be put out for nearly two months. The locals were also a bit relaxed for the early hour blast, if it would have had happen during the day time that was more dangerous than the disaster taken place by emphasizing that, one private school is running with 300 kids, nearby the blast area. The catastrophe raised some ethical issues by expressing anguish by the people of blasted vicinity that the pipelines are located in residential areas, they alleged that officials of oil companies have, of late, not promptly been attending to the safety aspects. The GAIL authorities

were not bothered though smell was coming and pipelines were rusting. The major cause for this mishap is apathy towards the haul of surveillance of GAIL and ONGC authorities.

The major reasons for this man made hazard are, lack of surveillance, GAIL officials negligence, no proper checking and maintenance of repairing of gas pipe rusting and leaking, and hovered GAIL administration. If GAIL India had installed the safety features as promised to the Chief Controller of Explosives (CCOE) while seeking his approval for the project in July 2001, says the government enquiry report on the incident. In the application submitted to CCOE on July 24, 2001, GAIL committed to set up a gas dehydration unit (GDU) at the start of the pipeline at Tatipaka to strip water and condensate from "wet" natural gas so as to prevent pipeline corrosion and leakage of inflammable condensate and gas in the open. But it did not set up the GDU at Tatipaka, as committed while seeking CCOE permission under Manufacture, Storage & Transportation of Hazardous Chemical Rules of 1989. GAIL has apparently flouted the declaration to the statutory authority as well as the declared design basis by not providing GDU at Tatipaka and Mori. Absence of GDU contributed to increasing the internal corrosion rate in the pipeline, says the Enquiry report. Pipeline was designed on the basis of handling dry natural gas. However, it was being regularly used for transportation of wet gas without taking any additional precautionary measures. Wet gas contains free water, carbon dioxide, sulphur etc which induced internal corrosion in the pipeline.

The enquiry committee's finding is that the explosion, followed by a major fire, was due to leakage of condensate and gas which was probably continuing from the night before the incident. The 200 km gas pipeline, 18 inches in diameter, stretches from Tatipaka refinery that produces seven lakh cubic meters of natural gas per day. The leak probably occurred overnight and was undetected due to cloudy conditions, and the gas settled at a lower height. The condensate formed vapour cloud with gas pockets, and triggered a major fire when a tea vendor lighted the stove. The probe ordered to investigate by petroleum and natural gas and the probe team comprising Oil Industry Safety Directorate, National Disaster Management Authority among other agencies, the probe report reflects the fire flashed back to the source of leak i.e. at pipe near to the canal, resulting in the bursting and ripping away of the pipe and leading to leakage of huge quantity of hydrocarbon from the pipeline, thereby increasing the intensity of the fire. Corrosion and leaks were a regular affair and the section between Tatipaka and chain age 5.8 km experienced seven leaks in last two years. But GAIL persisted in operating this line with wet gas, despite being aware of the leaks, and resorted to makeshift repairs by small contractors who would weld clamps, sleeves or pads to cover the leaks. No inspection was carried out in spite of repeated leaks. The 'lapses observed' section says the "inadequate systems/ approach of GAIL in undertaking repeated repair of these high pressure lines by following temporary measures with the help of clamps/ sleeves/ pads was a factor in this accident, the probe report prepared by the committee, headed by Rajesh Kumar Singh, joint secretary (refineries) in the ministry of petroleum and natural gas, states.

The probe team stumped, during the course of maintenance work way back in 2010, experts found corrosion (damage) in the same lines and three years later recommended infusion of a 'corrosion inhibitor', a chemical compound which decreases the corrosion rate of the metal. An audit by pipelines regulator PNGRB in August 2011 too did not make any observation in connection to composition of gas and associated issues. Investigators also said the high-intensity explosion could have also been aided by the presence of condensate, a low-density mixture of hydrocarbon liquids, present as gaseous component in the raw natural gas, which GAIL received from ONGC. The region is prone to such blasts, mostly due to human negligence, and about a dozen such incidents have taken place since 1990 when oil and natural gas exploration picked up in the Krishna-Godavari basin. Lastly R.K.Singh in its report blamed that the 'inadequate systems/approach' resulted for the accident.

The report said there was "no evidence of any efforts" by Nagpur-based Petroleum and Explosives Safety Organisation (PESO) to enforce putting up of Gas Dehydration Unit to drain out water and liquids. The pipeline was also audited by OISD and there has been no observation on wet gas content. The report said it was difficult to establish individual culpability. Besides installation of dehydration facility for removal of water and condensate prior to feeding natural gas in the pipeline, it recommended through inspection of the pipelines and putting up of leak detection system. Comprehensive procedure shall be developed for repair of pipeline in case of leak, and added that GAIL must develop proper supervisory and control systems for maintaining the health of pipelines.

2. Objectives of the Study

- To find the major reasons hidden for this anthropogenic hazard.
- To study the decimation over GAIL and governments' ex-gratia and beyond.

- To study the effectiveness and efficiency of disaster relief operations in the rescue of GAIL blast.
- To suggest some preventive measures to curb the future anthropogenic hazards.

3. Review of Literature

Jain &Yerramilli (2012) in their study 'A Case Study of Blow out and its control in Krishna-Godavari (KG) Basin, East Coast of India: Safety and Environmental Perspective' explains about the major blow outs occurred in KG basin and resulted the number of risks in the relation to the loss of human lives and material assets, environment pollution due to the geological complexity of the wells at Amalapuram, Razole and Narsapur have led to major disasters. This study is an attempt to identify the most possible causes of these disasters and to propose a safe drilling procedure to prevent these disasters in the upcoming ventures. They recommended efficient drilling and safety procedures to prevent further blow outs in the future and suggested the utmost importance for oil and gas operators and service companies to take necessary steps in future drilling operations in over pressured formations of KG basin to prevent loss to personnel, property and damage to the environment.

Pandithurai & Devara (1997) in their research article 'Solar Multi-Spectral Radiometric Observations of Atmospheric Optical Thickness over Pasarlapudi Gas Well blow-out site in India' explains about the unique and special observations have been made to study the aerosol (a substance enclosed under pressure and released as a fine spray by means of a propellant gas). Though it is a scientific study, the reasons were explained as the potential effects of human activities on climate and associated with combustion process and often anthropogenic mistakes. The Pasarlapudi incident was surrounded by coconut trees and sparsely populated areas. This was accomplished mainly by using a specially designed machine called a Halliburton sand cutter, which sprays silica and water at tremendous force which resulting in narrowing the horizontal extent of the flame. The results of the study concluded that it took more than 65 days to control at the cost of ONGC 20 crores which loss led to the major losses have been coconut and paddy plantations burnt to a crisp by the heat. The villagers have also complained about the heat affecting the prawn cultivation in local ponds.

Jyothi & Suthar (2012) in their article 'Disaster Statistics in Indian Scenario in the last two decade' discussed disasters in terms of natural and man-made during the 1999-2009 as per India government reports and EM-DAT data. The article mainly focused on the catastrophic events of natural and anthropogenic disaster definitions and disaster types. The natural disasters are resulting from natural causes with massive human, material and environmental losses whereas; the man-made disaster results from human decisions. According to the International Federation of Red Cross and Red Crescent Societies (2003) highlighted that a man-made disaster refers to non-natural disastrous occurrences that can be sudden or more long-term. The former includes structural, building and mine collapses when this occurs independently without any outside force, and the long-term man-made disasters tend to refer to national and international conflicts. There are disasters that result from both human error and natural forces. These are hybrid disasters. An example of a hybrid disaster is the extensive clearing of jungles causing soil erosion, and subsequently heavy rain causing landslides. The findings of the study reflect India has experienced 37.8% of total natural disasters and 62.2% man-made disasters. The study concludes that the consequences of the natural disasters can be reduced through an effective disaster management. In addition to this, natural and man-made disasters can also be prevented or reduced through public involvement in disaster management policies, training programmes, community participation, capacity building, mock drills etc.

Peter & Houghton (2011) in their article 'The wicked problem of humanitarian logistics and disaster relief aid' discusses and examines the issues, dilemmas and decisions facing the humanitarian logistician, as a key component of the preparation and response to a disaster, and concludes that they fall firmly into the ambit of a wicked problem. They discussed the "wicked problems" facing those who sought to develop solutions to urban planning challenges and proposes methods for management of such problems, and applies it to the humanitarian logistics field. The paper concludes that further research is needed to understand the ways in which the three primary approaches of employing authoritative, competitive and collaborative strategies might be best evaluated and employed and it also recognizes that it is essential to engage with the broader disaster management and humanitarian logistic communities in order to help operationalised this theoretical approach. Hence, the focus might be applied to the logistic challenges of preparing for and responding to a disaster relief by strengthening the humanitarian logistics.

4. Methodology

The Methodology we adopted as the purposive sampling technique with sample size of 40 family members of GAIL blast victims' of those who burnt of death and severely injured of kith and kin. The researchers conducted personal interviews with semi-structured interview schedule based on this anthropogenic hazard, and the disaster relief operations such as housing, medical aid, ex-gratia and the role of medical and fire engine department in the rescue operations. The views of victim's families gathered on various issues related to future disaster preventive plans, and safety measures to arrest the aftermath incident. The secondary sources collected from the articles, newspaper reports, local media reporters, Andhra Pradesh Fire Services department and RK Singh report. The perspective of the Rajesh Kumar Singh enquiry committee report over this anthropogenic hazard and this probe committee report also supports the study analyzed the technical parameters apart from human error. Meanwhile, the A.P. Fire Services Department has prepared a special report about the explosion. In its technical evaluation, when the natural gas started leaking from the pipeline, formation of vapour cloud began. The increase in its concentration level was the cause for the explosion. The report said the natural gas consists of methane (95 per cent) and other fossil fuels such as ethane, propane, butane and pentane. Its characteristics are lighter than air, highly combustible and clean burning in nature, odorless, invisible and explosive under pressure. The intensity of the damage is more if it would have caused extreme fire hazard when mixed with appropriate concentration of air or oxygen in the presence of ignition of source. The field research is carried out between the dates of 18th -20th August and 18th -20th October 2014 by visiting twice to the field area and the hospitals where the injured got admitted. The data collected was analyzed by SPSS 16.

5. Field Analysis

Table: 1 Respondent Kin Type * Major Reasons for the GAIL Blast

Respondent Kin Type	Major Reasons for the GAIL Blast						Total
	Gas Pipeline Leaking and Rusting	GAIL Officials Negligence	Lack of Surveillance	Inadequate System of GAIL	Human Error	Hovered GAIL Administration	
Death Kin	1	3	6	7	2	4	23
	4.3%	13.0%	26.1%	30.4%	8.7%	17.4%	100.0%
Injured Kin	3	3	3	3	3	2	17
	17.6%	17.6%	17.6%	17.6%	17.6%	11.8%	100.0%
Total	4	6	9	10	5	6	40
	10.0%	15.0%	22.5%	25.0%	12.5%	15.0%	100.0%

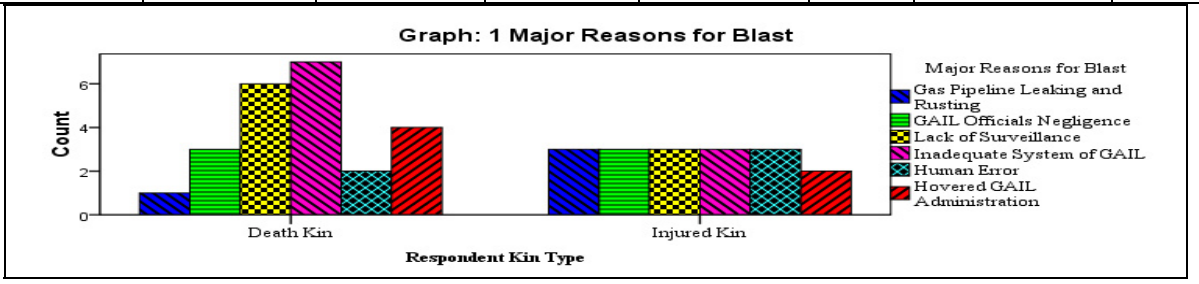

Fig. 1. Major reasons for blast

The above table explains about the major reasons for the GAIL blast from the respondents' kin type families as they are the main source of first-hand information about the hazard. Both the death and injured kin families of 25% reported that the blast was due to inadequate systems/approach of GAIL in repairing these high pressure lines by temporary measures with the help of clamps/sleeves. Around 22.5% have responded lack of surveillance on leakages, whereas the equal proportion of 15 % respondents expressed their anguish about the GAIL official's negligence and their hovered administration over warnings of an impending disaster went unheeded for a long time. Lastly, around 22% had spell out the human error and internal corroded and leaking pipeline.

Table: 2 Respondent Kin Type * Expecting Government help apart from Ex-gratia

Respondent Kin Type	Expecting Government help apart from Ex-gratia					Total
	Employment in Government	Financial support to restart their business	Housing Facility	Ex-gratia for Coconut tress	Ex-gratia for Vehicles and Property	
Death Kin	10	4	5	3	1	23
	43.5%	17.4%	21.7%	13.0%	4.3%	100.0%
Injured Kin	5	1	3	5	3	17
	29.4%	5.9%	17.6%	29.4%	17.6%	100.0%
Total	15	5	8	8	4	40
	37.5%	12.5%	20.0%	20.0%	10.0%	100.0%

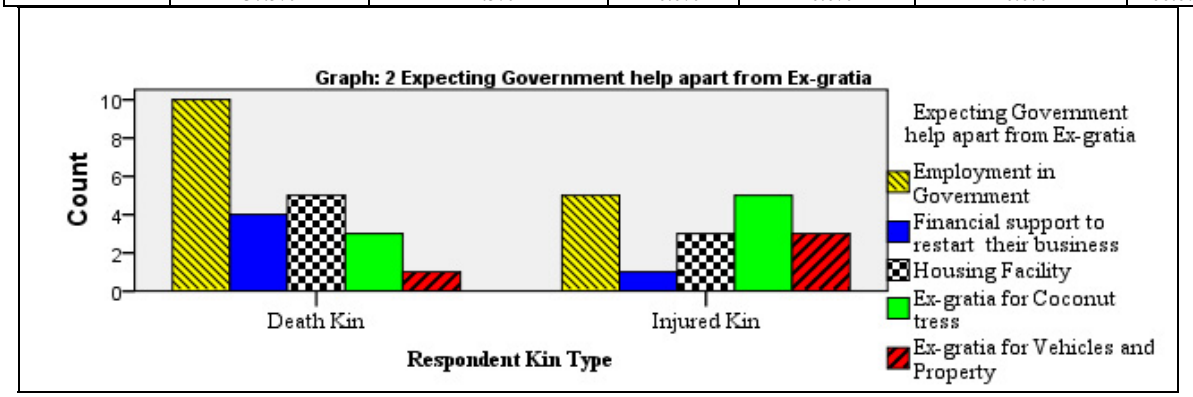

Fig. 2. Expecting government help apart from Ex-gratia

The total damage occurred due to the intensity of the blast as flames rose to as high 250 meters by killing 23 people and 17 severely injured, burning hundreds of coconut trees, birds, animals, about more than dozen of houses and vehicles (Tractors and Motor Bikes)to ashes. GAIL has announced an ex-gratia of 25 lakhs to the next kin of those who died, and 5 lakh to those who suffered permanent disability as a medical aid. The government of Andhra Pradesh provided 50,000 rupees and by the Jagan 25,000 rupees as relief fund for the blast victims. Despite this ex-gratia the victim's kin are expecting/seeking help for their loss from the government of Andhra Pradesh. The above table depicts that the kin group of death and severely injured respondents are seeking help from the government of Andhra Pradesh that majority of 37.5% are seeking employment in the government sector, followed by 40% are expecting ex-gratia for coconut trees and housing facility by replacing the broken and damaged houses. Around 12.5% have responded for the financial help to restart their business and the rest of 10% had opinioned that ex-gratia should be provided for the lost property and vehicles which remain into ashes.

Table: 3 Respondent Kin Type * Major Disaster Relief Operators in Rescue Operation

Respondent Kin Type	Major Disaster Relief Operators in Rescue Operation			Total
	Excellent Medical Aid	Highly Committed Fire Engine Work force	Dynamic District Administration	
Death Kin	12	8	3	23
	52.2%	34.8%	13.0%	100.0%
Injured Kin	9	2	6	17
	52.9%	11.8%	35.3%	100.0%
Total	21	10	9	40
	52.5%	25.0%	22.5%	100.0%

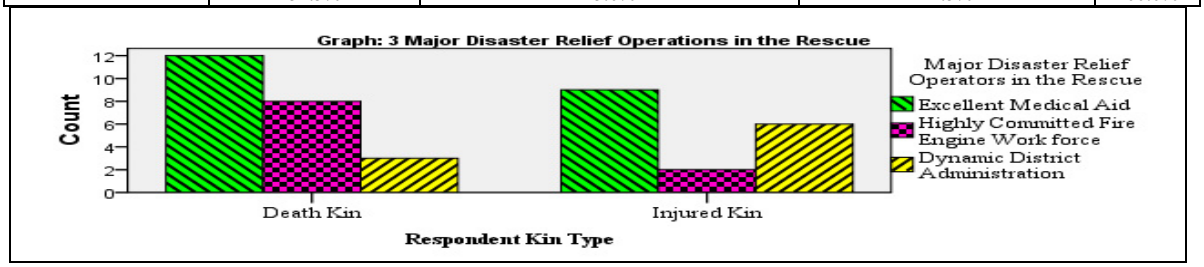

Fig. 3. Major disaster relief operations in the rescue

The above table enumerates about the major disaster relief operations were carried out by the departments of medical, fire engine and dynamic district administration. Majority of 52.5% victims 'kin have appreciated the timely provided medical aid by the hospitals KIMS –Amalapuram, Apollo and Trust Hospitals of Kakinada, and personal care has been taken for the severely injured patients regarding their surgeries as well as in the treatment in order to ensure their speedy recovery. About the 25% of respondent's kin group reminded the highly committed fire engine officials, the major source in controlling the fire around the blast vicinity and 22.5% had responded that the district administration has responded immediately and sanctioned money for the victims' treatment. The media, police and villagers had a key role in transporting the victims to the hospitals as a part of disaster relief operation.

Table: 4 Respondent Kin Type * Preventive Measures to curb the Future Anthropogenic Hazards

Respondents Kin Type	Preventive Measures to curb the Future Anthropogenic Hazards					Total
	Severe Punishment for the responsible	Improving Surveillance	Setting up of Leak Detection System	Replacing from Residential Vicinity	Developing Permanent Repair Mechanism	
Death Kin	5	6	6	3	3	23
	21.7%	26.1%	26.1%	13.0%	13.0%	100.0%
Injured Kin	2	4	4	4	3	17
	11.8%	23.5%	23.5%	23.5%	17.6%	100.0%

Total	7	10	10	7	6	40
	17.5%	25.0%	25.0%	17.5%	15.0%	100.0%

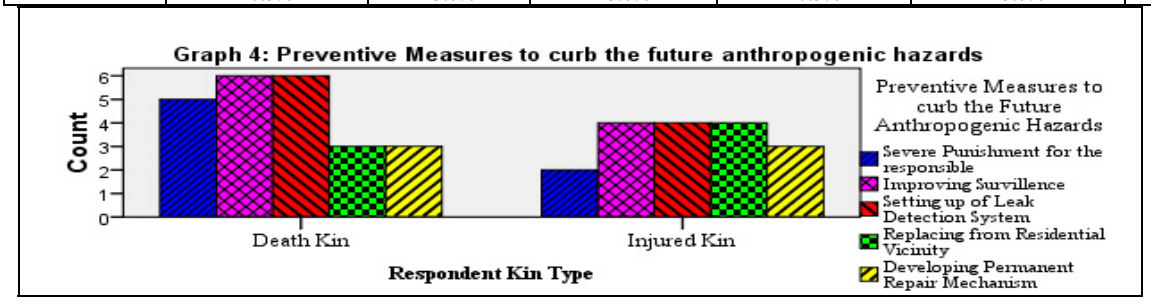

Fig. 4. Preventive measures to curb the future anthropogenic hazards

The above table elucidates about the preventive measures for the future anthropogenic hazards by respondents kin type of both death and severely injured. The majority of 50% victims kin group have responded that GAIL has to set up the permanent leak detection system and it should improve the surveillance and integrity check-up of the pipeline about the leaking, rusting and internal corroded lines which were prone to leakages. Around 35% have responded that punishment should be severe to those who are responsible for this kind of mishap and it is better to replace from the residential area as it is endangered for the lives of residents. Lastly, 15% of victim's kin group has opinioned that there should be permanent repairing mechanism system within GAIL administration in order to avoid temporary measures through the private contractors for this kind of high pressure pipeline works. The probe report also reveals the factors responsible for this anthropogenic hazard was the GAIL negligence towards the integrity check-up of the pipeline, there is no mechanism of permanent repair methodology, and lapses observed such as inadequate system of GAIL in undertaking repairs by following temporary measures with the help clamps/sleeves/pads of private contractors.

6. Findings of the study

- The Nagaram villagers had complained that this is completely GAIL official's negligence and human error which led to this anthropogenic hazard. Despite their several complaints about the internal corrosion of gas pipeline there was no proper integrity check-up system in the GAIL administration.
- The locals expressed their anguish that an ex-gratia is not a permanent solution, they were expecting a permanent solution for the severely injured with permanent disability with a government job from A.P. Government and the hike in ex-gratia from 5 lakh – 15 lakh rupees as medical aid from GAIL, and separate compensation for the loss of coconut trees, animals, and property including house and vehicles.
- GAIL should ensure the permanent safety measures of aftermath future hazards as the pipelines are passing through the residential area.
- The probe team by Rajesh Kumar Singh said there was no evidence of permanent repairing mechanism for the earlier repairs, and the temporary measures were undertaken by the local contractors who would weld clamps by clamping or by sleeves (a corrosion protective wrap) to cover the leaks.
- It is also due to GAIL's inadequate systems approach and lack of long haul surveillance.
- GAIL should be taken preventive measures for setting up of Gas Dehydration Unit (GDU) and permanent leak detection system.
- GAIL must develop comprehensive procedure for repair of pipeline in case of leak, despite considering the individual culpability

7. Conclusion

The management failure and human error contributes to this major disaster. GAIL had failed to meet its commitment to install a gas dehydration unit (GDU) at the start of the pipeline at Tatipaka to strip water and condensate from wet natural gas so as to prevent pipeline corrosion and leakage. Besides installation of dehydration facility for removal of water and condensate prior to feeding natural gas in the pipeline, it recommended through inspection of the pipelines and putting up of leak detection system. The study concludes with an inquiry committee, headed by the ministry's Joint Secretary (Refineries) Rajesh Kumar Singh. In his report he blamed GAIL's 'inadequate systems/approach' and it was difficult to establish individual culpability. This case study also recommended that GAIL should revive the internal managerial failures at different levels and fix responsibility for the lapses pointed out in the report. The village is limping back to normalcy but there is widespread anger at ONGC and GAIL for what they perceive to be 'gross negligence'. The locals are demanding that the mini refinery of ONGC and the gas collection station should be relocated, as they are now too close to the village for comfort. There is also concern over the safety of several villages in the Konaseema area, as GAIL pipelines criss-cross the entire area.

This disaster left a trail of destruction in the area, and there was heavy damage to the flora and fauna. The prevention of anthropogenic hazard lies in the hands of the operators and their personnel. The combination of hazard consciousness management, efficient and reliable equipment and well educated and trained officials are the best options for anthropogenic hazard prevention and to avoid environmental damage.

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