Artificial Intelligence Powered IoT Services that Aides Humanitarian Support – A Case Study

T. Reuban Gnana Asir, Hansa Lysander Manohar

Abstract*: The Internet of Things (IoT) is transforming the normal lives of everyone even during Natural or Manmade disasters. With a case study of a natural calamity and the impacts caused to Humanitarian needs, we will see how Artificial Intelligence could help in effective prevention, monitoring of flood and effective transportation and distribution of Humanitarian Supply Chain to the needy people at right time. This paper analysis the challenges of humanitarian logistics using Ishikawa diagram tool and presents the techniques that would help to address it.

Index Terms: Cloud systems, IaaS, IoT, Artificial Intelligence.

I. INTRODUCTION

During humanitarian crisis, we could see lot of Good Samaritans rising up to support the needy, that includes neighbours, fellow citizens, Government, NGO, Corporates, etc.. When this is assisted by the latest technologies on board and appropriate Artificial Intelligence techniques, the efficiency of this support grows up. Humanitarian supply chains (HSCs) play a central role in effective and efficient disaster relief operations. Transportation has a critical share in HSCs and managing its risks helps to avoid further disruptions in relief operations. In this paper, we will discuss few challenges in humanitarian logistics and how the IoT powered by AI could facilitate this role and with possible usecases [1].

II. CASE STUDY

Let me bring a case study of a natural calamity that hit my residence (Chennai, India). Chennai witnessed a huge rainfall of 494.2mm [2] in 02 Dec 2015 and subsequently got hit by heavy flood in the residence areas. This has costed the lives of 500 people; 1.8 million people were evacuated with damages costing between USD 3 billion to USD 16 billion [3]

Figure.1. Water Logging In My Apartment

The greater challenge we witnessed is the logistics to address their needs of next moments that includes:

Infrastructures: With airport and bridges got submerged in water. Electricity and Telephone connections were disconnected. Transportation modes through land and air got cut.

Uncertainties: Most faces were stuck with sadness as they were clueless about next moments, that includes how do we get food? Does my child get a dress to change as its wet? Do I get the medicines for my dependents, who are under medication?

Urgency: Every second is precious and lifesaving. People were stranded in upper floors of the building as their lower floors got submerged. Boat ambulance came to my street to rescue my friend, a teenager who got drown into the water. Efforts went in vain.

Adverse environment: The mind set of group behavior started witnessing physically and emotionally. They desperately needed something to eat and drink. Although everyone wanted to support others, they are scared too to accommodate them in their houses due to safety and security needs.

Social Media: Kudos to the social media. Few people who were lucky with mobile connections, were sharing the details of where they are, what is the immediate need for them, etc and Government agencies had tried to reach out to them as much as possible.

Bureaucracy: Supply of food pack, water bottles, medicines etc were coming from neighbor states and got accumulated into stadiums. Distribution process took time also due to the dependency in quick decisions from authorities.

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Lack of right information: Rising level of water in the rivers were not accessible and reachable to the people. Most people got to react to it, after seeing the water entry into their houses. After the flooding, we got repeated rumors which confused everyone, on which ones to believe, which ones not to believe.

III. IoT AND CHALLENGES OF HUMANITARIAN LOGISTICS

Figure 1 gives high-level graphical overview of the challenges in Humanitarian logistics [4]

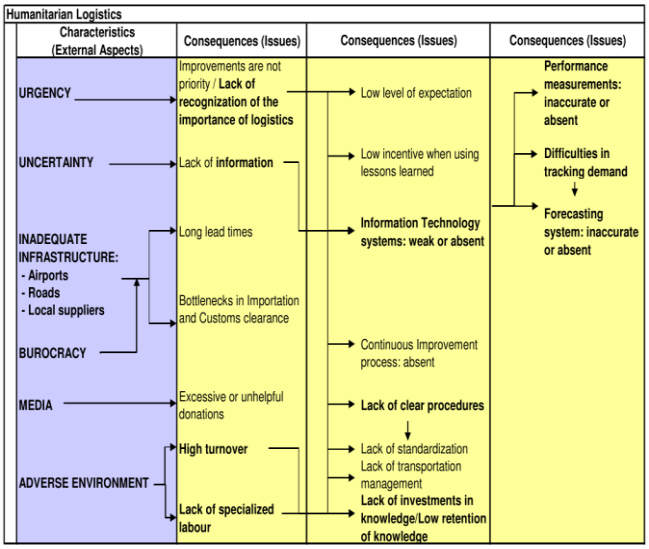

Figure.1. Challenges in Humanitarian Logistics

Looking in detail, majority of the challenges can get nailed down, if right information is available at right time. Since the catastrophe has impacted human kind, its important to have the Technology to support everyone on the difficult times and to get rid out of the situation immediately.

Likewise, the barriers in Humanitarian Supply Chain can also get classified that includes Managerial, Human Resources, Political, Financial, Educational, Informational and Tools and Resources [5]

IoT Technology can help to address lot of situations here with the support of effective Artificial Intelligence. The main reason is, in IoT the so called 'things' are connected to each other as in Figure. 2 [6].

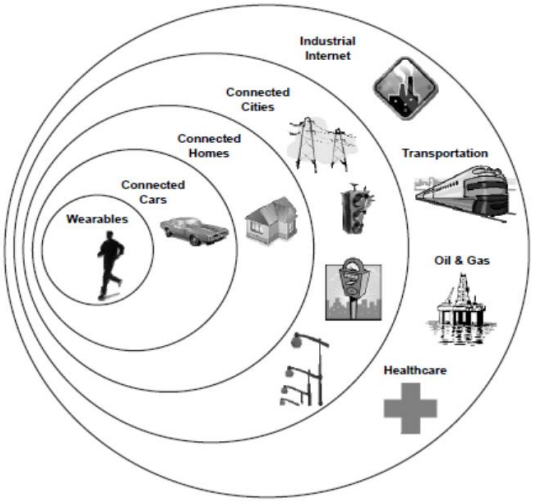

Figure. 2. IoT Landscape

A radical evolution of the current Internet into a ubiquitous network of interconnected objects that not only harvests information from the environments (sensing) and interacts with the physical world (actuation/command/control), but also uses existing Internet standards to provide services for information transfer, analytics, and applications

The IoT infrastructure can be divided into 4 layers [7]:

- Sensing layer
- Communication layer
- Management layer
- Application layer

The Sensing Layer comprises of sensors across locations and will have the data getting checked with the defined threshold limits. The Flood Alarming Systems will acquire data that constitutes the sensors placed at various levels of river beds, rainfall data from Meteorological Departments and Government Agencies and gives the monitoring data in real time mode [8], which acts as the source of Artificial Intelligence to forecast and arriving key decisions.

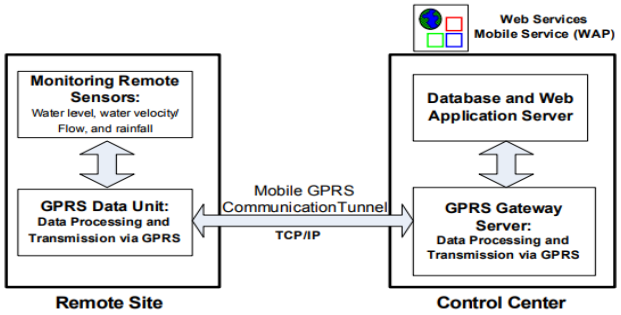

Figure.3. High level view of Flood Monitoring Systems

The other layers contribute the Communication, Management and Application as in Figure 4. These layers convey the information coming from flood monitoring system to the application layers using Middleware and Backend servers [9]. For example, in the Figure-4, the Environment Monitoring Application would use these information for further processing.

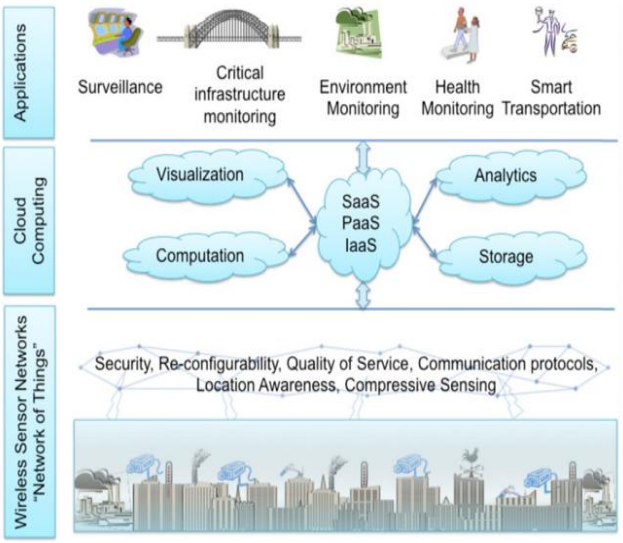

Figure.4 IoT Infrastructure from Different Layers

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The middle layer of computation consists of the middleware. Leveraging the latest technologies and evolution of Cloud Computing the usage varies based on the requirement, either making an inhouse data center (on premise cloud) or letting the data center distributed across locations. For managing the applications to support catastrophic case, On Premise Cloud is not recommended.

IV. IoT ADDRESSING THE CHALLENGES

Let's take a deep dive into the factors affecting humanitarian support using an Ishikawa (fish bone) diagram as in Figure 5 and see how IoT can address these causes.

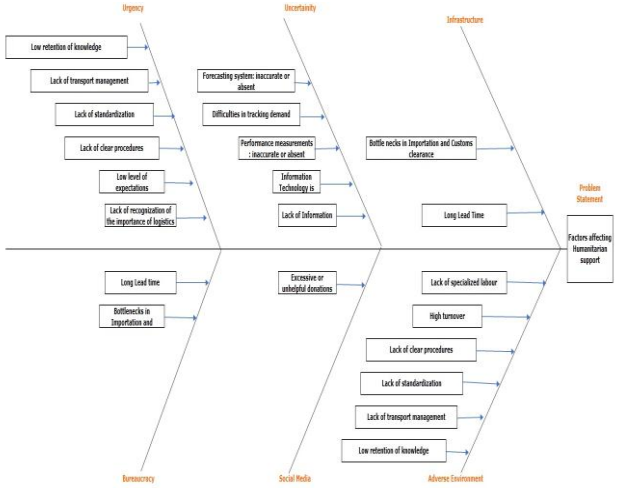

Figure.5 Factors Affecting Humanitarian Support

The cycle for disaster management is described often with the 4 stages, that includes - Mitigation, Preparedness, Response and Reconstruction [10].

These factors can be addressed by combination of IoT applications powered by AI that includes:

- Flood Monitoring and Forecast Predictions
- Transportation (Logistics) Management
- Smart City Applications

Real time Flood Monitoring and Forecast Predictions are feasible using IoT as we discussed earlier. There are multiple vendors that provides these solutions, as given below [11].

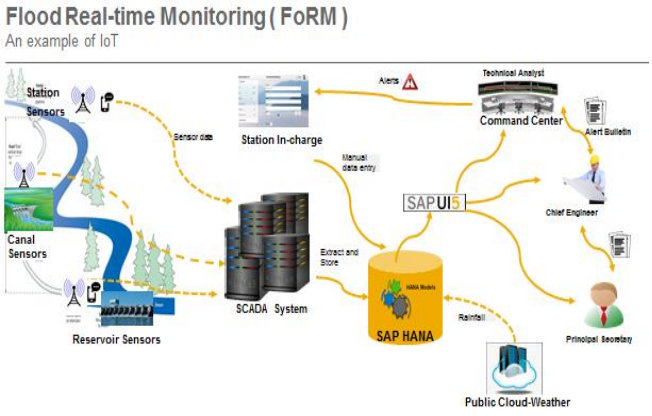

Figure.6 Real Time Flood Monitoring System

The challenges in transportation management, logistics and issues in delivering at right locations at right time is achievable using the IoT logistics solutions powered by AI. For example, let us see the Cold Chain Logistics Solution [12]

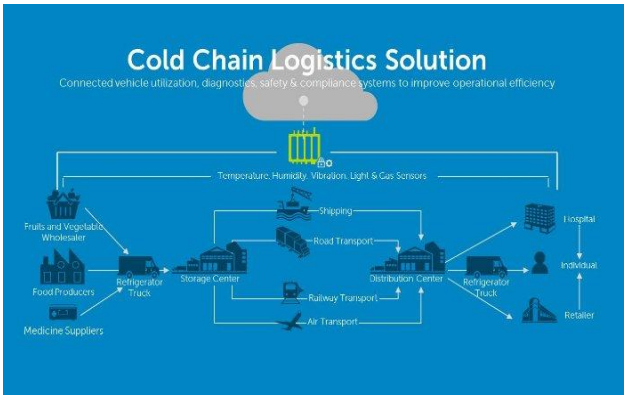

Figure.6 Cold Chain Logistics Solution

Cold chain logistics management is the use of Internet of Things (IoT) solutions to ensure the constant temperature for perishable products such as food, vaccines, pharmaceuticals, chemicals, or even medical supplies such as transplant organs.

IoT transportation and logistics solutions enable data aggregation from sensors and edge analytics to take action on the data. This remote management and control of cold chains drives operational efficiency that results in reduced transportation time of perishable goods and leads to a reduction in spoilage.

The above figure 6 captures the multiple steps in the cold chain that perishable goods will often traverse to get from a farm or medical supplier to various food distributors and retailers spanning multiple locations. Transportation time can be influenced by external factors (such as traffic, road conditions, and weather) which may lead to food spoilage if the conditions are not constantly monitored and controlled.

Fresh produce and perishable goods often need to be stored at a constant temperature with proper ventilation in order to maintain their desired humidity. Bananas are one such example – in order to preserve their freshness, you need to maintain 62-70F and 85-95% humidity during transportation. Many pharmaceuticals and medical supplies have even tighter ranges to ensure that no degradation of effectiveness occurs during transport.

Sensors in containers, trailers, and pallets make it possible to continuously track and transmit data (such as temperature, humidity, vibration, light, and gas content) throughout the cold chain. The state of the containers can be recorded and monitored consistently during transportation to distributors and retailers.

These additional sensors are leading to an unprecedented explosion of devices connecting to the internet, forming the Internet-of-Things (IoT).

This sensor data is utilized by transport and logistics solutions along the supply chain in different ways. Transportation providers use it to analyze, prioritize and re-route goods that could expire or spoil sooner than others and based on the crowd sourcing that requires these items on right time.

Finally, we need to integrate these transportation solutions and Flood monitoring solution using Smart City Solutions.

Now most cities in the world are proceeding towards making their city smarter. The smart city trends are on the raise and so the publications towards it [13]

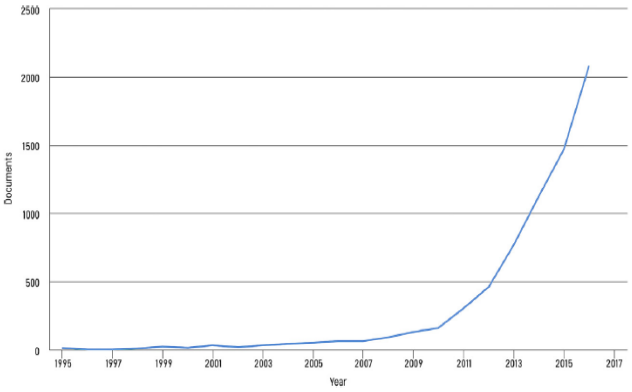

Figure.7 Articles on Smart Cities

The smart city encapsulates multiple solutions including the traffic monitoring and crowd sensing that aids the supply of humanitarian needs powered by AI. The overview of Smart City solution is given in Figure-8.

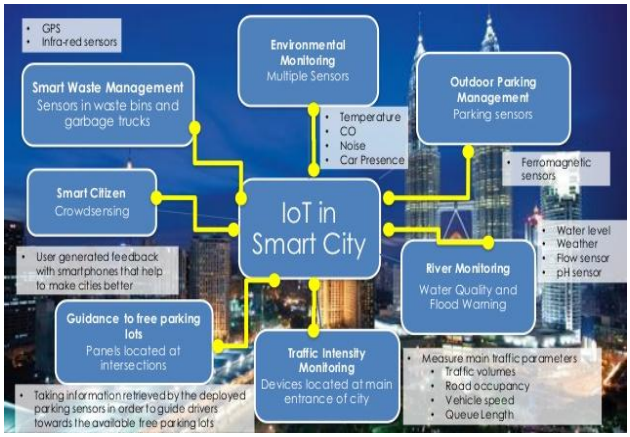

Figure.8 Smart City Overview

The smart cities integrate the information received from various AI sources that includes Real Time Flood Monitoring Solutions, Smart Transportation solutions, Crowd sensing data and co-ordinates the traffic signals and delivery of humanitarian needs to the needy in right time.

V. CONCLUSION

From this paper, we see the role played by Artificial Intelligence with the case study of a real-life instance on Catastrophe caused by sudden flood, listed the difficulties and learnt how the IoT Technology could act as a effective Good Samaritan. This will help to learn the lessons and effectively implement the humanitarian support. In addition, the AI makes a forecast of flood monitoring and issues appropriate alarms to prevent and minimize the impact caused by such disasters in future.

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