A Model to Facilitate Healthcare Infrastructure Pertaining to Medical Emergencies using Block Chain

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Abstract

In India, the number of deaths caused just by failing to treat a patient in an emergency situation in a timely manner is considerable. One of the key factors is India's emergency response system, which is out of date, in comparison to other technology. This study focuses on achieving operational excellence using block chain technology. The proposed concept focuses on real-time location monitoring of the ambulance, allocation of the nearest ambulance and hospital depending on the real-time location of the patient. Since there is a surge in demand for speedy medical emergency help, the study also focuses on maintaining a database of the patient's past medical records. However, these records shall be encrypted and accessible by the pertinent Doctors or Authorized Persons before the patient arrives at the hospital. The concept has essentially addressed all issues of safety and compliance. A descriptive analysis employing simulation techniques and secondary data from a literature review are used to support the proposed concept. After examining the contributions of all other entities, this research proposes a model that uses block chain to help in the reduction of time during crisis and the facilitation of healthcare infrastructure related to medical emergencies.

Keywords
Emergency Response, Electronic Health Record, Block Chain, Real-Time Location, Monitoring.

1. Introduction to Healthcare

For the sake of clarity, health and health care must be distinguished from one another. Health entails more than the absence of disease. Good health ensures disease-free living as well as the ability to fulfil one's full potential. As a result, health should be considered the inevitable foundation for assessing a person's sense of well-being. In every mature civilization, population health is a distinct important challenge in public policy discourse, usually determining the deployment of a big society. They include the country's cultural perceptions of disease and well-being, the level of socioeconomic inequality, the accessibility of health services, and the quality and cost of care as well as an up-to-date biomedical understanding of health and disease.

Not only does health care include medical treatment, but it also includes all aspects of preventative care. It also can't be limited to government-provided or paid-for care; it has to include incentives and disincentives for self-care and treatment paid for by private individuals to overcome disease. When private out-of-pocket spending dominates the cost of health-care financing, as it does in India, the consequences are bound to be regressive. At its most basic level, health care is often seen as a public good. As a result, demand and supply cannot be regulated only by the invisible hand of the market. It can't be established only on the basis of utility maximization.

1.1 Introduction to Healthcare Infrastructure

Infrastructure is a critical component in achieving the core goal of improving the quality of treatment and welfare for all patients, as well as a positive experience with the health-care system. The hospital's infrastructure must incorporate it as a center for acute and inpatient treatment into the health-care system as a whole (Logvinov and Malonoga 2019). According to AIIMS study, there are around 30% of deaths are caused by delays in receiving emergency care, more than 150,000 deaths due to traffic, 98.5% of ambulance runs convey dead bodies, and 95% of ambulance staff are not trained well (Niti aayog report 2021).

The seven quality domains should be made easier. Patient satisfaction, efficacy, efficiency, timeliness, safety, equality, and sustainability are all factors to consider. The constructed environment, as well as supporting aspects such as equipment, access, information technology (IT), systems and procedures, sustainability efforts, and people, are all included in infrastructure.

1.2 Introduction to Block Chain Technology

The blockchain is a decentralized database that stores and shares records of all transactions or digital events that have occurred. Each transaction is double-checked by the majority of the system's members. It holds every single transaction's record. Blockchain Technology's Advantages mainly in Consensus-based Distributed, Secure Transparent, Time and money are saving and Increased security (Attaran 2022).

1.3 Medical Emergency

A medical emergency, often known as a life-threatening situation, is an acute injury or illness that poses an immediate threat to a person's life or long-term health. Because some of these conditions, such as cardiovascular (heart), pulmonary, and gastrointestinal emergencies cannot be addressed by the sufferer alone, they may require the assistance of another knowledgeable person. Many levels of care, ranging from first aiders through emergency medical technicians, paramedics, and emergency physicians may be necessary depending on the severity of the situation and the quality of any treatment offered.

1.3.1 Types of medical emergencies

The following types of emergencies can be address with the help of this model and optimize the process excellence.

- Accident/ Trauma emergency
- Natural medical emergency
- Natural disaster emergency
- Act of Terrorism

2. Review on various aspects of Healthcare Infrastructure

The healthcare infrastructure depends on various cross dimensional aspects as described below.

2.1 Inadequate Infrastructure

For an unusually long time, India has struggled with an inadequate foundation and a lack of well-equipped medical institutions. Furthermore, as compared to the critical requirement, the speed of constructing such clinical education or preparing offices remains slower (Khalfaoui and Hammouche 2021).

2.2 Manpower Shortages – Less Efficient and Not Well-Trained

One of India's most important problems is a severe shortage of qualified labor in the clinical field, which includes specialists, attendants, paramedics, and key medical care workers. The current situation remains concerning in India's provincial areas, which account for almost 66 percent of the country's population (Kulshrestha and Singh 2016).

2.3 Unmanageable Patient-Load

Indeed, even before the Covid-19 epidemic erupted, medical services offices were under strain because to an excessive patient load. In addition, serving a population of billion people is a Herculean task in and of itself when it comes to properly managing medical care facilities. There is a need to embrace innovation wherever it is possible in order to smooth out the functional and clinical cycles for medical care offices to manage a smooth patient flow (Kulshrestha and Singh 2016).

2.4 Proactive Healthcare and Public Health Policy

The most current National Health Policy (NHP) includes the 'Health for All' approach to ensure that everyone has access to medical treatment at an affordable cost. Regardless, the NHP allows for a significant increase in the amount of work that can be done. In an ideal world, the whole health strategy would be centered on proactive medical treatment rather than reactive medical care (Ciani et al. 2012).

2.5 Expenditure

It is undeniably true that accessible and affordable medical care in the public sector may significantly reduce dependency on private companies (Jaldell et al. 2014). While public emergency clinics provide free health treatment, but they are understaffed, unprepared, and primarily located in urban areas.

3. Literature Review and Summary

According to our study, we discovered that the majority of publications focus mostly on ambulance tracking rather than ambulance allocation (Rao et al. 2008) and (Kim et al. 2020). Although there is no track record of its implementation, many applications and models have been introduced. There are various reasons behind this, which are covered in this paper, and there is also no clear vision of how to inspire individuals to volunteer without maintaining a data management system (Higgs 2004).

The patient's life may be saved if the ambulance is dispatched on time and the ambulance driver is given the shortest and fastest route (Yandri et al. 2020). Because there is a growing need for immediate medical help, our study focuses on both real-time position monitoring of ambulance members, allocation of the nearest ambulance and hospital based on the patient's real-time location (Khan et al. 2021). It also relies on a database of the patient's past medical records, which is encrypted and accessible only by the pertinent doctors and the patient. The concept has essentially addressed all issues of safety and compliance.

3.1 Research Questions gaps

The summary of Research Questions are as follows:

- Are hospitals well-versed in assisting and contributing to this goal?
- Is the general public willing to adopt and use the application?
- Is the public's disregard for their health a major concern that must be addressed first?
- Financial commitment to the project
- Is Project implementation is systematic?
- People training and hiring for the project

3.2 Objectives

The objectives of studies are as follows:

- Optimizing healthcare infrastructure
- Improved response procedure
- Implementation of Merge-In-Transport (MIT) infrastructure
- Implementation of Capacity planning
- Use of block chain to secure data integrity

4. Standard Operating Procedures

There are three phases for the entire execution process as described below:

4.1 Phase 1: Assumptions for Creation of Framework

- The user must be covered by a health insurance policy that includes coverage for medical emergencies.

- The user must give medical records from the previous year, as well as information on any prior surgeries, accidents, or pre-existing disorders (if applicable).
- Basic personal information, emergency contact information, medication and allergy information (if any).

4.2 Phase 2 – Data Storage, Security and Integration with Emergency Services Support System

- All data, as well as the client's biometric, must be uploaded to a cloud storage account via the customer app for authentication reasons (Khalemsky and Schwartz 2017).
- Each individual client ID will receive a QR Code sticker.
- The data authentication will be separated into two levels:
- Level 1, which will use customer biometric authentication to connect with an ambulance based on the level of emergency need.
- Level 2, with the support of customer biometric verification, sharing of encrypted client ID by ambulance to a neighboring priority hospital (Higgs 2004).
- All data will be encrypted using blockchain technology and only authorized hospital personnel will be able to decipher it.
- There will also be a synchronization option for closed groups, such as relatives and friends. As a result, with the aid of only one person, QR codes may make this service more accessible to them. With the aid of biometric authentication, client ID and medical report identification may be filtered out.

4.3 Phase 3 – Real Time Operation

The following are the different scenarios:

4.3.1 Scenario – Accident/ Trauma Emergency

Any nearby individual can use his or her smartphone to access the app > Scan the patient's QR code > If a recognized person's account is synchronized with the patient's ID, then previous steps can be skipped > Choose a person > Take patient biometric authentication and Select the needed level of emergency (High, Medium, Low) > The system will allocate an ambulance depending on nearby availability > When an ambulance arrives, a paramedic records the patient's biometrics on their device, which immediately assigns a nearby hospital and shares the patient's ID with that hospital > While the patient is on the way, authorized hospital personnel will get all personal and medical information as well as notify his or her family or friends. The event of operation shown in figure 1.

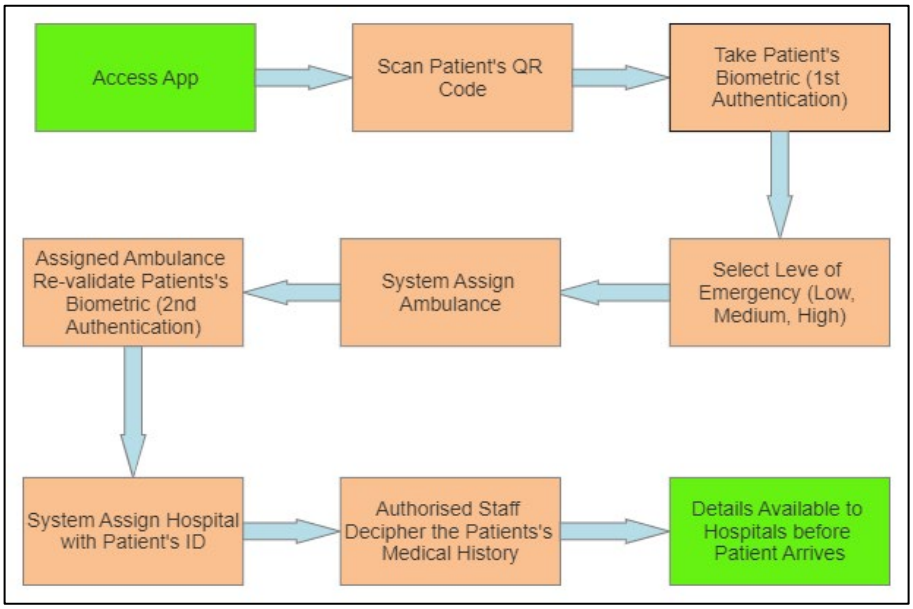

Figure 1. Block Representation of Accident/ Trauma Emergency Scenario.

4.3.2 Scenario – Natural Medical Emergency

Any nearby individual can use his or her smartphone to access the app > Scan the patient's QR code > If a recognized person's account is synchronized with the patient's ID, the previous steps can be skipped > Choose a person > Take patient's biometric authentication and Select the needed level of emergency (High, Medium, Low) > The system will allocate an ambulance depending on nearby availability > When an ambulance arrives, a paramedic records the patient's biometrics on their device, which immediately assigns a nearby hospital and shares the patient's ID with that hospital > While the patient is on the way, authorized hospital personnel will get all personal and medical information as well as notify his or her family or friends. The event of operation shown in figure 2.

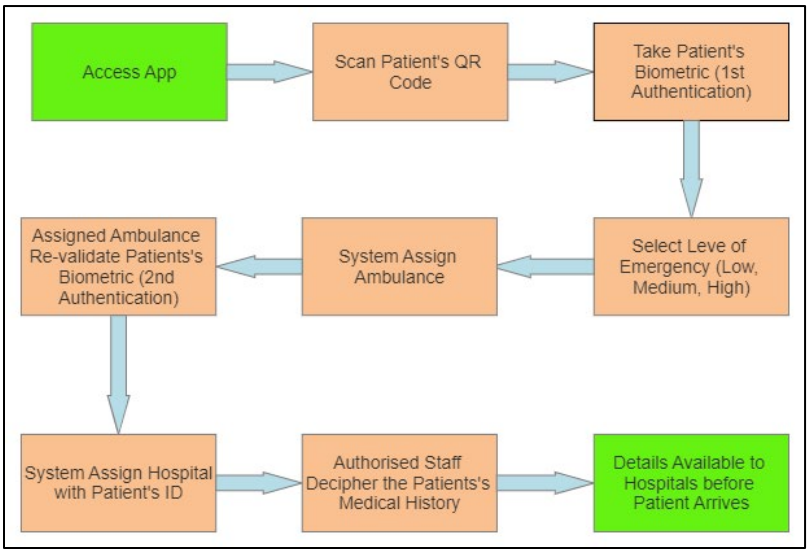

Figure 2. Block Representation of Natural Medical Emergency Scenario.

4.3.3 Scenario – Natural Disaster Emergency

Evacuation personnel can capture biometrics of the patient, when the patient's QR code is not scannable on their smartphone > Select the level of emergency required (High, Medium, Low) > When an ambulance arrives, the paramedics record the patient's biometrics on their device > which will immediately share to a nearby hospital, along with the patient's ID > Authorized hospital personnel will receive patient's ID and will access all of the patient's personal and medical information, as well as notify his or her family or friends, while the patient is on the way. The event of operation shown in figure 3.

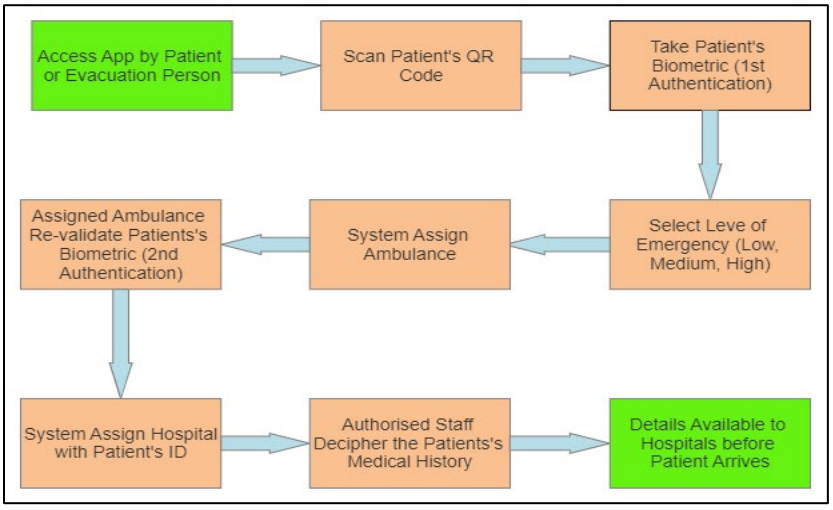

Figure 3. Block Representation of Natural Disaster Emergency Scenario.

4.3.4 Scenario – Act of Terrorism

Evacuation personnel can capture biometrics of the patient, when the patient's QR code is not scannable on their smartphone > Select the level of emergency required (High, Medium, Low) > When an ambulance arrives, the paramedics record the patient's biometrics on their device > which will immediately share to a nearby hospital, along with the patient's ID > Authorized hospital personnel will receive patient's ID and will access all of the patient's personal and medical information, as well as notify his or her family or friends, while the patient is on the way. The event of operation shown in figure 4.

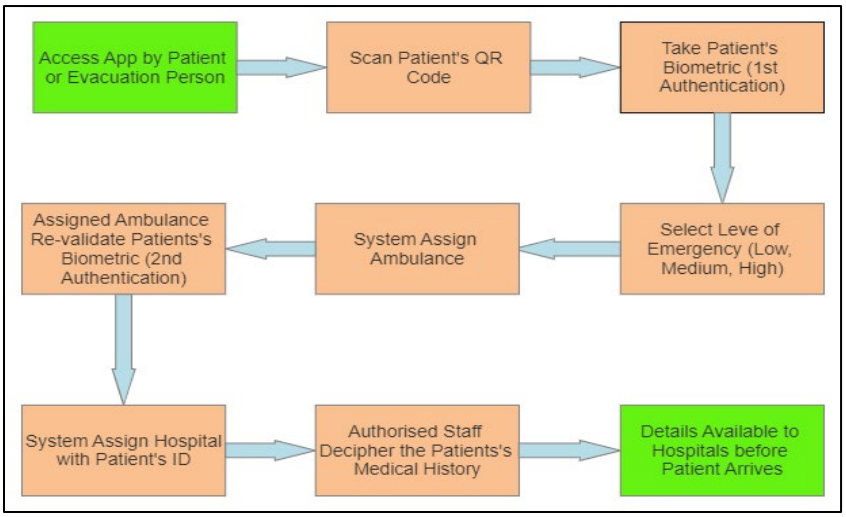

Figure 4. Block Representation of Natural Disaster Emergency Scenario.

5. Topics of Focus

The main focus of study as follows:

5.1 Medical Reports at all Healthcare Facilities Should be Uniform

Standards can help to increase efficiency, especially in complicated domains like healthcare. The debate over sustainable, cheap, and efficient healthcare is increasingly influenced by standardized clinical routes. According to patient surveys done by statista, the quality of treatment is an important factor to consider while selecting a hospital. Patients are frequently required to repeat tests since hospitals do not accept data from other laboratories and prefer their own. Reports are deemed untrustworthy by hospitals. If the patient is not in the vicinity of the hospital, an emergency will arise. They'll need to go to a hospital that's easy to get to. Then you'll have to redo the examinations, which will waste time, energy, money, and important resources. That is something that might be put to greater use. No one would have to repeat exams if all of the hospitals indicated above standardized their reporting systems. It would save a significant amount of time and money. For the patient, it would be a very much helpful.

5.2 Lowering the Cost of Medical Check-Ups and Increasing Insurance Benefits for Everybody

A medical health check-up is a luxury that not everyone enjoys, but it is an absolute requirement in today's environment. People over the age of 25 are more likely to suffer from health problems as a result of their stressful job lives and lifestyles. People who are prone to illnesses or who may have hereditary problems should undergo a medical health checkup (Buongiorno et al. 2015). However, with today's lifestyle changes and many young people experiencing medical concerns, it's more important than ever to get regular medical check-ups, even at a young age. The following are some suggestions for lowering medical healthcare check-up costs:

- Initiation of capacity planning
- Implementation of cost-effective insurances by lowering unit costs
- Proposal of insurance services for every Indian citizen

5.2.1 Start of the Product Capacity Planning Process

A product capacity plan guarantees that a company, in this example a hospital, has enough beds or facilities to deliver adequate healthcare (Shi et al. 2020). The capacity planning process is heavily influenced by the efficiency and usage of capacity.

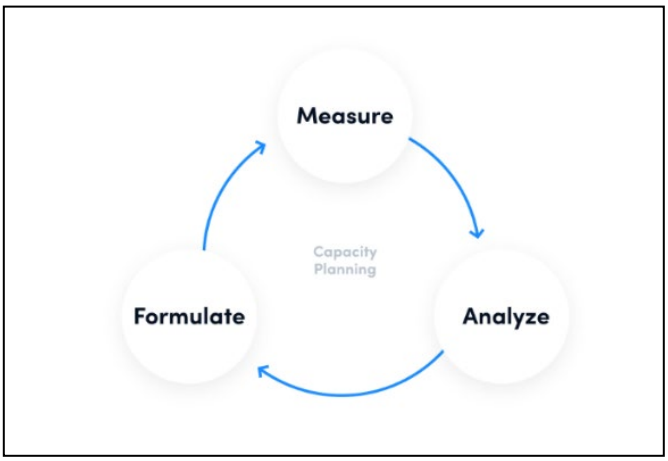

Figure 5. The basic capacity planning cycle.

The existing capacity-planning approach is quickly becoming outmoded, and we must adopt new solutions before healthcare facilities collapse, as they did during Covid-19's second wave, which increased the demand for better medical systems and medical insurance. Traditional capacity planning has led to asset-heavy investment plans centered on high-margin inpatient and specialist treatments, which are frequently funded on a fee-for-service basis (Smith et al. 1988). As shown in Figure 5, the basic capacity planning cycle consists of three approaches i-e measure, analyze and formulate to plan the capacity. Healthcare with decent facilities is a basic requirement, and we may minimize the unit prices of these medical check-ups by introducing medical insurances and price standardization.

5.2.2 Implementing Low-Cost Insurances through Lowering Unit Costs

Medical health expenditures can be cut by increasing the number/volume of insurance policies and lowering check-up unit prices. Health insurance influences whether and when people receive essential medical treatment, as well as where they receive it and, ultimately, how healthy they are. With the formation of a pact between all hospitals and insurance providers. In return for exclusive contracts, an insurance company or plan can obtain cheaper prices from a hospital, benefiting both the plan and its subscribers. Patients and citizens can be well insured by forming a hospital syndicate, while insurance firms can access a database of all their clients' data.

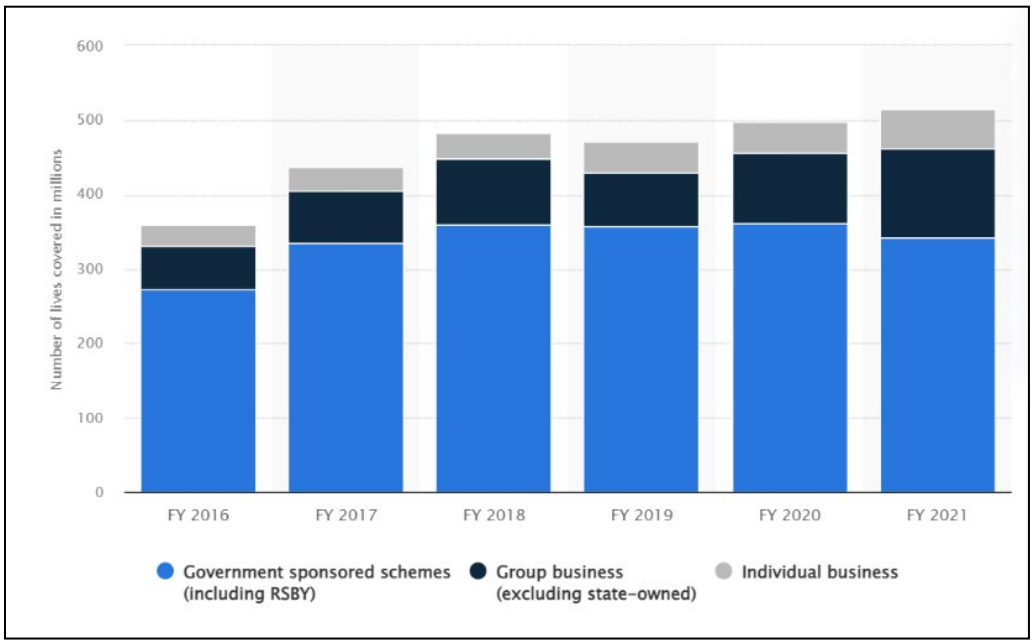

Figure 6. From 2016 to 2021, the number of persons in India opt for health insurance. (Source: www.statista .com)
From Figure 6, the financial year 2016 through 2021, the insurance premiums are gradually increasing. India's health-care system is decentralized, allowing for health insurance to be optional. Technically, all residents are entitled to free healthcare at government institutions, but it is up to individual governments to organize these services. However, the country's health-care system is critically underfunded, both in terms of personnel and supplies. Private providers are used by a large number of people (Jaldell et al. 2014).

5.2.3 Proposal for Insurance Services for All Indian Citizens

According to a report (Rai et al. 2021), hospitalized patients spend on average 58% of their whole annual income to finance bills, more than 40% of hospitalized patients take out large loans or sell assets. Hospital costs push more than a quarter of indigent Indians below the poverty level (Niti aayog report 2021). Only 30% of participants felt the certainty of being properly prepared for a health emergency after analyzing the replies on the provided questionnaire, shown below in figure 7. This clearly demonstrates the importance of implementing insurance for all citizens. Health is everything, and failing to prioritize, it can prove fatal.

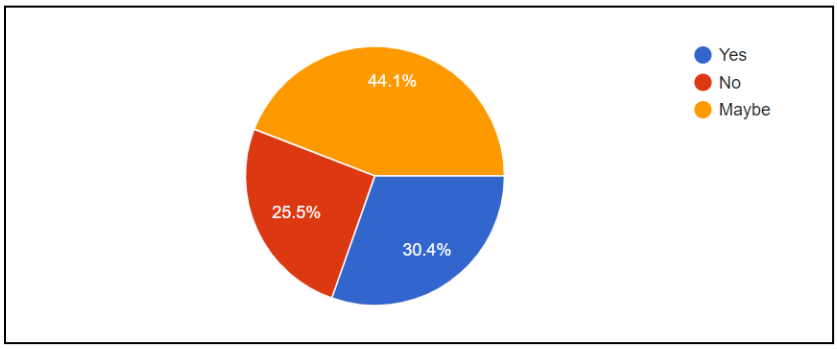

Figure 7. Survey data analysis on families prepared for health emergencies.

For persons living below the poverty line in India, there are numerous insurance plans available, as well as health insurance premiums. It also includes strategies for senior citizens and young children (Niti aayog report 2021). India's residents should take advantage of government services to the utmost extent possible. Ayushman Bharat, for example, is an insurance program run by the Indian government that offers coverage of up to 5 lakh rupees for a monthly subscription of 30 rupees. The cost of healthcare facilities may be decreased by introducing insurance for all Indian people, as well as by adopting capacity planning.

5.3 Prioritizing Beneficiary Data Security and Data Authentication

To offer a blockchain-based lightweight mutual authentication mechanism that safeguards the privacy of both the patient and the doctor. Blockchain technology is a decentralized database maintained by a group of individuals that has been widely used in a various range of fields (Hasavari and Song 2019). Without the need for third-party trust affirmations, blockchain may create a fully trusted environment amongst unfamiliar participating parties (Pai et al. 2021). It may also provide traceability, irreversible alteration, and privacy protection using encryption technologies. Blockchain technology has been seen as a powerful tool for solving tracking systems in the healthcare industry because to its enticing qualities (Hasavari and Song 2019). We offer a simple backup and recovery solution for health blockchain keys based on biosensor nodes (BSN). A biosensor wireless sensor nodes used to measure biological parameters which can provide valuable medical information (Balasubramanyn et al. 2007).

The following are some of the advantages of this method:

- The production, backup, and recovery of health blockchain keys will be handled by biosensor nodes in the BSN, enhancing the security of these keys.
- Under the concept, each block on the blockchain may be encrypted with a unique key that has a low storage cost and a high level of efficacy, greatly strengthening the security of physiological data privacy on the health block chain.

- Encrypt and decode sensitive data (e.g., patient biotic statistical data and doctor's medical prescription) to maintain confidentiality. To maintain secrecy, both the patient's BS data and the confidential MP of the doctor are encrypted.

5.3.1 Man-in-the-Middle Attack

Man-in-the-Middle (MM) assaults are not possible with the presented study. The patient communicates biotic statistics to the doctor in the form of cypher text, including the timestamp, during the data exchange. Similarly, the doctor obtains the patient's medical history and prepares for an emergency medical situation. If the intruder tries to capture the data using this manner, the data transferred yields zero knowledge (Sasanfar et al. 2021). Furthermore, if the attacker transmits fresh bogus data in place of the original data, the data will be delayed and hence rejected owing to the presence of a timestamp. As a result, an MM assault is impossible to carry out.

5.3.2 Propose a Mechanism for Transmitting Authentication to the Medical Practitioner by providing the Patient's Identifying Code (QR code)

The supply of QR code-based medical identification alerts as well as a hospital patient verification system are the foundations of this research. Each member of the medical system is allocated a unique QR Code sticker to allow medical identification alerts; the QR Code Identity sticker can be put on the back of the phone (or mobile rear) or carried as an ID card. These QR codes link to the app's QR Code Identity, which stores extensive information; to scan the code, use a smartphone or a standalone QR code scanner. The architecture of this system allows authorized personnel (e.g., paramedics) to access more detailed patient information than the ordinary mobile viewer: emergency service professionals or doctors are given access to patients' medical histories in order to improve the accuracy of medical treatment by maintaining data integrity and defending against them from replay attacks and man-in-the-middle attacks.

5.4 Providing Help in Escorting the Patients to Emergency Services Support

Escorting a patient to hospital facilities is just as important as emergency services support, since it raises the patient's chances of survival by a percentage.

5.4.1 Bystanders/Citizens Do Not Actively Assist Victims in Receiving Prompt Care

There is a 'diffusion of responsibility' amid in a crowd (Ciani et al. 2012). No one believes it is their job to assist, hence no one volunteers. When alone, however, one's obligation is solitary, which motivates one to assist those who are afflicted. According to Samir Parikh, consultant psychiatrist and director of Fortis Healthcare's department of mental health and behavioral sciences, "this diffused blame may be seen in many other situations."

- **A profound lack of empathy**
  The other cause, according to experts, is our society's growing lack of empathy.
- **Anxiety About Harassment**
  The dread of police harassment is another issue that holds individuals back. The first thought that comes to mind is, "Will I get into trouble?" (Kulshrestha and Singh 2016).
- **India and the Law of Good Samaritans**
  Over 13 lakh individuals have died in traffic accidents in India in the previous ten years (Morth Report 2022). According to the Indian Law Commission, 50% of these people died as a result of avoidable injuries that may have been avoided if they had gotten prompt medical attention. The bystander's involvement in delivering emergency treatment to the injured is important. Bystanders in India, on the other hand, have been reticent to assist the injured for fear of legal ramifications and procedural difficulties (Kim et al. 2020) and (Sarkar 2016).

5.5 Optimization of Arrival of Emergency Services to the Place of Incident

The execution part on field is directly depends on how fast an emergency response team reach to the incident. This required a well planning and operational optimization.

5.5.1 Network Operates Centralized

The purpose of emergency medical services is to either offer treatment to people in need of immediate medical attention with the goal of successfully treating them, or to arrange for the patient's prompt transit to the next point of final care. This is most likely a casualty in a hospital or another location with doctors on hand. The expenses of health-care infrastructure and equipment are substantial, and they are certain to rise with each technological advancement. When there is a lot of exposure to relevant examples, training and maintaining skills is a lot easier.

5.5.2 Merging in Transit Network Planning for Medium and Low-Level Emergency Needs

A new transportation model emerges from the practice of constant performance improvement: merge in transit (MIT). The benefits of this technique are discussed, as well as the phases of the operation process and the ramifications within the model framework. According to the WHO, one ambulance is required for every 100,000 people (Kancharla and Verma 2022). This demonstrates that there is a shortage of ambulances in the system. To meet this, radio taxis are convenient way to cater to low or medium levels of casualty, and because they are many, they will be conveniently accessible and maneuverable in traffic. The impacts of this paradigm are examined from the perspectives of cost, service, quality, and technological integration.

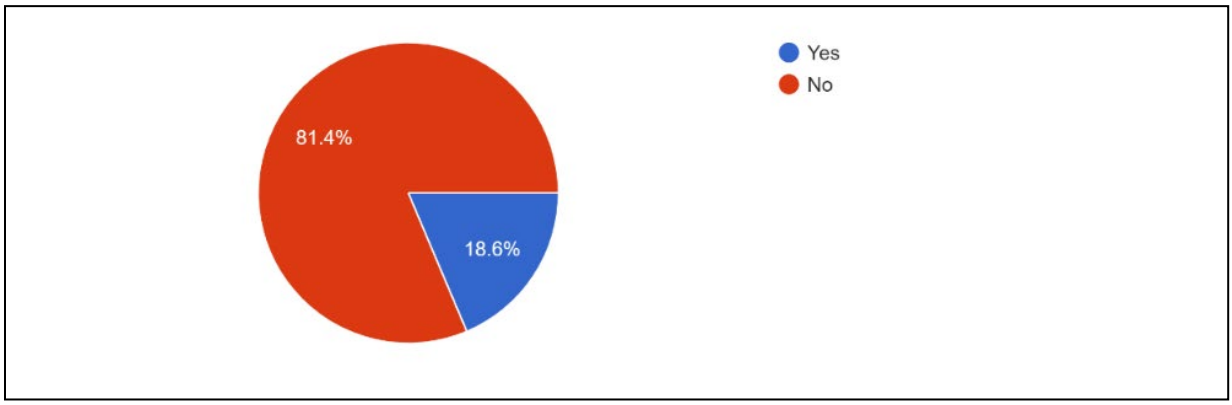

Figure 8. Survey data analysis on ambulance preference by public.

According to our poll of public opinion on ambulance choice for non-critical circumstances, the majority of individuals (81.4%) shown in Figure 8, prefer not to wait for an ambulance unless they are in a life-threatening situation. Furthermore, adopting such a strategy can led to lean transportation time management as well as avoid traffic congestion for lengthy periods of time.

5.6 Methodology for Determining Cause and Effect based on Survey Data

According to the findings of a poll, we divided public opinion into six categories, each of which has the impact of obstructing medical emergency services: -

- Transportation System
- Resources and Legal Issues
- Operational Infrastructure
- Hospital Administration
- Technology and Data Management
- Public Behaviour

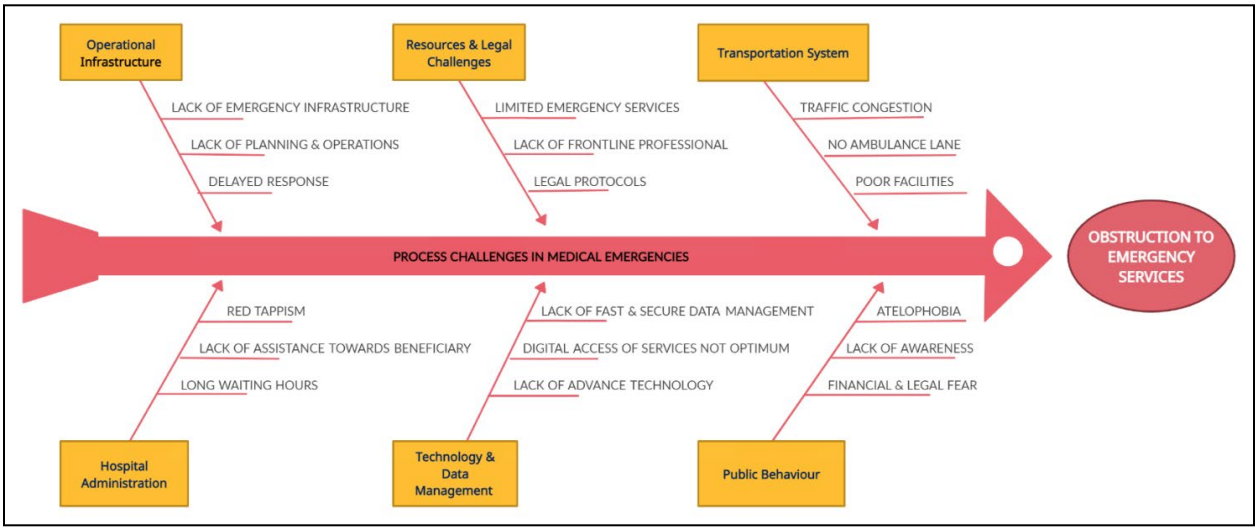

Figure 9. Cause and effect analysis on different major challenges in medical emergencies operations.

Figure 9, describe the various challenges that obstruct the entire operation process of medical emergencies, and how they can be reduced to a bare minimum by implementing the appropriate processes, reengineering the system, raising public awareness, improving technology, and redeveloping the current set of legal laws (Aringhieri et al. 2017).

6. Limitations

Various studies, including the health ministry's assessment of Emergency Management and Research Institute (EMRI), discovered the following shortcomings in India's existing Emergency Management Services (EMS):

- Hospital infrastructure for treating and managing medical crises, particularly in public hospitals, has to be strengthened.
- A lack of training and infrastructure for medical emergency management/first aid training for public and private sector health workers.
- Existing government-owned ambulance fleets are unhappy with the new ERTS programs (in terms of operational links and fleet uniformity) and enforcement across states (Al-Shaqsi 2010).
- The legal structure that defines and regulates the duties and responsibilities of various stakeholders (such as ambulance operators, emergency technicians, treating hospitals and personnel, and so on) requires more clarity, consistency, and enforcement across states.

7. Conclusion

Within a hospital, there are many more medical crisis occurrences than cardiac arrests, and many of these may go unnoticed and untreated. By providing immediate access to critical care personnel and equipment, a medical emergency response system can help avoid accident fatalities. India's medical infrastructure is severely deficient, resulting in innumerable deaths that may have been averted if the system had been improved with better technology, money, and less hardship. According to Cause and Effect analysis, we found that majorly six challenges are individually fragmented. These can be address as well as synchronize as per this model to validate with positive results and can reduce the mortality rate and various emergency response challenges. Objective criteria for diagnosing a crisis should be included in the medical emergency response system. We discovered an impediment to

medical emergency services as a result of our study and observations, and developed a model to facilitate healthcare infrastructure related to medical emergencies utilizing Block Chain Technology.

Future Recommendations:
Because the above study is simply a model, the actual implementation of QR codes and block chain may differ from the research, making the entire process difficult to execute. The project can be completed in stages, with the block chain being added afterwards. The goal of this research is to improve healthcare facilities, and implementing QR code authentication might be a time-consuming procedure. QR code authentication is being phased out in favor of newer methods.

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