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Original Article

Ensuring Worker Safety at Construction Sites Using Geofence

Balusamy Nachiappan[1], N. Rajkumar[2], C. Viji[3], A. Mohanraj[4]

[1]*Prologis, Denver, USA.*
[2,3]*Department of Computer Science & Engineering, Alliance College of Engineering and Design, Alliance University, Karnataka, India.*
[4]*Sri Eshwar College of Engineering, Tamilnadu, India.*

[1]*Corresponding Author : tnbalu@yahoo.com*

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Abstract - *Worker protection is a vital problem in the primer of working sites, given the immoderate hazard of injuries and accidents. This summary delves into key factors of ensuring employee protection, collectively with implementing safety regulations, imparting private protective devices, and emphasizing schooling and cognizance packages. It moreover explores how eras, like drones and wearables, can beautify protection measures. The summary underscores the want for a holistic method of employee protection concerning cooperation amongst employers, employees, and regulatory bodies. The development organization has experienced a large international boom in brands new a long time. To make certain a manufacturing undertaking's achievement, the safety of every system and employee is paramount. Protection problems have to start at the layout diploma and keep via to the form's finishing touch and handover. The development enterprise employs professional and unskilled workers who are susceptible to injuries and fitness dangers at production sites. However, there is mostly a lack of coordination among contractors, clients, and employees in ensuring comfy portray conditions, in Indian manufacturing businesses. Irrespective of the presence of difficult artwork safety legal guidelines, the frequency of accidents at creation net sites remains excessive, indicating a loss of manipulation and commitment to employee fitness and protection. Worker protection is a paramount problem in the manufacturing internet site, given the dangerous nature of the rendering surroundings. This summary outlines key techniques and practices for ensuring the safety of employees in such settings. It discusses the significance of enforcing protection protocols, supplying the right schooling, wearing out ordinary inspections, and promoting a way of existence of protection among humans and management. Moreover, it highlights the placement of technology in enhancing protection measures alongside the usage of wearable devices and tracking systems. Ordinarily, the summary emphasizes the importance of proactive safety measures to save you from injuries and injuries in introductory workplaces.*

Keywords - *Geofence, IoT, Construction, Worker safety, Civil Engineering.*

1. Introduction

In India, the improvement employer is the second biggest enterprise after agriculture [1]. Globally, civil engineering introduction is taken into consideration as one of the maximum volatile industries, with a brilliant variety of deadly accidents taking place at construction sites, normally due to falls from heights and through openings [2]. The Indian creation enterprise is massive and complex, regarding current-day technology and further to manpower.

However, alongside its improvement, the major disadvantage in the stage of safety and fitness elements is also witnessed. Indian manufacturing exerts pressure on money owed for 7.5% of the worldwide difficult employees and contributes to 16.4% of deadly worldwide work-related accidents [3]. The risk of a fatality within the production organization is 5 instances more likely than in a production company at the identical time because the danger of chief damage is a 1/2 time higher. Constant with an ultra-modern day take observed via the Global Labour company (GLO), India has the region's maximum twist of destiny price amongst introduction personnel, with one survey of using a community useful, beneficial aid business organization displaying that a 100 sixty 5 out of every 1,000 employees are injured on the undertaking [4].

The ones' injuries now not simplest have an impact on the appearance of personnel but also have an impact on most people, side kids, and make contributions to a lack of professional difficult paintings, thereby diminishing the photo of the improvement corporation [5]. In the past few years, there has been a growing popularity of the need for safety

interest inside the Advent Corporation [6]. That is because of the excessive prices related to work-associated injuries, human reimbursements, insurance fees, indirect fees of injuries, and litigation. Every 365 days, a massive quantity of time is out of place due to professional work-related condition troubles and area accidents [7]. Many elements contribute to fitness problems and the advent of manufacturing and building construction site accidents. Ordinary to the Occupational Safety and Health Administration (OSHA), falls account for 39.9% of fatalities in production, located through being struck using devices (8.4%), stuck in incidents (1.4%), and electrocution (8.5%) [8].

Diverse techniques may be determined for exertion protection, which incorporates safety enterprise and management, protection insurance implementation, protection schooling, safety committees, net page online format making plans, provision of first beneficial aid, adequate lighting, provision of personal protecting tool, and welfare centers. Loss of conversation between several departments and the absence of the right inspections are the main motives for accidents happening at production sites. Injuries can arise because of construction or earth shape collapses, falling objects, falling from heights, ladders, and stairs, loading and unloading of hundreds, gadget operations, and explosives blasting.

Efforts want to be made to elevate our reputation amongst employees and manage the reputation of fitness and protection at work sites [9]. Preventing labor accidents, occupational ailments, and injuries is a pinnacle of precedence for all employers. At the same time as many preventive measures were proposed and carried out, accidents continue to stand up often. Therefore, new and powerful measures to prevent exertion accidents are constantly sought. Large-scale construction obligations generally adhere to proper protection practices, often having a dedicated safety branch.

However small-scale duties with the beneficial aid of manner of close by contractors may also furthermore lack hobby to protection requirements, primary to manufacturing site online injuries. Stopping hard work accidents and injuries is the number one situation for all employees inside the manufacturing enterprise. This appears at one wants to examine the present-day United States administrative center safety and create an extra at-ease jogging environment for introducing enterprise business organization employees.

The test protected physical visits to awesome production sites, gathering facts and remarks regarding the number of people, the nativity of the personnel, desired walking hours, and working shifts from production net page personnel using a questionnaire. Facts on the wide variety and motives of accidents at small and massive manufacturing sites, further to the forms of injuries suffered through manner of personnel, became moreover accrued and analyzed.

1.1. Geofence

A geofence is a digital virtual fence or boundary around a particular area. Similar to a real fence, a geofence designs a separation between that place and the site around it. In the judgment of an actual fence, it can moreover come upon travel inside the simulated boundary. It can be any period or shape, even a right-of-way line among factors. Geofencing is an area-based general technology that creates a digital boundary around a real-international geographic vicinity.

This boundary is described by the usage of way of GPS, RFID, wireless, or cellular records. At the same time as a mobile tool or high-quality tracked item enters or exits the geofence, it triggers a selected motion or notification. Geofencing is typically implemented in packages that encompass vicinity-normally-based general marketing, asset tracking, fleet management, and protection. Geofencing in IoT (Internet of Things) refers to the use of geographical boundaries to trigger actions or events in IoT devices. This technology utilizes GPS, RFID, Wi-Fi, or cellular data to define virtual boundaries. When an IoT device enters or exits these boundaries, it can trigger actions such as sending notifications, adjusting device settings, or activating / deactivating certain functions.

1.1.1. Benefits of Geofencing

Geofencing technology offers several benefits, which include targeted marketing, advanced patron engagement, greater safety, green asset control, geotargeted offerings, protection compliance, and valuable facts insights, making it a treasured device for agencies across numerous industries. Geofencing offers numerous sanctifications in various industries and applications:

- Location-Based Marketing: groups can aim clients in particular geographical regions with custom-designed gives and promotions, improving consumer engagement and growing sales.
- Improved Customer Engagement: Geofencing permits corporations to supply applicable and well-timed notifications to customers based mostly on their vicinity, improving their common stage and increasing brand loyalty.
- Enhanced Security: Geofencing may be used to show relaxed touchy areas, which encompass production sites or warehouses, with the aid of manner of sending signs while unauthorized get admission is detected.
- Efficient Fleet Management: Geofencing lets fleet managers music vehicles in real-time, optimize routes, and display reason strain conduct, leading to stepped-forward performance and price monetary financial savings.
- Asset Tracking: Geofencing permits agencies to tune precious belongings, which include machines or inventory, and get hold of indicators if they’re moved outdoors or centered regions.

- Increased Productivity: Through automating wonderful obligations based totally on region, geofencing can help corporations streamline operations and beautify common productivity.
- Enhanced Safety: Geofencing can be used to create safety zones around hazardous areas or production sites, ensuring that workers and gadgets remain in distinct internal areas.
- Better Data Analysis: Geofencing gives groups treasured records of patron behavior, site visitors' styles, and worker actions, which can be used to make knowledgeable choices and improve operational efficiency.

2. Literature Review

The improvement of enterprise companies is extremely risky. The entire overall performance of the enterprise corporation in professional health and protection can be extremely terrible. The nature of work-related health and protection is even worse in growing nations. In Indian production organizations, OHS has in no way been given excessive importance.

Regardless of the truth that during India's advent, employers are drastically growing, there aren't any appropriate duties that started out with the useful aid of the government to the region into impact OHS policies and regulations. Huang and Hinze analyzed the twist of destiny brought on because of the use of personnel at manufacturing sites, and the end result showed that most fall accidents happened at improvements of an extraordinary deal a great deal much less than nine.15 m, taking place within the important new advent projects of business houses and home duties of quite low creation price [10].

Jannadi and Bu-Khamsin finished a survey amongst business enterprise contractors inside the eastern Province of Saudi Arabia. They diagnosed face to face-to-face meetings with the contractors and directors chargeable on behalf of manufacturing protection had been taken. 70 % of the agencies that participated in this survey had preferred building manufacturing businesses [11].

The twenty maximum vital elements and 85 sub-factors and their degree of importance primarily based on the survey consequences except evaluation had been diagnosed. Pheng and Shiua give importance to that mixture remarkably and protection has to be executed for better control and utilization of assets [12].

Koehn and Datta concluded their take element determined that protection recommendations and regulations now not the best overwhelming problems like horrible high-quality work, volatile working occasions, and absence of environmental management but additionally lessen fees and beautify productivity [13]. Wilson Jr. And Koehn encouraged that security practices range with manufacturing sites, as every internet site online has unique safety factors. Massive production duties are incredibly prepared whilst small to medium businesses do now not have a competent enough security application or individual to supervise safety standards [6].

In advanced worldwide places, the latest upgrades in a generation, on the other hand, have contributed virtually to business enterprise productiveness, but it has created extra tough and hazardous artwork surroundings [14]. Each manufacturing employee is in all likelihood, in brief, no longer worthy of paintings at some time due to minor harm or fitness problems after strolling on an advent site [15]. Between 1989 and 1992, 256 humans were significantly harmed inside the Australian advent organization.

Facts discovered that the coincidence rate changed to 10.4 in step with 100,000 humans, which became the deadly accident price for avenue accidents [16]. It's miles expected that, in China, each year, three 000 human beings suitable to the improvement location are killed in painting-associated accidents [17].

An exam achieved via way of the Egyptian production enterprise, it changed into concluded that protection applications organized by way of Egyptian contractors have been masses less formal, and the twist of destiny coverage charges was everyday regardless of the contractor's safety popular performance [18].

The maximum commonplace cause of accidents and dying inside the manufacturing place is falling from heights [19]. The primary motives embody foot on a scaffold or platform without shielding rails or a protection harness efficiently related, and fragile roofs and ladders which might be probably badly maintained, located, and secured. Slips, journeys, and falls are the most important reasons for accidents in all sectors [20].

In India, administrative regions beneath the Ministry of Difficult Work and Employment deal with OSH troubles in the production area beneath the top of the chief hard work Commissioner. The Directorate General of Factory Advice Service & Labour Institutes (DGFASLI) gives technical useful assets in drafting version guidelines, sporting out surveys, and engaging in education packages inside the creation region. Several tough work crook guidelines are located for human beings engaged at production sites.

The Constructing and Distinct Creation Humans (Law of Employment and Conditions of Provider) Act, 1996, was modified into enacted on 1.3.1996. The act is relevant to all institutions employing 10 or greater personnel in any creation and top-notch manufacturing work. The leader's hard work Commissioner is delivered with the task of enforcement of this

act and the critical hints [21]. Regulations and requirements play an essential role in ensuring employee protection. The Occupational Safety and Health Administration (OSHA) within the United States of America. The United States units and enforces requirements to ensure relaxed and healthy going-for-walk situations. For instance, OSHA's manufacturing safety necessities (29 CFR 1926) specify protection requirements for different factors of advent paintings, together with fall safety, scaffolding, and electrical protection (Occupational protection and fitness management).

Effective threat assessment and manipulations are crucial for figuring out and mitigating dangers at introduction sites. Studies by way of Zhang and Wu (2019) highlight the significance of integrating protection risk assessment into the development venture lifecycle to beautify safety and overall performance. They emphasize the want for proactive threat management techniques to prevent from injuries. Supplying appropriate enough protection training and training to personnel is essential for preventing accidents.

Through an evaluation by Hinze and Thurman (2014), effective protection training programs can appreciably reduce the variety of accidents and injuries on introduction sites. They endorse incorporating hands-on education and real-life situations to enhance the effectiveness of protection schooling. Technological upgrades have delivered the improvement of progressive answers for boosting worker protection. For instance, the use of building data Modeling (BIM) technology allows for the digital simulation of construction initiatives, permitting protection risks to be identified and addressed in advance before creation starts off evolved (Zhao et al., 2017).

The previous study seem to plan a device that possibly utilizes geo-fencing generation to enhance Women's safety and tracking. Geo-fencing may be a precious tool in such structures, allowing for the creation of virtual limitations that cause signals or movements while crossed, doubtlessly aiding in the prevention of incidents or offering well-timed assistance.

The paper probably explores how IoT devices and the geo-fencing era can be included to create a device that complements safety and monitoring for girls. It is able to discuss the implementation details, challenges, and ability advantages of one of these systems.

3. Working on Geofencing

Geofencing permits agencies and agencies to create virtual obstacles around bodily places and cause computerized actions based totally on the motion or place of cell devices or objects. This era is extensively applied in advertising, protection, fleet control, and different applications to enhance performance, decorate protection, and provide location-based offerings.

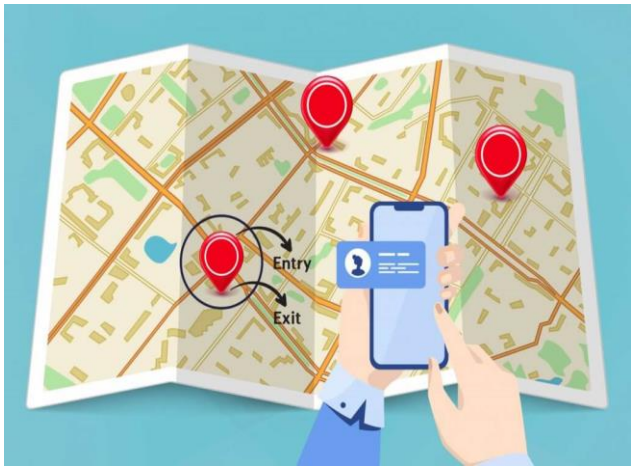

Fig. 1 Geofencing

- Define the Geofence: A geofence is created using geographical coordinates to outline the bounds of the area. This could be finished with the usage of specialized software or structures (Figure 1).
- Set Triggers: As soon as the geofence is defined, triggers are set to prompt when a cellular device or item enters or exits the geofenced location. Triggers can be based on moves or activities.
- Monitor Location: The geofencing tool continuously monitors the vicinity of the cell devices or items inside the geofenced area and the usage of GPS, wireless, or different region-primarily based absolute technology.
- Trigger Actions: even as a cellular tool or item enters or exits the geofenced vicinity, the device triggers predefined moves. Those actions can include sending notifications, signs, or messages to the person or administrator, updating a database, or controlling devices or systems.
- User Interaction: depending on the application, users may also get preserves of notifications or messages on their cell gadgets based on their area in the geofenced area. Customers can also interact with the geofencing machine through precise moves or responses.

3.1. Geofence in Construction Area

Geofencing is an era that makes use of GPS or RFID to create a virtual boundary or "fence" around a selected geographic location. Inside the context of production worker safety, geofencing may be used to decorate safety in several approaches:

- Zone-based Safety Alerts: Geofencing can be used to define dangerous zones on creation net sites. When a worker enters or exits a volatile area, the system can use real-time indicators to warn them and supervisors of potential risks.
- Equipment Safety: Geofencing can also be used to make sure that employees are the use of devices in exact areas. For example, heavy machinery may be programmed to

robotically shut down if it leaves a predefined artwork region, stopping injuries and unauthorized use.

- Time and Attendance Tracking: Geofencing can be used to music the time spent with the aid of workers in precise areas of a manufacturing net page. This will assist in making certain that humans are adhering to protection protocols and not exceeding safe exposure limits in hazardous regions.
- Emergency Response: In the event of an emergency, geofencing can help emergency responders discover and evacuate humans more quickly and correctly, probably saving lives.
- Site Access Control: Geofencing additionally may be used to control entry to creation sites. Best legal employees with appropriate credentials (e.g., RFID badges) can be allowed to enter positive areas, enhancing regular site protection and safety.

Geofencing technology can significantly improve construction worker safety by providing real-time monitoring, alerts, and control over activities within predefined areas of a construction site (Figure 2).

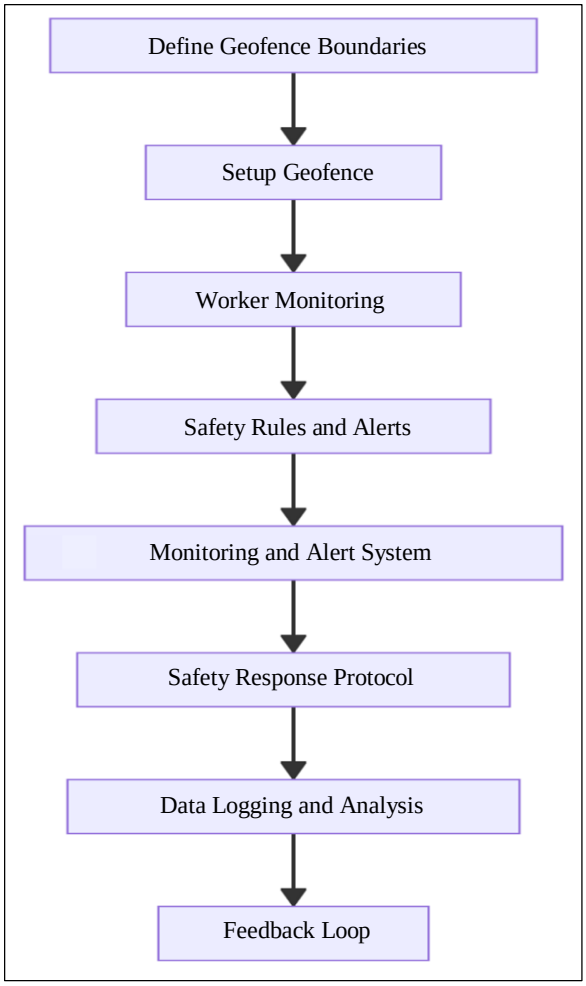

Fig. 2 Flow diagram

Step 1: Define Geofence Boundaries: Become aware of the specific areas inside the production net site wherein workers must be placed or confined from entering.
Step 2: Set Up Geofence: Implement geofencing generation with the usage of GPS or RFID to create a digital fence around the described areas.
Step 3: Worker Monitoring: Equip human beings with devices (e.g., Smartphones, RFID tags) that might communicate their place within the geofenced vicinity.
Step 4: Safety Rules and Alerts: set up protection guidelines and protocols for worker conduct inside the geofenced place. Configure the tool to ship signals or notifications while human beings violate those tips.
Step 5: Monitoring and Alerting System: Put into effect a tracking and alerting system that can signal worker places in actual time and problem indicators to supervisors or protection employees while vital.
Step 6: Safety Response Protocol: Increase a protocol for responding to protection signs, which incorporates figuring out the character of the alert, assessing the chance, and taking appropriate motion.
Step 7: Data Logging and Analysis: acquire and log information on worker movements and safety incidents for evaluation and improvement of protection protocols.
Step 8: Feedback Loop: Use the records amassed to constantly enhance safety protocols and geofencing configurations to decorate worker safety.

4. Result and Discussion

Geofencing is an era that uses GPS or RFID to create a digital fence around a specific location. It has numerous programs in numerous industries, including advent, which may be used effectively to ensure employee safety. Right here are a few effects and discussions on how geofencing can be used to ensure employee safety at construction sites.

Geofencing may be used to put into effect safety protocols by triggering alerts at the same time as humans enter dangerous zones without the desired safety system or schooling. Supervisors can show the area of employees in actual time, ensuring that they may be no longer in chance or unauthorized regions. Geofencing may be used to, in a timely style, discover and evacuate humans in case of emergencies, together with fires or injuries. Geofencing may be used to mechanically close the machine even as it enters constrained regions, preventing accidents.

Whilst geofencing can beautify safety, it additionally increases privacy worries, as it includes monitoring the place of people. Companies need to make sure that proper consent and privacy tips are in place. Geofencing may be blanketed with special generation which include wearables and sensors to in addition beautify employee protection. As an example, sensors in difficult hats can come across falls and motive signs

and symptoms. Implementing geofencing technology may be pricey, particularly for big manufacturing sites. Businesses have to weigh the price in opposition to the ability to protect advantages. Personnel want to have a look at the manner to apply the geofencing generation and recognize its significance in enhancing their safety. Popular geofencing can notably improve worker protection at manufacturing sites at the same time as applied successfully and with consideration for privacy and rate issues.

5. Conclusion

Geofencing Technology offers a promising method to decorate worker protection at creation net sites through growing virtual barriers and triggering signs at the same time as humans input or go out of one's zones. This approach allows for actual time tracking of worker locations, assisting in preventing injuries and decorating emergency response instances. In this situation, geofencing is a treasured tool for making sure worker protection within the creation of places of work. Its capability to offer real-time place tracking and signs can extensively decorate safety protocols and decrease the chance of accidents. However, a successful implementation calls for cautious planning, integration with specific protection measures, and ongoing monitoring and evaluation to ensure effectiveness. Regular, geofencing holds superb functionality for enhancing employee protection within the creation of the organization. Making sure employee protection at creation sites is paramount for the right well-being of absolutely everyone concerned. Through the manner of imposing comprehensive safety measures, which embody presenting adequate training, implementing strict adherence to safety protocols, and the usage of suitable private defensive systems, manufacturing companies can considerably reduce the risk of accidents and injuries.

Furthermore, fostering a way of life of safety inside the company, wherein all employees are encouraged to prioritize protection and file any functionality dangers, can similarly decorate installed safety stages. Regular protection inspections and audits can also help become privy to and address functionality dangers in advance than they beautify into severe incidents. In the end, making an investment in worker safety now not the most effective way to protect employees from harm; however also contributes to additional green and inexperienced advent surroundings. Via prioritizing protection, creation organizations can show their self-discipline for the well-being of their humans and beautify their popularity as accountable and reliable employers.

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