

Survey on Wearable Sensing Technology Applications in Construction Safety and Health

Aniket Sanjeev Kangane, Satyajit D. Patil

M. E Student, Department of Civil Engineering, TSSM's Bhivrabai Sawant College of Engineering & Research, Pune, India

Professor, Department of Civil Engineering, TSSM's Bhivrabai Sawant College of Engineering & Research, Pune, India

ABSTRACT: Over the past few years construction work has been increasing in undeveloped as well as developed countries. In developing countries, safety rules usually do not exist; if they do, the regulatory authority is usually very weak in implementing such rules effectively. India is mainly agricultural based country but now a day construction industry stands next to agriculture. Construction job is very risky jobs as compared to other in safety point of view. The disturbing thing in construction work is mainly number of fatalities occurring. So it is important to standardize safe management system. In this paper, identify cause of accidents, assessed, and satisfactorily rectified and gave analysis of two visit out of one is precast industry and another is construction industry. Also several construction safety techniques were used for the safety of major construction organizations across India involved in construction industry. The need of this research is to determine the importance of integrating and improving safety management standards within construction project management in India. To improve health and safety standards at construction sites by covering general emergency and safety provisions as well as duties and responsibilities of the employers, engineers, contractors, and sub-contractors regarding safety measures and the minimum necessary requirements. Present works provide information on how accidents may be prevented but assume that a strong regulatory body exists to enforce legislation. This literature review therefore presents information which is either specific to developing countries or has been prepared in a developed country context but would also be applicable to developing countries. The construction industry is a labor intensive industry both in developed and developing countries, with a large number of tasks being undertaken in similar ways in both regions. But the number of accidents in foreign countries is very less compared to India. The need of this research is to determine the importance of integrating and improving emergency and safety management standards within construction project management in the India. To improve health and safety standards at construction sites by covering general emergency and safety provisions as well as duties and responsibilities of the employers, engineers, contractors, and sub-contractors regarding safety measures and the minimum necessary requirements. From the study of literature will find out types of emergency and safety management and which are temporary suggestions are given to organization will found out. In this project will find that why the emergency will come and how can avoid it by satisfying basic requirements on site. Also economical loss due poor safety and emergency management will found out and solution will be given to satisfy conditions. For carrying out the proposed work, following methodology will be adopted for data vii collecting and analysis. Collection of relevant research data from national and international journals, web source etc., Analysis of exact cause of accidents, To study the important causes and identify the most important causes of accident, Listing of precautions to be taken and comparing them by relative index method, Questionnaire is prepared to investigate safety management plans carried out by company, After the analysis of questionnaire survey actual onsite safety and its utilization while emergency will be find out, Preparing list of safety precautions to be followed in general on all construction site. This research benefits to reduced risks in the workplace, less absences by employees and hence increased productivity, fewer accidents and less threats of legal action, improved standing among clients and partners, and obviously reduced costs to the business. This research offers a best practice guide to emergency and safety management in Indian construction companies.

KEYWORDS: Wearable Sensing Technology, Construction Safety, Health, Safety Management, Productivity, Safety Measures

I. INTRODUCTION

1.1 General

In the course of recent years construction work has been expanding in undeveloped just as created nations. In developing nations, safety rules typically don't exist; in the event that they do, the administrative authority is normally powerless in executing such rules successfully. India is primarily agrarian based nation however now a day's construction industry remains alongside farming. Construction work is unsafe employment when contrasted with other from safety perspective since safety on building site has been disregarded by numerous construction businesses

particularly where work power is for the most part significant. The upsetting thing in construction work is primarily number of fatalities happening. This is fundamentally because of absence of information in regards to work even the preparation or safety during the work. This absence of information and safety prompts major and genuine accidents. The danger of wounds in the construction business is high fundamentally in view of the idea of the work completed by various offices utilizing to a great extent untalented specialists. Because of increment in number of accidents and wounds covered construction ventures, safety is turning out to be progressively significant issue today in construction industry. Consequently the board of safety and crisis assumes significant job in construction industry. Construction accidents can be limited by discovering main driver of accidents by the examination strategies, for example, reason for accidents and human mistakes. In the greater part of construction industry reason for accident is poor usage of arrangements which are made to dodge accidents. It is essential to have safe building site for the laborers performing business related the undertakings.

Crisis and safety is appropriate to all pieces of industry, it is particularly huge for the Construction business. It has reliably been a critical issue as it is considered as among the most revealed sections concerning word related accidents. Albeit colossal enhancements have been made in safety and safety execution in certain nations, the construction business keeps on lingering behind most different enterprises. This has been the experience inside most nations. Actually the construction business ceaselessly has damage and casualty insights that make it one of the most risky businesses in which to work dominantly in developing nations. Because of the expanding number of accidents. Crisis and safety hence is a monetary just as compassionate worry that requires legitimate administration control. One of the most widely recognized fantasies that have tormented this industry is that emergency & safety includes some major disadvantages. Construction administrators will in general accept that presenting and executing estimates that guarantee crisis and safety in construction division will prompt greater expense, and thus lower gainfulness. Notwithstanding, it has been demonstrated that interest in construction crisis and safety really builds the benefit by expanding profitability rates, boosting representative resolve and diminishing whittling down. Accidents in the construction business are exorbitant in human and budgetary terms. The financial expense isn't the main premise on which a contractual worker ought to think about construction safety. The purposes behind considering safety are philanthropic concerns, monetary reasons, laws and guidelines and authoritative picture. Cost of safety is paid by the association either through the uncontrolled expense of accidents or through the controlled expense of safety program. The uncontrolled expense of accidents incorporates the loss of profitability, regulatory time for examinations, and interruption of timetables, compensation paid to the harmed laborers, antagonistic exposure, risk cases, and gear harm. To avert safety perils at work, every single imaginable source ought to be distinguished before beginning of construction work. Dangers at a building site may originate from unsafe substances utilized nearby; likewise ecological factors may make extra dangers as warmth and clamor. Most construction accidents result from essential underlying drivers, for example, absence of legitimate preparing, insufficient requirement of safety, dangerous gear, hazardous techniques or sequencing, perilous site conditions, not utilizing the safety equipment that was given and a poor frame of mind towards safety. To accomplish this significant goal, it is crucial to perceive the significant components of the safety the board framework and fortify the equivalent at each stage. Safety implies free from peril or hazard and dealing with the laborers/works for guaranteeing securely called administration. In this way the building site safety the executives manages safety of works and representatives working at the site. So it is critical to institutionalize safe and crisis the executive's framework. Government must give not just legitimate rules and viable usage of laws yet additionally ought to effectively take an interest in it by the mechanism of shock safety and crisis review by government itself. It is outstanding that construction ventures have many business related accidents and wounds. In late year to defeat such safety issue, execution of safety program has been noteworthy thought. Safety implies unimportant loss of property, process and fundamentally individuals. The board of safety and crisis implies recognizing reasons for accidents evaluated and acceptably amended.

Keeping up great nature of work is one of the primary goals of safety and crisis the executives notwithstanding meet no minor accident and human misfortune moreover. Furthermore economy or cost of undertaking is one of the main considerations thought about when deciding accomplishment of task. So the quantity of rates among construction works and level of mindfulness matters concerning safety of laborers. The point of safety and crisis the executives are to decrease accidents, improve efficiency, improve human relations and upgraded firm picture. Construction Industry in India is profoundly inclined to perils identified with site exercises and construction ventures connect enormous number of legally binding laborers. These laborers originate from differed exchanges particularly from country regions and farming foundation who don't have appropriate preparing in construction safety likewise are not educated enough to conjecture the obscure threats. During execution at site, these laborers are presented to different dangers associated with construction works and other word related ailments and safety peril which cause wounds and ailments. Therefore, the construction ventures get deferred because of loss of working hours and other legitimate problems. This at last records for cost and time invade. In this manner, it is basic for any construction undertaking to have certain safety rules

and system to be pursued for site exercises and to make mindfulness among the laborers, site administrator and specialists.

1.2 Definition

Safety- Safety is the condition of being protected. Safety characterizes zero loss of property, procedure, and individuals.

Safety Management- Safety the board is an authoritative capacity, which guarantees that all dangers have been recognized, surveyed and agreeably relieved.

Accident-Accidents are a spontaneous and sudden event, which disturbs an arranged grouping of work; are coming about to loss of generation, damage to faculty, harm to plant and gear and inevitably intruding on creation stream.

Emergency Management-Emergency Management is the capacity of an association to get ready for, react to moderate against and recoup from a crisis or calamity outside the office, in the network or inside the office. Crisis the board is the order managing and keeping away from both characteristic and synthetic calamities. Crisis is a genuine, unforeseen and frequently perilous circumstance requiring prompt activity.

Risk -Risk is the probability of a substance to cause damage; and hazard is blend of the probability of an event of a dangerous occasion or exposure(s) and the seriousness of damage or sick safety that can be brought about by the occasion or presentation.

Emergency Plan-A crisis plan is an instructive report, which familiarizes the inhabitants of a manufacturing plant or inhabitation with systems to be actualized, during a crisis.

1.3 Advantages and disadvantages

Accident in building destinations are spontaneous rates including construction of people, articles or materials which are bring about wounds, harms and misfortunes to properties or individuals and to diminish these, appropriate safety and crisis the board required in construction industry. On destinations accident happen because of risky conditions, dangerous act and outside human ability to control. In construction industry part of organizations are having the safety the board yet every organization isn't utilizing the cutting edge strategies. In any case, just they convey an essential safety the executives. Little undertakings are not working regarding safety and crisis the board which causes the significant number of accident however the huge tasks are working by utilizing safety and crisis strategies which results the less measure of accident.

In construction division the parcel of group comes or associated from country territory, so there is an absence of information with respect to the safety and in regards to the preparation and these are two fundamental components which are cause for the accident. Aside from that absence of inspiration, absence of information about safety in laborers, no utilization of individual defensive equipment, correspondence issues are some fundamental safety the executive's issues happened in little scale even in enormous scale construction businesses. So preparing ought to be offered by their prerequisites on location to laborers. On the off chance that a few strategies of safety and crisis administrations are utilized it can avoid significant misfortune that is; loss of human life, safety misfortune and conservative misfortune.

1.4 Need of Work

As we most likely are mindful the greatest specialists in India in the wake of cultivating are in the Construction business. Working the safety of a human life is huge rather than whatever else. There is a nonattendance of data as for the security and with respect to the planning these are two essential parts which are cause for the accidents. Accidents in building districts are improvised. We can't predict the distinct frequencies of accidents where there is no chronicled support. Crisis are a portion of the time obvious or eccentric. Contractual worker takes astoundingly less number of protections since number of repeat of emergency is extraordinary.

The work environments in Construction practices are normally dynamically hazardous, than various organizations in light of the usage of overpowering equipment, unsafe instruments, and risky materials, all of which increase the potential for veritable accidents and wounds. Thusly, it is clear that a connected with duty inwards safety is required

from Construction at all levels. Due to less repeat of emergency, lack of regard to prudent steps become troublesome issue. To avoid this emergency, rules for satisfying essential necessities of site will be prescribed.

The need of this exploration is to decide the significance of coordinating and improving crisis and safety the executive's gauges inside construction venture the executives in the India. To improve safety and safety measures at building destinations by covering general crisis and safety arrangements just as obligations and duties of the utilizes, specialists, contractual workers and sub-contractor in regards to safety measures and the base vital prerequisites. Measures to be pursued during every one of the phases of the undertaking to give safe working environment to all representatives and to ensure them against accidents.

1.5 Scope of study

To examine the security and crisis the board through case study analyses and recommends the rules for fulfilling essential prerequisites of site to keep away from accidents as for following focuses:

1. To comprehend the present Scenario of security the board at destinations and the developing requirement for same in Indian Construction industry. To comprehend various sorts or classes of accidents and their reasons.
2. Identify and understand these accidents and compare safety precautions according to importance.
3. To study the safety and emergency management over the past few years and its effectiveness on site.
4. Investigate area of emergency and number of safety management techniques according to that study suggests guide lines.

1.6 Objective

Following are the objectives of the proposed dissertation work.

- 1) To study the causes of accidents based on past literature.
- 2) To study severances of different reasons of accidents by relative index method.
- 3) To compare safety precautions according to the importance of relative index method.
- 4) To analyze present practices of safety & its effectiveness to handle emergency on construction site.
- 5) Case study of the big construction site or industry will be taken to understand safety management & to investigate area of emergency based on past accidents.
- 6) To suggest the guide lines for satisfying basic requirements of site to avoid accidents.

1.7 Research Methodology

For carrying out the proposed work, following methodology will be adopted for data collecting and analysis.

1. Collection of relevant research data from national and international journals, web sourced
2. Analysis of exact cause of accidents.
3. To study the important causes and identify the most important causes of accident.
4. Listing of precautions to be taken and comparing them by relative index method.
5. Questionnaire is prepared to investigate safety management plans carried out by company.
6. After the analysis of questionnaire survey actual onsite safety and its utilization while emergency will be find out.
7. Preparing list of safety precautions to be followed in general on all construction site.

II. LITERATURE SURVEY

Ibukun Awolusi et al. This paper provides an evaluation of the potential applications of WSDs and IOT for the continuous collection, analysis, and monitoring of construction workers' safety metrics to mitigate safety hazards and health risks on construction sites. Wearable sensors and systems that can be used for physiological monitoring, environmental sensing, proximity detection, and location tracking of a wide range of construction hazards and vital signals which can provide early warning signs of safety issues to construction workers are reviewed. A schematic model for integrating wearable sensors for interoperability and multi-parameter monitoring to capture and track several safety metrics is also presented. The study evaluated wearable sensors and systems that can be used for physiological monitoring, environmental sensing, proximity detection, and location tracking of a wide range of construction hazards and vital signals which can provide early warning signs of safety issues to construction workers. The schematic model presented in this study can be used by manufacturers of WSDs as a tool for integrating wearable sensors and systems into a single device for interoperability and multi-parameter monitoring of construction safety metrics.

Matthew Hallowell et al. the applications of wearable technology for personalized construction safety monitoring and trending. A comprehensive evaluation of the features of wearable technology and the resulting safety metrics thought to be capable of predicting safety performance and management practices is presented. The review showed that a wide variety of wearable technologies is being used in other industries to enhance safety and productivity while few applications are observed in the construction industry. The objective of this paper is to provide a comprehensive review of the applications of wearable technology for personalized construction safety monitoring. The characteristics of wearable devices and safety metrics thought to be capable of predicting safety performance and management practices are identified and analyzed.

Shyamal Patel et al. developments in the field of wearable sensors and systems that are relevant to the field of rehabilitation. The growing body of work focused on the application of wearable technology to monitor older adults and subjects with chronic conditions in the home and community settings justifies the emphasis of this review paper on summarizing clinical applications of wearable technology currently undergoing assessment rather than describing the development of new wearable sensors and systems. A short description of key enabling technologies (i.e. sensor technology, communication technology, and data analysis techniques) that have allowed researchers to implement wearable systems is followed by a detailed description of major areas of application of wearable technology. Applications described in this review paper include those that focus on health and wellness, safety, home rehabilitation, assessment of treatment efficacy, and early detection of disorders. This paper summarized enabling technologies developed over the past decade and put a great deal of emphasis on surveying studies focused on the deployment of wearable sensors and systems in the context of a concrete clinical applications, with main focus on rehabilitation. The interest of researchers and clinicians for pursuing applications of wearable sensors and systems has caused a shift in the field of wearable technology from the development of sensors to the design of systems.

Menachem Domb et al. Wearable devices have embedded sensors which acquire the data for which they were built. This data are then pushed to its integrated processor. The processor analyzes this data and accordingly launches commands, actuators or activates other sensors to collect more data or execute tasks according to predefined scenarios and processes. Wearables are embedded in various domains, such as healthcare, sports, and agriculture and navigation systems. Each wearable device is equipped with sensors, network ports, data processor, camera and more. To allow monitoring and synchronizing multiple parameters, typical wearable's have multi-sensor capabilities and are configurable for the application purpose. For the wearer's convenience, wearable's are lightweight, modest shape and multifunctional. Wearable's perform the following tasks: sense, analyze, store, transmit and apply. The processing may occur on the wearer or at a remote location. For example, if dangerous gases are detected, the data are processed, and an alert is issued. It may be transmitted to a remote location for testing and the results can be communicated in real-time to the user. Each scenario requires personalized mobile information processing, which transforms the sensory data to information and then to knowledge that will be of value to the individual responding to the situation.

Lili Wang et al. The design concept of a multifunctional biosensor has many ideal characteristics, such as self-healing, biocompatibility and biodegradability, which will be highlighted in this section. To mimic bio functions, the selection of nanomaterial's with mechanical compatibility is an important factor for wearable sensors. Smart wearable sensors with excellent bio functionality furnish medical devices with various smart functions such as biocompatibility, biodegradability, and self-healing, which have attracted widespread interest from device engineers and materials scientists. Herein, a comprehensive review of the latest progress concerning these smart wearable sensors is presented with a focus on bio-multifunctional (biocompatible, biodegradable, and self-healing) device designs. The medical

applications of bio-multifunctional smart wearable sensors are also briefly covered, and to conclude, a discussion of the challenges, opportunities, and future perspectives is provided.

Gobinath Arogam et al. The uses for wearables differ. Some need it, some want it. Examples of when it is needed are mostly common in work spaces. An individual will benefit from wearable intelligence if the body worn item can sense relevant data to educate them on a procedure or identify safety concerns. The trends and projections for wearable technology in the consumer sports sector (excluding professional sport). Analyzing the role of wearable technology for different users and why there is such a need for these devices in everyday lives. It shows how different sensors are influential in delivering a variety of readings that are useful in many ways regarding sport attributes. Wearables are increasing in function, and through integrating technology, users are gathering more data about themselves. The amount of wearable technology available is broad, each having its own role to play in different industries. Inertial measuring unit (IMU) and Global Positioning System (GPS) sensors are predominantly present in sport wearable's but can be programmed for different needs.

Mokhinabonu Mardonova et al. wearable device technology and its potential deployment in the mining industry were conducted. It also suggested a wearable safety management system for miners and other possible applications to the mining industry. A few initiatives are underway to introduce wearable technology to mining. The successful utilization of these advanced devices in other sectors suggests that they can be used to provide practical solutions. The classification of wearable devices with some examples of their utilization in various industrial fields as well as the features of sensors used in wearable devices. Existing applications of wearable device technology to the mining industry are reviewed. In addition, a wearable safety management system for miners and other possible applications are proposed. The findings of this review show that by introducing wearable device technology to mining sites, the safety of mining operations can be enhanced. It was difficult to analyze actual mining environments due to the use of vague techniques and unpredictable mining conditions therein. However, the deployment of advanced technologies in the form of wearable devices can help regularly monitor the mining process, create a healthier and safer workplace, and improve the professionalism of personnel.

Rushabh Shah et al. the impacts of technologies such as IOT and AI in healthcare through a systematic review of 75 peer-reviewed scholarly journal articles. The analysis reveals exponential growth in the number of articles published in the last decade, a wide variety of publication outlets, a large number of authors, and many conceptual and design science papers, all indicating an emerging field with great publication potential in future years. The analysis further reveals that applications of these technologies are being studied worldwide. highlights key insights for the top application categories, which include wearable's and connectivity, disease detection and treatment, patient care, and sensor networks, and identifies gaps and future research directions related to technology design and acceptance, regulations for data security and privacy, and systems efficacy and safety. The impacts of two technologies - IOT and AI – on healthcare through a systematic review of the literature. Systematic literature reviews, also called PRISMA style reviews, involve systematically searching for articles on a given topic in various library databases or through other sources, screening the articles for appropriateness, further evaluating the full text articles for eligibility, and conducting quantitative and qualitative analyses.

Dhruv R. Seshadri et al. The convergence of semiconductor technology, physiology, and predictive health analytics from wearable devices has advanced its clinical and translational utility for sports. The detection and subsequent application of metrics pertinent to and indicative of the physical performance, physiological status, biochemical composition, and mental alertness of the athlete has been shown to reduce the risk of injuries and improve performance and has enabled the development of athlete-centered protocols and treatment plans by team physicians and trainers. Our discussions in this review include commercially available devices, as well as those described in scientific literature to provide an understanding of wearable sensors for sports medicine. The primary objective of this paper is to provide a comprehensive review of the applications of wearable technology for assessing the biomechanical and physiological parameters of the athlete. A secondary objective of this paper is to identify collaborative research opportunities among academic research groups, sports medicine health clinics, and sports team performance programs to further the utility of this technology to assist in the return-to-play for athletes across various sporting domains.

Abdolrasoul Habibipour et al. this paper is to investigate social, ethical and ecological issues related to wearable technologies from end-users' perspectives. We undertook a systematic literature review as well as two rounds of interviews with domain experts as well as end-users of IoT wearable devices to find relevant issues related to social, ethical and ecological. After synthesizing the results, eighteen issues found to be relevant to the wearable technologies. These issues have important implications for reducing the negative barriers that challenge the adoption of wearable technologies. The originality of this study lies with its non-technological focus that provides insights into issues that are

rooted into individuals' concerns. Qualitative data collection was conducted in different phases with different sources of data in each phase. The corroboration of data sources allowed us to achieve this rich picture we set out to achieve, meaning that primary and secondary data were used in this study. This study offers several implications for wearable's and IOT. Summarizing extant research, current study enables us to obtain insights into the potential (intended and unintended) consequences including benefits and drawbacks of using wearable sensors by end-users in their real-life everyday use context. The theoretical contribution highlights what issues are to be considered when studying adoption behavior in an IOT context. In this vein, future research can include these issues to effectively evaluate and analyses the adoption barriers related to human needs, expectations, and values that end-users have. For practice, our findings point into two trajectories. First, to allow service providers in addressing the issues by developing recommendations on how to facilitate adoption of IOT wearable technologies.

III. CONCLUSION

Attributable to increment in multifaceted nature of activities, the construction business has gotten more perilous than any other time in recent memory. Construction associations are looked with the test of having to intently screen their safety the board frameworks to limit word related perils. In India successful safety construction the executives isn't accessible. Besides, the way to legitimate safety execution isn't really through severe rules and gauges, yet through a powerful all out safety the board activity, first upheld by an associations senior administration, at that point incorporated by means of explicit safety the executives usage instruments/frameworks, lastly by consistent construction and checking to guarantee quality and persistent improvement. In this exploration, the significant parameters which are considered in the safety the board were talked about. The various phases of safety the board have been watched and dissected. Different accidents which are happening in a building site were watched and cures that are to be taken so as to anticipate these accidents were sifted through. In construction industry parcel of organizations are having the safety the board yet every organization isn't utilizing the cutting edge procedures yet just they are convey a fundamental safety the board. By contemplating out my overview just one organization have great safety and crisis the executives and one organization isn't utilizing a solitary thing for the safety just as for the crisis. By the assessments of the entirety of the visited destinations hello need a propelled rule model for limiting the accidents By the study of destinations we found that the organizations which are utilizing the SM are not unreasonably much compelling and just 50-55% execution of safety strategy is finished on building site. Close about 30% major and 70% minor accidents happens on locales. On locales the accidents are happening because of perilous condition, risky act and outside human ability to control.

REFERENCES

1. Ibukun Awolusi "Enhancing Construction Safety Monitoring through the Application of Internet of Things and Wearable Sensing Devices: A Review" Computing in Civil Engineering 2019
2. Matthew Hallowell "Wearable technology for personalized construction safety monitoring and trending: Review of applicable devices" Automation in Construction 85 (2018) 96–106 www.elsevier.com/locate/autcon
3. Shyamal Patel "A review of wearable sensors and systems with application in rehabilitation" Journal of NeuroEngineering and Rehabilitation 2012, 9:21
4. Menachem Domb "Wearable Devices and their Implementation in Various Domains" The Big Wave of Innovation DOI: <http://dx.doi.org/10.5772/intechopen.86066>
5. Lili Wang "Bio-Multifunctional Smart Wearable Sensors for Medical Devices" Advanced intelligent system www.advintellsyst.com DOI: 10.1002/aisy.201900040
6. Gobinath Aroganam "Review on Wearable Technology Sensors Used in Consumer Sport Applications" Sensors 2019 DOI: 10.3390/s19091983 www.mdpi.com/journal/sensors
7. Mokhinabonu Mardonova "Review of Wearable Device Technology and Its Applications to the Mining Industry" Energies 2018, 11, 547; doi:10.3390/en11030547 www.mdpi.com/journal/energies
8. Rushabh Shah "IOT AND AI in Healthcare: A Systematic Literature Review" Issues in Information Systems Volume 19, Issue 3, pp. 33-41, 2018
9. Dhruv R. Seshadri "Wearable sensors for monitoring the internal and external workload of the athlete" NPJ Digital Medicine (2019) 2:71; <https://doi.org/10.1038/s41746-019-0149-2>
10. Abdolrasoul Habibipour "Social, Ethical and Ecological Issues in Wearable Technologies" Twenty-fifth Americas Conference on Information Systems, Cancun, 2019
11. FAN WU "WE-Safe: A Self-Powered Wearable IOT Sensor Network for Safety Applications Based on LoRa" Special Section On Wearable And Implantable Devices And Systems Received June 12, 2018, accepted July 17, 2018, date of publication July 25, 2018, date of current version August 15, 2018. Digital Object Identifier 10.1109/ACCESS.2018.2859383