

VARIOUS TECHNIQUES FOR SAFETY AND HEALTH MANAGEMENT IN CONSTRUCTION INDUSTRY: A REVIEW

¹Shervin Joseph, ²Harsimranjit Singh

¹PG Student, ²Assistant professor

¹School of civil engineering

¹Lovely Professional University. Phagwara, Punjab, India

Abstract : In several countries the building industry is considered to account for multiple workplace fatalities, accidents and illnesses. This situation could be direr in emerging economies and management of health and safety is important in tackling this. We all know that the technologies and materials are the key element to secure the construction work site accidents, welfare and wellbeing of construction workforce. Compared with other manufacturing industries sectors construction sector has witnessed a high range of fatality and hazardous situation. so the penetration of methods for decreasing this fatalities and accidents related to workers and work site has gained awareness in this modern era. Various techniques for enhancing and assuring the healthy environment in the work site reduce the risk in the work, provides safe working environment, increase the productivity, high quality and fast delivery time. This paper reviews the exciting literatures and finds that strengthening coordinators and potential motivators, hybrid BN-HFACS model, VP based safety system management, RFID technology with mobile application , leading and lagging indicators , BIM technology, science mapping and 4D cad models in this domain are getting popular day by day and scenario has became in focusing on workers safety and health which eventually speeds up advantage and quality of construction. This particular paper reviews 20 excising research paper on various technologies on safety and health management methods and this paper not only gives contribution to this particular domain but also contributes the knowledge to the construction project mangers, engineers and decision maker to implement modern technologies for ensuring the heath and safety management in construction site.

Index Terms : *heath and safety management, various technologies, construction industry*

I. INTRODUCTION

The Construction industries is the one of the major industrial sectors which contributes it immense constitution to the global domestic products (GDP).The building industrial sectors provides its contribution by developing infrastructures, homes and building which are the essential part of the human being and in terms of industrial sectors. The building industry is known worldwide as a risky sector. Every year, serious and fatal incidents happen at construction sites. Accidents and work force life and their healthy environment to work is the major challenge faced by these industrial sector. Over the ears construction industrial sectors has invested the efforts and time to reduce the fatalities and accidents which cause the uncomfortable working condition to the work force. Historically, across three simultaneous periods, numerous attempts have been made to improve the situation. The key objective which these sector focus in these modern period is to uplift the technical stage and the implementation of technical steps to minimize risks in the construction project environment.

1.1 Construction work force and Accidents

The work force in a work site are the real power house and back bone of the construction industrial sector. All the industrial sectors are forwarding the process of transformation by implementing the automation for the production in there working limits. The construction industry is a complicated sector to bring automation as a replacement to the constructional work force . This particular sectors have its own demandable limitation to completely give its hand to automation , even though the revelation has gained its upper hand in this sector . so the construction work force are the essential part of the construction industry and if there is a healthy and secure atmosphere to work then their will be unimaginable progress and productivity in work. In this particular field put the chance of implementing monitoring of safety of workers. The health and safety monitoring is awareness to the all sectors to keep focus on their safety and health situation by providing protective aids , regular shifts, prediction of unsafe conditions and overall management.

The construction work site and atmosphere is very vulnerable to accidents and some of them are really unpredictable .the accident in the site which is above in some heights and in some conditions can cause death and also it even leads to paralyze, as this falsities and other conditions cause lose of life as well as it eventually effect the progress of the work. In this era the monitoring systems and the trends to monitors work site and force is emerging and gaining demand . Number of techniques and technologies are getting concern and becoming poular to keep up the life .

1.2 Application of technologies for health and safety monitoring

In the building industrial sector, to assure the safety policy and to provide the healthy environment is very challenging but industry having witnessing lot of methods and technologies since few decades. The use of motivators and supervisor to ensure the safety in work is conventional method and it has been not gain that much attention over all periods has it own wide range of applicable

limitation. These methods ensure the visual inspection of work site and the motivation, mental health to the workers. The continual method applicable and used for the small works like construction of homes and small building. The computer aided design models are also used and applicable for the monitoring as these models and system provide a pre workable model about the real workable model and also can detect the unsafe condition and can provide alert.

The trend of using wearable sensing devices has enriched the fields with immense detection and prediction of situation. These devices are too small and handy which can be fixed with worker and devices provides wide range of worker related information such as working time, unsafe condition, gas and substance sensing and information. These devices are vulnerable to eventual artificial updates and provide a guided monitoring by controller. Wearable safety devices are used in high raised building construction site where visual inspection is not possible and the sensing of hazard is must needed. Wide capability of applying computer application to this task is practiced in the industry in this current scenario. VP based computer application is mated and it is fused with RFID technologies to use for live tracing and also providing risk assessment plan. This technique is widely used in dam construction where the assessment is very difficult to done and the situation of risk is very important to predict as mass pumping of concrete is done in geographically vulnerable conditions. Other techniques like tracking devices, leading indicators, Hazard beacon lights, and risk map graphing is practiced in industry.

II. LITERATURE REVIEW

Vacharapoom Benjaoran . Sdhabhon Bhokha. et al (2010) Paper describes an integrated framework using the computer aided model for performing a plan for work site to prevent from construction accidents. In order to formulate the model the required data were collected to automatically identify any work-at-height risks, the device analyses this combined information and also ensure safety precaution. This system is efficient in providing safety to the workers and construction management by predicting the risk and safety issues before the work is executed.

Alessandro Carbonari . Alberto Giretti^b, Berardo Naticchia . et al (2011) Explain the contribution of a proactive system for tracking and analyzing of the risk and safety in construction work sites. The system is capable of performing real time tracking with the help of signal technology and forwarded with active virtual barriers. These system proves its efficiency to predict the dangers and the unprotected areas to the workers with simple computer logics and suitable for workers at outside conditions.

Y. Zhou, L.Y. Ding . L.J. Chen . et al (2013) Suggested approach for fatality assurance in metro rail construction work sites by using visualization techniques to develop a 4 dimensional model (4D model). These system has an intelligence to detect unsafe activities and conditions and also provides direction to overcome the situation. These model provides the advantage to designers, site managers and project managers to eventually know about the risky conditions and suitably advises the remedial measures.

Gustavo E. Aguilar . Kasun N. Hewage . et al (2013) Explain a system that is capable of performing hazard tracking for one or more construction work site and also provide sensing alert, The framework offers safety metrics for a particular project or for industry-wide statistics. These system posses the benefits like real-time data can be used by on-site administrators to perform decision making as per as the need of industrial authorities and officials.

Ros Serrano Antonio . Ortiz-Marcos Isabel . Palomo Sánchez José Gabriel . Uruburu Colsa Angel . et al (2013) Observed that the analyses carried out by using mathematical methods like comparing means, statistical graphs and calculation techniques showed that this system can be merely used for pre assessment of risk in the work site as this method compare previous data which is likely possible to happen again.

H.L. Guo . Heng Li . Vera Li . et al (2013) Performed a real-life case study and discussed to illustrate how to enforce the VP-based framework for the assurance of safe and healthy condition in the work site. This system proves that applicability and capability to program the models which are capable of doing the real time tracking and also provides option to imitate the mock model of real models.

Shahram Mahmoud . Fakhradin Ghasemi . Iraj Mohammadfam . Esmail Soleimani . et al (2014) Examined that the relative importance of motivators and management level officials in enhancing the work site environment and thus to reduce the construction work site accidents. The finding from the study proves the motivators can control and take safety assurance measures by the advice of management level and it ensure the control of unsafe conditions.

Herry Pintardi Chandraa . et al (2015) Stated that the relationship between motivators and building safety and health is correlated with a standardized system in working can take the situation and can performed control over the works safety and the mental health of worker by providing canceling and to give awareness of working in safe condition as well as usage of safety aids.

Lance W. Saunders . Brian M. Kleiner . Andrew P. McCoy . Kimberly . Ellis d .Tonya Smith-Jackson . Christian Wernz . et al (2017) addressed the programming of safety atmosphere instrument to assess behaving towards construction site measures, Stakeholders of the sector, founders, builders, and contractors and leading to a conclusion that the framework offers to define safety behaviors and, eventually, as a benchmark tool for comparison between projects.

Waleed Umer . Heng Lia , Wei Lu . Grace Pui Yuk Szetob . Arnold Y.L. Wong . et al (2018) Showed that a balance monitoring of construction workers is implemented with assistance of a mobile phone application for managers to monitor the foremen for the balance performance profiles. This will help to detect fall-prone employees early, prepare prevention systems before the work is actually exsiccated.

Nini Xiaa . Patrick X.W. Zoub . Xing Liua . Xueqing Wanga . Runhe Zhua . et al (2018) explained implementation HFACS for building safety analysis in a five level with the help of mobile phone based application and proves the advantage of using it in high rise construction where the supervisors and controllers can take control over it.

Kent J. Nielsen . Regine Grytnes. Johnny Dyreborg . et al (2019) explained a test of tailors intervention which resulted in a iterative process, a targeted intervention was created to build healthy institution by giving advices and motivation to meet the current standards and to create a productive construction.

Ramsha Akram . Muhammad Jamaluddin Thaheem . Abdur Rehman Nasira . Tauha Hussain Alic . Shamraiza Khana . et al (2019) Addressed that the implementation of (BIM) model for inspection in construction site and conclusion also shows several BIM characteristics, has a Important significance and can be used for protection of building but the the three dimensional viewing implementation is usefull as it can be used for determination of risks, spreparation and coordination of plans for Staff.

Temidayo O. Osunsanmi . Ayodeji E. Oke . Clinton O. Aigbavboa . et al (2019) Studied the use and the application and the implementation vision to apply the RFID method with mobile application method for the monitoring construction especially for working officials. The studies was focused on south Africa and the studies was by using the data collection and surveying and resulted in formation of a model which uses mobile application with the integrated RFID technology to alert the workers and working professionals from unsafe situation and hazards.

Tahira M. Probst . Linda M. Goldenhar . Jesse L. Byrd . Eileen Betit . et al (2019) Found that the Environment Assessment Method is being developed and validated. Instead of conventional Like scale responses, the S-CAT offers businesses the chance to use rubric descriptors to find degree of accident free environment and earn a composite score in predicting dgree of accidents against others.

Xuejiao Xing . Botao Zhong . Hanbin Luoa . Heng Li . Haitao Wua . et al (2019)) Study is being developed to formalize working enviornment in metro construction to support the identification of risks. A method of ontology creation with five phases is been adopted adopted and indicate the important requirements to serve the purpose of sharing and reusing information. The model be broadly applicable to the identification of hazards in metro building.

Katelyn Versteeg . Philip Bigelow . Ann Marie Dale . Ashok Chaurasi . et al (2019) Suggested to analyze the influence of sensing indicators on a project level in order to better understand how business can use leading indicator data Administration. When assessed at a company level using company administrative data, this study explores the relationship between leading and lagging indicators.

Udara Ranasinghe . Marcus Jefferies . Peter Davis . Manikam Pillay . et al (2020) objective of this study is to mesure the advantage of using the resilient work environment in higher-risk industries , particularly in construction renovation, has been identified as essential in developing and evaluating. Indicators were achieved through a systematic literature review conducted between 2004 and 2019 of studies and academic publications. The literature review analyzed RE measures in different industries.

Amir Mohammadi . Mehdi Tavakolan . et al (2020) Showed that at various points, archetypes have been demonstrated, including the complex theory, actions over time, and the leverage point to demonstrate how to treat the archetype. For decision-makers, the archetypes built may be useful and allow them to be aware of the long-term consequences of their project decisions. They also provide project managers with a systemic vision that helps they understand the dynamic dynamics of the management of construction safety.

Weili Fanga,b,c,d . Lieyun Dinga,b . Peter E.D. Loved . Hanbin Luoa,b . Heng Lie . Feniosky Peña-Morac . Botao Zhonga . b . Cheng Zhoua . b . et al (2020) Indicated that the computer vision combined with deep learning has the ability to automatically recognize hazardous construction site actions and conditions and can therefore be used to increase safety efficiency.

III.CONCLUSION

The following conclusions are drawn from the Literature Review.

- Modern technologies for the enhancement of health and safety monitoring in the construction sites is developing day to day from safety supervisors to safety sensing application and sensing devices
- The conventional methods like use of coordinators and motivators for site safety mentoring proves to be effective method , but wide limitation of these techniques is not effective in large construction where number of worker is very high
- Wearable safety devices, leading and lagging sensors and other safety devices proves to be more effective and reliable to use in the work site to avoid safety as well as to give sensing about the unsafe conditions.
- With rapid research in FFID technology with mobile application explain that it gives the indication, alerting and prediction of hazard and unsafe conditions before the work id exsiccated
- 4D cad models and usage of BIM technology assures the safety design to the workers and their safe working patterns.
- In huge construction site and in every construction site the application of modern technologies proves to be efficient and suitable method for safety and health of work force

REFERENCES

- [1] Alessandro Carbonari , Alberto Giretti, Berardo Naticchia. 2011. A proactive system for real-time safety management in construction sites. Università Politecnica delle Marche, DACS Department - Division of Building Construction
- [2] Amir Mohammadi, Mehdi Tavakolan. 2020. Identifying safety archetypes of construction workers using system dynamics and content analysis.University of Tehran, College of Engineering, School of Civil Engineering, Department of Construction Engineering and Management
- [3] Gustavo E. Aguilar , Kasun N. Hewage . 2013. IT based system for construction safety management and monitoring. C-RTICS Kelowna Civil Engineering, University of British Columbia Okanagan
- [4] Herry Pintardi Chandraa. 2015. Initial investigation for potential motivators to achieve sustainable construction safety and health. a Department of Civil Engineering Petra Christian University

- [5] H.L. Guo , Heng Li , Vera Li . 2013. VP-based safety management in large-scale construction projects: A conceptual framework. Department of Construction Management Tsinghua University, Department of Building and Real Estate Beijing China,
- [6] Katelyn Versteeg , Philip Bigelo , Ann Marie Dal , Ashok Chauras. 2019. Utilizing construction safety leading and lagging indicators to measure project safety performance: A case study. a University of Waterloo, School of Public Health and Health Systems, Institute for Work & Health Toronto, Division of General Medical Science, Washington University School of Medicine
- [7] Kent J. Nielse, Regine Grytne , Johnny Dyrebor. 2019. Pilot test of a tailored intervention to improve apprentice safety in small construction companies. Department of Occupational Medicine, Regional Hospital West Jutland Denmark b National Research Center for the Working Environment
- [8] Lance W. Saunders , Brian M. Kleiner , Andrew P. McCoy , Kimberly . Ellis, Tonya Smith-Jackson , Christian Wernz. Developing an inter-organizational safety climate instrument for the construction industry. 2017. Grado Department of Industrial & Systems Engineering
- [9] Nini Xiaa , Patrick X.W. Zoub , Xing Liua , Xueqing Wanga, Runhe Zhua . 2018. A hybrid BN-HFACS model for predicting safety performance in construction projects. a College of Management and Economics. College of Management and Economics, Tianjin Chengjian University. Department of Civil and Construction Engineering & Centre for Sustainable Infrastructure, Swinburne University of Technology Hawthorn
- [10] Ramsha Akram , Muhammad Jamaluddin Thaheem , Abdur Rehman Nasira , Tauha Hussain Alic , Shamraiza Khana. 2019. Exploring the role of building information modeling in construction safety through science mapping . Dept. of Construction Engineering & Management National University of Sciences Islamabad . School of Architecture and Built Environment Deakin University, Geelong Australia. Dept. of Civil Engineering Mehran University of Engineering and Technology Pakistan
- [11] Ros Serrano Antonio , Ortiz-Marcos Isabel , Palomo Sánchez José Gabriel , Uruburu Colsa Angel. 2013. A proposal for improving safety in construction projects by strengthening coordinators' competencies in health and safety issues. EU Arquitectura Técnica e Ingeniería de Edificación, Universidad Politécnica de Madrid, Spain, ETS Ingenieros Industriales, Universidad Politécnica de Madrid Spain
- [12] Shahram Mahmoudi , Fakhradin Ghasemi , Iraj Mohammadfam , Esmaeil Soleimani . 2014. Framework for Continuous Assessment and Improvement of Occupational Health and Safety Issues in Construction Companies . Department Systems and Quality Tehran, Iran, Department of Industrial Hygiene School of Public Health, Hamadan Medical Science University Hamadan, Iran
- [13] Tahira M. Probst, Linda M. Goldenhar Jesse L. Byrd , Eileen Betit . 2019. The Safety Climate Assessment Tool (S-CAT): A rubric-based approach to measuring construction safety climate. Washington State University Vancouver Vancouver United States of
- [14] Temidayo O. Osunsanmi, Ayodeji E. Oke, Clinton O. Aigbavboa. 2019. Survey dataset on fusing RFID with mobile technology for efficient safety of construction professionals. SARCHI in Sustainable Construction Management and Leadership in the Built Environment, Faculty of Engineering and the Built Environment, University of Johannesburg, South Africa
- [15] Udara Ranasinghe , Marcus Jefferies , Peter Davis , Manikam Pillay . 2020. Resilience Engineering Indicators and Safety Management: A Systematic Review. School of Architecture and Built Environment The University of Newcastle Australia , School of Health Sciences The University of Newcastle Australia
- [16] Vacharapoom Benjaoran , Sdhabhon Bhokha . 2010. An integrated safety management with construction management using 4D CAD model School of Civil Engineering, Institute of Engineering, Suranaree University of Technology Nakhon Ratchasima, Thailand , Department of Civil Engineering, Faculty of Engineering Ubon Ratchathani University Ubon Ratchathani Thailand
- [17] Waleed Umera, Heng Lia , Wei Lu , Grace Pui Yuk Szetob, Arnold Y.L. Wong . 2018. Development of a tool to monitor static balance of construction workers for proactive fall safety management. Department of Building and Real Estate The Hong Kong Polytechnic University Hung Hom, Kowloon, Hong Kong Special Administrative Region b School of Medical & Health Sciences, Tung Wah College, 31 Wylie Road, Homantin, Kowloon, Hong Kong Special Administrative Region c Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong Special Administrative Region
- [18] Weili Fanga, Lieyun Dinga, b, Peter E.D. Loved , Hanbin Luoa, Heng Lie , Feniosky Peña-Morac , Botao Zhonga , , Cheng Zhoua. 2020. Computer vision applications in construction safety assurance. Dept. of Construction Management, Huazhong University of Science and Technology China , Hubei Engineering Research Center for Virtual, Safe and Automated Construction China, Dept. of Civil Engineering and Engineering Mechanics, Columbia University in the City of New York New York , School of Civil and Mechanical Engineering Curtin University Australia , Dept. of Building and Real Estate, The Hong Kong Polytechnic University Hong Kong
- [19] Xuejiao Xing , Botao Zhong Hanbin Luoa, Heng Li , Haitao Wua. 2019. Ontology for safety risk identification in metro construction. Dept. of Construction Management, School of Civil Engineering and Mechanics Huazhong University of Science and Technology Wuhan . Hubei Engineering Research Center for Virtual Safe and Automated Construction Wuhan. Department of Building and Real Estate The Hong Kong Polytechnic University
- [20] Y. Zhou, L.Y. Ding , L.J. Chen. 2013. Application of 4D visualization technology for safety management in metro construction. School of Civil Engineering & Mechanics Huazhong University of Science & Technology Wuhan, University of Science & Technology Wuhan