

# A New Integrated System of Safety and Health Model Development for Manufacturing Industries: A Case of Ethiopia

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## ABSTRACT

**Purposed:** The purpose of this study is to identify the most prominent occupational safety and health (OSH) improving factors from numbers of previous studies and develop a novel integrated OSH model that is suitable for manufacturing industries based on the factors identified. The triggering force toward this study is that OSH became a global issue in reference to sustainable development and capturing the attention of many scholars for a few years later.

**Research Methodology/Approach:** In order to arrive on this unique model, different articles were reviewed, data were collected from 189 manufacturing industries through questionnaires, interviews, group discussions, experimental works, and field observation during the study period. **Findings:** The research finding identified six major factors based on the literature, primary data sources, and questionnaires. These identified factors such as knowledge diffusion, workplace innovation, OSH management, collaboration, proper technology utilization, and lean workplace. Thereby after each factor analyzed, they were integrated and interlocked to create a unique model for the OSH improvement.

**Originality/Value:** The previous works were focused only on a single factor that solely investigates a single OSH improvement approach and it missed the other factors that hugely create another hole in the other part of the workplace safety and health accidents minimization strategies. Hence, this finding model was not considered in any kinds of literature so far.

**Conclusion:** The model has a contribution for the practitioners to create awareness on employees, solve workplace hazards and accidents and increases organizational productivity as wellbeing improved with the integrated systems

**Keywords:** OSH; Integrated model; Manufacturing Industry; Workplace management system

## INTRODUCTION

Manufacturing industries are equipped with human resources and these resource need at their workplace safest working environment so that they make the organization more profitable and productive. The consideration of workplace safety and health in the global scenario for employs was weak until recent years [1]. Because of existing models like safety culture, OSH management, knowledge diffusion, and workplace innovation does not address the subject of OSH integrated model that helps to improve workplace safety and health [1,2]. In the previous study, a new model for knowledge diffusion at workplace improvement was proposed by borrowing from the existing innovation diffusion model or devising a new approach that can be used at national or international levels [2,3]. This model places more responsibility on the tripartite i.e. government, organizations (employers) and individuals (employees) actions to come up with interventions that will be valued in the

competitive manufacturing industries and business environment. The previously introduced model did not address all required elements at a time to create a safe workplace system. Hence, it was a mandatory to introduce another new and inclusive integrated model. The basic four factors identified during data analysis for integrated model development were knowledge, management, collaboration, technology, innovation and lean. Integrated unique model was developed after justification drawn for the individual factors model were highlighted here so that they lead us to the integrated model development [4].

According to Jilcha, Beshah & Kitaw and Marakas, knowledge is an organized combination of ideas, rules, procedures, and information. Knowledge is a tool that builds up the mindset of the employees and the management of any organization [2,5]. One of the best ways to create awareness in the society is to change their mindset through knowledge diffusion so that workplace

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safety and health would be greatly improved [6]. In order to censor situations hampering workplace safety improvement, it is necessary to have the means for spreading OSH knowledge. Thus, a conceptual framework model has been developed based on data analysis and the study conducted on the literature review for workplace safety enhancement placed knowledge diffusion is the grass root to bring belief of the society toward a workplace safety culture. As a result of fewer studies, works done on knowledge diffusion and dissemination regardless of workplace safety and health, communication channels are very slow. Sometimes, due to high illiteracy among workers, the question of safety is not even taken seriously by the workers themselves [7,8]. Thus, knowledge diffusion in this study is means the transfer of knowledge from the source through the communication channels to the end users at workplaces [2]. New knowledge emerging from research holds great potential to expand horizons and create a significant impact on society plus workplaces. Knowledge Translation (KT) is about harnessing that potential and bridging the gaps between what industries know and what they do.

In developing countries, top managements have neglected workplace safety and health impacts on productivity and health partly because these countries have cheap labor forces compared with those of developed countries [9-11]. According to some studies, governments did not enforce policies, legislation, regulations, laws, and standards to promote the operational efficiency of an organization [1,12]. OSH Management is another factor, prioritized second, that is involved in the integrated unique model. The elements of the OSH management system specified under the BS 8800, OSHAS 18000, ISO 45001 and other related management system are policy, organizing, planning and implementing, performance auditing and initial and periodic status review [1,13].

The policy is one of the requirements for safety and health improvement at work that reflects the management commitment towards the organization's safety and health improvement lines. Once an organization set policy toward OSH improvement system comes to planning and managing change. Organizations adopt a planned and systematic approach to policy documentation. This includes the management arrangement such as resources, personnel, contingency plans, organization activities, measuring performance, audits, status review, and corrective measures.

Another factor which was considered third in the improvement of workplace safety and health is the collaboration of different actors which play a role in enhancing workplace safety and health improvement system as identified by this study. Organizations having the same goals would negotiate and share their knowledge with each other. Individuals having a common goal are motivated to collaborate when they believe that they require each other's contribution to be successful in their own work [6]. When engaged in joint work, individuals are interdependent and rely on each other to reach their goals. This collaborative work helps the organization to enhance workplace safety and health improvement through support, information sharing and knowledge benefits with each other. Collaboration has three elements, i.e. common goals, joint work, and interdependence. Participants in collaborative relationships hold common or mutual goals that may be beneficial to their organization, to themselves, and to each other [6,14-15]. The argument for collaboration is that helps in creating network, support, and experience-sharing and communication channels internally and externally. However, the culture of collaboration

and the effort of seeking support from internal and external bodies were declining in manufacturing industries as previous studies and field observation indicated [6]. Studies showed that there is a large gap in inter-firm collaboration for innovation and organizational learning in developing countries [16]. Hence, organizations need to collaborate and obtain support through the interactions between internal and external flexibility within the workplace improvement processes. There are two types of collaboration approaches distinguished in this study.

Vertical Collaboration which is a network that should be existed in-between top management and bottom management lines [6]. In a perfect world, frontline workers should submit suggestions to their supervisors for improving work and workplace safety. In turn, top executives should provide direction on improvement priorities down to frontline workers. But this is rare. In most organizations, frontline workers do not have a mechanism to submit suggestions up the hierarchy, and the few that do have flawed suggestion systems. And top executives do not have good mechanisms to share their vision by moving downwards. The second one is horizontal Collaboration in which it is a form of collaboration that is to be exercised among the same professions in the management hierarchy. Technology has given a level of communication never seen before. It can be literally connected with anyone among the industry employees, leaders, and co-workers at anytime, anywhere. With this dramatic increase and demand in collaboration comes a heightened level of flexibility in communication, allowing co-workers to facilitate continued partnership no matter where each individual may be. Teamwork is much more engaged and boosted to a whole new level. Hence, when professionals collaborate with each other, they can manage the right OSH improvement systems. It can be seen in terms of external collaboration where this is the kind of collaboration that takes place with external bodies beyond the internal circle of companies. The collaboration that takes place between companies (inter-organizations), stakeholders and international organizations. These diversified forms of collaboration can be carried out with online communities using social networking technologies (like Facebook equivalents) to share OSH improvement experiences.

The other factors that were identified for the OSH improvement model were proper technology utilization in which it is another issue to improve OSH. There is evidence that new technologies can improve the quality of the workplace by enhancing communication, standardizing processes, and enhancing workflow, especially when used in addition to existing processes rather than as a substitution. There is also the import of hazardous technologies unless thorough attentions are given. Technology means different thing to people and organizations. According to Megantz, to a scientist, technology is the end product of research, inventions, and know-how that may be developed into a commercial product, while to an engineer; technology is a tool or process that can be employed to build better products [17]. Technology is therefore defined as a set of tools both hardware (physical) and software (algorithms or procedures) that help us act and think better [16]. Technology refers to the diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human needs and wants. Technology has its own impacts on OSH improvement approaches. Technology utilization makes jobs easy and fast to be accomplished in an organization. The technology or materials at the same time have their own negative impact at workplaces. The software and hardware technologies exported from developed to developing countries are at times hazardous for the countries

imported them [18]. Industrial robots, computer-controlled machine tools, video display terminals-these, and other space-age technologies can help reduce workplace injuries and illnesses if safety, health, and work organization factors are built in during design and development. But when accident and illness prevention techniques for new technologies are adopted only after worker injuries or illnesses begin, the result can be serious new workplace hazards [19]. Introduction of software training on how to improve OSH is very important for management and organizations. The software technologies application helps organizations to grasp difficult training system easily and in a manageable time table. Latest technologies have an impact on workplace safety and health improvement. But the selection of proper use and type of technology is a mandate belonging to the industries.

In solving OSH problems, one of the methods employed as a factor in Workplace Innovation (WPI). WIP is different from technical innovation (scientific technologies) in which new end product or a service development process is undertaken, rather than non-technical innovation (supportive technologies) [1]. It is defined by Pot as the implementation of new and combined interventions in the fields of work organization, human resource management, and supportive technologies [16]. It is complementary to use technological innovation. The researcher stresses new and combined interventions, by which new is understood as innovation and combined as a bundle of measures referring to work organization, human resource management and supportive technologies [6]. Thus, innovation is not a goal but a means in which it improves a process performance. There is a growing importance of nontechnical factors to foster economic growth; implying technological innovation alone is not enough to make renewal of an organization's work. It needs efforts in looking into overall process optimization and changing organizational systems. Innovations considered as non-technical factors are for, instance, high-performance work systems and new ways of working. Such nontechnical innovations are considered by studies interchangeably as organizational innovation, workplace innovation, and social innovation in the workplace [20-26]. These innovations are neither the end products (new products or services), nor the Research and Development expenditures. But they deal with renewal and improvement of the deployment of people, management, human resource, organizational structure, primary process, marketing methods, production methods, organizational policies, redesigning, workplace improvements and refreshment of systems. The major problems which are not addressed in workplace improvement are workplace innovation and the meaning it conveys in recent times. Innovation was painstaking and it is the only new idea creation and/or new product development process. Hence, workplace innovation was not stated well in the research findings like that of ordinary innovation. The author of this study has identified workplace innovation being ignored in OSH improvement system one of the remaining improvement factors [1]. Workplace innovation helps to improve workplace performance, quality of working life, human resource management, and policy issues. European countries are initiating this workplace innovation programme [22]. Therefore, workplace innovation programme is indispensable for the policymakers to improve workplace safety and health. Studies indicate that workplace innovation and safety issues have been ignored in developing countries. Therefore, this call for the need to continue conducting research in the future to modernize workplace safety and health improve.

Among the six factors, one of the methods that enable manufacturing

industries to reduce accidents or hazards is a lean philosophy. This philosophy can be an introduction to workplace safety and health improvement. Under this topic, lean workplace improves OSH and reduces ineffective manufacturing work through 6S techniques that add safety as one of the 5S's [1]. Lean is a method of reducing non-value adding activities in the manufacturing industries [27-29]. Workplace safety and health accidents improvement help the manufacturing industries to cut wastes like that of time, when an employee gets absent, compensation cost, skills, unnecessary human resources, energy and damaged manufacturing equipment and tools. Hence, lean OSH philosophy is one of the techniques employed to reduce workplace accidents and hazards if properly applied as an improvement driving force within the manufacturing industries' environment.

Studies have shown that many research works have not been conducted on the subject of lean OSH philosophy. Thus, the wastes due to unsafe workplace conditions have not been clearly identified. Therefore, insight has been gained how lean OSH philosophy safety and health administration through the use of 6S techniques combined with the identified elements.

By integrating the methods into other methods, manufacturing industries will decrease costs, lessen downtime, reduce errors related to safety and health hazards, and apply safety metrics to Value Stream Mapping (VSM). Elimination of wastes can also be interpreted as the elimination or minimization of risk that adversely affects wasted human resources/talents and lost time from injuries [4,30]. Lean imperatives of faster, better and cheaper methods must encompass the issue of running safer workplace as well. A key to worker safety in lean manufacturing operations is the development of informed, empowered and active workers with the knowledge, skills and opportunity to act in the workplace (5S) to eliminate or reduce hazards [27].

Therefore, the aim of this study is to combine the individual parameters discussed in so far analysis to an integrated system. This integrated system interlinked to improve workplace safety and health improvement which is a unique model and that has not been developed in so far researches finding.

## METHODOLOGY

This study has considered mixed types of methodology to come up with this novel schematic workplace improvement model. The study majorly considered the existing studies and manufacturing industries practice in Ethiopia. Thus the primary and secondary data were used. About 189 questionnaires were considered and the Cronbach alpha for the data reliability were made. The questionnaires were clustered into knowledge, management, collaboration, technology, policy and regulations. The data collection considered the secondary data from the literature based on the parameters to identify the six elements for model development.

The reliability coefficient of 0.70 and above is considered "acceptable" in most research situations[31]. In this study, reliability analysis for internal consistency of Likert-Scale measurement after deleting 13 items was found to be better. The reliability coefficients were found for 60 items 0.820 and for the individual groupings made by the researcher. It was also found internally consistent using Cronbach's alpha test. Table 1 shows the internal consistency of the seven major instruments in which their reliability falls in the acceptable range for this research were found.

The overall research process took place as indicated in Figure 1 formulating a problem, reviewing works of literature from recognized journals, collecting data from primary and secondary sources, based on this sources developed the model and checked practicality of the model in the short and long term.

## RESULTS AND DISCUSSION

In this study, different factors of OSH improvement keys were used and came to be combined to produce generic OSH unique model so that readers and practitioners will utilize those comprehensive model either breaking them up to suit their industry safety culture or developing the overall approach in continual pace. The only minor improvement or modification needed is to tailor this model to each organization’s requirements.

The proposed integrated approach in this section indicates that it has five processes. The initiation level which is a driving pressure to improve workplace safety and health of industries. The pressures can be internal and/or external that drives the industry opening a room to an improvement of OSH problems. The pressures from the internal environment would be employees, marketing system, internal management system, working condition, the organizational system, and all inputs are assembled together. These internal pressures need to be addressed by the company owner or top management. The external pressures are wide and determinant of the organization’s existence. They can be customers who need a quality product, fast delivery, WHO, ILO, government policy, regulatory issues, and global competitiveness. The WHO and ILO also one of the pressures to the organization’s indirect that urges the government to improve safety and health so that government goes down to the enterprise level. These drivers are the initiation

force to change safety and health problems to success conditions.

In both the previous and this chapter, the aim of the questions has been to prioritize the OSH success factors based on literature, data analysis, and expert opinions. The OSH factors were ranked as knowledge acquisition and awareness creation, management system, collaboration and support, and proper technology utilization respectively. The second line is an indication where transformational change can be undergoing or recognized through the composition of the approach variables (Figure 2).The organization can take action on the priority factors at the same time in combined with workplace innovation and lean. Otherwise one of the priority element based on the rank step by step in a combination of workplace innovation and lean. This process could be exercised as follow. Knowledge acquisition and awareness creation can be practiced at the first priority through training, promotion, education, practical experiences, research output dissemination, accident reporting and information flow were placed first while management system was placed second in the priority incorporating top management commitment, strong political decision, OSH strategic plan development, team of steering committees, allocation of budget and enforcement, policy development, and developing management standards as being most influential factors for OSH improvements.

When the knowledge acquisition and management system are well exercised, the system gets to stretch forward to collaboration and networking system created with internal and external supporters with collaboration and support geared to workplace safety and health improvement framework. Strong collaboration and networking can be the third priority obtaining the support

Table 1: Occupational safety and health problems based instrument-Reliability.

s/n	Qualitative data major groups	Items number	Alpha (Standardized)
1	Knowledge related factors	K01 to K08	0.864
2	Management related factors	M01 to M17	0.877
3	Technology and suppliers related factors	T01 to T10	0.792
4	Collaboration and support related factors	C01 to C07	0.781
5	Policy , standards and guidelines related factors	P01 to P08	0.888
6	Hazards and accidents related factors	H01 to H10	0.720
	Total	60	0.820

Where: K stands for knowledge; M, management; T, technology; C, collaboration; P, Policy, standards, and regulation; H, hazards and accidents conditions; PPE, Personal protective equipment.

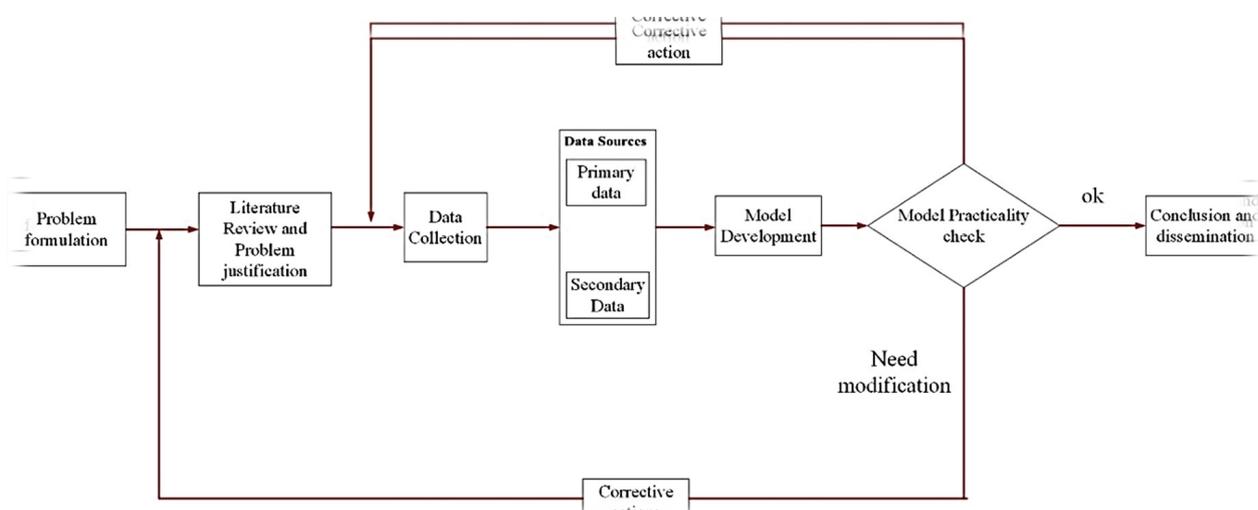


Figure 1: Research Framework.

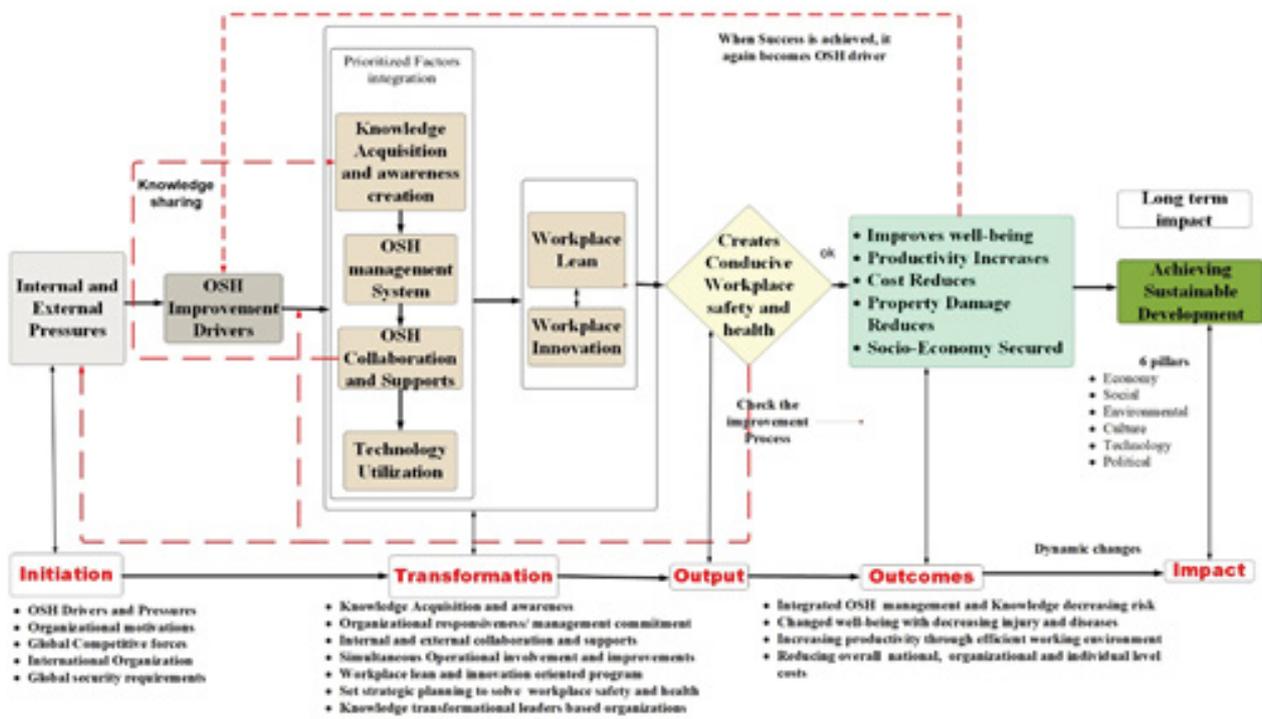


Figure 2: Integrated OSH Improvement Framework (Author).

of stakeholders, networking of inter-organization, working with consultancy services, national teamwork (internal) and international collaboration (external) driving the industries to get strong with experience sharing and chain formation that improves workplace safety and health throughout the life of industries.

The other priority towards OSH improvement is technology utilization approach. Technological change can change jobs, create new skills, redefines employee needs to learn and receive training to determine what they want to do. Technological change is continuous and if an organization's employees are ready to use it properly. On the other hand, it is not used properly; it could be a cause for sudden death. The best thing is to consider technology after having taken into account the three priority areas. Now, it is easy for the use of the latest technology, i.e. environmental friendly, software application, and modern communication tools and promotes workplace safety and health.

It is important to use the improvement systems all at the same time. However, due to economic constraints, lack of large resources, and cultural norm and top management decisions towards OSH improvement system, implementation at the same time is not possible.

All the processes must be integrated or aggregated into workplace innovation (i.e. improving existing, adopting the best practice or creating new systems) and applying lean (waste minimization) measures at each level so that smooth and cost-effective OSH improvement approach could be developed.

The approach could an output which is a signal a conducive work environment and if not takes the loop to the drivers or priority focus so that continually improves the system. If the output is tending to show a signal of the conducive workplace, it leads to the outcome of the process/transformation and it will be the success factor. These success factors tend to be another industry drivers or triggers to act more on workplace safety and health improvement culture. When the overall system of the industries are improved,

the competitiveness of the industry increases and productivity level rise. Direct and Indirect costs of the manufacturing industry will be reduced with the improvement of workplace safety and health. These outcomes lead the organization being successful and the success by itself now become a trigger or initiation for the companies. This forms a loop toward initiate of an organization to improve safety and health challenges (Figure 2). There is a long term impact on the socio-economic development as sustainable development for the whole nation [1,4,14].

In general, OSH management helps both the management and the practitioners to understand the OSH improvement pressures, priorities, workplace innovation, workplace lean policies, and their influence and impact on sustainable developments.

The people with a sense of responsibility in the workplace always think of the employees and their working environment, i.e. their safety and health ahead of productivity. This is similar to people who think that legs are more important than shoes. For the question of productivity is next to human health, happiness, and safety.

### Model validation

The study has conducted some justification approaches of the framework model. The model was developed based on the expert's opinion and agreements with each variables being important. After the model has been developed, the new integrated model was subjected to experts and industries' employees in line with the training of workers. After the discussion, with experts, the applicability of the proposed approach was tested.

A case industry was taken for an illustrative example of model validation during the study time. The training was conducted in the industry to see the challenges, impact and training process. The training conducted by the researcher in this sample pilot manufacturing industry helped to substantiate the model specially the power of knowledge and education in improving workplace safety and health. The author has witnessed how much training

improves workplace safety and health by leading a training session in Selit hauling Plc.

The session could be considered as an example that has changed the attitude, skills, awareness, interests and knowledge of both management and line staff in the industry. The training was given for top management and line employees at different times. After the training, the employees showed better motivational skills, interest, reaction and capability. The reflection on the company's exposure to OSH ideas has demonstrated that training has a strong influence on employees and brings fundamental attitudinal changes that help to increase productivity, reduce costs, improve the health of employees, encourage proper handling of property and raise the general well-being of the environment in which the employees are living. The overall mode was exposed to the employees to forward their intention on its practicality.

The experts added value to the primary model. Based on the expert's feedback, the primary model was changed to the one which is presented in this dissertation (Figure 2).

However, some process of the model like sustainable development needs a longer period of time to investigate the real impact of the outcome. During the discussion of the overall model validation, the judgment of the discussants was that it is difficult to predict the outcome and impact of the conceptual model at this level. Rather, it needs continuous implementation process in the long term as indicated under recommendation section of this study.

### Benefits of proposed integrated approach of OSH

As observed above workplace safety and health comprehensive model results in the sustainable development of manufacturing industries and paves the way towards sustainable development in industrial OSH in line with the development pillars (society, economics, environment, culture, technology, and politics).

The dynamism of socio-economic development has brought change in all aspects of the expansion. Dynamical change on workplace health and safety innovation, a high prevalence of OAS and ODS registration are the initial factors of sustainable development. As Pot argues sustainable development cannot be thought without considering the environment, society, and economy. However, this dissertation has found their study to be lacking culture, politics, and technology as factors influencing sustainable development in corporations with the six bottom-lines to workplace safety and health models [6].

Working in safe and healthy conditions enhances the employees' performance, increases their motivation and effectiveness, raises business productivity, and consequently improves the quality of the product as well as reducing its costs and increasing the sales and revenue in the long term. The quality of the products manufactured in a firm influences people's health in society and significantly affects the environment in which people works and lives [32]. However, as the studies recently presented indicate culture, politics and technology are the modern world's elements of sustainable development and OSH improvement tools. So, they are very important ideas to be added to the six pillars.

Therefore, companies must understand that healthy employees are wealthy and add profit to the industries. Hence, companies should turn their faces from traditional thinking such as productivity and profit-maximization to modern thinking such as keeping employees healthy and happy within the working environment. On the other hand, providing the workers' safety and healthy

infrastructure drives the nation for social, economic, political and environmental sustainability and development. Without healthy workers, safe work places, green environment, and satisfied society cannot be expected to reach their development goals. In another word, unhealthy employees in unsafe environmental working conditions cannot have the maximum productivity and efficiency required from them. It is obvious that without social and economic sustainability, safety and health would not be successfully managed and guaranteed. Citizens of society having economic problems cannot be mentally and physically healthy; nor do employees at workplaces. Besides, lack of economic and advancement and constant regression may lead to an absence of motivation on the parts of workers impacting on their effectiveness and productivity. Environment, culture, and technology also influence the workers' health and their productivity at work. This is mainly because the industries or the organizations are part and parcel of the society and whatever affects one of them, directly or indirectly affects the other.

In general, the model of for industrial workplace safety and health improvement proposed in this research is expected to bring positive results in the direction of sustainable development. The results constitute performances in minimizing workplace accidents, reducing workplace diseases, minimizing cost of injuries, and developing sustainable workplace safety and health management systems. Creating a sense of responsibility into all corporate participants, opening room for employees to contribute their share and facilitating smooth flow of communication in all directions are also parts of these results. Results are also registered by conducting research-based development and experience sharing, focusing on culture, technology, politics, economics, and employees, wellbeing social and environmental benefits so that the entire process lead to sustainable development of enterprises and/or the nation as a whole.

To come up with conclusion, the integrated approach of OSH benefits the organizations as well as the country in solving and reducing workplace hazards. The culture of the society towards safety and health improvement, and leading every individual to seek his/her safety is priority to every need.

## CONCLUSION

This chapter has proposed an OSH improvement model based on the information obtained from the previous analysis conducted in this research. The chapter has attempted to investigate each OSH factors and the proposed framework in terms of its contribution to the overall objectives outlined in the study.

The first part of the model discusses in detail the elements of knowledge diffusion to improve the condition of workplace safety and health. This was based on its being first in priority in the hierarchical development that was outlined in the previous chapter. The second step that was adopted to improve workplace safety and health was the OSH management system. The third OSH enhancement driver discussed was collaboration and support. The model further developed how proper technology utilization was also found to be the major methods to overcome workplace safety and health challenges. The remaining two elements were joined with the four OSH improvement success factors set in priority including workplace innovation and lean philosophy. These six elements based on the literature, data analysis, and the researchers' efforts have been used to design the proposed integrated OSH improvement model.

Based on these factors and approaches, the benefits leading to sustainable development of the nation (macro level) and enterprise level (micro level) were devised. The pillars of sustainable development are social, technological, economic, and culture, as well as political and environmental factors, obtained in line with the search to formulate the OSH model.

## REFERENCES

1. Jilcha K, Kitaw D. A literature review on global occupational safety and health practice & accidents severity. *Int J Qual Res.* 2016;10(2):279-310.
2. Jilcha K, Kitaw D, Beshah B. Knowledge diffusion to workplace safety and health improvement. *JOIE.* 2017;10(21):7-16.
3. Rogers EM. *Diffusion of innovations* (5th ed). New York: Free Press. 2003.
4. Kassu J. An integrated approach of occupational safety and health practice for Ethiopian manufacturing industries. 2017.
5. Marakas GM. *Decision support systems in the twenty-first century.* Prentice-Hall, Englewood Cliffs, New Jersey. 1999.
6. Jilcha K, Kitaw D. Industrial occupational safety and health innovation for sustainable development. *Int. J. Eng. Sci. Technol.* 2017;20:372-380.
7. ILO. *Work related accidents and diseases take a heavy toll worldwide 2010.*
8. Kharbanda OP, Stallworthy EA. *Safety in the chemical industry: Lessons from major disasters.* Heinemann Professional Publishing, Oxford, UK. 1998.
9. Alli BO. *Fundamental principles of occupational health and safety* (2nd ed). International Labour Office-Geneva: ILO. 2008.
10. Tadesse S, Israel D. Occupational injuries among building construction workers in Addis Ababa, Ethiopia. *Journal of Occup Med and Tox.* 2016;11:16.
11. Shahid A, Jamali T, Kadir MM. Noise induced hearing loss among an occupational group of textile workers in Karachi, Pakistan. *Occup Med Health Aff.* 2018;6:282.
12. Alkilani SZ, Jupp J, Sawhney A. Issues of construction health and safety in developing countries: a case of Jordan. *Australasian J of Cons Econ and Building* 2013;13(3):141-156.
13. HSE. *A guide to measuring health and safety performance.* HSE, Rep. 2001.
14. Kumie A, Amera T, Kiros B, Samet J, Hundal N, Fitsum G, et al. Occupational health and safety in Ethiopia: A review of situational analysis and needs assessment. *Ethiop J Health Dev.* 2016;30(1):17-27.
15. Welch M, Sheridan SM. *Educational partnerships: Serving students at risk.* San Antonio, TX: Harcourt Brace. 1995.
16. Pot FD. Workplace innovation for better jobs and performance. *Int J Product Perform Manag.* 2011;6 (4):404-415.
17. Megantz, Robert C. *Technology management: Developing and implementing licensing programs.* Wiley, Hardcover, USA. 2002.
18. Hany M. Idreis, Carlos E. Siqueira, Charles C. Levenstein. Impact of software and hardware technologies on occupational health and safety policies in Saudi Arabian oil refineries, *NEW Solutions. J Environ and Occup Health Pol.* 2006; 16(2): 193-216.
19. ILO. *Economic Security for a better world, ilo socio-economic security programme.* International Labour Office: Geneva. 2004.
20. Hage JT. Organizational innovation and organizational change. *Annual Review of Sociology.* 1999; 25: 597-622.
21. Lam, A. Organizational innovation. *The oxford handbook of innovation.* Oxford University Press. 2004:115-147.
22. Totterdill P. Workplace innovation. Europe 2020's missing dimension. Report of a workshop hosted by DG Employment: Social Affairs and Equal Opportunities. 2010.
23. Eeckelaert L, Dhondt S, Oeij P, Pot F, Nicolescu GI, Webster J, et al. Review of workplace innovation and its relation with occupational safety and health. Bilbao: European Agency for Safety and Health at Work. Publications Office of the European Union: Luxembourg. 2012.
24. EU DG. Enterprise and industry. Short meeting report supporting social innovation in the workplace. Paper presented on the European Commission meeting. 2012.
25. Pot F, Dhondt S, Oeij, P. Social innovation of work and employment. In: HW. Franz, J. Hochgerner & J. Howaldt Challenge Social Innovation. Potential for business, social entrepreneurship, welfare and civil society. Berlin: Springer Verlag. 2012.
26. Peter RA Oeij, Dhondt S, Kraan K, Vergeer R, Pot F. Workplace innovation and its relations with organizational performance and employee commitment. *E-journal Lifelong Learning in Europe.* 2012.
27. Anvari A, Zulkifli N, Yusuff R. Evaluation of approaches to safety in lean manufacturing and safety management Systems and clarification of the relationship between them. *World Applied Sciences Journal.* 2011;15 (1):19-26.
28. Kilpatrick J. *Lean Principles.* Utah manufacturing extension partnership. Utah. An Empirical Study of Malaysian Construction Industry. 2003.
29. Spencer DPPG. *Applying lean manufacturing principles across the IT Organization.* INFOSYS Technologies Limited 2007.
30. Goshime Y, Kitaw D, Jilcha K. Lean manufacturing as a vehicle for improving productivity and customer satisfaction: A literature review on metals and engineering industries. *International Journal of Lean Six Sigma.* 2018:1-25.
31. Mohsen Tavakol, Reg Dennick. Making sense of Cronbach's alpha. *Int J Med Edu.* 2011;2:53-55.
32. Garetti M, Taisch M. Sustainable manufacturing: Trends and research challenges. *Prod Plan Control Manag Oper.* 2012;23(2-3):83-104.