

HOSTED BY



ELSEVIER

Contents lists available at ScienceDirect

Engineering Science and Technology, an International Journal

journal homepage: www.elsevier.com/locate/jestch

Full Length Article

Industrial occupational safety and health innovation for sustainable development

Kassu Jilcha^{a,*}, Daniel Kitaw^b^a Mechanical Engineering department, Kombolcha Institute of Technology, Wollo University, Kombolcha, Ethiopia^b Industrial Engineering Chair, School of Mechanical and Industrial Engineering, Addis Ababa Institute of Technology, Addis Ababa University, Addis Ababa, Ethiopia

ARTICLE INFO

Article history:

Received 31 August 2016

Revised 24 September 2016

Accepted 22 October 2016

Available online 2 November 2016

Keywords:

Safety and health

Innovation

Pillars

Workplace

Sustainable development

ABSTRACT

Sustainable development is not thought in a box without development pillars. Previous researchers put these pillars as economy, social and environment. Upon improving these three pillars, sustainable development becomes trustworthy in relation to workplace safety and health improvement. However, the researchers' findings have drawback in considering existing three pillars. Previous researches neglected to incorporate the other three pillars of sustainable development which are culture, political and technological factors. Having these pillars, sustainable development can also be guaranteed by considering workplace safety and health innovation for all internal and external entities engage at work. This is because of the implementation the pillars reduce the working environment accidents and disease. Hence, this research focuses on the workplace safety & health innovation, introducing new pillars for sustainable development, their impact on sustainable developments and indicating the three pillars future research areas. Methods like literature review, interviewing employees and observation of industries were used. There were few researches found on how sustainable development affected by workplace safety and health innovation approaches. However, this literature more focused on the relationship workplace innovation and sustainable development share in common. The other finding in this study showed that the innovation of workplace safety and health brings sustainable development through healthy people, safer workplace, reduced cost of accidents, controlled environment, managed workplace accidents and improved workplace safety knowledge. The researchers have also attempted to forward roads toward sustainable development through occupational safety and health innovation and improvement approaches.

© 2016 Karabuk University. Publishing services by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Modern economies are driven by agriculture, manufacturing and service industries. Regardless of the governing factors, national economic growth and development on the basis of weak Occupational Safety and Health (OSH) regulatory regime is an invitation for accident [30]. Yesterday, occupational safety and health was not the concern of all parties. But, nowadays, health and safety is becoming the key issues of global worries. In many studies, effective management of occupational safety and health found to play a pivotal role in running a successful business [21]. The global issue for sustainable development of the citizen is the health and safe working groups at their workplace. In order to achieve this, one

of them is the development of sustainable occupational safety and health environments.

Having this challenges, it is mandatory to answer the questions how workplace safety and health innovation results in sustainable development of citizens and forward the roads toward sustainable development in industrial occupational safety hand health. The dynamism of socio-economic development has brought change on all aspects of the expansion. Dynamical change on workplace health and safety innovation, high prevalence of occupational diseases and accidents registration are the initial factors of sustainable development. The existence of occupational safety and health problems is adding level of poverty onto existing burden of the society. There is a strong Malthusian movement which maintains that continued economic growth will disturb the balance of nature, and will eventually lead to ecological catastrophes [34]. This imbalance between innovation and development tends to result in failure in sustainable developments.

* Corresponding author.

E-mail addresses: jkassu@gmail.com (K. Jilcha), danielkitaw@yahoo.com (D. Kitaw).

Peer review under responsibility of Karabuk University.

As Zohreh and Napsiah [33] wrote in their research findings in summarizing that sustainable development and occupational safety, health, and environment are the two controversial concepts which have attracted the attention of many researchers in recent years. They argue that sustainable development cannot be thought without considering environment, society, economy and their working condition.

Hence, this research has attempted to assess OSH innovation in relation to sustainable development variables and their impact on each other. The other approach used is from the interview and observation made in some of Ethiopian manufacturing industries. The researcher used semi-structured interview question to justify the how industrial occupational safety and health innovation affects sustainable development of socio-economy. The result obtained showed us that workplace safety and health innovation has not been considered as a key driver of sustainable development. The companies have less consciousness about these issues. As it has been discussed in literature review, most of the companies' focus on productivity improvement, technological build up and profit maximization of the industries than workplace safety and health innovation. This approach results in indifference of workplace safety, health and environment for sustainable development. Hence, this research attempted to show how workplace safety and health innovation results in sustainable development of the socio-economy. The researchers also forwarded a way how to relate OSH and sustainable development. The future research areas recommended from the gaps identified. The remaining sections in this research includes literature review, methodology of data organization, result & discussion, concluding remarks and future research areas recommended.

2. Literature review

2.1. Occupational safety and health

Occupational safety and health are controversial issues which are most significant in succeeding in industrial development. The German philosopher (1788–1860), Schopenhauer, emphasized on the importance of health by stating that “health is not everything, but without health, everything is nothing [17]. Therefore the specific definition of health, safety and the integration of the two can be seen as occupational health and safety is a holistic approach towards total wellbeing of the employee at work [5]. According to WHO [32] occupational health includes the actions for occupational medicine, occupational hygiene, occupational psychology, safety, physiotherapy, ergonomics, rehabilitation, etc. Safety on the other side involves the protection of people from physical injury [37]. The International Occupational Hygiene Association (IOHA) generally defines occupational health and safety (OHS) as the science of anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well-being of workers, taking into account the possible impact on the surrounding communities and the general environment [18]. Thus, OHS can be seen to concern the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations [20].

As discussed by Amponsah-Tawiah occupational health and safety matters are particularly critical in the developing world especially Africa and Asia. Africa is especially beleaguered with unsafe working conditions in industries such as mining, construction, manufacturing and even service. Alli [12] describes that Africa and Asia have most unsafe practice and conditions in management of children labor, employment, informal economy, gender mainstreaming, labor statistics, labor inspection and maritime safety, HIV/AIDS and the world of work and international migration.

Migration especially from Africa to Europe is one which indicates that the existence of unsafe and sustainable workplace safety and health. People are crossing borders to Europe due to the workplace and living area unsafe for all kinds of activities. Unsustainable development comes from uncomfortable working conditions or low economic status otherwise due to instable political condition.

Estimating the economic cost of occupational injuries and illnesses is another issue of workplace accident and disease. In addition to immeasurable human suffering, these fatalities and ill health cause major economic losses for enterprises and societies as a whole, including lost productivity and reduced work capacity [3]. This study has compiled that an estimated that around 4% of the world's gross domestic product (GDP) is lost due to various direct and indirect costs, including compensation, medical expenses, property damage, lost earnings and replacement training (ILO, 2003, 2012 cited in [3]).

It is much more widely recognized today that occupational accidents and diseases can have a major impact on the productivity, competitiveness, reputation of individual enterprises, livelihoods of individuals and their families. Moreover, at the national level, occupational accidents and ill health can cause an intolerable humanitarian and economic burden, damaging any reputation for good business and negatively impacting sustainable economic growth. In short, prevention pays [3]. This indicates that relevant high-burden non-communicable diseases are getting increased than communicable disease in which these are from occupational burdens globally. These non-communicable disease results in deficiency of sustainable development of the citizen, especially for developing countries, it draws backward from sustainable development movement.

2.2. Sustainable development

Sustainable development is the optimum use of resources in all respects. The Rio Summit [32] and Gilding et al. [8] in its declaration defined sustainable development comprehensively as strategy to meet the needs of the present world population without causing adverse effect on health and on the environment, and without depleting or endangering the global resource base, hence without compromising the ability of future generations to meet their needs.

The new strategy outlined by the World Conservation Union, Caring for the Earth, defines sustainable development as “improving the quality of human life while living within the carrying capacity of supporting ecosystems” (18). This report focuses on sustainable development as a process requiring simultaneous global progress in a variety of dimensions: economic, human, environmental, and technological.

Thus, sustainable development appears that gains marked in green technology and sustainable development stands the risk of being offset by costs of occupational health and safety, diseases and hazards [5]. Sustainable development from the definition should focus on the present and future generation needs centering the human health and environmental protection as a base line of the development. It does not compromise the present and the future world changing generation health and needs so that productive life and needs of the generation kept well. In traditional view, sustainable development was seen as interlocking of three pillars economic development, social development, and environmental protection overlooking emerging dimensions of sustainable developments [22,5].

The sustainable development strategy of an organization is not only reflected in the increase in the production value of the organization, but should be evaluated together with other aspects such as economic effectiveness, utilization of resources, occupational health and safety, and environmental protection [1]. In this

research the writer says that economic effectiveness and OSH are the inseparable variables. Hence, the overlooked dimensions in sustainable development are cultural, political and technological changes.

2.3. Workplace and innovation

Workplace innovation (WPI) brings radical change in the workers' environment, thereby enhancing the profitability of companies [21]. However, most research and discussion of innovations are focused on product development and/or process improvement, disregarding workplace and service innovation [21].

The term workplace innovation refers to how people are deployed in order to improve performance and also to create good quality jobs [14]. The definition of workplace innovation (WPI) is taken from Pot [23] as the implementation of new and combined interventions in the fields of work organization, human resource management and supportive technologies. It is complementary to technological innovation even though it was unnoticed as being a basic workplace environment comfort forming process. Pot and Karolus Kraan [25] and Pot [23] described workplace innovation as new or plain innovation and as combined interventions or a bundle of measures referring to work organization, human resource management and supportive technologies which is a commonly used definition and widely accepted. WPI is important because of its social, economic and labor market impact, which is now being widely acknowledged among many European policy-makers [29]. The term innovation is defined by Pot [23] as renewal and by Totterdill [29] as a change leading to workplace improvement. Renewal/change is to make alteration, transformation or modification on the existing system to fit the current state-of-the-art [21]. They concluded the researchers' discussion that the outcomes converge to the same concluding central idea which carries the term improvement.

Eeckelaert and Steven Dhondt [15] also conceived social innovation as a means to combat both social and societal challenges such as financial and economic crises, unemployment, participation, social cohesion, and climate change, and to increase innovation, productivity and growth. These all factors improvement have major contributions to the global sustainable development.

Empirical findings suggest that technological innovation accounts for 25% of the success in radical innovation, whereas workplace innovation accounts for 75% of success (Volberda Vanden Bosch, and Jansen, 2006 cited in [24]; Jansen et al., 2011 cited in [25]). However, with such evidence of the impact of WPI on performance results, it remains remarkable that so few companies are investing in WPI. Therefore, more focus on WPI practice and investing knowledge and finance to see the impact it has on improving productivity levels is needed. Thus, WPI results in "active work situations" where in workplaces and jobs, workers have sufficient autonomy to control their work demands combined with a more discretionary capacity for learning and problem-solving [21]. WPI is also related to the development and implementation of coherent interventions in the areas of work organization, control structure and employability of staff [14].

Eeckelaert et al. [15] in their study also showed that WPI areas dealt with the design of the organization, the design of management tasks, and the design of jobs with the objective of simultaneous improvement of organizational performance and quality of working life. It therefore affects not only the internal functions of an organization (work organization, labor relations) but also the external functions (network relations), and in turn WPIs will be affected by environmental flux [15]. It does not cover the whole range of occupational safety and health (OSH) topics and OSH performance, but it does include low stress risks, high job autonomy, lower physical workload, continuous development of competences

and better labor relations [24,31,26]. In general innovation and workplace innovation gives mandate to the sustainable development of the citizen in any means.

2.4. Links between occupational safety & health innovation and sustainable development

Occupational health & safety innovation and sustainable development can be approached from varying perspectives. Existing literature review has mentioned a lot on the occupational safety and health (see for instance Joan Burton [2], ILO, 2010, [7,36,11,16,27,10]). However, the relationship between occupational safety and health with sustainable development has got little research priority. Currently, the workplace safety and health impact on sustainable development for developing economy has no significant implication as the industries are not well developed. As described by Alli, workplace being unsafe and unhealthy means sustainable development cannot be achieved as the employment rate decreases and by the reverse migration increases in developing economies.

The interface between OSH and sustainable development as indicated in Fig 1 of three P's (people, planet and profit) are strongly infused entities for the improvement of OSH and sustainable development of the citizen. When we speak about people or society we are talking about their health, safety, and sustainable development. In similar fashion in discussing about planet (environment), we are discussing the sustainable green economy and green environment were the living place, and working environment is comfortable for the people. Lastly when we are discussing about profit (economy), we are talking about the result of saved poele and controlled environment (planet) which results in sustainable development. Thus, these three pillars are the interfused for the improvement of OSH and sustainable development.

Firms cannot be considered as optimizing profitability without significant occupational health and safety related to diseases, accidents, hazards, working environment and people improvement scheme.

Globally, costs of occupational health and safety diseases have been on the increase. Global financial losses due to workplace injuries and ill health exceed \$1250 billion [38]. By conservative estimates workers suffer 270 million occupational accidents and 160 million occupational diseases each year [19]. Occupational injuries alone account for more than 10 million Disability-Adjusted Life Years (DALYs) lost, or healthy years of life lost whether to disability or premature death, and 8% of unintentional injuries worldwide [35]. Poor occupational health and reduced working capacity of workers may cause economic loss up to 10–20% of the Gross National Product of a country [32]. Globally occupational deaths, diseases, and illnesses account for an estimated loss of 4% of the Gross Domestic Product [28]. These changes are hindrance of development especially for African and Asian. As discussed workplace accidents and diseases costs accounts for 10–20% of the GDP of the nation.

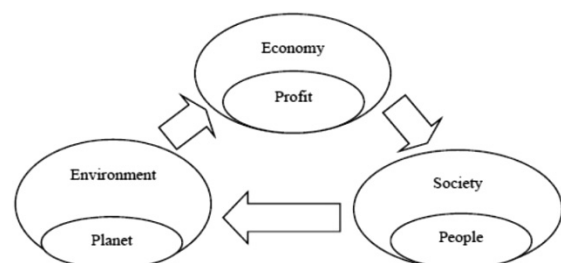


Fig. 1. OHS sustainable development interface [5,13].

As indicated in Fig. 2 is a schematic representation of the relationships between occupational safety, health, and environment, and sustainability. This figure illustrates that working condition would influence the sustainability triple bottom line and it would be also affected by the company's policy towards sustainable development.

Hence, without improving or innovating workplace safety and health, occupational accidents, disease and costs will not be reduced. Without considering our planet green economy workplace safety and health challenges cannot come to an end. If these two are not controlled, profit is only imagination and thereby sustainable development is unexpected. Hence, sustainable development is an integration of all the three P's.

3. Methodology

This study was conducted using the methodology of desk review considering data sources from international journals related to occupational safety, occupational health, innovation and sustainable development as well as the link exists between occupational safety, health, environment and sustainable development. It also utilized websites source from Wikipedia, reports, discussions and other magazines. The desk review method was organized based on data sources from OSH researches finding in developing countries, research finding from sustainable development prospective, from studies showing linkage between occupational safeties and innovation related to sustainable developments, and cost of accidents from different research databases.

The other primary data sources were obtained from eighteen manufacturing industries of Ethiopia through interview and discussion. Individual and group discussions were conducted on the OSH related problems, OSH accidents and disease, impact on productivity, impact on firm costs, OSH innovation, sustainable development lagers due to OSH and workplace innovation impact on sustainable development and workplace safety improve. The interview was conducted based on some important factors the researcher considered important for this paper (Table 1). The interview and data collection was held from March 10, 2016 to April 25, 2016 for the purpose of the principal Author dissertation. There were some interview questions related to this research aim and they were drawn out from the interview elements. These have been reorganized and presented in Table 1:

More than fifteen questions were asked and eight of them were found weighing more. In Table 1 semi-structured interviews indicates that multi response were allowed for the interviewee to express their opinion freely on all issues. The interview was conducted on only 18 companies from leather, steel, chemical, textile and wood work industries due to high contribution to employment and priority areas of government second growth transformation plan hubs in Ethiopia. The interview question type was yes or no type for the semi structure questions. Where there is need for open-end question, the question were extended to the next response seeking.

In addition to this primary data collection, field survey/observation was conducted. This observation helped the researchers to triangulate the responses those obtained from interview and manual of the companies.

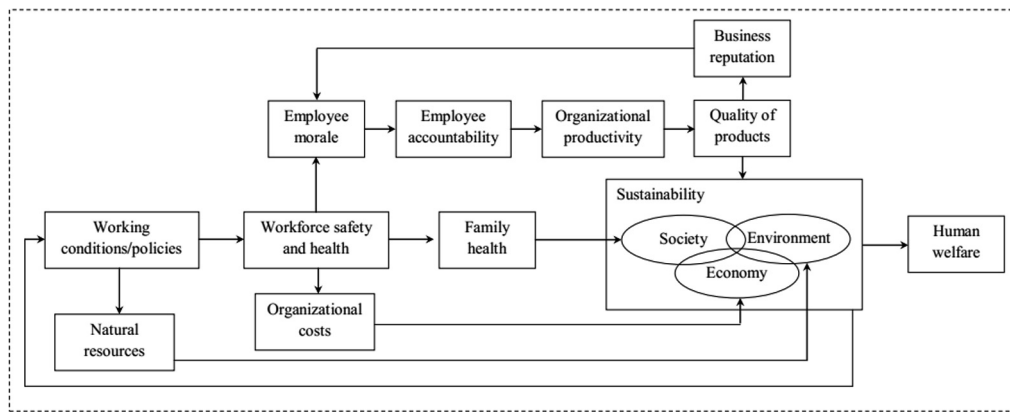


Fig. 2. Occupational safety, health & environment and sustainable development linkage [33].

Table 1 Interview response numbers and their percentage share.

Codes	Question items	Number of respondents said (yes)	Percentage	Number of respondents said (No)	Percentage
WPIE	Is there workplace innovation experience in the company?	1	5.56%	17	94.44%
OSHK	Do your company have Occupational safety and health knowledge?	2	11.11%	16	88.89%
OSHISD	Do you think OSH improvement result in sustainable development?	10	55.56%	6	33.33%
WPISD	Do you think workplace innovation is a key to sustainable development?	17	94.44%	1	5.56%
TMCIWI	Do top management commitment improves workplace and innovation?	15	83.33%	3	16.67%
SDASHRM	Do you think sustainable development comes when OSH risk minimized?	17	94.44%	1	5.56%
QLIRWH	Do you think quality of life improved in reducing workplace hazards?	15	83.33%	3	16.67%
WPIRCI	Do you think workplace innovation reduces cost of injuries?	16	88.89%	2	11.11%
AFDIRWP	Do you think annual forum discussion bring innovative ideas and reduce workplace problems?	17	94.44%	1	5.56%

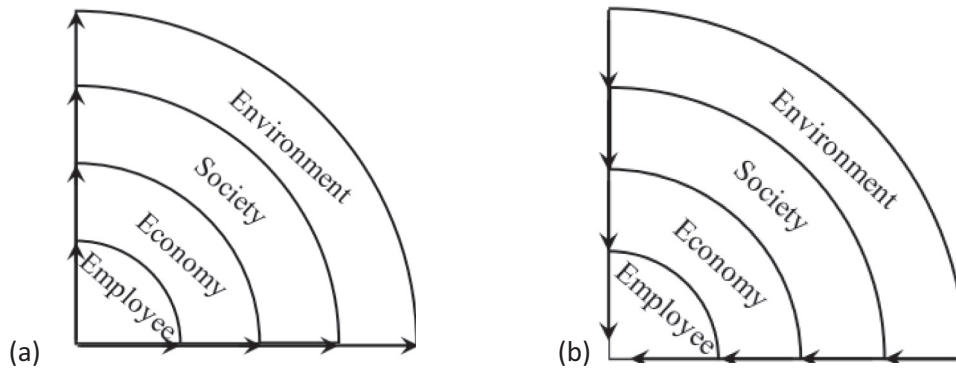


Fig. 3. (a) The approach of occupational safety, health, and environment; (b) the approach of sustainable development [22,33].

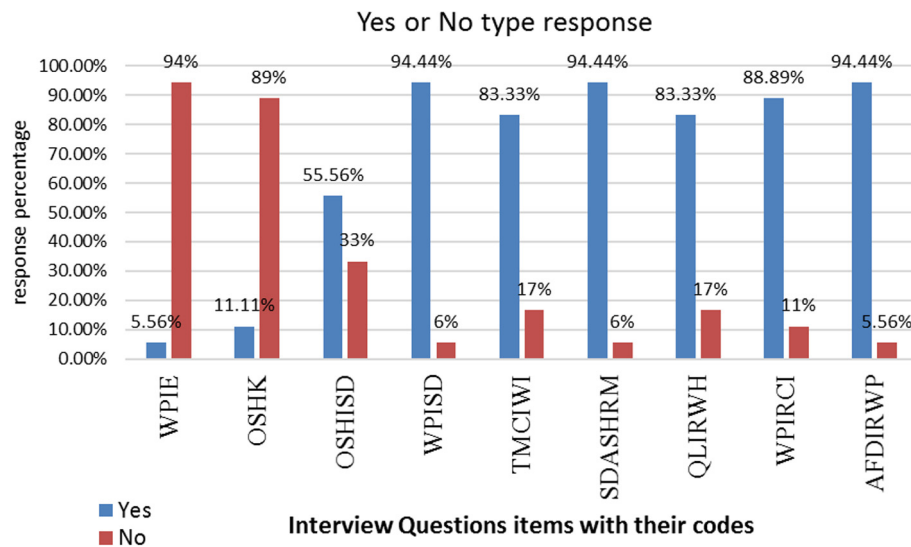


Fig. 4. Interview questions response in percentage (codes are in Table 1).

4. Result and discussion

Previous studies conducted on OSH link with sustainable development showed that there are three pillars of sustainable development as economic, environment and society. However, they missed the other three basic elements such as culture, technology and politics which improves the OSH and sustainable development. These, in turn, give a sign of linkage to working environment and health within the basic pillars. As a result of this inconsideration of researchers, in this research the new approaches of sustainable development were introduced. The case study also utilized to see the current effects of the pillars and OSH to sustainable development.

Researchers' literature discussion proved that how OSH ignorance creates injury cost, accidents and disease on the employees. In turn, it contributes to weak development of the economy. It can be inferred from the previous discussions and definitions of sustainability and occupational safety, health, and environment that they are attempting to reach the same goal through different processes. As it is shown in Fig. 2, working in safe and healthy conditions enhances the employees' performance, increases their motivation and effectiveness, raises the business productivity, and consequently improves the quality of the product as well as reduces its costs and increases the sales and revenue in the long term. The quality of the products produced in a firm influences people's health in the society and significantly affects the environment in

which people works and lives [9,22]. However, as the studies recently shown us that culture, politics and technology are the modern world's elements of sustainable development and occupational safety and health.

The Interaction between people, planet and profit which are the so called the three pillar dimensions of sustainable development were discussed in different literatures. However, in this modern and dynamically changing world, they overlooked the three pillars which are political, technological and cultural issues (refer to Fig. 5). Amponsah-Tawiah [5] and Garetti and Taisch [22] discussed about sustainable development dimensions and OSH improvement approaches. But both of them unnoticed the influence of culture, politics and technology. When there is a good and positive culture, there is a good social mottoes in which all the people are devoted to participate in the sustainable development through improving all the contributing factors. Similarly, with good and confident, stable and self-sustained political policy, people are stable and systems are leading toward the development roads.

As shown in Fig. 3(a) occupational safety, health, and environment approach primarily addresses the employees while that of Fig. 3(b) addresses the environment [33]. Sustainable development, in other hand aims at preserving the natural resources for the future generations while the present generation's needs and the societies' requirements are being considered. Both OSH and sustainable development have the four elements in common for firm profitability conditions [22,33]. These researcher add

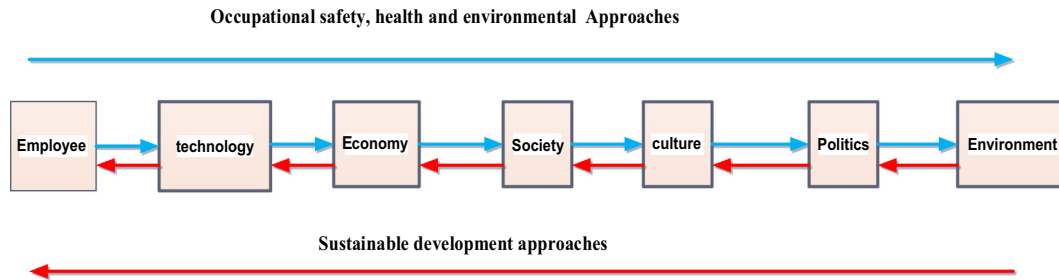


Fig. 5. OSHE and sustainable development approaches element improvement.

employee as one pillar and the other consider the three once only. They did not consider politics, technology and culture.

4.1. A case study

To elaborate the overall discussion, the researchers considered a case studies on eighteen manufacturing companies. The interview and field observation were conducted. Interview questions were prepared and responses obtained. The companies are negligent for workplace safety, health, environment, workplace innovations, workplace injury costs and sustainable development.

A number of respondents' age lies between 20 and 30 years. These means the employees working in this companies are in productive age and if they face accidents, they are costly to the economy of the citizen. They have recommendable job experience so that we can consider them enough matured to give reliable data.

Almost, all companies' employees were complaints that the companies are not giving them personal protective device, upgrading training, job manuals, and other privileges related to workplace. Many of them replied that the companies are focusing on the productivity improvement, profit maximization, and getting more money. But these could not be attained without improving the workplace environment, carrying for the safety and health of employees and focusing on occupational accidents and disease minimization. Reduction of problems cannot be achieved without the involvement of employees and the company owners/managers. In their response, most of the interviewee said that if one raise safety and health issue, the companies' owner prefer to fire and hire new once. They do not consider firing and hiring has cost to the company. They do this because of the availability of human resources in Ethiopia.

The quote of Schopenhauer answer for this thought of the companies which is stating that "health is not everything, but without health, everything is nothing [17]. We can understand from this that health and safety are preliminary issue of the sustainable development. Alli [12] also describes that Africa and Asia have most unsafe practice and conditions in management of children labor, employment, informal economy, gender mainstreaming, labor statistics, labor inspection and maritime safety, HIV/AIDS and the world of work and international migration. Without safe and healthy workplace, sustainable development cannot be expected as we can see from this researcher's attest.

Fig. 4 shows that the interview response as "yes" or "no" have been obtained on workplace innovation experience. The response obtained from the interviewee with "yes" has been indicated in bracket and the remaining is for "no". The response on workplace innovation experience (5.56%), employees have Occupational safety and health knowledge (11.11%), OSH improvement resulting in sustainable development (55.56%), workplace innovation is a key to sustainable development (94.44%), top management commitment improves workplace and innovative (83.33%), sustainable development comes when OSH risk minimized (94.44%), quality of

life improved in reducing workplace hazards (83.33%), workplace innovation reduces cost of injuries (88.89%) and forum discussions (94.44%) were obtained on these issues. Unfortunately, the companies taken for the sample did not interesting intention toward the employees' health and safety. The employees are working for the survival of their families and the employers are working for profit maximization. These do not create any common targets toward inclusive development of the society.

There is a missing point where both employees and employers are not working for inclusive sustainable development. These could not be initiative compromising working environment and pillars of OSH and sustainable development.

The above discussion can correlate with other researchers finding point of view. Totterdill [29] defined innovation as a change leading to workplace improvement. This study tells that innovation support improvement of workplace environment through continuous improvement tools so that the working environment becomes comfortable. Hence, the sustainable development of a citizen accelerated due to reduction of workplace accident, disease and injury costs. Sustainable workplace environment means sustainable development for any country. From Eeckelaert et al. [15] also we can learn that such as financial and economic crises, unemployment, participation, social cohesion, and climate change, and to increase innovation, productivity and growth through societal innovation is a key for the sustainable development. Without these parameter sustainability, in the case companies no sustainable development of inclusive change of citizen. As discussed by Pot et al. [24], Ramstad [26], Westgaard and Winkel [31]; WPI includes low stress risks, high job autonomy, lower physical workload, continuous development of competences and better labor relations which results in sustainable development stability of a country. From the case companies, the researchers attempted to triangulate the theory with observation and developed a correlation among factors indicated in Table 2.

Table 2 as organized by the Authors from the literature summery and interview discussion points, it shows that improving workplace safety and health management elements can improve workplace innovation and makes to reach the goals of sustainable development. Occupational safety and health improvement or accident causes related factors such as Personal protective equipment, job systems, personal characteristics, occupational accidents/injuries, occupational diseases, occupational injuries cost, occupational environment (external-internal), society, government, stakeholders/employers, employee participation, work culture, management culture/system, and family/individual are correlated with workplace innovation and sustainable development.

As Alli tried to summarize workplace being unsafe and unhealthy means sustainable development cannot be achieved as the employment rate decreases and by the reverse migration increases in developing economies. As a result of this finding, companies must understand that healthy employee are wealthy and profit for the company. Hence, companies should turn their face

Table 2
Relationship among workplace safety and health factor, workplace innovation and sustainable development.

s/n	OSH related factors	Influence of Workplace innovation	Effect on sustainable development
1	Personal protective equipment	Enforce employees to use properly	Use of PPE reduces productive labor force injuries which leads to sustainable development
2	Job systems	Makes job and job characteristics easy and simple to both employees and managements	When job system improved, sustainable development is secured
3	Personal characteristics	Improve the personal behaviors and increase the workplace satisfaction	When all employees and employers behavior focus to changes, sustainable development will emerge
4	Occupational accidents/injuries	Decreases the number of fatality, disability and injuries	Upon reducing occupational injuries, costs and property damages secured and leads to sustainable development
5	Occupational diseases	Decrease prevalence of occupational diseases due to accident causing factors innovations	Disease resulted due to occupational accident reduced means sustainable development of the citizen granted
6	Occupational injuries cost	Decrease the occupational costs through reduction in accidents and disease	When injury costs reduced, health and economic failure reduce, hence sustainable development is improved
7	Occupational environment (external-internal)	Improves both internal and external environment that results in failure to meet the compliance	When both external and internal environment gets green, sustainable development results
8	Society	Life of the society and standard of the society increases and society decreases environmental degradation results in unsafe workplace	Upon society thought development, sustainability increases. One of the driver of sustainable development is society, hence change culture and development
9	Government	Drives government to engage in the policy making decision and resource allocation	Play a great role for the sustainable development while supporting the working environment safety and health
10	Stakeholders/employers	Changes their attitude from productivity and profitability based attitude to workplace innovation	Sustainable development comes when stakeholders/employers come out of the box
11	Employee participation	Increases the employee to participate in workplace accidents prevention and hazard control with confidential communication	In every industries, enthusiastic and sense of owner participation of employee bring sustainable development in improving workplace safety and health
12	Work culture	Improve and makes systematic approach of working process change with change in system	Upon improving working culture of the industries, sustainable development is assured
13	Management culture/system	Leads to innovative workplace and confidential management decision making, help to approached employee properly	Top to lower management commitment to the workplace innovation and improvement leads to sustainable development of citizen/society
14	Family/individual	Safe the individual safety and health hence the family does not suffer from accidents	Safe and healthies family/individual creates combined energy to ward sustainable development

from traditional thought such as productivity and profit maximization scheme to modern thought such as keeping employee health and working environmental leads to greening the economy is a profit and wealth.

4.2. Results and new approaches

Occupational health is considered by this orientation to be at the center of sustainable development [33]. Generally, WHO [7,6] identified safe workplaces and healthy workers as the prerequisites for productivity and social, economic, and sustainable development. Amponsah-Tawiah [5] has indicated that the enterprises with the best occupational safety and health practices are the most productive and the most economic, social, and environmentally friendly businesses. According to BHPbilliton [4], sustainable development is an indispensable part of occupational safety, health, environment, and community, and aims at propelling constant improvement in performance.

The Fig. 5 shows an improved approaches of workplace safety, health environment and sustainable development.

As previous studies debated that the approach to occupational safety, health and environment primary focus on employees, economy, society and environment respectively. Here, the authors attempted to include technology after employee, culture next to society and political issue before environmental consideration (see Fig. 5). Technology is one of the state-of-the-art to improve working conditions and get priority. There by optimization of economy and social standards improvement become a priority. Even though society life is to be improved, the culture of the society should be reconsidered while improving the working environment and health. Culture vary (culture is dynamics) from society to society and need the consideration of social culture when improving the working environment. To improve and control environment the other issue that has not been considered in the

researches was political issues. Considering those all issues and ignoring political strength leads to weak sustainable development.

Hence, Fig. 5 shows the modifications of the approaches mentioned by Garetti and Taisch [22], Molamohamadi and Ismail [33] in Fig 3, and Fig. 6 the modification of three pillars Garetti and Taisch [22], Molamohamadi and Ismail [33] in Fig 1 to enhance sustainable development through those pillars.

As indicated in Fig 6, the six bottom line for sustainable development were derived from the three sustainable developments pillars. In this research technology, culture and working environment (politics) were introduced as new parameters for sustainable development.

Therefore, in other hand, providing the workers' safety and health infrastructure drives the nation for social, economic, political and environmental sustainability development. Shorn of healthy workers, safe working places, the environment and the society satisfaction, it cannot be expected to development. In another words, unhealthy employees in unsafe environmental working conditions cannot have the maximum productivity and efficiency. As a result, the organization would experience financial crisis which in turn brings difficult economic sustainable conditions for workers and the stakeholders, including customers, shareholders, and the society. Moreover, workers' injuries and property damages are not only do increase the company's costs, including medical expenses, operational costs, and compensations to the society and individuals, but also destroy its business reputation and decreases its market share [33]. This, in turn, undermines the employee morale and motivation, adversely affects the quality of the products, and results in organization's unavoidable disappearance from the market. Consequently, the occupational safety and health programs directly address the employees, while indirectly affect the society, technology, innovation, culture, economy, politics and environment in the long term. On the other hand, without social and economic sustainability, safety and health would not be successfully managed and guaranteed. Society having

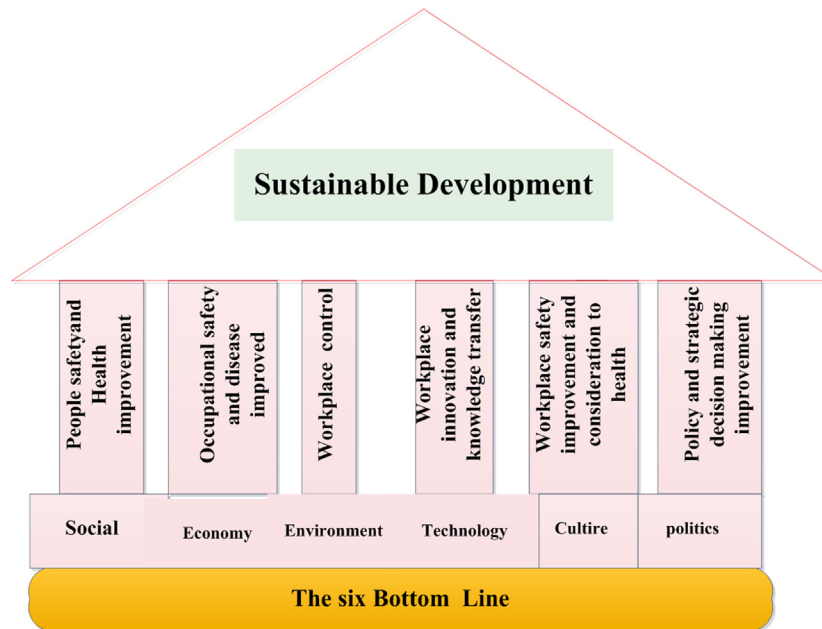


Fig. 6. Pillars of sustainable development and approaches of safety and health.

economic problems cannot be mentally and physically healthy employees at work. Besides, lack of economy and its inconsistency may lead to lack of motivation and affect workers' effectiveness and productivity effort. Environment, culture and technology also influence the workers' health and their productivity at work. This is mainly because the company or the organization is a part and territory of the society and whatever affects one, directly or indirectly impacts the other.

In general, industrial workplace safety and health innovation results in sustainable development in improving the following basic areas. They performances in minimizing workplace accidents, reducing workplace diseases, deducing cost of injuries, developing sustainable workplace safety and health management systems, creating responsibility to all corporate participants, opening room to employees participation and creating smooth flow of communication in all directions, research based development and experience sharing, focusing on culture, technology, politics, economics, employees, social and environment.

5. Conclusion and recommendation

In conclusion, this study has attempted to see the industrial occupational safety and health innovation effect on the sustainable development. In literatures many researchers had attempted to show the link between safety, health, environment and sustainable development. This research targeted and focused on the impact of OSH and sustainable development in conjugation of pillars. The pillars previously considered were sees as economic, social and environmental for sustainable development. However, sustainability cannot be thought in a box without the consideration of workplace safety and health improvement, reduction of occupational accidents and disease, workplace innovation, people safety and controlling environment. Profit and sustainable development are interlocking parameters if and only if the working environment, society and culture are considered key elements for the sustainable development.

The most three pillars of developments have elaborated and the three were found as gaps of the studies. It has been attempted to introduce culture, technology and politics to the bottom lines of

the existing triple pillars. This makes strong interconnection of the six pillars for sustainable development.

The study also took eighteen Ethiopian case companies using interview questions and field observation. It supported to triangulate the literatures and the stand point of the researchers to recapitulate how the manufacturing industries employees and managements understand the workplace innovation, sustainable development, workplace safety & health situations, and workplace cost reduction and forum discussion. Form the result it was obtained that 94% of the respondents resulted in there is no workplace innovation experience, 89% of the respondents gave response in no workplace safety and health knowledge (training), and 33% of the respondent response show that OSH improvement does not result in sustainable development. In contradiction, even though there is no such involvements in the companies, more than 84% of the respondents believe that workplace innovation is important for injury reduction, cost reduction, sustainable development and top management commitment and forum discussions take this share of the response rate. Most of the response indicated that workplace innovation is one element for the sustainable development but their companies did not exercise these elements for the improving of the organization.

In general, recommendation are drawn-out from the discussions above on some sort of ideas for further research areas. Researchers can go further on economic effectiveness and OSH interrelation and inseparability; short-term and long-term benefits, partial and the overall benefits of workplace innovation and sustainable pillars; a new production management style and workplace safety and health improvement systems to utilize effectively renewable resources including human resources, and people to learn to value and protect themselves. Finally, on the effects and long term impacts of culture, technology and politics have all sustainable developments pillars in relation to workplace safety and health.

References

- [1] Qiang Chen, Sustainable development of occupational health and safety management system – active upgrading of corporate safety culture, *Int. J. Arch. Sci.* 5 (4) (2004) 108–113.

- [2] Joan. Burton, WHO Healthy Workplace Framework and Model: Background Document and Supporting Literature and Practices, International Labour Organization, Geneva, 2010.
- [3] ILO, Safety and health at work: a vision for sustainable prevention: XX World Congress on Safety and Health at Work 2014: Global Forum for Prevention, 24–27 August 2014, Frankfurt, Germany/International Labour Office. – Geneva, 2014.
- [4] BHPBilliton, Health, safety, environment and community management standards: BHP Billiton HSEC management standards, no. 3, 2005.
- [5] K. Amponsah-Tawiah, Occupational health and safety and sustainable development in Ghana, *Int. J. Bus. Administration* 4 (2) (2013) 74–78.
- [6] WHO, Global strategy on occupational health for all: the way to health at work. Recommendation of the second meeting of the WHO Collaborating Centres in Occupational Health, Beijing, China. [Online]. Available: http://www.who.int/occupational_health/globstrategy/en/, 1994.
- [7] WHO, Health indicators of sustainable jobs, presented at Initial findings from a WHO Expert Consultation, pp. 17–18, 2012.
- [8] P. Gilding, M. Hogarth, R. Humphries, Safe companies: an alternative approach to operationalizing sustainability, *Corporate Environ. Strategy* 9 (4) (2002) 390–397.
- [9] Adam Szirmai, Developing countries and the concept of development: The Dynamics of Socio-Economic Development: An Introduction, Cambridge University Press 0521817633 – Excerpt, 2005.
- [10] Z. Aderaw, D. Engdaw, T. Tadesse, Determinants of occupational injury: a case control study among textile factory workers in amhara regional state, Ethiopia, *Hindawi Pub. Corp. J. Trop. Med.* 2011 (2011) 1–8. <http://dx.dio.org/10.1155/2011/657275>.
- [11] S.Z. Alkilani, J. Jupp, A. Sawhney, Issues of construction health and safety in developing countries: a case of Jordan, *Aust. J. Constr. Econ. Build.* 13 (3) (2013) 141–156, <http://dx.doi.org/10.5130/CEB.v13i3.3301>.
- [12] B.O. Alli, Fundamental Principles of Occupational Health and Safety, International Labour Office, Geneva, 2008.
- [13] K. Amponsah-Tawiah, Occupational health and safety and sustainable development in Ghana, *Int. J. Bus. Administration* 4 (2) (2013) 2013.
- [14] U. De Sitter, Human resources mobilization: setting the stage for organizational innovation, in: L.E. Andreasen, B. Coriat, F. den Hertog, R. Kaplinsky (Eds.), *Europe's Next Step: Organizational Innovation, Competition and Employment*, Frank Cass, Ilford (Essex), Portland, 1995, pp. 243–249.
- [15] Eeckelaert, L. Steven Dhondt, Peter Oeij, Frank Pot, Georgiana Ioana Nicolescu, Alina Trifu, Jennifer Webster, Review of workplace innovation and its relation with occupational safety and health, Luxembourg: European Agency for Safety and Health at Work: Publications Office of the European Union, 2012.
- [16] P. Hamalainen, J. Takala, K.L. Saarela, Global estimates of occupational accidents, *Safety Sci.* 44 (2006) 137–156, <http://dx.doi.org/10.1016/j.ssci.2005.08.017>.
- [17] Hassard, J. Flintrop, T. Clausen, K. Muylaert, Motivation for employees to participate in workplace health promotion, A Report prepared for the European Agency for Safety and Health at Work, Luxembourg, 2012, pp. 1–29.
- [18] International Labour Organisation, ILO Standards on Occupational Safety and Health: Promoting a safe and healthy working environment, International Labour Conference, 98th Session, Geneva, 2009.
- [19] International Labour Organization (ILO), Occupational health and safety: synergies between security and productivity, ILO, Geneva committee on Employment and Social Policy: GB295-ESP-3-2006-01-0211-1-En.doc/v2, 2006.
- [20] Joint ILO/WHO Committee, Definition of Occupational and Safety, 12th Session of Joint ILO/WHO Committee on Occupational Health. [Online] Available: www.ilo.org/safework, 1995.
- [21] Kassu Jilcha, Daniel Kitaw, Birhanu Beshah, Workplace innovation influence on occupational safety and health, *Afr. J. Sci. Technol. Innovation Dev.* 8 (1) (2016) 33–42, <http://dx.doi.org/10.1080/20421338.2015.1128044>.
- [22] M. Garetti, M. Taisch, Sustainable manufacturing: trends and research challenges, *Prod. Plan. Control Manage. Oper.* 23 (2–3) (2012) 83–104.
- [23] F.D. Pot, Workplace innovation for better jobs and performance, *Int. J. Prod. Perform. Manage.* 64 (4) (2011) 404–415, <http://dx.doi.org/10.1108/17410401111123562>.
- [24] F.D. Pot, E.A.P. Koningsveld, Quality of working life and organizational performance: two sides of the same coin?, *Scand J. Work Environ. Health* 35 (6) (2009) 421–428, <http://dx.doi.org/10.5271/sjweh.1356>.
- [25] Pot, F. Karolus Kraan, Peter R.A. Oeij, Robert Vergeer, Steven Dhondt, Workplace innovation and its relations with organizational performance and employee commitment. E-journal Lifelong Learning in Europe, 4. <http://www.iline.fi/en/issue/42012/issue-42012>, 2012.
- [26] E. Ramstad, Innovation generating model – simultaneous development of work organization and knowledge infrastructure (Ph.D. thesis in Technology), Helsinki University of Technology, Espoo, Finland, 2008.
- [27] Y.S. Serkalem, A.N. Ansha, Determinants of occupational injury in Kombolcha textile factory. North-East Ethiopia, *Int. J. Occup. Environ. Med.* 4 (5) (2014) 84–93.
- [28] J. Takala, Safe work—the global program on safety, health and the environment, *Asian-Pacific Newsletter Occup. Health Saf.* 7 (2002) 4–8.
- [29] P. Totterdill, Closing the gap between evidence based practice and common practice? Workplace innovation and public policy in Europe, E-Journal Lifelong Learning in Europe, 2012.
- [30] Usman Abubakar, An overview of the occupational safety and health systems of Nigeria, UK, USA, Australia and China: Nigeria being the reference case study, *Am. J. Educ. Res.* 3 (11) (2015) 1350–1358.
- [31] R.H. Westgaard, J. Winkel, Occupational musculoskeletal and mental health: significance of rationalization and opportunities to create sustainable production systems – a systematic review, *Appl. Ergon.* 42 (2) (2011) 261–296, <http://dx.doi.org/10.1016/j.apergo.2010.07.002>.
- [32] WHO, Global strategy on occupational health for all: the way to health at work, Geneva, 1995.
- [33] Zohreh Molamohamadi, Napsiah Ismail, The relationship between occupational safety, health, and environment, and sustainable development: a review and critique, *Int. J. Innovation Manage. Technol.* 5 (3) (2014) 198–202.
- [34] G. Bruntland (Ed.), *Our common future: The World Commission on Environment and Development*, Oxford University Press, Oxford, 1987.
- [35] Disease Control Priorities Project (DCPP), Developing countries can reduce hazards <http://www.dcp2.org/file/139/DCPP-OccupationalHealth.pdf> (Accessed 26-03-2009), 2007.
- [36] J. Takala, International agency efforts to protect workers and the environment, *Int. J. Occup. Environ. Med.* 5 (1) (1999) 30–37.
- [37] P. Hughes, E. Ferrelt, *Introduction to Health and Safety in Construction Industry*, third ed., Butterworth-Heinemann, Imprint of Elsevier, USA, 2008, pp. 2–5.
- [38] ILO, Safety culture at Work. Safety in numbers: Pointers for global safety culture at work. International Labour office, Geneva, 2003.