



# **ADVANCING INDUSTRIAL ENGINEERING IN NIGERIA**

**THROUGH**

# **TEACHING, RESEARCH AND INNOVATION**

**A BOOK OF READING**

*Edited By*  
**Ayodeji E. Oluleye  
Victor O. Oladokun  
Olusegun G. Akanbi**

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**(A Festschrift in honour of Professor O. E Charles-Owaba)**



**Professor O. E. Charles-Owaba**

Advancing Industrial Engineering in Nigeria  
through Teaching, Research and Innovation.

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## FOREWORD

It gives me great pleasure writing the foreword to this book. The book was written in recognition of the immense contributions of one of Nigeria's foremost industrial engineers, respected teacher, mentor, and lover of youth – Professor Oliver Charles-Owaba.

His commitment to the teaching and learning process, passionate pursuit of research and demonstration of excellence has prompted his colleagues and mentees to write this book titled – Advancing Industrial Engineering in Nigeria through Teaching, Research and Innovation (A Festschrift in honour of Professor O. E Charles-Owaba) as a mark of honour, respect and recognition for his personality and achievements.

Professor Charles-Owaba has written scores of articles and books while also consulting for a medley of organisations. He has served as external examiner to various programmes in the tertiary educational system. The topics presented in the book cover the areas of Production/Manufacturing Engineering, Ergonomics/Human Factors Engineering, Systems Engineering, Engineering Management, Operations Research and Policy. They present the review of the literature, extension of theories and real-life applications. These should find good use in the drive for national development.

Based on the above, and the collection of expertise in the various fields, the book is a fitting contribution to the corpus of knowledge in industrial engineering. It is indeed a befitting gift in honour of erudite Professor Charles-Owaba.

I strongly recommend this book to everyone who is interested in how work systems can be made more productive and profitable. It represents a resourceful compilation to honour a man who has spent the last forty years building up several generations of industrial engineers who are part of the process to put Nigeria in the rightful seat in the comity of nations. Congratulations to Professor Charles-Owaba, his colleagues and mentees for this festschrift.

Professor Godwin Ovuworie  
Department of Production Engineering  
University of Benin

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## CHAPTER 13

### On Safety, Health, Productivity and National Development

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#### Abstract

Occupational health and safety has become an important subject of discourse globally. The aim is to safeguard the safety, comfort and well-being of the workforce of any nation. This is applicable to all branches of industry, business and commerce, information technology establishments, recreational facilities without leaving out domestic activities. As a result of the effect of this subject on the economy and national development together with the challenges involved, the issue has attracted the attention of many stakeholders including government, management of work organisation, researchers among others. In this chapter, the combined impact of safety, health, productivity and national development is conversed. It is concluded that for a nation to develop, productivity must grow steadily and one of the key ways to attain this, is that the health, safety and well-being of the workers who are the drivers of development must be guaranteed in any workplace.

#### 1.0 Introduction

The issue of health and safety has become a worldwide subject. The reason is that safety, comfort and well-being of the workforce of any nation is very germane to the goal of attaining national development. Safety and health matters are important to any area of human endeavours

and are applicable to business and commerce, information technology establishments, recreational facilities and even domestic activities. As a result of the impact of this subject on the economy of any nation and by extension, national development together with the challenges involved, the issue has attracted the attention of many stakeholders including researchers, management of work systems and government agencies. In virtually all countries of the world occupational safety and health is an important subject matter as efforts are made to for the safety and well-being of people at work. The importance of safety and health cannot be overstressed, so also is productivity. Work as noted by Charles-Owaba (2010) is very vital for any nation to achieve development as it is the only known bridge between human desire and its fulfillment. Hence for an individual or nation at large, any meaningful development cannot take place unless work is done. In this chapter, the synergy between safety, health, productivity and national development is discussed.

## **2.0 Safety, Health and Productivity**

Though the keywords stated here may not be unfamiliar to most readers, it may still not be out of place to make attempt to describe them.

### **2.1 Safety and Health**

Safety according to OSHA 1800 1 as quoted by Paul (2013) is a tool or device designed to prevent accidents, incidents and injuries which can be achieved by eliminating or reducing hazards and risk involved in every working activities that are conducted on industrial or work premises. In occupational safety and health, safety is seen as state of being safeguarded against occupational accident,damage, injury, death and other detrimental circumstances while at work. Furthermore, it is where known hazards that may be present in a work environment are reduced. Hughes and Ferrett (2011) define health as the protection of the bodies and minds of people from illness resulting from materials, processes or procedures used in workplace, while WHO statedthat health is a state of complete mental, physical and social well-being and not merely the absence of disease or infirmity. Eurofound (2015) was of the view that health and safety is not just prevention of accidents and disease but also consists of every aspect of workers' comfort. The definition of ILO and

the WHO reiterated that health and safety regulations are aimed at advancement and sustenance of:

- (i) The maximum degree of mental, physical, and social well-being of all employees in every occupation.
- (ii) The avoidance of workers leaving work as a result health challenges due to their working conditions.
- (iii) The security of workers in their occupation from risks coming from factors hostile to health;
- (iv) Every worker is placed in an environment that is adapted to his or her physiological and psychological capabilities (Eurofound, 2015)

Based on the aforementioned definitions and others from the literature, Molamohamadi and Ismail (2014) submitted that two major objectives of occupational safety and health and sustainable development maybe highlighted as:

- (i) Protecting the workers' mental and physical health by averting work related accidents, injuries, and diseases and making work environment safe.
- (ii) Focusing on the nature and the environment by forbidding and or controlling the usage of injurious objects to the environment, decreasing environmental effluences, and using resources prudently.

## **2.2 Concept of Productivity**

Like any other subject, productivity has been defined in several ways. European Productivity Agency (EPA) explained productivity as an attitude of mind. It is deliberately making efforts to make progress, constant advancement of what is in existence. It is the conviction of ability to get better than yesterday and always. It is the continuous adaptation of economic and social life to changing conditions and continual efforts to apply new procedures and techniques. Another definition is that productivity is the relationship between the output of a production or service system and the input available to generate this output hence productivity is defined as the efficient and effective use of resources (Charles-Owaba, 2004). And resources include, land, labour, energy, information, materials e.t.c. in the production of goods and

services. In addition, it is not only determined by quantity and quality, but also by the value the customer gains. This is particularly true for the service industry. Perhaps an all-encompassing description of productivity is by Prokopenko (1987) who stated that on a general note, productivity may be seen as a comprehensive assessment of how an organization meets some standards stated as follows: (i) Objectives- which indicate the extent to which the objectives are attained. (ii) Efficiency: How well the resources are utilised i.e. doing things right and (iii) Effectiveness: This is comparing what is achieved to what is possible, i.e. doing the right things.

Productivity is important to the life of industrial firm and the economic progress of a country. It is expected that when productivity is growing in every facet of the economy, the standard of living of citizens should improve.

### **3.0 Work system, Safety, Health and Productivity**

Workers (man) and workplace are two words that appear common to all the terms either implicitly or explicitly. Safety and health are addressing issues that have to do with man while at work, and productivity has to do with performance of work systems where man works. It is imperative to examine on the roles of man and the work system.

#### **3.1 Man and Work system**

Production of goods and services take place in a work system. This indicates that productivity would be affected by the environment and the way a work system operates. A work system is a system in which man is one of the main components interacting with facilities, materials, information, energy and finance to perform any of these objectives:

- (i) Transform raw materials into finish goods
- (ii) Extract raw materials in their natural state and
- (iii) To perform predetermined service or an item or people.

Any industrial set-up or establishment would be involved in any of the three objectives of work system. Furthermore in a work system, work would either be performed by man or machine and or combination of the

two. A combination of the two is termed man-machine work system. Charles-Owaba (2010) defines man-machine work system as the combination of humans and machines as well as their mutual interrelations in the effort to receive and utilise input resources to attain desirable outputs. In another words man-machine system is an arrangement in which one or more human beings together with at least one physical component with interrelationship to bring out from given set of inputs, some desired outputs. It can vary from a simple structure to a very complex one. Irrespective of whether a work system is simple or complex, man at work is the main focus. It is man that drives work systems, hence his safety and health are paramount.

### **3.2 Man-Machine Work system**

On a general note, the main goal of designing any work system is to determine suitable man-machine combination that most effectively and efficiently make use of information, material, energy and finance to accomplish relevant tasks for the achievement of set goals and objectives. During the designing process, parameters that relate to man should be regarded as constants while those having to do with facilities, material, energy, information, finance and environment are considered as variables. Hence, to put in place a work system with the desired level of productivity in view, the systems variable values are chosen to suit the nature of man, his abilities, capabilities and limitations. The reasons for this approach are due to the following:

- (i) In virtually all work systems, man acts as the controller, to ensure effective and efficient control therefore the designer is constrained by the capabilities and limitations of man. A designed work system that does not take this into consideration may not be controllable or usable.
- (ii) The designer can at will restructure the machine and the material information system and the environment if need be. However, to redesign a man is an impossible and infeasible task.

Thus, man components are regarded as the most critical or important in any work system and it is necessary that this prominence is given to man in every work system. In any work system/workplace safety practitioners must be concerned with the operations in the work system

in such a way as to ensure that the main principle of Human Factor Engineering/Ergonomics of “fit the task to the man and not the man to the task” is maintained. It should be noted that this principle is applicable in manufacturing and commercial environment as well as service industries including hospitals, education, sports as well as domestic and leisure activities. Upholding this principle in workplace would lead to higher productivity, safety of the workers and reduction in rate of accidents while failure to adhere to this will lead to negative impacts of various forms of musculoskeletal disorder and cardiovascular problems, increases possibility of operator-related health hazards together with decrease in productivity.

### **3.3 Man-Machine Work system and Environment**

Whether or not man performs effectively and efficiently in his workplace to ensure increase in productivity and guarantee his safety and health will depend on some factors. These factors to some extent will determine the health, well-being, safety and efficient performance in working place as well as everyday activities. Ergonomists have identified these to include general environment, immediate environment and personal inherent limiting factors in man (Murrell, 1965; Groover, 2007)

#### **3.3.1 General Environment**

This refers to ambient conditions in the workplace and includes such as lighting conditions, background colour, heat or cold, noise, humidity, pollution, wind velocity, pressure, vibrations, and radiations. These general environments have to be conducive to the body requirement so that man can work effectively and efficiently. One of the tasks of management is to determine the value of the above which will be conducive to the productivity of the work system.

#### **3.3.2 Immediate Environment**

The immediate environment include such things as tools, materials, machines, space, posture, displays, clothing, controls and other men. In specified immediate environment, the main task is that of stating the number, types, sizes and relative position of each.

### **3.3.3 Personal Limiting Factor**

Apart from environmental, anatomical and physiological as well as psychological factors inherent in man that serve to limit or enhance his performance are some characteristics inherent in an individual that contribute to his good or poor performance. Some of these are anthropometric structure, physical work capacity, mental capacity, motivation, gender, age and rest activities.

These ergonomic factors interact in affecting human performance. When these factors are appropriate and conducive for a worker in a work system, his safety and comfort would be guaranteed and would be productive. Figure 1 presents a summary of how these factors interact to affect human performance and productivity.

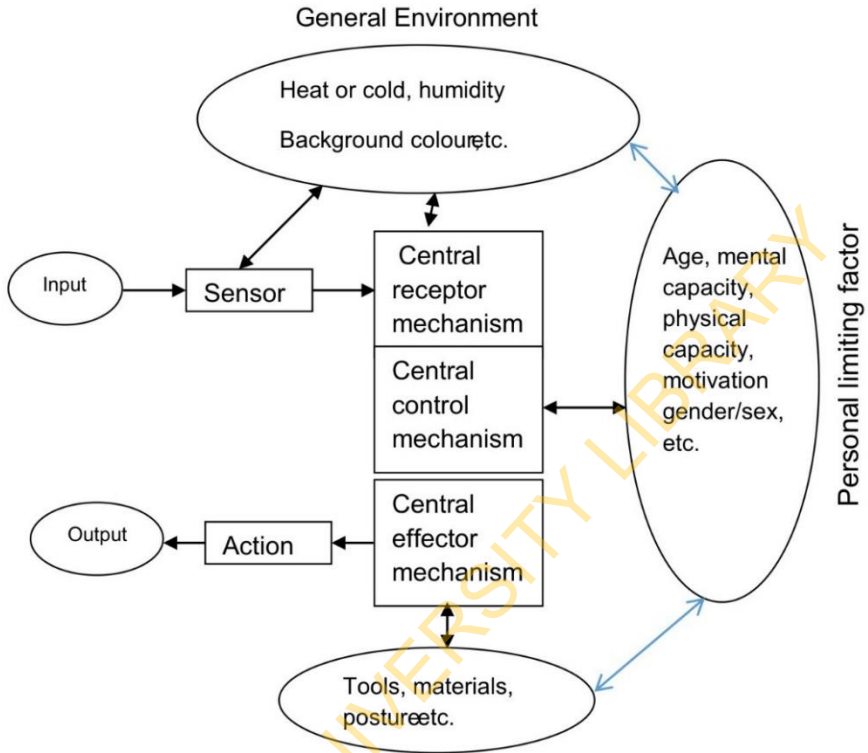


Fig.1: Human interaction with work environment (source: Charles-Owaba, 2010)

#### 4.0 Safety and Health Programme for Productivity and National development

The possibilities of integrating safety and productivity are becoming increasing topical interest in occupational safety (Salminen and Saari, 1995). The desire of most productive system be it production or service system is to increase productivity sometimes at the expense of safety of workers. However, rather than prioritising productivity above safety, the two should be seen as goals that can be attained concurrently. Karanika *et al.*, (2018) observed that generally, when workers are pleased with the conditions and environment where they work and also feel secured from



any form of injury, they would be more productive. There is therefore a need to consider how ensuring safety and health programme in workplace would eventually lead to productivity improvement.

#### **4.1 Safety and Health Programme**

In order to have a healthy and safe work system that would lead to increase in productivity, there should be a concerted effort for effective health and safety programme. Avoiding injuries, discomfort and death together with financial pains for employees, their families as well as employers are major concerns of safety and health programme (OSHA, 2016). Ikeoguet *al.*, (2013) identified two approaches to health and safety programme as reactive and proactive approaches. Reactive is responding to injury or illness after occurring with an aim of reducing cost relating to illness and or injury while proactive approaches considers safety and health prior to incidence of any accident. Proactive foresees and make efforts to avoid accidents, it includes all actions directed toward removing accident, procedures used towards managing risks, analyse the environment for any form of hazard, prevent sickness or diseases and ensure that no worker has zero workday. Maintain. Ikeoguet *al.*, (2013) further stated that reactive is costlier than proactive programmes as it waits for the occurrence of injury or accident before taking any action. This statement of Ikeoguet *al.*, (2013) was corroborated by OSHA (2016) with the submission that proactive method is better than reactive in handling safety and health in workplace as it recognises that locating and dealing with hazards before accident occurs is a much more effective approach.

##### **4.1.1 Core Elements of Safety and Health Programme**

To implement and have an effective safety program that workers would want to embrace without hindering production and services, OSHA (2016) suggested some practices for an effective safety and health programme. These are described as follows.

**Management Leadership:** Top management must demonstrate its commitment to continuous improvement in safety and health, communicates that commitment to workers, and sets program

expectations and responsibilities. At all levels, safety and health should be made a core organisational value by managers, establish safety and health goals and objectives, provide adequate resources and support for the programme and set a good example.

**Participation of Worker:** In setting goals, identifying and reporting hazards, investigating incidents, and tracking progress; workers and their representatives are involved in all aspects. All workers, including contractors and temporary workers, understand their roles and responsibilities under the programme and what they need to do to effectively carry them out. Workers are further encouraged to have means of communicating openly with management and to report safety and health concerns without fear of retaliation. Whatever may serve as barrier to worker participation in the programme should be removed.

**Hazard Identification:** Safety and health hazards from routine, non-routine, and emergency situations are identified and assessed with procedures put in place to continuously identify workplace hazards and evaluate risks. An initial assessment of existing hazards, exposures, and control measures is followed by periodic inspections and reassessments to identify new hazards. Any incidents are investigated with the goal of identifying the root causes. Identified hazards are prioritised for control.

**Hazard Prevention and Control:** Employers and employees work together to identify and choose ways for eliminating, preventing, or controlling workplace hazards. Controls are selected based on a hierarchy that uses engineering solutions, safe work practices, administrative controls, and personal protective equipment (PPE) in that order respectively. A plan is developed to ensure that controls are implemented, interim protection is provided, progress is tracked, and the effectiveness of controls is verified.

**Training and Education:** Every worker should have understanding about how the programme works and how to perform the responsibilities assigned to them under the programme. Employers, managers, and supervisors receive training on safety concepts and their responsibility for protecting workers' rights and responding to workers' reports and concerns. All workers are trained to recognise workplace hazards and to understand the control measures that have been implemented. Safety

knowledge which is basically the level of workers' awareness on organisational safety systems, practices, and procedures is determined by the level of education and training that an employee is exposed to (Liu, *et al.*, 2020). It has been found that organisations that increase the knowledge of employee about safety through safety training record lower rate of accidents and injuries (Tinmannsvik and Hovden, 2003). This stresses the importance of employees acquiring necessary skills through education and training.

**Programme Evaluation and Improvement:** Control measures are periodically evaluated for effectiveness. Processes are established to monitor program performance, verify programme implementation, and identify programme shortcomings and opportunities for improvement. Necessary actions are taken to improve the programme and overall safety and health performance.

One other important means for safety and health in workplace is to take advantage of digital tools. Safety and productivity can be improved through technology by upgrading old machinery or making use of digital record-keeping tools that track key safety metrics across all locations. Old machinery not only presents a safety risk but also results in productivity loss. Outdated equipment leads to unplanned productivity loss because most of these machines require frequent mechanical work and maintenance. It also puts workforce in danger.

#### **4.2 Relating Safety, Health and Productivity**

It is obvious that safety and health compliance activities would impose cost on management of any work system. The question one may want to ask is whether safety compliance really worth it. Several studies have shown that investment in occupational safety and health is very beneficial. For example, Thiede and Thiede (2015) stated that Health and safety measures decrease injuries, increase efficiency, and bring income security to workers' families apart from intangible benefits such as trust, motivation and security. Similarly, Riaño-Casallas and Tompa (2018) reported that investment in occupational health and safety per full time

equivalent in medium and large companies in Colombia was statistically significant at 1% level. It was estimated that 4,919 injuries were averted through these investments resulting in the avoidance of \$3,949,957 in costs.

Also, Hendrick (1996) stated that good ergonomics or safety and health programme is good economics. This implies that on the long run benefits to be derived would outweigh the cost. Safety should not be an afterthought and it also does not have to be associated with productivity loss. Proper and continuous safety training at all levels within any work system can reduce costly and dangerous mistakes.

Effective management of any method that enhances safety and health such as ergonomics has been linked to accident and incident prevention for decades. Resnick and Zanotti (1997) and Kadefors et al. (1996) noted that a comfortable environment supported operators in performing their job tasks productively, and a safe working environment increased the confidence of personnel, reducing, in turn, the occurrence of injuries. Giving employees with well-designed workstations and training in proper body postures allows them to work more efficiently. On the other hand, poor ergonomics or safety and health practices in workplace have been associated with lower productivity (Clarke, 2006; Dianat et al, 2016).

Many work and everyday life situations are hazardous to health. Dul and Weerdmeester (2008) noted that apart from different type of costs that are associated with poor health and safety programmes across the globe, illnesses of the musculoskeletal disorders (majorly lower back pain) and psychological diseases constitute the major causes of absence due to illness and of occupational disability. Some side effects of neglecting or non-compliance with safety principles may not manifest in the body system of the workers immediately but later at old age. Providing the right working environment can assist in reducing these problems.

## **5.0 Benefits of Safety and Health Compliance**

From Hendrick (1996) and OSHA (2016), it can be deduced that effective implementations of occupational safety and health programmes bring other benefits which are summarised as follows:

- i. Reduction in turnover as new employees will likely find ergonomically designed tasks that are not beyond their physical capacity.
- ii. Compensation costs and other forms of payment such as illness and engaging new employee are reduced.
- iii. The self-esteem of workers is enhanced.
- iv. Productivity would go up by making tasks easier and creating more conducive environment for employees thereby enhance overall business operations
- v. Workplace illnesses are avoided
- vi. Compliance with required laws and regulations are improved upon. Enhance their social responsibility goals
- vii. Absenteeism is drastically reduced as workers will not likely take off time to recover from soreness of muscles, fatigue and other musculoskeletal disorder related problems. A significant decrease in employees' compensation premiums would be achieved

## **6.0 Conclusion**

Importance of safety and health of man at work has been enumerated as key to productivity increase and national development. It has been highlighted that it is people (workers) who are well, mentally and physically fit that would engage in activities that would lead to national development. When people are hale and hearty to perform their jobs in both public and private sectors, there would be development.

The prominence placed on the importance of health of workers as explained in this chapter agrees with the saying that though health is not everything, but without health, everything is nothing. It appears safe to state that health and safety are not everything but with good health and safety there would be room for growth in productivity and national development. It is concluded that a growing productivity in every ramification will lead to better standard of living of the citizens and

thereby national development. Therefore to attain national development, the health, safety and well-being of the workers who are the drivers of development must be guaranteed in any workplace.

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