QUANTITATIVE ANALYSIS OF FACTORS AFFECTING MANUFACTURING WORKERS PERFORMANCE IN INDUSTRY: CASE STUDY OF PLASTIC COMPANIES IN EASTERN NIGERIA, USING SPSS.

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ABSTRACT: *This work investigates the quantitative analysis of some factors that affect the performance of manufacturing workers in industries in southern Eastern Nigeria. Experiments were designed, and conducted through the use of work measurements technique and Tests Studies. These selected specific factors (maintenance, equipment, Power/Energy, technology, safety and Training.) used for the study, were investigated using eighty-two manufacturing workers from thirteen manufacturing companies. Data were collected for analyses. The software used was SPSS. Software tools used for various analyses in the study are: statistics, correlation, multi linear regression, response surface regression and multi- co linearity diagnoses, while t – value, F- ratio, p – values and variance of inflation factors (VIF) were used to test the hypotheses. The various statistical analyses performed were presented, studied and interpreted. The correlation coefficients are positive and in descending order of maintenance, equipment, Power/Energy, technology, safety and Training. The coefficient of determination, R^2 and the variance ratio (VR); and F- value and t –coefficient values were also determined for strong inference. Curves were generated to observe the behavioral patterns of the relationship between manufacturing workers' factors influence on performance. Results showed that the identified factors affected the performance of manufacturing workers in the manufacturing industries, in such a manner that the Companies productivity is affected positively by some factors and negatively by some others. Therefore, in the general consideration, the factorial indices that predicted the manufacturing workers performance of the selected factors: motivation, power, safety, maintenance, training, equipment and technology are found to be 0.877, 0.48, 0.614, -1.36, 0.789, 1.421 and – 0.495 respectively. These factorial indices are valid in controlling problems arising from manufacturing industries.*

KEYWORDS: Quantitative, Analysis, Factors, Manufacturing Workers, Performance Industry, Company.

INTRODUCTION

Background of the Study

Manufacturing is an important production activity, carried out by a person or group of persons or company that produces articles or products and sell to customers or consumers. Manufacturing involves making of products from raw materials by means of various manufacturing processes, machinery, and operations through a well-organized plans of activities called the production system. The production systems are divided into two categories: facilities and manufacturing support systems. The facilities of the production system consist of the factory, the equipment in the factory, and the way the equipment is organized. Manufacturing support systems are set of procedures used by the company to manage production and to solve the technical and the logistics problems encountered in ordering materials, moving work through the factory and ensuring products meet quality standards; product design and certain business functions are inclusive (Mikell, 2002). The type of manufacturing performed, depends on the kind of products to make. Manufacturing can be carried out by manual, semi-automation and automation processes. Manufacturing can be carried out on the discrete (plastic cans, bolts and nuts, etc.) or continuous (vegetable oil) types of products (Serope, 2000). These products are sometimes termed to be industries that are carried out in factories.

Today, the term factory is generally referred to as a large establishment employing many people involved in mass production of industrial or consumer goods. Some form of the factory system, however, has existed since ancient times. The textile industry was one of the first industries to be mechanized in 18th century in Britain.

In Nigeria and Africa in general, manufacturing Industries, particularly small and medium–sized operate under various conditions and constraints which oppose the achievement of organizational goals. These are the conditions and constraints which oppose the achievement of organizational goals such as unavailability of electricity, inadequate infrastructures, incompetent personnel, equipment, problems arising from government policies, incentives, and operating environment problems; inadequate protections or safety, inability to control costs and many other factors are adversely affect performance in manufacturing industries. Therefore, the understanding of their nature is quite important as we gear towards the development of Industries in Nigeria.

Furthermore, Farr Grant et al (2007), proclaimed that there are scattered throughout Nigeria small family of businesses producing traditional craft goods – **pottery, Carvings, ornamental cloth, and leather goods – and modern consumer goods, such as bricks and other building materials, milled grain, and beverages. They** presented that large scales of enterprises were established, mostly in the Southern Nigeria; they include **motor vehicle assembly plants, oil refineries, and factories producing textiles, fertilizers, rubber goods, pharmaceuticals, foodstuffs, pulp and paper, cigarettes, aluminum, iron and steel, ply wood and petrol chemicals.** The smaller industries are often organized in craft guilds involving particular families, who pass skills from generation to generation.'

Statement of Problem

One of the major concerns of manufacturing firms is focused on improving workers productivity (performance measures) [Borman, 2004], and it is the extent of achieving the objectives of any firm (Greguras, 1996). Companies, oftentimes desired to produce in order to break-even and to make effort for the provision of inputs for good outputs, but this intention was not usually realized due to some degree of limiting factors in productivity. Poor productivity results to low profitability or poor profit margin. Sometimes, these limiting factors affect the quality of productions, and manufacturing workers performance.

A lot of factors are considered to be responsible for these poor outputs in the manufacturing industries and many of these factors have been studied by many researchers singularly and they came up with the results that those factors affect productivity and hence performance of manufacturing workers in manufacturing industries.

Objectives of the Study

I To determine the percentage contributions of each of those factors in affecting the performance of manufacturing worker in ind ustry in the Southern Eastern States of Nigeria.

II To use test and times studies to generate data from the chosen manufacturing workers from the various industries or companies randomly selected from the existing population.

III To use the software package for social science (SPSS) to analyze the processes

IV To develop models, and determine the variability of the factorial indices relative to manufacturing workers performance

Research Hypotheses

Statement of hypothesis is postulated out of curiosity to find the relationship between cause and effect variables (Davis, 1981)). The following null hypotheses were drawn to enable the researcher validate the various responses emanating from the field work.

H_{01}: Performance of manufacturing workers in industries is not affected by Motivation, Power and Energy, Maintenance, Safety, Training, Equipment or Technology.

H_{02}: That the observed relationship between the dependent and independent variables occurred by chance.

H_{03}: That the Coefficients of the independent variables are not good enough to predict the regression model.

H_{04}:That the quantitative values of the results obtained from the various parametric measurements of the factors do not fit adequate to the manufacturing workers performance characteristics.

Scope and Limitation

The scope of the study is to determine quantitatively factors that affect the manufacturing workers performance in industry macroscopically and limited to the study of some selected discrete products industries, such as the manufacturing of injection, extrusion and PET blowing plastic products industries.

It is also important to determine the factorial indices of those factors and the various regression models that predict the performance; the significance, validity of the indices and the co-linearity diagnosis of the factors that sort for confirmatory tests.

Theoretical frame work

Human Resources Management is becoming more and more complex as society develops (Hersey & Blanchard, 1988)). Psychological thinking has produced a veritable jungle of theories which try to explain human behaviour in general and employees' motivation in particular, but basically these theories can be divided into two major conceptions: the internal set of theories and the external set.

The internal set of theories (otherwise known as nativistic or humanistic) stem from the works of Kant, which are supported by Freud, Maslow, McGregor and Herzberg; in these, man is seen as capable of developing physiologically and psychologically from biological essentials. Therefore, it is argued, that the focus should be on stimulating the growth of internal capacities which give rise to feelings, attitudes and the like. More recently, this field has been expanded by the addition of cognitively-based motivational theories such as Vroom's Expectancy Theory and Adam's Equity Theory (Luthan, 1988). Needs theories assumed that the motivation process is built on the foundation of an unsatisfied need, and amongst them is:

Maslow's Hierarchy of Needs

The most widely accepted 'needs classification' was proposed by Abraham Maslow. He hypothesized that within every human being there exists a hierarchy of five needs:

(i) Physiological; which includes hunger, thirst, shelter, sex and other bodily needs,

(ii) Safety; which includes security and protection from physical and emotional harm

(iii) Social; which encompasses affection, belongingness, acceptance and friendship,

(iv) Ego includes internal esteem factors such as self-respect, autonomy and achievement, and external esteem factors such as status, recognition and attention,

(v) Self-actualization; which is the drive to become what one is capable of becoming includes growth, achieving one's potential and self fulfillment.

From the standpoint of motivation, a substantially satisfied need no longer motivates any action towards meeting it. Higher order needs are satisfied internally to the person, while lower order needs are satisfied predominantly externally, by such things as money, wages, union contracts, job security. Maslow's theory received widespread recognition among managers, because of its intuitive logic and ease of understanding. But the theory suffers from serious deficiencies.

LITERATURE REVIEW

Overview of socio-technical system theory

The term "socio-technical system" was first coined by Emery and Trist to better convey the nature of complex human-machine systems. Socio-technical systems theory proposed a top-down view of a system as a transformation process permeable to the external environment. Two major components interact in this transformation process: the personnel subsystem, and the technological subsystem. The personnel subsystem comprises the human element of the distributed group. The technological Sub system includes not only machines, but also conceptual tools not represented by any physical equipment. Socio-technical systems theory emphasized the concept of joint causation which dictates that all parts of a system react together to causal events in the environment. This idea of joint causation serves as the foundation for a joint design and joint optimization approach to distributed group research and design. In this sense, since both subsystems react jointly to changes in the external environment the only way to avoid sub-optimization of the distributed group as a whole is to avoid optimizing one subsystem and then fitting the other (Hendrick, 1991).

Co-existing with these two subsystems is the organizational design. The organizational design of a distributed group determines how the external environment affects each of its two main subsystems. Also, the organizational design affects the way the two subsystems interact at every human-machine interface by defining task and function allocations as well as lines of communication, authority, and responsibility. Therefore, the goal of organizational design should be to optimize the interaction of all subsystems to better match the whole system to the requirements of the external environment (Weisbord, 1987).

Factors Affecting Manufacturing Workers Performance

The production worker performance and productivity have significant effects on company's bottom line. Offering band—aid solutions, such as, performance bonuses or performance training do not solve the core problem, according to employment expert Susanne Krivanek writing for the Tech Republic website. You need to understand the factors affecting employee performance to increase productivity (Anderson, 2011). A lot of factors can influence the performance of a production worker positively or otherwise in a Nigerian manufacturing firm, South Eastern States as case study chosen from engineering application. These factors include but not limited to (i) Power/Energy infrastructure (ii) Trainings (iii) Motivations (iv) Machines reliability,

(v) Technology and Technological changes and (vi) Work place safety (vii) Standard Equipment. However, other factors, such as, leadership effectiveness, time management, process charge and others, also influence the production worker performance in the medium and large-scale manufacturing industry in Southeastern

Compensation (Incentive)

Compensation is the basis of an exchange relationship between the employee and the employer (Banjoko, 2000; John, 2002; Lloyd & Leslie, 2004). Several studies have shown **that employee performance can be achieved through compensation** [Mazumbar and Mazaheri, (2002); John, Wick, Sue, and Juani, (2003); Mclntyre, (2005), McQueen & Knussen, (2003) & Michael, (2003)]. This is because factors in organization context especially rewards, may induce behaviour and focus it in a particular direction, then filter through the employees' motivation to perform (Ivancevich, 2003). This indicates that there is a direct relationship between compensation and employee performance. Further research is needed to extend this understanding of the impact of compensation on employee performance.

By way of definition, compensation is the totality of both financial and non-financial rewards that an employee receives in return for his labour or services to the organization [Banjoko, (2006); Milkovick & Newman, (2005); O'Leary,(2004)]. It refers to all the rewards employees receive in exchange for their work. Compensation is composed of the basic wage or salary, incentives or bonuses and benefits (Lewis, 2001). Compensation management can be viewed as a matter that is closest to the heart of every employee and employer [Amaram, (2005); Tom & Adrian, (2006): Banker & Lee, (1996)]. No issue is more relevant and crucial to any employee than the total remuneration package received. An acceptable way of retaining employees is through attractive compensation package. A wrong implementation of remunerations may trigger an employee's intention to quit the job and increase employee turn-over (Huselid, 1995). Therefore, to achieve high performance, workers must be properly compensated.

Compensation is the money received in the performance of work, plus the many kinds of benefits and services that organizations provide their employees. It consists of direct and indirect monetary and non-monetary rewards (Anjorin, 1992). Employee's commitment to the achievement of organizational goal is enhanced, by the compensation package the organization has to offer in exchange for their services (Huang, 2000). It determines an employee's economic worth, social status, reflects economic growth and maturity within the organization.

The purpose of compensation is to attract, retain and motivate employees towards better performance (Allen et al, 2003). It is believed that good compensation package have impact on performance of workers, as the attainment of high organizational productivity must recognize the need to inspire and motivate the employees through the design, establishment and implementation of a robust reward system that calls out the best in the employees in term of performance , commitment, contribution (Huselid, 1995).

Motivation and Manufacturing Worker Commitment

Motivation is a basic psychological process. Motivation is the management process of influencing behaviour based on the knowledge of what make people tick (Luthans, 1998). He asserts that motivation is the process that arouses, energizes, directs, and sustains behaviour and performance; hence, it is the process of simulating people to action and to achieve a desired task. One way of stimulating workers is to employ effective motivation which makes workers more satisfied with and committed to their jobs. The level of performance of production worker relies not only on his actual skill, but also on the level of motivation each person exhibits (Burney and Widener, 2007). Motivation is an inner drive or an external inducement to behave in some particular way, typically a way that will lead to rewards (Dessler, 1978). Over-achieving, talented production workers are the driving force of all forms, so it is essential that organizations strive to motivate and hold on to the best workers (Harrington, 2003).

The quality of human resource management is a critical influence on the performance of the firm. Concern for strategic integration, commitment flexibility and quality, has called for attention for employees become the most concern in today's organization, and tying to Maslow's basic needs, non-financial aspect only comes in when financial motivation has failed.

According to Greenberg and Baron (2003), definition of motivation could be divided into three main parts. The first part looks at arousal that deals with the drive, or energy behind worker(s) action. Workers turn to be guided by their interest in making good impression on others, doing interesting work and being successful in what they do. The second part referring to the choice workers make and the direction their behviour takes. The last part deals with maintaining behaviour clearly defining how long people have to persist at attempting to meet their goals. Motivation can be intrinsic and extrinsic. Extrinsic motivation concerns behaivour influenced by obtaining external rewards (Hitt, Esser and Marriott, 1992). Praise or positive feedback, money and the absence of punishment are examples of extrinsic or external rewards (Deci, 1980).

Intrinsic motivation is the motivation to do something simply for the pleasure of performing that particular activity (Hagedoorn and Van-Tperen, 2003). Examples of intrinsic factors are interesting work, recognition, growth and achievement. Several studies have found that, **there is positive relationship between intrinsic motivation and job performance**, as well as, **intrinsic motivation and job satisfaction** (Linz, 2003). This is significant to firms in today's highly competitive business environment in that intrinsically motivated employees (workers) will perform better and therefore, be more productive, and also because satisfied workers will remain loyal to their organization and feel no pressure or need to move to a different firm.

However, the Nigerian situation tends to give a different argument to the above assertion. At this juncture, prominent motivational discourse are; the content of work, extent of employee participation in organizational decisions, and the core extrinsic incentives, such as wages, promotion, fringe benefits, job and post-employment security. The strongest motivator, according to Maslow (1970) is self-actualization, that is, the desire to maximize one's potential, fulfill oneself and use one's abilities to the fullest. Maslow was quick to suggest, however, that unless lower level needs such as, the physiological, security and esteem needs are satisfied, self-actualization will not occupy a prominent place in a worker's list of needs. Herzberg (1967) likewise found that when workers are satisfied with their jobs, they are concerned about the environment in which they work, namely organizational policies and administration, supervision, working conditions, interpersonal relations, wages, status and job security.

Production workers in the medium and large-scale firms will continue to be employed within a distressed economy. By 1986, when the Nigerian government enacted a Structural Adjustment Programme greatly declined due to high inflation, scarcity of commodities, a weak currency, and other weaknesses in the economy. By 2011, when this study is being conducted, through informal observations, the cost of basic necessities (food, housing, clothing, transportation, and health care) has skyrocketed relative to the previous decades. As low – income earners, we expect workers in manufacturing firms to place greater emphasis on extrinsic/hygiene than on intrinsic / responsibility factors of work. Therefore, the degree of employee satisfaction with wages, promotion, job security, fringe benefits, cordiality between management and workers, equity and manger(s) benevolence are likely to be stronger predictors of employee commitment to the organization than would a challenging job and employee participation in decision-making. Paradoxically, saying, do not preach to a hungry man, cause he will not be interested", then get his stomach filled first and let others follow.

Since production is a social enterprise it involves technical components known as factor of production and social relations of production to form economic basis or productive work force. Therefore, in motivating the enterprise for a properly developed work force – a company develops appropriate strategy and equip its organization with effective system of information, planning, control, training and more importantly rewards to get the job done – through incentives, promotions, introduction of new technologies in operation, provision of social amenities to workers. Good pay and regular pay packages, reforms on the policies of the board of directors and of the governments. By this it became widely clear that motivation on social relations of production will enforce considerably the work force of any company or business firms whose work force remains un-predicted. The social relations of production indicates that the effects of motivation on the work force depends on the presence of motivation processes applied on the productive work force i.e. capability of its non-existence.

The basic fact remains that the extent of performance of manufacturing workers in any organization depends on how well they are motivated. To say that managers motivate their subordinates is to say that they do things which they hope will satisfy those derives and desires and induce the subordinates to work harmoniously, efficiently, effectively and harder in anticipation for higher rewards. According to Abimbade (1999), motivation is related derives produced by certain experience in organism. Adeboyeje and Afolabi (1991), say that motivation is the spontaneous arousal of tendency to engage in certain worthwhile activities. Ejiofor (1987) portrayed these motivational processes on work force as managing a company as profit oriented project whereby the management should set out goals and stimulate the work force to achieving its dreams by the application of motivational processes that put all hands at work and brings out the best from every worker.

Motivation involves a serious consideration of the goals and motives that produce observed human behaviour. It is essentially an internal urge that spurs an organism into action. This desire becomes a need that compels one towards achieving a goal (Onyehalu 1988). Morgan and King (1966), observed motivation to be a cyclic phenomenon where motive leads an organism worker to perform an instrumental action, which in turn leads to the attainment of a goal and achievement of any organization. In fact, workers motivation is neither bribery nor manipulation; rather it is all about understanding the need that prompts the staff to engage in certain desirable goals which in this study is effective means of attaining high performance of manufacturing workers that would yield better production output of results in the lives of the organization (production firm).

To any worker in a given organization, motivational factors are found to be, which are: regular payment of salaries or wages, promotion opportunities, fringe benefits such as housing and transport allowances, medical allowance, utility, vehicle loans, conducive accommodation, in service training opportunities, provision of modern machines, tools and equipment. These motivational factors form two categories: material incentives and non-material incentives. Material incentives motivation include provision of well furnished offices, provision of vehicle loans, provision of modern working facilities, provision of good accommodation, while the non-material incentives are: regular payment of salaries or wages, regular promotion, provision of medical services, job securities, as well as proper management and subordinate good human relationship. The effectiveness of a worker lies on the degree of how such a worker is motivated.

Therefore, the major issues confronting management of an organization is motivating employees to perform assigned tasks to meet or surpass predetermined standard.

Sometimes, in spite of the intensified efforts by the management to boost its employees' morale, it is still confronted with the problems of getting the best out of the workers. Training program, seminars, workshops related to workers productivity were also conducted; all to improve workers efficiency, but there was still little or no difference on the performance of its employees.

Electric Power Supply and Utilization in Nigeria

Electric power has become the greatest sources for power required in operating industrial and non-industrial machines and equipment. Most commonly National electric power supply is not continuous in its supply. This in consequence resulted to constantly break in production which is usually the order of manufacturing industries in Nigeria.

Of crucial concern today is the state of electricity supply in Nigeria. An efficient infrastructure connects markets and expands investment opportunities (Malik, Teal and Baptist, 2004). By far, the most significant problem of the physical infrastructure relates to unreliable and irregular power supply. The vast majority of firms in Nigeria expressed their dissatisfaction with the services of National Electric Power Authority (NEPA) otherwise known as Power Holding Company of Nigeria (PHCN) which is only a baptism of name as they remain the same.

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Government has been making efforts to ensure sustainable power supply but such effort is yet to yield a remarkable result. Consequently, industrial and other developmental activities slow down because electricity is either non-existent in some areas and where it is available occasionally caused some human and material losses due to incessant fluctuations in supply. Whole expensive equipment has been destroyed, buildings have been burnt down and even lives have been lost due to poor energy management. Nevertheless, the supply authority (NEPA) and the consumers (industrial, residential and commercial) both contribute in no small measure to degrade power supply in Nigeria. It is absolutely necessary to trace out the root cause of poor power quality and to suggest some measures that should be adopted to improve the situation for the good of all.

Status, Impact and Spread of Nigeria's Electric Power

Nigeria has three hydro power stations and six thermal stations with a total installed capacity of 6000MW. All through the years, power made available for consumption has been grossly inadequate and, besides, fluctuate all the time. According to NEPA (2003), the actual (peak) power generation from all the nation's power stations and the Independent Power Producers (IPP) as at December 2002 was 2944MW. The average estimated daily national demand forecast for the month of January 2003 was 4,200MW. The maximum demand as at 29th August 2003 was 3479MW. The remarkable fall in power made available to the consumer is further depicted in Table 1.

Table 1: Deficiency between Installed and Actual Generating Capacity of Power Plants

S/no	Name of Power Station	Installed Capacity (MW)	Installed Available Capacity (MW)	Actual Generation (MW)
1	Kainji Hydro	760	220	169
2	Jebba Hydro	540	386.2	235
3	Shiroro Hydro	600	450	257
4	Egbin Steam	1320	880	821
5	Sapele Steam	720	360	247
6	Sepele Gas	300	-	-
7	Afam Gas	700	114	86
8	Delta Gas	600	240	203
	Total	5,540	2,650.2	2068

Source: National Control Centre, Oshogbo Broadcast (2001)

Efforts have been strongly made to improve and stabilize the contents of power supplies in Nigeria industrial areas. The new administrations led by President Good-luck Ebelechukwu Jonathan have intensified efforts to improve and stabilize power generation and distribution in the country to improve industrialization. The new improvement contributions in the recent times in power generation and distribution in Nigeria is displayed as shown below:

Impact of Training on Manufacturing Worker Performance

Industrial psychology literature defines training from trainee and trainer perspective. From a trainee perspective; training is the systematic acquisition of skills, rules, concepts, or attitudes that result in improved performance in another environment and whose effectiveness stems from a learning atmosphere systematically designed to produce changes in the working environment (Goldstein, 1986). From a trainer perspective, including the organization providing the training; training is, a planned effort by an organization to facilitate the learning of job-related behaviour on the part of its employees; the term "behaviour" include knowledge and skills, acquired by the employee through practice (Wexley, 1984). Training as an activity was formally recognized as early as the Industrial Revolution. The support of industrial activity, however, did nothing to support workforce training, partly due to the fact that machines were considered for more efficient than the workers at the time, and partly due to the social legislation that existed in the 18th and 19th centuries in England (Donns, 1983).

A manufacturing organization is driven by the products it develops and markets. The productivity of the organization is improved by developing processes that aid in manufacturing the product with the required quality, short lead times, and low unit cost. Some specific reasons for training production workers include:

(1) Lack of adequate instructions; most work instructions or process plans requires an understanding of the process. Training increases the domain knowledge that the worker possesses and therefore improves the processing operation. This results in lower scrap rates, lower production cost, shorter cycle times, and better quality of the product.

(2) Improvement of efficiency; training may also be required for the worker to develop a thorough understanding of the process such that instructions, written or otherwise, are not required for continued performance of the tasks. This will improve the efficiency of the operation, thus reducing time and cost.

(3) Inadequate man-machine interfaces; many training issues arise because of inadequate design of the user interfaces on machines. Production workers will have to be trained to understand and adequately operate the equipment. Such training will also result in better products, lower lead times, and lower cost (Pennathur, 1999).

TECHNOLOGY: MANUFACTURING WORKER AND ADVANCED

Technology

An issue of increasing interest to researchers and policy makers is how the introduction of new technologies into the workplace will impact production workers. In particular, there is concern about how less educated workers will face in an environment characterized by higher rates of technological advancement.

Seventeen advanced technologies specific to the manufacturing sector were examined in the Survey of Manufacturing Technology (SMT), 1988. Of these technologies, manufacturing plants using the following six advanced technologies were selected for a detailed study of the connections among plant size, wages of production workers, and advanced technology usage. The six technologies are: (1) Computer –Aided Design/Computer-Aided Engineering (CAD/CAE) (2) Numerical /Computer Controller machines (NC/CNC). (3) Computers used on the factory floor (4) Local Area Networks (LAN) (5) Automated sensors for Materials and (6) Robotics and Automatic sensors (Dunne and Friedman, 1993).

According to human capital theory (e.g. Ben Porath, 1967), higher rates of obsolescence will reduce the optimal amount of investment in training at any point in time. Since general human capital is likely to be more immune to the introduction of new work processes, the rate at which an individual's stock of general knowledge and problem-solving skills depreciate will be less than the rate for specific, vocational skills. The second mechanism by which technology change will reduced training is related to the fact that technological advancement increase the risk of uncertainty of investment in human capital (Williams, 1979). While this uncertainly effect impacts the decisions of both individuals and firms, if individuals are more risk averse than firms, the negative effects should be stronger for individuals' investments than firms' investments

Manufacturing Worker and Safety Regulation:

Workers' perceptions and experience in relation to Occupational Health and Safety (OHS) are scarcely considered in programmes for the prevention of work related injuries and diseases. Healthy environments and healthy behaviours are key determinants in occupational health and safety. Workplace environment includes physical as well as organizational factors, and attention and interventions should be focused on (Garcia, 2004). In 1980, Zohar, introduced the concept of safety climate in industrial organizations, defined as the summary of molar perceptions that employees share about their work environments. According to these perceptions the workers develop coherent sets of expectations regarding behaviour –outcome contingencies and then behave accordingly. Zohar identified two main influential climate dimensions in determining safety climate levels; (i) relevance of safety to job behaviour (including workers' perceived importance of safety training and worker's perceived effects of required work pace on safety) and (ii) workers' perceived attitude of the management towards safety.

In the United States, allegations have been made that the federal occupational safety and Health Administration (OSHA), charged with regulating work place safety, has proved woefully inadequate in aggressively tacking workplace fatalities. Although OSHA has a criminal provision, no one has ever spent day in jail for violation of the Act (Blomley, 1990). The same situation is applicable in Nigeria, where the Health safety and Environment (HSE) regulations are in place but hardly implemented to the letters. A lot of deaths have been reported at workplaces in Nigerian industries; however, the family of this deceased manufacturing worker is left to take care of its dead. The enforcement of HSE regulations suffers the same fate as any other judicial process in the country.

Maintenance and Repairs

Maintenance is undertaken to preserve the proper functioning of a physical system, so that it will continue to do what it was designed to do. Its function and performance characteristics not only take account of output, unit costs and effectiveness of using energy, but also such factors as end-product quality, process control, achieved comfort and protection of the employed personnel, compliance with environmental-protection regulations, structural integrity and even the physical appearance of the productive system.

The quality of maintenance significantly affects business profitability. The factors involved include safety, and customer service, not just plant costs and availability. Increased downtime affects adversely the capability of physical systems by reducing their average rate (i.e. speed) of output, so increasing the operating costs and lowering the average customer's satisfaction with the service [Moubray J., 2000]. With system availability becoming critical, issues such as reducing operating costs as well as the strategic importance of employing better and, if feasible, optimal maintenance schedules need to be more universally recognized and implemented. Maintenance can be defined as a combination of any actions, carried out to retain any facility on, or restore it to an acceptable condition (Taiwo et al, 2003). Maintenance in modern term is a process of programmed activities designed to ensure or maintain the integrity of a device or facilities (Olowekere 2002). Sustenance of engineering infrastructure and services means sustained maintenance (rehabilitation and repairs) of the facilities to keep them in continued efficient operating conditions (Obah, 1998). Maintenance of any system requires adequate planning. The planning must start from the time of design through purchase or construction to operation. It is pertinent to state that in most developing countries, maintenance is usually pushed to the background. More often than not the general attitude is to emphasize more on new project to the detriment of maintaining old facilities.

Maintainability is a discipline within the science of energy and defined as characteristics of design and installation which is expressed as *the probability that an item will conform to specified condition within a given period of time when maintenance action is performed in accordance with prescribed procedures and resources* (Taiwo et al, 2003). The objective of maintainability is to design and develop system which can be maintained in the least time at least cost and with minimum expenditure of support resources without adversely affecting the item performance or safety characteristics. Maintenance can be classified into *preventive* and *breakdown maintenance*.

Equipment

Equipment is tools, apparatus, gear (informal), utensils, paraphernalia, kit required to carry out certain work or operation in all the classes of industries mentioned in section 2.3. It varies in forms according to the services intended to render. Equipment requirement depends on the operation(s) to be carried. In manufacturing industries equipment required for effective operations are numerous to mention but a few. In a typical plastic industry, the outstanding equipment required is: Injection moulding machine, Extrusion machine, Blow molding machine, Blow film Extrusion machine, Calendering machine, Compression Molding machine, Laminating machine, Reaction Injection Molding machine, moulds, Jacks, Forklift, In house transportation equipment, and so on.

Though the cost of equipment procurement is usually high, as a result many industries do not undertake to achieve standard and efficient manufacturing. Consequently, substandard or outdated and unreliable equipment are procured which will affect the performance of the user.

It is advisable for the management to procure standard, modern, easy to operate and reliable equipment for use. Complex or sophisticated equipment usually is difficult to manipulate and so reduces performance of the user (manufacturing workers). Otherwise the manufacturing workers must have need to undergo trainings that will subdue the technological challenges in effective manipulation and use of the available equipment.

Feasibility studies have to be carried out to ascertain the equipment needed for the operations.

In order to determine the effectiveness of equipment on the performance evaluation of workers, we need to consider the various productivities of manufacturing workers using a specific type of equipment/machine at certain specified period of time with several models of such selected type of machines. Several data will be collected from these models for the study. One of the models of the machines be chosen as standard and its production output quantity is assumed standard daily/weekly/monthly Output.

$$\text{Performance} = \frac{\text{Output of a machine model} \quad x \quad 100}{\text{Output of a standard model machine}} \tag{1}$$

METHODOLOGY

Area of Study

The study focuses on trying to find out processes and solutions to the common problems on factors affecting manufacturing workers in manufacturing Industries in South Eastern States of Nigeria. It is further narrowed down to discrete products manufacturing Industries, such as: plastic product, automobile components, machine parts or components, products of blowing and forming, assembling products. The study was carried out in three different industries. As a result, the study was actually carried out in plastic machine parts or components, blowing and forming products Industries in the South Eastern States of Nigeria. This is done with the view to understanding the strategic factors constraining the performance of manufacturing workers in Industries in the South Eastern States of Nigeria.

Sample Size

The population of the study consists of three selected manufacturing industries in the South Eastern States of Nigeria. However, the sample was drawn from Nigerian manufacturing industries such as: **Discrete products fabrication industries** (plastics, products of Extrusion, Injection Molding and PET Bottle blowing) chosen from some of the states in the zone. Table 2, gives a summary arrangement of the industries and numerical relationships to the manufacturing workers.

Multiple regressions are a seductive technique: "plug in" as many predictor variables as you can think of and usually at least a few of them will come out significant. It is because of capitalization on 'chance' when simply including as many variables as you can think of as predictors of some other variable of interest. This problem is compounded when, in addition, the number of observations is relatively low. Intuitively, it is clear that one can hardly draw conclusions from an analysis of 100 test study items based on 10 respondents. Most authors recommend that for convenience one should have at least 10 to 20 times as many observations (cases, respondents) as there are variable factors of interest; otherwise the estimates of the regression line are probably very unstable and unlikely to replicate if another experiments were to be conducted again.

A total of four (4) manufacturing companies producing Plastic products of Extrusion industries were taken for the study, and different cadres of manufacturing staff (respondents) in the categories of Semi-skilled workers, therefore, the sample was made up of eight (8) manufacturing workers each selected from the four selected Companies giving a sum of thirty two (32) manufacturing workers used in the study of the Extrusion Industry.

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Stratified random sampling (SRS) was used in selecting the sample size, that is, the subjects were selected from the different departments or sections of the companies.

A total of four (4) manufacturing companies producing **Injection Plastic industrial Products** were taken for the study, and different cadres of manufacturing staff (**respondents)** in the categories of Semi-skilled workers, therefore, the sample was made up of eight, eight, eight and six (8, 8, 8, & 6) manufacturing workers each selected from the four selected Companies giving a sum of thirty (30) manufacturing workers used in the study. Stratified random sampling (SRS) was used in selecting the sample size, that is, the **subjects** were selected from the different departments or sections of the companies.

A total of Five (5) manufacturing companies producing **PET bottle blown Products industries** were taken for the study, and different cadres of manufacturing staff (**respondents)** in the categories of Semi-skilled workers, therefore, the sample was made up of four (4) manufacturing workers each selected from the five selected Companies giving a sum of twenty (20) manufacturing workers used in the study. Stratified random sampling (SRS) was used in selecting the sample size, that is, the **subjects** were selected from the different departments or sections of the companies.

Industry and Companies Association in the Study

Table 2: Industry Types and Numerical Relationship of the Manufacturing Workers Employed

S/N	Industry	No. of workers	No of Companies	No. of Subjects	Remarks
1	Extrusion Plastic Industry	32	4	32	1 omitted
2	Injection Plastic Products Industry	30	4	30	-
3	PET Bottle Blowing Industry	20	5	20	1 omitted

Field work, 2011

Companies Visited and Used in the Study

(1) Extrusion Plastic Product (PMC) Industry

A) Finoplastic Company Located at Agu- Awka, Anambra State;

Produces PVC sewage pipes of various sizes and lengths

B) Bold Ventures Plastic Company Nkwele Awka; undertake the production of Conduit pipes of various sizes in diameters, lengths, and colours.

C) Ayom Plastics Company located at Arroma, Awka. Produces PMC pipes for fluid transports in various sizes and lengths; also producers of PVC Ceiling Roof

D) Global Concept, Agu Awka; producers of plastic sewage and Conduit pipes.

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(2) Injection Plastic Product Industry

a) Millennium Plastic Company, Awka Anambra State.

Producers of plastic Chairs, buckets, basins and Containers

b) Innoson Plastics, Emene, Enugu State.

Producers of all types of plastic Chairs, Toys, Containers, Drums, and Tables

c) Louis Carter Plastics, Newi, Anambra State;

Producers of plastic buckets, basins and Containers, etc.

d) Ada-Obi Plastic Industries, by Ossioma Rd. Aba, Abia State; Producers of plastic buckets, basins and Containers; plastic Chairs, Toys, etc.

3) Pet Bottle Blowing Industry

a) Event Waters Company, Umudim Newi;

Producers of water Cans and bottles

b) Millennium Plastics Company Awka, Anambra State;

Producers of plastic Chairs, buckets, basins and Containers

c) Merah Plastic Company, Ebonyi State;

Producers of Pure water Bottles

d) Plastic Package Industries (PPI), Mgbemene Street Onitsha;

Makers of all types of packages of plastic base materials

e) Louis Carter Plastic Company, Uruagu Newi.

Producers of plastic buckets, basins, Containers and PET plastic, etc

Test Study Specimens

A 43-item of self made instrument titled "Factorial Indices affecting the performance of manufacturing workers in Industries in south Eastern States of Nigeria" was used as the Tests Study for data collection. The contents of the Test Study were designed and constructed based on the literature reviewed on the factors affecting the performance of manufacturing workers in industries in south Eastern States of Nigeria. The Test study specimen was measured on a 5-point of Spits' Liker scale of: Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree which their numerical strength value is 5, 4, 3, 2 and 1 respectively is as shown in appendix 02.

A total of Eight- five (85) prepared Test Study were distributed, monitored and collected by the researcher. Information supplied as answers to the Test Study were tabulated as shown in tables 12 to 21 in appendix 3 and served as data used in statistical analysis. Further investigations have to be carried out to validate these factors that were thought to have influence on workers performance from engineering perspectives based on the data collected from the Time Study on manufacturing operators' production activities of the various manufacturing companies.

Times Study Specimen For Data Collection

To generate the standard industrial data that sufficient enough or reliable for use in determining the factorial indices affecting the performance of manufacturing workers in industries, the following guide lines were used for a good study:

- For a named chosen industry, certain numbers of manufacturing workers were selected as the specimens for the study which is fixed to be Thirty- two (32), Thirty (30), and Twenty (20) respectively for the three chosen Industries.
- Those chosen manufacturing workers were specifically monitored in their daily operations for **FIVE** given days of operation. Records were taken based on their daily productivities. From the company's (work measurement) daily production maximum for each machine, the performance of each operator then calculated.
- Furthermore, each of these chosen Operators were given Tests Study Information Guide tagged A_1, A_2, A_3, A_4,… for company A; B1, B_2, B_3, B4,… for Company B; and so on.
- The Test results from the Test Study supplied by the respondents (Operators) on the **SEVEN** selected factors (rated according to Spit's Liker Scale), were summed up and recorded correspondingly for each of the factors and Operators.

The average values of the calculated performances of Operators in the five days monitor were tabulated correspondingly with the Respondents Test results (which are summed up with the individual operator factors' data). Computer Software such as MINITAB, SPSS or EXCEL tools is used to analyze the various statistical quantities relevant in testing the hypothesis at 0.05 level of confidence (i.e. 5%).

Validity of Instruments

Face and content validity of the instrument are established by experienced Engineering psychologists, and other persons who are experts in the field of psychology, sociology, anthropology, production management engineering, and human factors engineering. They scrutinized the contents of the Test Study, offered useful corrections and suggestions, which led to some modifications. Based on such corrections and modifications the instrument is considered adequate and standard for use.

Standard machine Output of the products for each machine controlled by operators was collated from the production managers of each of these chosen companies. Also the machines operators were monitored daily to determine the production capability of each operator, hence performance calculated according to [Beeley, 1973],

$$\text{Performance} = \frac{\text{Total Number of products produced} \quad \text{x } 100}{\text{Total standard Number of products to produce}}$$

This method of calculation was used in like manner for all the selected companies' workers.

How Manufacturing Performance Determined

To generate the standard industrial data that will be sufficient enough or reliable for use in measuring the factorial indices affecting the performance of manufacturing workers in industries, the following guide lines were used for a good study:

- For a named chosen industry, certain numbers of manufacturing workers were selected as the specimens for the study which is fixed to be 3, 4, 8, and 9 as case may be for all the Companies used.
- Those chosen manufacturing workers were specifically monitored in their daily operations for **six** given days of operation. Records were taken based on their daily productivities. From the company's (work measurement standards - daily production maximum for each machine), the performance of each operator then is calculated.
- Furthermore, each of these chosen Operators were given Tests Study tagged A_1, A_2, A_3, ... A_n, for company A; B_1, B_2, B_3, ... B_n, for Company B; and so on.
- The answers from the Tests Study supplied by the respondents (Operators) on the **SEVEN** selected factors (rated according to Spit's Liker Scale - 5), were summed up and recorded correspondingly for each of the factors and Operators.
- The average values of the calculated performances of Operators in the six days monitor are tabulated correspondingly with the Respondent's Tests study result were summed up from the individual operator and factor and is shown in the table 3.

Analytical Tools Employed:

Some analytical tools are found useful and employed in this research setting; they are statistical and modeling tools.

The statistical tools that of importance are among the following: T-test, F-test, Correlation of variables, ANOVA.

These tools would be used in determining and establishing the quantitative information on the factorial indices of the factors affecting the performance of the manufacturing workers in manufacturing Industries in Eastern States of Nigeria.

Quantitative Evaluation Techniques in the Study

To get the manufacturing workers individual performances, daily personal monitoring of a certain number of selected machine operators of the different companies was done by the researcher. Each manufacturing worker or machine operator that produces a particular item was monitored and his/her actual daily production quantity would be recorded for at least six days. The workers daily performance is then calculated using the mathematical relation as:

$$P\ (x_i) = \frac{Q_2}{Q_1}$$

Where Q_1 = fixed or max. Machine produced capacity

Q_2 = actual daily operator's output and

$P(x_i)$ = workers performance for each day

$$\boxed{\text{Daily Performance} = \frac{\textit{Actual daily output}}{\textit{fixed or max. daily machine capacity}}}$$

The average performance (P) for the six days was calculated and tabulated on tables 8, 9 and 10 for the thirty workers. Meanwhile, machine daily max capacity is given by the relation below.

$$\text{Max capacity per day} = \frac{\text{Daily working hour}}{\text{Cycle time}} \qquad (3a)$$

$$\therefore \text{Cycle time} = \frac{\text{one hour}}{\text{Max. Capacity per hour}} \qquad (3b)$$

Hence cycle time is the number of seconds or time needed to produce one shot, i.e. from the first closing of machine moulds to the next closing.

Data Presentation and Content Analysis

The researcher used data presentation and content analysis to find out the truth in the study. Also simple numerical values from the information (data) obtained were used to analyze for the basic problems seeking solutions. By content analysis the researcher examined the views of the respondents as well as operators performance as affected by the factors. From these processes, the researcher performed several statistical analyses from which inferences and conclusions were drawn.

In the previous section, there were discussions on the methodology adopted in the research. In this section, the collation and analysis of the data are carried out; the SPSS software chosen for the analysis and which composed of the formulas and procedures outlined in the analytical principle of ANOVA. Here the formulas and procedures were coded into computer language with a view to aid accurate and faster in calculations.

The Collation and analysis of data obtained from the thirteen companies visited were carried out. The individual manufacturing workers average performance observed were recorded and the factorial tests study values from the thirteen companies whose subjects totaling (82) eighty-two manufacturing workers were calculated and tabulated into a useful form menial able to

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generate the required models and finally analyzed to get the proper results that satisfies the aim and objectives (in section 1.1) and the four hypotheses put forward earlier (in section 1.2). It would be through these analyses that the factorial indices be determined and validated.

EXPERIMENTAL DATA PRESENTATION

The Three Industries Combined Data

Table 3: Overall Data for All the Three Industries Chosen For the Study

Workers	Motivatn	Power	Safety	Maint	training	equipt	Technol	Perform
A_{11}	25	21	20	22	26	22	24	85
A_{12}	24	28	27	26	27	29	28	90
A_{13}	25	24	26	24	25	25	24	87
A_{14}	16	13	14	12	14	15	12	70
B_{11}	19	18	20	19	23	18	10	76
B_{12}	27	26	25	25	24	26	25	89
B_{13}	24	22	20	24	21	22	20	85
B_{14}	25	27	26	27	26	27	27	90
C_{11}	26	25	25	25	24	25	24	87
C_{12}	17	12	14	14	10	12	17	70
C_{13}	20	20	20	17	17	17	15	76
C_{14}	26	27	26	24	24	25	26	89
D_{11}	15	15	20	14	16	14	12	70
D_{12}	18	20	19	18	18	15	16	76
D_{13}	26	26	26	25	26	25	26	89
D_{14}	24	25	23	21	25	20	22	85
E_{11}	28	26	28	26	27	26	26	90
E_{12}	26	24	24	22	25	25	27	87
E_{13}	26	26	28	25	28	27	30	90
A_{21}	17	23	16	20	16	18	17	67
A_{22}	25	30	23	26	24	27	24	85
A_{23}	27	31	24	27	25	29	26	88
A_{24}	19	26	19	23	20	22	20	75
A_{25}	23	28	20	24	22	24	24	79
A_{26}	27	32	25	28	25	29	25	89
A_{27}	15	22	14	18	14	16	13	63
A_{28}	17	24	16	20	17	19	17	68
A_{29}	21	27	20	23	21	23	21	77
B_{21}	26	31	24	27	25	29	26	88
B_{22}	15	21	15	17	13	15	14	60
B_{23}	12	15	12	15	11	13	13	56

B_{24}	16	22	15	19	15	17	16	65
B_{25}	20	26	19	23	20	23	21	76
B_{26}	19	28	20	24	21	24	22	78
B_{27}	23	26	20	23	21	23	23	77
B_{28}	15	22	15	19	15	17	16	64
C_{21}	16	25	17	21	18	20	18	70
C_{22}	13	21	13	17	13	15	14	60
C_{23}	12	12	9	9	9	7	7	45
C_{24}	14	17	12	15	11	13	12	56
C_{25}	23	28	20	24	22	24	22	79
C_{26}	25	28	21	24	22	25	23	80
C_{27}	21	30	23	26	24	27	24	84
C_{28}	14	15	12	15	10	12	11	55
D_{21}	18	25	18	22	19	21	22	72
D_{22}	20	26	20	23	21	23	21	77
D_{23}	16	23	16	19	16	18	16	66
D_{24}	15	19	13	15	11	13	12	56
D_{25}	27	31	22	27	25	29	28	88
D_{26}	10	16	7	12	9	9	6	48
D_{27}	14	19	12	15	10	12	9	55
D_{28}	23	28	18	24	21	24	22	78
A_{31}	14	13	14	13	13	10	14	54
A_{32}	17	11	13	13	16	15	16	60
A_{33}	12	14	15	15	12	10	12	48
A_{34}	10	16	17	18	10	10	15	42
A_{35}	12	18	17	20	8	6	12	34
A_{36}	23	8	6	8	22	22	25	81
A_{37}	23	8	8	8	21	21	24	80
A_{38}	20	10	10	10	20	16	20	72
B_{31}	18	11	12	10	16	14	18	64
B_{32}	22	10	11	10	18	18	21	72
B_{33}	22	8	10	9	18	18	22	73
B_{34}	15	13	13	14	14	11	14	55
B_{35}	10	16	17	18	10	8	18	40
B_{36}	18	12	13	12	16	13	16	60
B_{37}	12	16	16	17	10	9	10	43
B_{38}	16	12	12	11	17	14	18	64
C_{31}	23	9	8	8	21	20	23	79
C_{32}	14	12	14	12	15	12	15	58
C_{33}	30	6	9	7	26	24	30	90
C_{34}	19	10	11	10	18	17	20	70
C_{35}	10	17	19	20	8	9	12	32
C_{36}	14	12	16	17	11	12	10	44
C_{37}	18	10	11	12	17	14	18	65
C_{38}	14	14	16	15	12	9	12	47

D_{31}	18	11	12	14	15	14	16	61
D_{32}	16	13	14	14	14	10	14	53
D_{33}	21	9	10	8	20	20	21	76
D_{34}	20	9	10	9	21	18	20	75
D_{35}	25	12	6	6	25	22	27	84
D_{36}	25	10	9	11	20	22	23	77
SUM	1586	1572	1370	1463	1496	1513	1552	5758
AVER	19.34	19.17	16.7	17.84	18.24	18.45	18.93	70.22

Field work data, 2011

Graphical Analysis of Data

The data collected from Companies were tabulated (table 3) and analyzed with the statistical package for social sciences (SPSS) and a chart created which shows seven independent variables and one dependent variable (performance). The SPSS software was used to create the XY-plot each for the seven predictors ($X_1 - X_7$) against performance (P) for the eighty-two workers (figures 1-7). This package, when customized, displays both the Equations, values of correlation coefficients (R) and the values of the coefficients of determination (R^2) for each independent variable(X) plotted against performance (P). The fit of the curves of the distributions was tested and it was found that the coefficient of determination R^2 was fairly good, ranges from 0.5 to 0.905 (from tables 3, 6, 9, 12, 15, 18 and 21), hence all of these give nice correlation coefficient, R.

Plots: Model Summary, Parameters and

Curves Estimates

As stated above, SPSS-software was employed and it gives neat points plotting. Model summary, parameters estimates (ANOVA) and coefficients tables were all displayed (tables 24, 25 and 26). Also displayed in the tables were other vital parameters e.g. F- and t-distributions, degree of freedom (DF), Significance and standard error.

The curve estimation chosen for each graph plotted must have the t- distribution significant and the corresponding co-efficient of determination (R^2) very high.

Critical Analyses of the Overall Collected Data:

SPSS Regression Analysis Values and Curve Estimation of the Overall Data Collected from the Three Industries

Table 3 **Model Summary**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.947	.897	.894	4.891

The independent variable is VAR00001.-motivation

Table 4 **ANOVA**

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	16440.043	2	8220.021	343.587	.000
Residual	1890.006	79	23.924		
Total	18330.049	81			

The independent variable is VAR00001.-motivation

Table 5 **Coefficients**

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
VAR00001	6.242	.837	2.147	7.460	.000
VAR00001 ** 2	-.091	.021	-1.222	-4.246	.000
(Constant)	-14.032	7.756		-1.809	.074

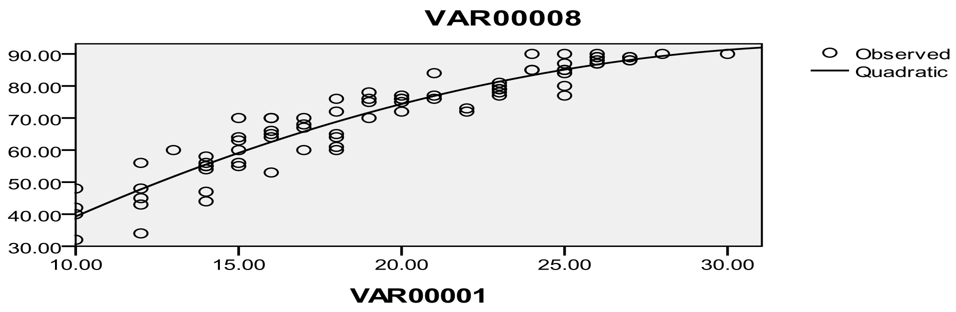

Figure 1: Graph of Performance (VAR00017) and Motivation (VAR00010)

Table 6 **Model Summary**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.698	.488	.475	10.901

The independent variable is VAR00011.-power

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Table 7 **ANOVA**

	Sum of Squares	df	Mean Square	F	Sig.
Regression	8942.962	2	4471.481	37.631	.000
Residual	9387.087	79	118.824		
Total	18330.049	81			

The independent variable is VAR00011.-power

Table 8 **Coefficients**

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
VAR00011	-5.987	1.099	-2.890	-5.447	.000
VAR00011 ** 2	.182	.028	3.400	6.409	.000
(Constant)	108.708	9.555		11.377	.000

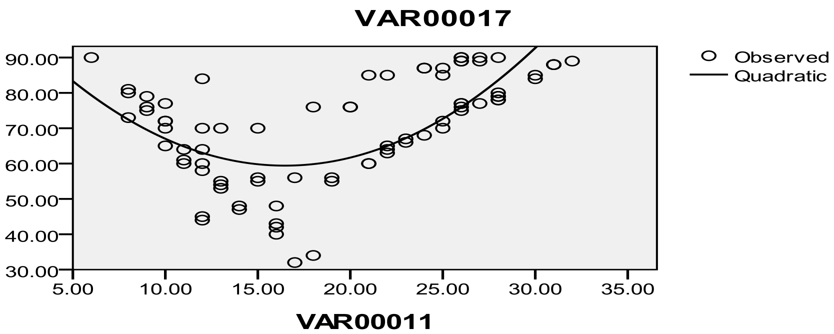

Figure 2: Graph of Performance (VAR00017) and Power (VAR00011)

Table 9 **Model Summary**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.721	.520	.501	10.622

The independent variable is VAR00012.- safety

Table 10 **ANOVA**

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	9530.012	3	3176.671	28.157	.000
Residual	8800.037	78	112.821		
Total	18330.049	81			

The independent variable is VAR00012.- safety

Table 11 **Coefficients**

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
VAR00012	-19.665	4.852	-7.399	-4.053	.000
VAR00012 ** 2	1.083	.301	14.219	3.594	.001
VAR00012 ** 3	-.017	.006	-6.428	-2.908	.005
(Constant)	169.306	24.392		6.941	.000

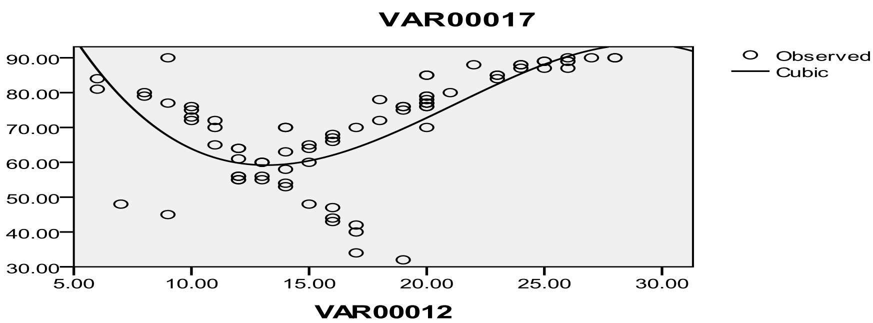

Figure 3: Graph of Performance (VAR00017) and Safety (VAR00012)

Table 12 **Model Summary**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.782	.611	.597	9.556

The independent variable is VAR00013.- maintenance

Table 13 **ANOVA**

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	11207.850	3	3735.950	40.915	.000
Residual	7122.198	78	91.310		
Total	18330.049	81			

The independent variable is VAR00013.- maintenance

Table 14 **Coefficients**

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
VAR00013	-19.851	4.830	-8.048	-4.110	.000
VAR00013 ** 2	.964	.297	13.799	3.243	.002
VAR00013 ** 3	-.013	.006	-5.379	-2.271	.026
(Constant)	181.282	24.323		7.453	.000

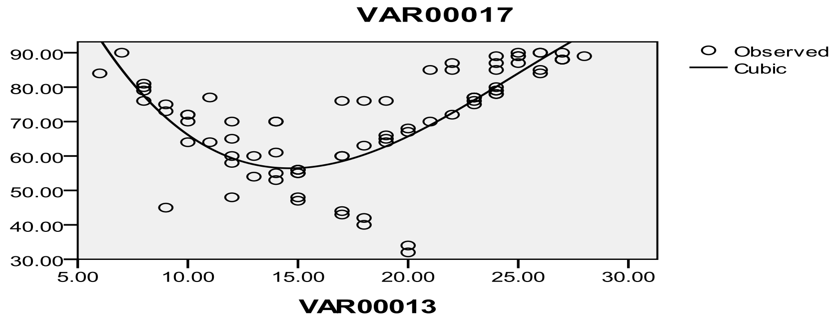

Figure 4: Graph of Performance (VAR00017) and Maintenance (VAR00013)

Table 15 **Model Summary**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.951	.905	.903	4.697

The independent variable is VAR00014.- Training

Table 16 **ANOVA**

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	16587.481	2	8293.740	376.000	.000
Residual	1742.568	79	22.058		
Total	18330.049	81			

The independent variable is VAR00014.- Training

Table 17 **Coefficients**

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
VAR00014	4.168	.667	1.537	6.253	.000
VAR00014 ** 2	-.045	.018	-.596	-2.423	.018
(Constant)	10.442	5.620		1.858	.067

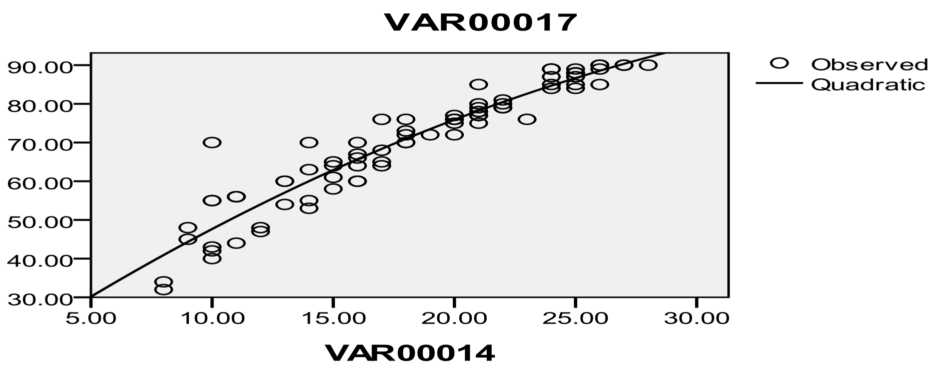

Figure 5: Graph of Performance (VAR00017) and Training (VAR00014)

Table 18 **Model Summary**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.946	.895	.892	4.944

The independent variable is VAR00015.- equipment

Table 19 **ANOVA**

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	16398.962	2	8199.481	335.438	.000
Residual	1931.087	79	24.444		
Total	18330.049	81			

The independent variable is VAR00015.- equipment

Table 20 **Coefficients**

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
VAR00015	4.679	.552	1.941	8.470	.000
VAR00015 ** 2	-.067	.015	-1.023	-4.462	.000
(Constant)	9.095	4.735		1.921	.058

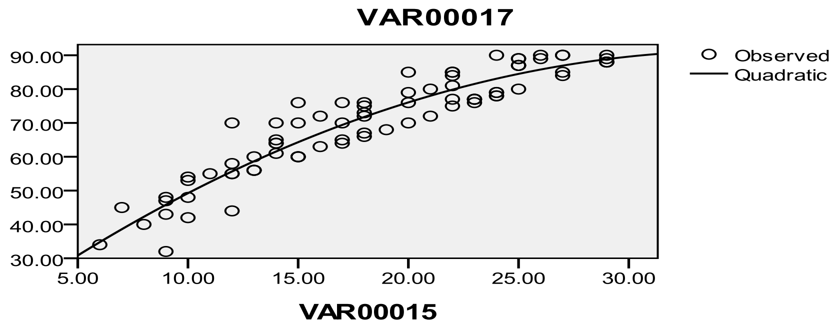

Figure 6: Graph of Performance (VAR00017) and Equipment (VAR00015)

Table 21 **Model Summary**

R	R Square	Adjusted R Square	Std. Error of the Estimate
.861	.741	.738	7.705

The independent variable is VAR00016.- Technology

Table 22 **ANOVA**

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	13580.357	1	13580.357	228.737	.000
Residual	4749.692	80	59.371		
Total	18330.049	81			

The independent variable is VAR00016.- Technology

Table 23 **Coefficients**

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
VAR00016	2.241	.148	.861	15.124	.000
(Constant)	27.800	2.931		9.485	.000

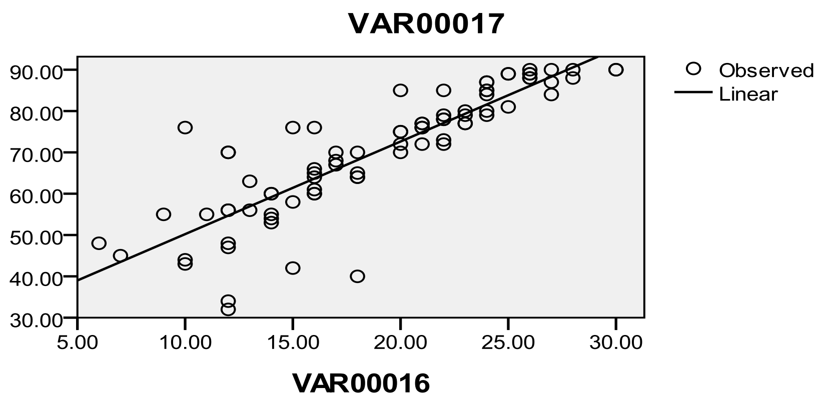

Figure 7: Graph of Performance (VAR00017) and Technology (VAR00016)

SPSS Regression Analysis of the Combined Data for the Study

Table 24 **Model Summary[b]**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.974[a]	.948	.944	3.57356

a. Predictors: (Constant), VAR00016, VAR00013, VAR00010, VAR00012, VAR00014, VAR00011, VAR00015

b. Dependent Variable: VAR00017

Table 25 **ANOVA[b]**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17385.046	7	2483.578	194.481	.000[a]
	Residual	945.003	74	12.770		
	Total	18330.049	81			

a. Predictors: (Constant), VAR00016, VAR00013, VAR00010, VAR00012, VAR00014, VAR00011, VAR00015

b. Dependent Variable: VAR00017

Table 26 **Coefficients [a]**

Model		Unstandardized Coefficients		Standard Coeffs	T	Sig.	Co linearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	26.065	2.087		12.487	.000		
	VAR0001	.877	.263	.302	3.331	.001	.085	11.773
	VAR0002	.480	.225	.232	2.130	.037	.059	16.982
	VAR0003	.614	.233	.231	2.637	.010	.091	10.998
	VAR0004	-1.356	.344	-.550	-3.947	.000	.036	27.857
	VAR0005	.789	.287	.291	2.748	.008	.062	16.096
	VAR0006	1.421	.300	.590	4.736	.000	.045	22.256
	VAR0007	-.459	.185	-.176	-2.474	.016	.138	7.273

a. Dependent Variable: VAR0008

SPSS Regression model of Overall Data Generated

$$P(X_i) = 26.065 + 0.877X_1 + 0.48X_2 + 0.614X_3 - 1.36X_4 + 0.789X_5 + 1.421X_6 - 0.495X_7 \quad (4)$$

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Table 27a **Co linearity Diagnostics [a]**

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	VAR00001	VAR00002	VAR00003	VAR00004	VAR00005	VAR00006	VAR00007
1	1	7.744	1.000	.00	.00	.00	.00	.00	.00	.00	.00
	2	.153	7.124	.00	.00	.01	.01	.01	.00	.00	.01
	3	.064	10.979	.44	.00	.00	.00	.00	.00	.01	.00
	4	.021	19.323	.06	.00	.10	.25	.00	.01	.02	.00
	5	.009	29.050	.01	.05	.00	.00	.01	.09	.02	.87
	6	.004	41.978	.14	.69	.03	.01	.06	.40	.00	.03
	7	.003	52.032	.25	.26	.60	.02	.09	.07	.77	.07
	8	.002	59.773	.11	.00	.25	.71	.84	.42	.18	.02

a. Dependent Variable: VAR00008

Table 27b : **Coefficients [a] of the** Overall **Raw Data**

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound	Correlations Zero-order	Partial	Part	Collinearity Statistics Tolerance	VIF
1	(Constant)	2.335E1	1.846E0		12.643	.000	1.967E1	27.020					
	VAR00005	2.569	.097	.948	26.520	.000	2.377	2.762	.948	.948	9.476E-1	1.000E0	1.000E0
2	(Constant)	2.388E1	1.671E0		14.291	.000	2.056E1	27.208	.000				
	VAR00005	1.618	.234	.597	6.915	.000	1.153	2.084	.948	.614	2.230E-1	.140	7.162E0
	VAR00006	.911	.208	.378	4.381	.000	.497	1.325	.932	.442	1.413E-1	.140	7.162E0
3	(Constant)	2.739E1	1.807E0		15.163	.000	2.380E1	30.990					
	VAR00005	1.312	.231	.484	5.666	.000	.851	1.772	.948	.540	1.692E-1	.122	8.175E0
	VAR00006	1.384	.230	.574	6.020	.000	.926	1.841	.932	.563	1.797E-1	.098	1.021E1

Table 27a **Co linearity Diagnostics** [a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	VAR00001	VAR00002	VAR00003	VAR00004	VAR00005	VAR00006	VAR00007
1	1	7.744	1.000	.00	.00	.00	.00	.00	.00	.00	.00
	2	.153	7.124	.00	.00	.01	.01	.01	.00	.00	.01
	3	.064	10.979	.44	.00	.00	.00	.00	.00	.01	.00
	4	.021	19.323	.06	.00	.10	.25	.00	.01	.02	.00
	5	.009	29.050	.01	.05	.00	.00	.01	.09	.02	.87
	6	.004	41.978	.14	.69	.03	.01	.06	.40	.00	.03
	7	.003	52.032	.25	.26	.60	.02	.09	.07	.77	.07
	8	.002	59.773	.11	.00	.25	.71	.84	.42	.18	.02

	VAR00004	-.372	.099	-.151	-3.764	.000	-.569	-.175	.417	-3.921E-1	-1.124E-1	.556	1.800E0
4	(Constant)	2.847E1	1.808E0		15.750	.000	2.487E1	32.071		.000			
	VAR00005	.889	.284	.328	3.132	.002	.324	1.455	.948	.336	9.072E-2	.076	1.307E1
	VAR00006	1.733	.265	.719	6.531	.000	1.205	2.262	.932	.597	1.892E-1	.069	1.446E1
	VAR00004	-.923	.246	-.374	-3.747	.000	-1.414E0	-.433	.417	-3.927E-1	-1.085E-1	.084	1.190E1
	VAR00003	.599	.247	.226	2.429	.017	.108	1.091	.490	.267	7.034E-2	.097	1.028E1
5	(Constant)	2.984E1	1.866E0		15.995	.000	2.612E1	33.553					
	VAR00005	1.080	.290	.398	3.728	.000	.503	1.657	.948	.393	1.053E-1	.070	1.431E1
	VAR00006	1.946	.276	.807	7.059	.000	1.397	2.494	.932	.629	1.993E-1	.061	1.640E1
	VAR00004	-1.003E0	.243	-.407	-4.130	.000	-1.487E0	-.520	.417	-4.281E-1	-1.166E-1	.082	1.217E1
	VAR00003	.628	.241	.236	2.606	.011	.148	1.108	.490	.286	7.360E-2	.097	1.031E1

Table 27a **Co linearity Diagnostics** [a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	VAR00001	VAR00002	VAR00003	VAR00004	VAR00005	VAR00006	VAR00007
1	1	7.744	1.000	.00	.00	.00	.00	.00	.00	.00	.00
	2	.153	7.124	.00	.00	.01	.01	.01	.00	.00	.01
	3	.064	10.979	.44	.00	.00	.00	.00	.00	.01	.00
	4	.021	19.323	.06	.00	.10	.25	.00	.01	.02	.00
	5	.009	29.050	.01	.05	.00	.00	.01	.09	.02	.87
	6	.004	41.978	.14	.69	.03	.01	.06	.40	.00	.03
	7	.003	52.032	.25	.26	.60	.02	.09	.07	.77	.07
	8	.002	59.773	.11	.00	.25	.71	.84	.42	.18	.02

	VAR00007	-.413	.185	-.158	-2.236	.028	-.780	-.045	.861	-2.485E-1	-6.314E-2	.159	6.298E0
6	(Constant)	2.658E1	2.122E0		12.525	.000	2.235E1	30.804					
	VAR00005	.803	.294	.296	2.733	.008	.218	1.388	.948	.301	7.383E-2	.062	1.609E1
	VAR00006	1.690	.279	.701	6.069	.000	1.136	2.245	.932	.574	1.639E-1	.055	1.831E1
	VAR00004	-.823	.241	-.334	-3.418	.001	-1.303E0	-.343	.417	-3.671E-1	-9.231E-2	.076	1.307E1
	VAR00003	.519	.234	.195	2.219	.029	.053	.984	.490	.248	5.995E-2	.094	1.059E1
	VAR00007	-.557	.184	-.214	-3.033	.003	-.923	-.191	.861	-3.305E-1	-8.191E-2	.147	6.820E0
	VAR00001	.743	.262	.256	2.840	.006	.222	1.264	.935	.312	7.671E-2	.090	1.110E1
7	(Constant)	2.607E1	2.087E0		12.487	.000	2.191E1	30.225					
	VAR00005	.789	.287	.291	2.748	.008	.217	1.361	.948	.304	7.254E-2	.062	1.610E1
	VAR00006	1.421	.300	.590	4.736	.000	.823	2.019	.932	.482	1.250E-1	.045	2.226E1

Table 27a **Co linearity Diagnostics** [a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	VAR00001	VAR00002	VAR00003	VAR00004	VAR00005	VAR00006	VAR00007
1	1	7.744	1.000	.00	.00	.00	.00	.00	.00	.00	.00
	2	.153	7.124	.00	.00	.01	.01	.01	.00	.00	.01
	3	.064	10.979	.44	.00	.00	.00	.00	.00	.01	.00
	4	.021	19.323	.06	.00	.10	.25	.00	.01	.02	.00
	5	.009	29.050	.01	.05	.00	.00	.01	.09	.02	.87
	6	.004	41.978	.14	.69	.03	.01	.06	.40	.00	.03
	7	.003	52.032	.25	.26	.60	.02	.09	.07	.77	.07
	8	.002	59.773	.11	.00	.25	.71	.84	.42	.18	.02

VAR00004	-1.356E0	.344	-.550	-3.947	.000	-2.041E0	-.672	.417	-4.171E-1	-1.042E-1	.036	2.786E1
VAR00003	.614	.233	.231	2.637	.010	.150	1.077	.490	.293	6.961E-2	.091	1.100E1
VAR00007	-.459	.185	-.176	-2.474	.016	-.828	-.089	.861	-2.764E-1	-6.531E-2	.138	7.273E0
VAR00001	.877	.263	.302	3.331	.001	.353	1.402	.935	.361	8.793E-2	.085	1.177E1
VAR00002	.480	.225	.232	2.130	.037	.031	.929	.471	.240	5.622E-2	.059	1.698E1

a. Dependent Variable: VAR00008

RESULTS

Models Summary Results

The model summary above (table 24) shows that the predictors in those Industries correlate highly with the performance. It is also found that the predictors are highly significant, which implies that the factors are perfectly affecting the performance of manufacturing workers in Industries.

R-Square value is high signifying that the predictors predict performance of the manufacturing workers with good determination.

The F-change value is far greater than the statistical table value (1.84) signifying that the values of the parameters obtained in the model summary in other tables are not accidental, but out of a predetermined experimental design setups.

Summary of ANOVA

The ANOVA table 25 shows the Regression and Residual Sum of Squares and through arithmetic operations to them emerge the F-values which are used to establish the suitability or reality of the data generated for use in the analysis. The higher the value of F- values the more the tendency of proving its worthiness in determination of chances of data occurrence. It is also seen that the predictors are highly significant, (see column for Significance) which implies that the factors are perfectly affecting the performance of manufacturing workers in Industries.

Summary of Coefficients

In the Coefficient table 26, there are parameters such as: B coefficients, t-values, Correlation coefficients, tolerance and Variance of inflation factors which are shown.

The B- coefficients are the various predictors' gradient coefficients that when operated with division operand of standard errors, t-values are obtained. When the critical t-value is greater than the t-value from the statistical table, significance of the factors occurs, otherwise, insignificance.

A look at the correlation compartment, considering the zero order type of correlation coefficients, the coefficients are too poor in the factor power, safety and maintenance in the combined data from the industries and fair in the refined of the combined data. The poor nature of these three predictors is due to the degree of problems associated with them in real life /nature in the industries. The vast majority of firms in Nigeria expressed their dissatisfaction with the services of Power Holding Company of Nigeria (PHCN) and high cost in fueling the standby Gen-Sets. In safety, there is no adequate provision of protective clothing to the machine operators to ensure safety for effective use of machines which resent fears and lack of composure or confidence in machine operators. In maintenance situation, machines receive no immediate and adequate maintenance program, much down time occurred as a result, and so operators lost interest at work most often.

When the tolerance is tending to zero, there is high multi-co linearity and the standard error of the regression coefficient will be inflated. A variance inflation factor (VIF) greater than 15 is usually considered problematic and the highest in the table is 7.2… (Table 26), hence the co-linearity diagnostics confirm that there are no serious problems with multi-co linearity, and therefore all the predictors affect performance of the manufacturing workers.

Result of Hypotheses Testing

1. H_o: Performance of manufacturing workers in industries is not affected by: Motivation, Power and Energy, Safety, Maintenance, Training, Equipment and Technology.

From the Table 25 of the regression analysis at the degree of freedom obtained, the value of F-statistic returned by the LINEST is greater than the $F\text{-}_{critical}$ value from the statistical table at 5% confidence level. Since F_{satist} = 3.84 and $F\text{-}_{critic}$ value returned by SPSS is 194.48, therefore the performance of manufacturing worker is affected by these treatment variables: Motivation, Power and Energy, Safety, Maintenance, Training, Equipment and Technology.

2. Testing for hypothesis two, 'that whether the relationship between performance and the predictors occurs by chance or not'. Since the observed F_{critic} value returned by

SPSS output 195 (approximately) is greater the F_{stat} value from the statistic table (3.84), the relationship does not occur by chance and the probability of not occurring by chance is 7.42579E-08.

3. Looking at the Regression equation of (4) and table 31, it is observed that the ratio of the slope (m) coefficients on each treatment to the corresponding standard error, (Se_i) of its coefficient of the form: $t = m_1 / Se_1$ or $m_2 / Se_2 \dots m_n // Se_n > t_{stat}$ statistic table value of 1.895 at 95% confidence level and at the specified degrees of freedom. The table below shows the absolute values of the seven t-observed values is in agreement to the Test conditions and is significance.

Table 31: Absolute Values of the seven, t-statistics values

Treatment	Motivation	Power	Safety	Maintenance	Training	Equipment	Technology	Const.
$t = m_i/S_{ei}$	3.331	2.130	2.637	-3.947	2.748	4.736	-2.474	12.487

If the absolute value of **t** of all the treatments is sufficiently high, greater than the value of t_{stat} obtained from the statistic table, it is then inferred that the slope coefficients are valid or useful in estimating the assessed value of the performance of the manufacturing workers in industries, as returned by the SPSS regression output program.

The values of co-efficient of correlation obtained in the calculations on the various treatments show that all except maintenance and technology have positive correlation and there is a degree of correlation between the factors and the Performance of manufacturing workers, as shown.

Table 32 : **Excluded Variables [g] of the Overall Raw Data**

Model		Beta In	T	Sig.	Partial Correlation	Co linearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	VAR00001	.381[a]	4.049	.000	.415	.121	8.279	.121
	VAR00002	.025[a]	.606	.546	.068	.773	1.294	.773
	VAR00003	-.038[a]	-.901	.371	-.101	.702	1.425	.702
	VAR00004	-.019[a]	-.473	.638	-.053	.792	1.263	.792
	VAR00006	.378[a]	4.381	.000	.442	.140	7.162	.140
	VAR00007	.029[a]	.351	.726	.039	.185	5.399	.185
2	VAR00001	.302[b]	3.366	.001	.356	.114	8.764	.084
	VAR00002	-.131[b]	-2.867	.005	-.309	.459	2.177	.083
	VAR00003	-.095[b]	-2.435	.017	-.266	.643	1.554	.128
	VAR00004	-.151[b]	-3.764	.000	-.392	.556	1.800	.098
	VAR00007	-.072[b]	-.915	.363	-.103	.170	5.892	.108
3	VAR00001	.213[c]	2.325	.023	.256	.101	9.942	.084
	VAR00002	.135[c]	1.224	.225	.138	.073	13.675	.073
	VAR00003	.226[c]	2.429	.017	.267	.097	10.278	.069
	VAR00007	-.149[c]	-2.026	.046	-.225	.159	6.280	.084
4	VAR00001	.180[d]	1.978	.052	.221	.098	10.248	.058
	VAR00002	.206[d]	1.901	.061	.213	.069	14.446	.037
	VAR00007	-.158[d]	-2.236	.028	-.248	.159	6.298	.061
5	VAR00001	.256[e]	2.840	.006	.312	.090	11.099	.055

	VAR00002	.145[e]	1.289	.201	.147	.062	16.010	.036
6	VAR00002	.232[f]	2.130	.037	.240	.059	16.982	.036

a. Predictors in the Model: (Constant), VAR00005

b. Predictors in the Model: (Constant), VAR00005, VAR00006

c. Predictors in the Model: (Constant), VAR00005, VAR00006, VAR00004

d. Predictors in the Model: (Constant), VAR00005, VAR00006, VAR00004, VAR00003

e. Predictors in the Model: (Constant), VAR00005, VAR00006, VAR00004, VAR00003, VAR00007

f. Predictors in the Model: (Constant), VAR00005, VAR00006, VAR00004, VAR00003, VAR00007, VAR00001

g. Dependent Variable: VAR00008

DISCUSSION OF RESULTS

Discussion of Results Generated from SPSS Analyzed Output

Fundamentally, the objective of this work is to find the relationship between the predictors (independent variables) and performance of the manufacturing worker in a manufacturing industry. Regression analyses were carried out on the data of table 2 which were obtained from the three Industries under study. From the model summaries of the regression analysis on these data indicated that the regression models have perfect coefficients of correlation of 0.994 and the coefficient of determination R^2 between 0.948 implies that the relationship between the observed value and predicted value is closely related and the difference between the observed and the predicted is called the Residual.

The ANOVA tables of 4, 7, 10, 13, 16, 19, and 22 also show good significance of the predictors evaluated using the three Industries with a 95% confidence interval i.e. 0.05 significance level. The linear regression model developed from the analyses is given as follow:

Model for the Overall Industrial Generated Data; this is most acceptable of all the models that predict performance in this research work and is expressed as:

$$\mathbf{P\ (X_i) = 26.065 + 0.877X_1 + 0.48X_2 + 0.614X_3 - 1.36X_4 + 0.789X_5 + 1.421X_6 - 0.495X_7} \quad \mathbf{(4a)}$$

NB: the output performance values of the individual manufacturing workers are generated using equations 1-3.

Co linearity Diagnostics

The second section of the coefficients table (table 27b) shown on the combined data table shows the different models of factors addition to measure the various parameters contained in the coefficient tables; that there is a problem with multi-co linearity in each case. For most of the predictors' model, the values of the partial and part correlations dropped sharply from the zero order correlation. This means, for example that much of the variance in energy that is exhibited by all workers in their performance is also exhibited by other predictors or independent variables.

The tolerance is the percentage of the variance in a given predictor that cannot be explained by the other predictors. When the tolerances are close to zero, there is high multi-co linearity and the standard error of the regression coefficient will be inflated. A variance inflation factor (VIF) greater than 15 is usually considered a problem and the highest in the table is 27 (table 27b), hence the co linearity diagnostics confirms that there are serious problems with multi-co linearity especially with maintenance and equipment as in the models 6 and 7 of table 27b.

Several Eigen values are close to zero indicating that the predictors are highly inter correlated and that small changes in the data values may lead to large changes in the estimates of the coefficients.

The condition indices were computed as the square roots of the ratio of the largest Eigen values of the each successive Eigen value. A value greater than 15 indicates a possible problem with co-linearity, greater than 30, a serious problem. Three of these condition indices are larger than 30, suggesting that training, equipment and technology have serious problems with co-linearity that is any two of them can be ignored in predicting the performance.

Solving the Problem of Co-linearity

In order to solve the co-linearity problem, there is need to rerun the regression analysis using z –scores of the dependent variables and the stepwise method of the predictors' selection (table 27b). This is to include only the most positive contributing variables to the dependent variable (performance) in the model. After the elimination or exclusion process, the predictors- motivation, power, safety, maintenance and technology are the variables left over in descending order of significance.

The predictors: Training and equipment are the variables excluded from the model 2b (table 70). This is an excellent indication that all the manufacturing companies under study have serious problem with the energy, training and somewhat motivation programs. Hence, the poor availability of Energy, Training and sometimes motivation to the production worker affect their performance negatively, thereby requiring improvement to make production process highly efficient and profitable.

Coefficient of Determinations R^2 and F- Distribution Statistics

The coefficient of determination "R^2" of the model summary as seen in table 24 which is approximately equal to one (unity) and indicates a strong relationship between the independent and the dependent variables.

The F- statistical distribution table can now be used to determine whether these results, or model, with such a high R^2 value occurred by chance. The term alpha is used for the probability of erroneously concluding that there is a relationship. Assuming an alpha of 0.05, the F – distribution of 194.48 at DF of 74 in SPSS output as seen in table 25 and could be used to assess the likelihood of a higher "F" value occurring by chance.

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Referring to the "F" statistical table, (appendix 8) an appropriate – F- distribution has df_1 and df_2 degrees of freedom while n = number of data points. From table 74, df_1 = n – df – 1 = 74 and df_2 = df = 7.

Hence, from the statistical table, the value of "F" distribution at the above stated points is 2.05, while the "F" returned by LINEST and SPSS at same points as seen in Table 25 and is 194.48, which is far above 2.05 and these occurred with a high coefficient of determination $R^2 = 0.948$ and a correlation coefficient (R) = 0.974.

To prove that this large value of "F" (194.48) did not occur by chance, Excel FDIST was employed (FDIST(F, df_1, df_2) to calculate the probability of a large F-value of 194.48 occurring by chance, and it was calculated to be 7.42845×10^{-8}. Since the probability is very small, to the magnitude of 10^{-8}; and this shows that the result did not occur by chance. With the alpha 0.05, as earlier stated in null hypothesis H_o that the results obtained occurred by chance is hence rejected, while the alternative hypothesis H_1, indicating that the results obtained did not occur by chance is accepted.

From the above evaluations, it is conveniently concluded that there is a relationship that exist between the manufacturing workers performance and the independent variables (factors) in the study, since F –critical value of 194.48 exceeds table statistics value of 2.05, and the probability of its occurrence by chance is very negligible.

The – t – Critical Values of Statistical Distribution Test.

Again from the results obtained, another good hypothetical test could be done, to determine whether each slope coefficient (m) is useful in predicting the model generated. This could be achieved using the statistical "t"- distribution test. Generally, $t = m_i / s_{ei}$ (where m_i is factor slope and $S_{e\,i}$ is the standard error) and from the statistical manual, t –statistical for one – tailed distribution with 74 degrees of freedom and alpha of 0.05 is given as 1.663 (see table 26).

If the absolute values of "t" returned in the Multilinear regression model generated from the seven predictors against 82 workers performance by SPSS software as seen in tables 26 are all greater than the t- values from the statistical – t- distribution tables appendix 8, which is 1.663, and in the table 26, all the values within t- column are greater than statistical table value of 1.663; then it means that their various slope coefficients (m_i) can conveniently be used to predict the model accurately. It is seen that those values of -t- that greater than 1.663 are found to be significant, hence if the statistical table is not consulted for slope coefficients validation, significance values are to be less than the chosen significance level of 0.05.

These values of t- shown in tables 26 have an absolute value greater than 1.663; therefore, all the variable coefficients that occurred in the multilinear regression equation are useful in predicting the performance of manufacturing workers in the industries. Table 32 of the Excluded Variables of the Overall Raw Data presented absolute values greater or less than 1.663, but only the t-values that greater than 1.663 are useful in predicting the performance of manufacturing workers in the industries only, in any of the model as shown in the table 32.

Application of the Results to Industries

Owing to the fact that the analyzed factors affect performance of manufacturing workers and productivity in general for the industries; but the results obtained in the various industries have some significance in affecting the overall performance of manufacturing workers in production output. These factors were studied in engineering environment of the companies or industries to illustrate engineering-management effects in the organizations production. Hence the following are the discussions on the factors-influence and relationship with the operational performance of the manufacturing workers.

Motivation and other factors investigated will be discussed in the light of engineering management manipulations to achieve effective improvement in production output of the companies:

Motivation

Motivation shows the scientific and engineering management manipulations in achieving effective improvement in production output of Companies. It goes a long way to find out what are the mechanisms that lead to achieving these targets. However, these mechanisms remain the motivational processes. Consequently, on the industrial setting motivation processes are the exciting induced tendencies, attractive, operating and encouraging work atmosphere geared towards enforcing and enhancing production through its work force. In fact, motivation refers to up-grading workers morale and commitment to work. Since production is a social enterprise it involves technical components known as factors of production and social relations of production to form economic basis or productive work force. Therefore, in motivating the enterprise for a properly developed work force – a company develops appropriate strategy and equip its organization with effective system of information, planning, control, training and more importantly rewards to get the job done – through incentives, promotions, introduction of new technologies in manufacturing operation, provisions of social amenities to workers. Good pay and regular pay packages, reforms on the policies of the board of directors and of the governments. By this it became widely clear that motivation on social relations of production will enforce considerably the work force.

The factorial index (+0.877) for motivation is positive and is second in ranking among the positive influential factors in predicting performance in the multi linear regression equation (model) number 4, with significance 0.001 and a normal value of Variance Inflation Factor, VIF (see table 26). Increasing the value of the index reduces the standard error value until there is no longer error value i.e. index attaining unity, but above unity, the significance becomes negative, then problem exists which implies redundancy; therefore, the manufacturing workers become negatively contributing to the Company's growth, and the more index increases the more significance tends to negativity, and the less performance due to psychological ego and too important syndrome of the manufacturing workers which initiates pride in profession, which is detrimental to performance, and consequently a reduced output. Furthermore, motivation will not tend only to move towards personal gains and acquisitions to workers, but also to move towards the direction of engineering management environmental improvement of the Company for effective and efficient manipulations, as this will give the Company its pride of strengthening the working environment which is important for efficient operation and control in the company settings. Since motivation is a function of many factors (as enunciated in the investigation); it can be improved upon to be effectively moving the company's operations.

Furthermore, other studied factors show their indices from equation 4, such as: Power (+0.48), Safety (+0.641), Maintenance (-1.36), Training (+0.789), Equipment (+1.421) and Technology (-0.494). These factors have to be discussed to show the management science and engineering

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relationship in manipulating manufacturing workers efficient performance in manufacturing Companies.

Electric Power

Electric power has become the greatest source of power required in operating industrial and non-industrial machines and equipment and other appliances. Most commonly, the national electric power supply is not continuous in its supply; in consequential resulted to constant breakdowns in production which is usually the order of manufacturing industries in Nigeria. Of crucial concern today is the state of electricity supply in Nigeria. An efficient infrastructure connects markets and expands investment opportunities. By far, the most significant problem of the physical infrastructure relates to unreliable and irregular power supply.

It is perceived that power with index (+0.48) dynamically contributes to positive increases of performance of manufacturing workers; the higher the power availability for use, the higher the performance of the manufacturing workers (all things being equal), because breakdowns in operations lead to imperfection in manipulating and controlling of machines and consequently reduction in production quantity.

A power supply can be said to be high in quality if it is continuous, the voltage and frequency within the stipulated limits and the power is sufficient to meet the needs of the consumer. Uwaifo (1994) has provided the Statutory Operational Limits of Electricity Supply in Nigeria's National and, thus: Frequency of A.C. system: 50Hz $\pm$ 1.5%; Standard A. C. voltage; 230V between phase conductor and neutral and 400V, 11KV, 33KV, 132KV and 330KV respectively between any two-phase conductors or 3-phase system; Over-voltage trip: 10% on 330KV bus and the Voltage is maintained within 6% above or below the nominal voltage at the consumer's main switchboard.

Safety of Workers

Workers' perceptions and experience in relation to Occupational Health and Safety (OHS) are scarcely considered in programs for the prevention of work related injuries and diseases. Healthy environments and healthy behaviours are key determinants in occupational health and safety. Workplace environment includes physical as well as organizational factors, and attention and interventions should be focused on them. In 1980, Zohar, introduced the co**n**cept of safety climate in industrial organizations, defined as the summary of molar perceptions that employees share about their work environments. According to these perceptions the workers develop coherent sets of expectations regarding behaviour –outcome contingencies and then behave accordingly. Zohar identified two main influential climate dimensions in determining safety climate levels: (i) relevance of safety to job behaviour (including workers' perceived importance of safety training and worker's perceived effects of required work pace on safety) and (ii) workers' perceived attitude of the management towards safety.

Safety with the index 0.614 (positive) has good influence in predicting performance; as a result safety improvements must be looked upon and adequately provided for effective performance of workers. Safety gadgets and protective clothing will not be left out of the needs of manufacturing workers in any manufacturing industry. Though safety is a motivational factor, but also guarantees workers of the management concerns over their life and properties preservation, and offers to them confidence during working, thereby promoting performance and productivity of manufacturing workers in companies.

Maintenance

Maintenance is an undertaken to preserve the proper functioning of a physical system, so that it will continue to do what it was designed to do. Its function and performance characteristics not only take account of output, unit costs and effectiveness of using energy, but also such factors as end-product quality, process control, achieved comfort and protection of the employed personnel, compliance with environmental-protection regulations, structural integrity and even the physical appearance of the productive system. The quality of maintenance significantly affects business profitability. The factors involved include safety, and customer service, not just plant costs and availability. Increased downtime affects adversely the capability of physical systems by reducing their average rate (i.e. speed) of output, so also increasing the operating costs and lowering the average customer's satisfaction with the service.

Maintenance has its factor index as -1.36(negative) in the model expression number 53. The value is high and affects performance negatively. Figure 31 also reveals low tolerance and high Variance of Inflation Factor, VIF, which all are tending to negativity. Traditionally, the higher is maintenance the lower is performance due to downtime which will virtually make manufacturing workers none working and loss of interest to work resulting in low performance of workers. To reduce this value, there should be the provision of redundant (stand by) machines to switch over on breakdown in order to give room for adequate maintenance and repairs of the breakdown machines.

Training

Training has its factor index as +0.789 (positive) and third in ranking in the model predicting performance. This coefficient suggests that training has good contribution in improving the performance of manufacturing workers. In table 31 training is found significant with fair tolerance and moderate value of VIF, indicating interference. Training of staff brings about acquisition of skill and knowledge for manipulating and controlling machines, especially complex ones such as computer integrated manufacturing (CIM) systems, writing program, encoding and decoding information in modern technologies. Training saves cost in production processes, reduces stresses and loss of interest in the profession.

Equipment

Equipment with its factor index as +1.421(positive) has its coefficient value highest of the factor indices in the model of number 53, implying that equipment and other facilities are adequately provided, for effective and efficient manufacturing. It is the highest factor that predicts performance in this study and as such it should be highly considered in manufacturing industries setup; and also this value indicated that new and modern equipment and machines are possibly procured.

Technology

Technology is another factor in the study and has its factor index as 0.495(negative), which implies that technology affects performance in the negative direction in these industries used for the study. The technologies employed in this industrial study can be termed Hi-technology and so manufacturing workers cannot easily manoeuver the principles of operation associated, and hence reducing the performance of the manufacturing workers. Since the variance inflation factor (VIF) 7.3 is below the normal value of 15; signifying gradual effect change on performance for any improvement in technology acquisition and application.

In general, these factors indices in equation (model) number 53 are worthy coefficients in predicting performance and further established by their significance level generated by the factors which is below the set value of 0.05 significance (i.e. 95% confidence interval).

CONCLUSION

From the analyses of the various data collected and the results obtained, it is categorically observed and concluded that Power/Energy, Safety, Maintenance, Training, Equipment and Technology are among the factors that affect the performance of manufacturing workers most in manufacturing Industries especially in the South Eastern Nigeria. It is uniquely observed that six of the factors are positively affecting the performance. Furthermore, it can be observed that the more other factors are considered to be improved upon, the higher the performances. Lightening (brightness), Working Compartment Temperature, Provisions of basic Utilities, Incentives, Excellent treatments to Workers, and Working Hours are some of the factors that may enhance the performance of manufacturing workers if well integrated into a manufacturing System.

Good and adequate motivation of tangible and intangible items will definitely accelerate the performance of workers to the extent of working incrementally without bound. Motivating elements are to be resorted to whenever more output is required from (manufacturing) workers, when all other influencing factors are put in place in standard state. The basic fact remains that the extent of performance of manufacturing workers in any organization depends on how well they are motivated. To say that managers motivate their subordinates is to say that they do things which they hope will satisfy those derives and desires and induce the subordinates to work harmoniously, efficiently, effectively and harder in anticipation for higher rewards.

More facts have been discovered from the analyses which show that the values of the t-Coefficients of the Industries used in the study revealed absolute Significance (with the significance levels less than the default, 0.05); and these outcomes further strengthened that those selected factors are actually affected the performance of manufacturing workers. The model expression is a multi linear regression equation, which reveals the various factor indices for the individual industry. The values of their coefficient of determination, R^2 and correlation coefficients, R showed the strength of the prediction by those factors on performance.

The variability in the results is as a result of human inefficiencies, psychological feelings (about what people do, have, think, know, feel or want) , and different other levels of factors influences which are very difficult to integrate into the individual workers, in equitable requirements for effective responses and results.

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