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Research Article

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Effective Hazard Control: An Imperative for Managing Health, Safety and Environmental Challenges of Construction Projects in Nigeria

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Abstract This paper exposed the hazard, health, safety, and environmental threats of construction projects' processes and operations and investigated the extent to which they are provided for and managed by construction companies and consultants in Nigeria. Sixty construction practitioners and fourty-six design consultants whose operations cut across the six geopolitical zones of the country cooperated in the study. The construction practitioners provided information on the extent to which they implement health and safety systems in construction, while design consultants recorded the extent of provision of design solutions to mitigate the environmental challenges of construction projects. The findings reveal below average application of health and safety provisions by contractors and marginally above average design solutions for controlling environmental challenges. The paper formulated a defacto hazard threshold control framework for use in managing health and safety as well as appropriate management strategies for health, safety and environmental impacts of our construction projects and recommends efficient implementation of the Canons of Health and Safety Management.

Keywords Hazards, Health, Safety, Construction, Environment, Impact, Management

Introduction

Construction and process operations are inextricable components of a developed society. They record 30-40% [1] of world fatal accidents which could be drastically reduced if the projects' potential hazards are identified and controlled through efficient safety management.

Hazard is a situation in which danger exists thus making it possible for an accident or incident to occur. Hazard is the existence of unsafe conditions and/or unsafe acts, which may remain for a while before an accident follows or result. Construction is a man-made process, fraught with inherent failings in man and the environment. The higher the complexity of projects and their technology applications the greater the potential hazards.

Hazard result from active or latent failings of human in safety management. In Nigeria, complex public and private projects are currently on-going and include canals, tunnels, superhighways airways railways, suspended long spanning bridges, extensive power projects, large water projects, irrigation works, refineries, industrial plants, sky scrapers and their rehabilitations. Hazards exist in these projects arising from unsafe acts and omissions of projects' design and construction operators/participants and unsafe conditions of project/work environment. Hence hazard can be classified as unsafe acts/omissions and unsafe conditions (see figure 1).

The cornerstone to effective safety management is the identification and control of projects' hazards. Put simply, it is the identification and control of unsafe acts and unsafe conditions inherent in planned projects. Unsafe acts are personal failings which constitute risks to health and safety. Unsafe conditions are inadequacies in either the situation or the system of work. Hence hazard identification seeks to identify both unsafe acts and

unsafe conditions. Unsafe acts are acts which deviate from specified or generally accepted Safeway of performing a task thereby increasing the likelihood of an accident, occupational ill-health or disease. It could be wrong action, inaction or omission, e.g. omitting vital step in construction or process. Accident is an unplanned event which may or may not result in injury or damage to property and environment (but may constitute a near miss).

Unsafe Acts - include but not limited to:

- Unauthorized use of machinery/equipment
- Operating machinery/equipment at unsafe speed, overloading, or unsafe use, excessive deadload and lifeload for buildings.
- Ignoring safety devices.
- Using defective equipment or components.
- Unsafe position during use (ergonomics)
- Attempting to repair/maintain equipment/machinery in motion.
- Unsafe or costly omissions/failures
- Failure to follow prescribed procedures.
- Failure to conform to legislative requirements.
- Failure to make work secure.
- Failure to warn or signal
- Failure to use personal protective equipment (PPE)
- Failure to instruct and train.
- Unsafe acts and omissions often result from management/supervisory failures.
  - Inadequate knowledge –lack of training.
  - Inappropriate attitude.
  - Inadequate skill.
  - Inadequate supervision.

Unsafe Conditions of Working Environment include:

- Poor light level, noise, vibration, dust, fumes, acidic environment.
- Inadequate access to and egress from (fire exist, construction/ process areas).
- Hazardous products (flammable, hot, cold etc) or conditions.
- Hazardous construction/process materials.
- Deficient site layouts.
- Inadequate plant and equipment designs.
- Poor condition of plant and equipment.
- Hazardous work procedures and methods.
- Poor communication/information, instruction, training and supervision.
- Poor housekeeping.
- Poor motivation.

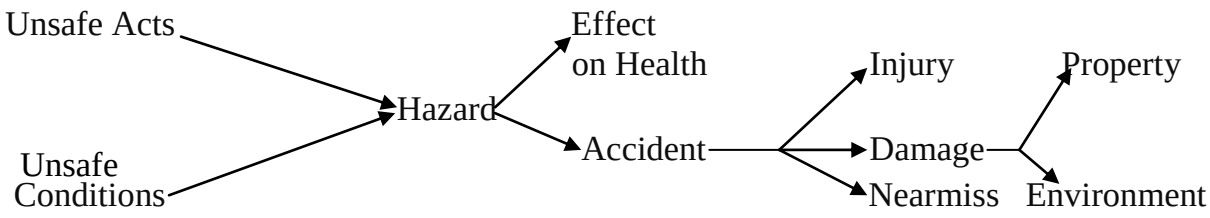

Figure 1: Hazard Causative Factors and Impacts

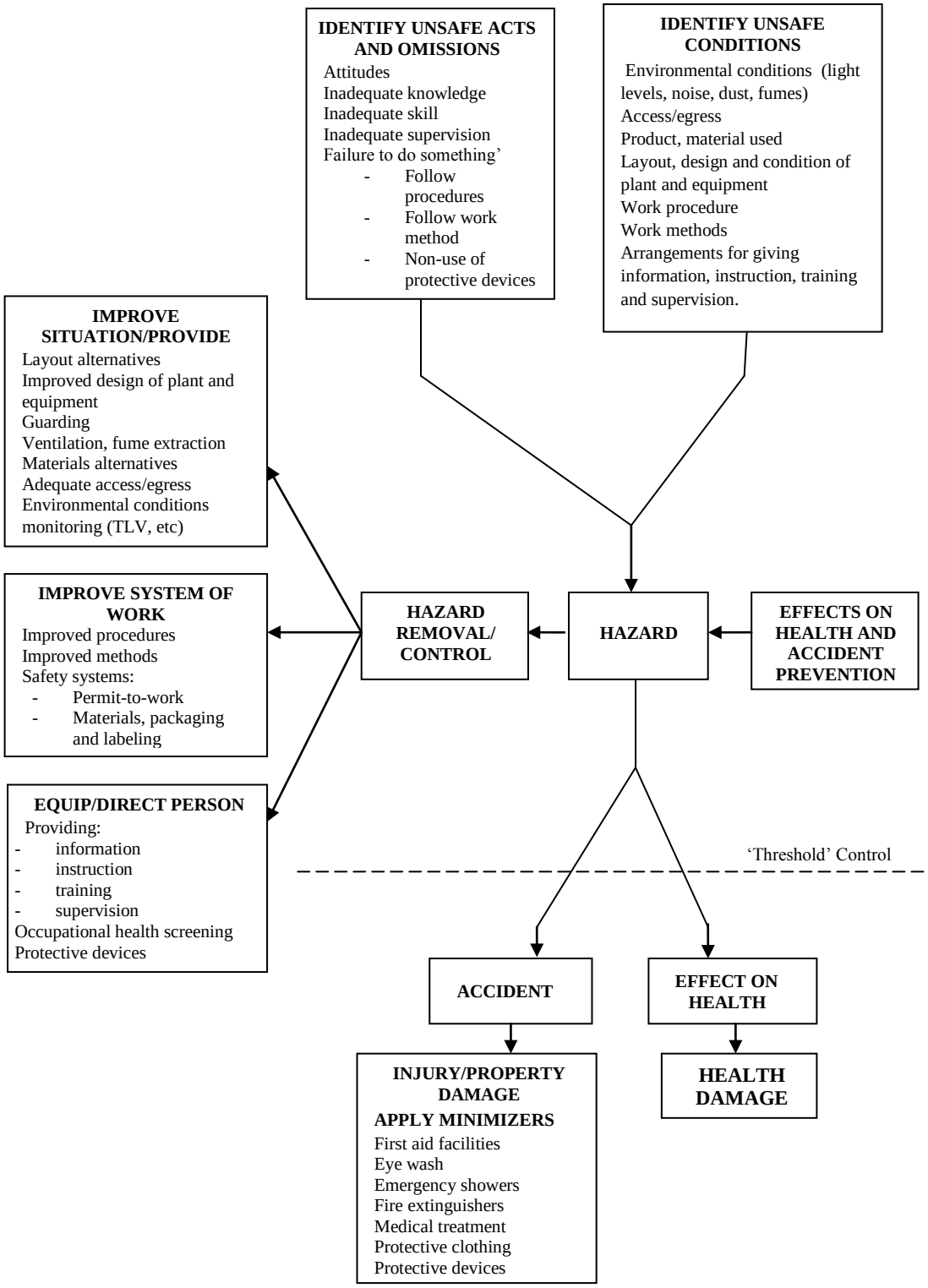

Figure 2: Framework for Identification and Control of Hazards [2]

Hazards provides a continual threat or risk of an accident or effect on health, thus the practical way of preventing accidents is to remove or effectively control the hazard. Projects where not properly planned and managed incubate the inherent hazards which at inadmissible threshold will impact health and safety, hamper ecological symbiosis, cause eco-imbalance and threaten natural resources or subject these to continued adverse effects.

Griffit (1994) [3] describes major adversarial effects of construction upon the environment as:
Health and safety impairment
Comfort disturbances
On-site material wastages
Land misuse (causing erosion and desertification)
Existing site dereliction
Habit destruction (genes, species, ecosystems, wide-life)
Misuse of natural resources
Energy consumption
Air/emissions/pollutions
Waste/effluent discharges
Misuse of water resources

The construction worksite is often a chaotic place with an incredible amount of action taking place. Workers and machines move about in frenzy manner, with every one focused on the task at hand. In such working environment, accidents can and do frequently happen. Also on-site construction practices result in a number of health and comfort disturbances especially to people living and working around any construction projects viz:-

- Noise of construction operations and equipment.
- Dust from processes and traffic.
- Hazardous contaminations (e.g. toxic wastes).
- Other usual disturbances (signs, advertising boards etc).
- Endangerment to health and safety of public in general and safety of work people.
- Nuisance (caused by temporary dwellings, construction traffic and road droppings).

These hazard-induced incidents have to be properly managed to ensure health, safety and secured living environment.

Objective

The objective of this paper is to expose the hazards, health and safety threats of on-site construction processes and environmental impacts of major construction projects. It evaluates the health and safety system implementation level of selected construction companies and level of environmental impacts/mitigation provisions for key infrastructural projects in Nigeria and prescribe appropriate hazard control/managerial strategies. It presents a defacto hazard threshold control framework/system (see figure 2) for use in managing health and safety. And prescribed plausible mitigation, management and transformational leadership measures necessary for handling health, safety and environmental issues of construction projects development in Nigeria.

Literature

Concept of Safety

The term safety derives from the word safe/protected. This means to be protected from any danger or harm. For instance safe fluid/water, means that which present no risk and which will not cause harm or damage and which is not lethal. Safe place, is where one is not likely to be in danger, suffer damage or lose. Hence we talk of safe workplace, safe mode, safe operation, safe space, safe seat etc.

Safety is the state of being safe and protected from danger or harm (Oxford Advanced learner's Dictionary, 8th edition oxford. Univ. Press). The state of not being in danger or protecting from danger. We talk about safety measures, safety belt, safety catch, safety net, safety operations, safety systems etc. the impact of the safety incidents is on health. Hence we talk of health and safety.

Health is the condition of a person's body or mind. Its assimilative capacity or vulnerability to safety issues. The state of being physically and mentally healthy.

Relating these to construction, Ajator, Onwuka and Ikekpeazu (2016) [4] analyzed the economic social and environmental considerations including Health and safety in budgeting for road construction projects in Enugu and Imo States.

Okorie, Okolie and Ajator (2015) [5] exposed the importance of transformational leadership style in managing health and safety in construction sites. Lutchman, Maharaj and Ghanem (2012) [6] maintained that substantial financial savings can be achieved through effective management of worker's health and safety including plants and equipment. Studies have shown that prevention and reduction of construction accidents can yield as much as 47% of return on investment [7]. The Governments of every nation impose legal responsibilities on employers to maintain a safe work environment and exercise moral, corporate and social responsibilities that guarantee healthy and safe work environment. ILO (2011) [1] exposed that accident may lead to prosecution and claims that can threaten the financial health of a company as well as damage the company's image and destroy goodwill, for failure to implement proper health and safety management systems. Lingard and Rowland (2005) highlight the reputational damage to a company found sloppy in maintaining health and safety which ensures workers' well being [8].

Okorie, Ajator and Macbarango (2016) [9] revealed that poor plant and equipment management and operators' behaviour have adversarial effect on construction health and safety performance.

Effective management of construction site activities should include management of plants and equipment. However, statistics have revealed that major construction site fatalities have been linked to plants and equipment accidents [10]. Construction site operations involve the use of sophisticated plants and equipments and hand tools. The sizes and sophistications of the machines and equipment used on construction site can be a source of major fatal and injury cases [1, 11]. Plants and equipments such as saws, ladders, scaffolds, forklifts, cranes, hoists, derricks, tractors, scrappers, bulldozers, and hydraulic drills have caused major fatalities and injuries on sites. The World Health Organization (WHO) (2010) [12], reports that over 3500 sites workers are killed every year as a result of plants and equipment accidents. Proper management of plants and equipment on site not only prolong the useful life span of those plants, but also provide necessary measures to protect lives of workers. Effective management of plants and equipment entails that site managers and supervisors conduct regular inspections and ensure that competent operators are hired to operate plants they have the certification. Anecdotal evidence has shown that some contracting firms hire the services of untrained plants operators to cut corners which have resulted in fatalities and plants and equipment damage.

Globally, poor maintenance culture among contracting firms is a serious challenge to effective management of plants and equipment. Construction plants and equipment, like every other types of machinery, can experience failure particularly if it is overused or improperly maintained. Hughes and Ferrett (2010) [10] contend that poor maintenance culture is one of the major factors attributable to plants and equipment accidents. However, in the developing countries and Nigeria in particular, most of the spare parts for plants and equipment maintenance are imported as a result the industry has a poor maintenance records. Improper maintenance of plants and equipment often resulted in malfunctioning or failure. Fewings (2010) [13] argues that most of the plants and equipments accidents could be prevented by regular inspection and maintenance. Plant managers and supervisors have duties and responsibilities to ensure that plants and equipment are regularly maintained for optimal performance. Brauer (2006) [14] asserts that plants and equipment accidents are indication of poor management and supervision. The link between management practices and sites H&S performance have been extensively investigated. It has been found that lack of management and supervision relative to construction plants and equipment has resulted in fatalities, injuries and equipment damage [10].

Alcohol use is common among Nigerian site workers and particularly plant operators. Majority of the accidents involving heavy plants on sites have been linked to drug and alcohol users. Unsafe behaviour of plant operators has been identified by many researchers [13] among others, as a factor contributing to accidents, incidents, plants and equipment damage. Unsafe behaviour of plants operators such as over speeding has resulted in fatalities and damages to company's property and equipment. Safety Handbook by ACT Building and Construction industry USA, has chronicled the dos and donts in managing health and safety by construction managers/operators. Several studies have examined the causes of site accidents in terms of management commitment, workers' H&S training, site conditions and supervisory leadership roles. For example, a past study relative to management commitment concluded that lack of management commitment among site mangers or supervisors are contributory factors to unsafe conditions and unsafe acts found on construction sites [6].

Hazard Control /Management

Personnel may behave in a way that would allow hazard to occur. Human is influenced by two factors-any intrinsic error tendencies present in the individual and any error-inducing conditions applied to the person. When either or both of these are present and a trigger occurs, then a hazard will exist. If the environmental conditions are unforgiving whilst the hazard exists, then an accident will occur. The unforgiving environment is the inadequacy of the facilities, barriers, controls and procedures which allow the accident to develop and the ineffectiveness of the mitigating factors such as protection facilities.

Part of hazard control process may include work inspections, both planned and unplanned, hazard reporting, Critical Task Analysis. Critical jobs could be assessed from its past injuries/incidents or newness and potential for injury or damage. Such jobs can be broken down into implementation steps and critical hazard control requirements for; people, equipment, materials and environment.

People:

- What contacts with energy, physical or chemical, are present that could result in injury or illness?
- Are there contacts that could cause fire or explosion?
- Does the worker understand and follow all rules, regulations and precautions?
- Has proper personal protective equipment been provided? Is it being utilized properly?
- Are the right number of people doing the job?
- Is there any idle time for workers that could be used more gainfully?

Equipment:

- Are the tools and equipment being used best suited to the job from all aspects (safety, quality, production)?
- Can tools be provided that would improve efficiency and safety?
- Can mechanical or power tools be applied more economically than hand tools?
- Is machinery and equipment being used to its maximum safe capacity?
- Is all equipment in proper operating condition?
- Is there a less costly piece of equipment that would do the same job properly?
- Are all tools readily available and properly positioned for most effective work?

Material:

- Can better, safer, less expensive or less scarce material be substituted?
- Can waste be cut down in any way?
- Are there any uses for scrap or waste?
- Is material being transported and handled in the most efficient manner?
- Is the right amount of material at the job site?
- Is there another product that could do the same job at less cost?

Environment:

- Are working areas and related storage areas clean and orderly?
- Is junk occupying space that could be used to more advantage by people, equipment and material?
- Is there anything in the environment that you would consider unnecessary to the task at hand?
- What in the environment could be changed or altered to improve conditions, atmosphere and general work climate for people/equipment and material?

Managing Health and Safety

Generally, and especially in construction, the secrete to achieving high standard of safety is commitment and hard work by all. Patience and constant dedication is required. Commitment must be made by everyone, from the board of directors to the part-time workers/office cleaners.

Construction company managers (strategic managers, middle/supervisory managers and operational managers) must dedicate and commit themselves to safety. Strategic managers must dedicate themselves to:

- Establishing safety policy and culture that looks at safety in the same way as they look at production, profits, research, planning, sales and all the other key ingredients of a successful business.
- Build the framework that gets the safety policy flowing effectively through the entire company.

- Value, recognize and reward safety achievements visibly to convince everyone that management is serious about safety. Put the other way; make safety top priority among the company's objectives.

Safety should be accorded top priority because safety of life is supreme [2]. We cannot accept that people are killed or maimed in our operation sites as all accidents can be avoided. Legislations (Health and safety at work etc Act, Workmen Compensation Act etc) exist to compel implementation of safety standards. Good safety management is linked with good business management and companies with high safety standards have high operational standards.

The tools that managers use to improve safety are the same ones they use to improve business: setting safety goals or operation procedures, monitoring progress, identifying and correcting aberrations or deviations from procedures while listening to staff at all levels.

The key tool to achieving safety is to maintain formal comprehensive programme of safety audits i.e. in-depth management and technical audits and frequent supervisory inspections:

- Management must regularly visit operational sites to observe check and question issues. It could be that the operators have never received operational procedures, or be trained in their use.
- The procedures were written by someone unfamiliar with the practicalities of the operations. The operators know/understand procedures, but disregarded it for observed management indifference.
- Implement "unsafe-practice-audit", to reduce unsafe acts and unsafe situations. Here supervisors, safety, committee workers are made to spot safety problems and communicate them to other workers. This enables all staff to constantly monitor their own and their colleagues' safety, implement moral suasion and positive counseling of defaulters. This technique was pioneered by Dupont Chemical Company.

The critical supportive tools for achievement of comprehensive programme of safety management are communication, training and monitoring/auditing.

Communication:

This must start with senior managers who must willingly devote their time/attention to safety matters. Management must modify the way organization works, so that supervisors at every level communicate safety paradigm directly to their subordinates. Communication flow is not one way top-down but integrated with participatory bottom-up, two-way approaches, such that safety concerns and suggestions of workers are communicated back up the line for management prompt action. This must not be occasional, but rather a continuous integral part of the daily work routine.

Training

For managers and supervisors to perform this vital role properly, they need training and retraining in safety management. Learn how to identify and correct unsafe acts and situations, and analyze accidents beyond their basic causes and locate main safety weaknesses of the operations.

Monitoring and Auditing

Safety progress performance must be monitored and reported in the weekly reports for all operating units and company's annual report. The report should be used in staff performance appraisal and promotion. In this way, the audit becomes a vital instrument in verifying that the company's safety management is working properly.

Technical audits check both the technical/technology integrity (the hardware) and safety procedures (the software). Since safety can only be achieved by merging both as a system.

Handling Human Failings

Accident causation models suggest that at least 98% of accidents in construction and businesses are by human failing; management, supervisors, employees and designers. Hence people must do things correctly to have high standard of safety performance, through safety awareness creation, cultivation of safety culture and adherence to safety codes/ethics. We must also understand the causes of accidents and hazards. There can be "Active failures" in safety management arising from failure of operational staff-building/engineering production staff/operators: drillers, welders, electricians, drivers, fitters etc. This active failures may be a function of the "latent failures" – in the system, such as design/ decision errors of designers, planners and managers.

Researchers understudied the psychological reasons for failures [2] and found the under listed common trend seemingly attributed to management and human failures:

- Poor safety motivation

- Inadequate defence against mistakes poor operating and maintenance procedures,
- Inadequate training
- Bad organization
- Lack of communication
- Priority of commercial goals over safety

Thus safety improvements must seek to remove both latent and active failures through:-

- Good quality design and engineering
- Well planned and pragmatic procedure
- Motivation of staff with imbued safety culture

Management must not allow operations without appropriate safety system in place. Managers and supervisors should be held personally responsible for the safety of operators under their control whether company staff, subordinate or contractor and must not renege in this responsibility or else be labeled 'sloppy'.

Corporate sloppiness means a company where things are poorly designed, with quality/safety control procedures habitually short-circuited, poor communications and bureaucratic delay. In deed an unsafe and inefficient company.

Morally, there is a duty to be safe. It is unacceptable for people to be killed or maimed in operations while accidents can be prevented. Construction companies that are well managed are likely to be both safe and prosperous.

Hence the principles of effective safety management requires that:

- Management demonstrates a visible commitment to safety.
- Safety be seen as the responsibilities of line management.
- Competent safety advisers be appointed
- High safety standards be made available and well understood.
- Audits of safety standards and practices be carried out
- Effective safety training be conducted
- Sound safety policies be put in place.
- Realistic safety targets and objectives be set.
- Techniques to measure safety performance be applied.
- Injuries and accidents be investigated thoroughly and followed up.
- Effective motivation and communication be entrenched in all activities.

We are cognizant of the often pleaded maxim-it takes time to generate safety commitment, even longer to develop safety culture and a lifetime to introduce the safety programme needed to ensure safe operations. But the issue of safety and security of life is paramount and must not be subordinated to unpragmatic maxims. A journey of a thousand miles starts with a step forward.

Managing Environmental Challenges of Construction Projects

Linear facilities are part of the infrastructural pre-requisites of industrialized economy, synonymous with development and have potential to cause great environment challenges. They are installations for the transportation of environment resources from the source of supply to centres of demand e.g. electricity transmission lines, gas and oil pipelines and physical channels for transportation itself such as highways and railways etc. These facilities and their construction tend to impact the environment, shape society around them, alter landscapes and patterns of development. Where uncontrolled, they compel society and landscapes to conform to technology rather than technology conforming to confines determined by society (Ajator, 2000), thus creating great environmental challenges.

In sitting linear facilities, the linear route selection for these facilities requires a detailed and formal approach to planning-viz regional screening, identification of alternatives, evaluation of the alternatives and final site selection. Lame routing exercise would result in delays in project approval and/or ultimate cancellation. Massa (1984) [15] indicated that such project failures result from routing studies that:

- Have weak determination of project needs, objectives and/or characteristics.

- Have inadequate interest representation.
- Fail to follow a clearly traceable sitting process.

  Hence proper sitting process and environmental management of construction should involve the successive narrowing of an appropriately identified region, using a phased logical and comprehensive route selection and development design/construction steps:
- Formulate project goal
- Define technical characteristics and requirements for the project
- Identify and screen the candidate area.
- Select/evaluate the candidate site.

The establishment of alternatives in environmental analyses must extend beyond feasibility and candidate site selections to analyzing alternative project designs, construction, operation and demolition ie address lifecycle impacts for the chosen project so that the best alternative that presents least environment impact is chosen.

- Design green
- Formulate mitigating measures and compensation plan
- Assess lifecycle environmental cost (both social and private costs) of resources and products designed for use [16]

Use Corridors

Corridors have become fashionable for the routing of transportation and resource-delivery systems [17]. It is the placing of transportation facilities within a planned continuous strip of land in such a manner that the use of land for right of way within the corridor is minimized while mitigating against any adverse environment and social effects on adjacent land uses. Hence corridors are intended to reduce land-use conflict by removing the need for multiple route alignments. In corridor planning, many linear facilities occupy adjacent rights of way, forming a de-facto utility corridor with several advantages including:

- Conservation of land
- Facility integrity
- Limited environmental disturbance
- Land-use planning co-ordination

While possible disadvantages may include

- Increased disaster potential
- The concentration of impact and cumulative impact effects
- Increased construction costs owing to congestion/proximity of other facilities.

Utility corridor agglomerate or cluster some transportation systems like highway and railway with elements of resource-delivery system as pipeline and/or transmission line. Railways included in a corridor dictate the whole corridor alignment and have similar impact to that of high way but of lesser magnitude because of reduced right of way width. Highways cause total environmental disturbance locally and have the greatest impact of any component both during construction and facility operation. Have potential to cause increased run-offs, erosion, landslide, deforestation, divide traditional communities, destroy cultural heritage, encroach on forest, disperse species, genes ecosystem, cause vehicular accidents, monopolize scarce resources [16, 18-19] aside from onsite construction environment degradations.

Pipelines have high environmental disturbance during construction but mitigation practices can minimize long-term impacts. Environmental issues of pipelines includes safety, reliability economics, aesthetics etc. They have large construction impacts, and are sensitive to soil and topographic features with ideal routing as the shortest distance between source and terminal point. They are influenced by product being transported (oil or gas, pipeline pressure, topographical and soil conditions, safety concerns and required surveillance and control procedures. Construction difficulties include river crossings and crossing of environmentally sensitive areas. And linear character e.g. blaze trail effect of the product carried.

Transmission lines have the least physical disturbance during construction, and permit the most effective reclamation practices. Their major impacts are visual, electrical interference and perceived health risks.

Transmission line siting depends on the location of load centres and power generating sites. This constrains the routing options which must be planned to minimize land use conflicts by possibly using the corridor concept and avoiding sensitive areas.

Sustainable Design

The critical step in managing environmental challenges of projects is to design green [20]. Design in simple term is a meaningful and imaginative allocation of physical resources [21]. It is thoughtful matching of physical form to organizational requirements [16]. Sustainable or green design requires that the impact of the design on humans and environmental health be of paramount consideration over and above the traditional factors of cost, aesthetics, material availability, ease of installation, durability and maintenance.

Proposed project must be environment and community responsible. It must be green in its materials' selection, energy planning, waste management, emissions to the air/water and designed for flexibility [20, 22-23].

Sustainability goes beyond environmental management of construction process to cover environmental management of operation and decommission/deconstruction. "If you build green and don't maintain green, you end up brown" is a popular maxim. The bottom line for managing environmental challenges is that these green considerations have to be articulated into an impact Mitigating statement (EIS) to form the strategic brief for the design consultants. The design consultants shall fully design and document green in the specifications and bills of quantities, to guide the selection of pro-green contractor who has to build and manage green, using environmental (sustainability) management system. There is no stop-gap measure in greening for sustainability [3, 20].

Methodology

The objectives of this research are to expose the hazards, health and safety threats of on-site construction process and investigate the extent to which they are provided for and mitigated in Nigeria construction projects. To highlight the environmental impacts/challenges of those projects and assess the extent to which they are considered and provided for in the design solutions by the design consultants. To prescribe appropriate managerial strategies for hazards, health, safety and environmental impacts of our construction projects.

To achieve these objectives, extensive literature search on hazards, health, safety and environmental challenges of construction projects was carried out. Research questionnaires on the subject, were evolved and administered to eighty (80) members of selected major construction companies and sixty 60 members of consultant firms which operations cover the six geopolitical zones of Nigeria. Sixty (60) questionnaires for the construction firms and 46 questionnaires for the consultants were properly, filled returned and used in the study. Anonymity of report was covenanted. The construction professionals; Architects, builders, engineers, quantity surveyors health, safety, security, environmental experts, strategic managers, senior, middle supervisory and operational managers and work operatives of the selected companies were issued questions requiring them to ascribe the extent or percentage level of application of listed health safety and security provisions in their work environment (see table.1). Similarly questionnaires were administered to design consultants to elicit the extent to which they consider and provide design solutions for mitigating identified project impacts (see table 2).

Simple likert scale analytic technique was applied in the analysis of their responses which are presented in the section below. The used likert scale metrics are: 4 for very high application/provision and 3 for high application/provision, 2 for average level application/provision, 1 for low and zero (0) for no application/provision (see tables 1&2 below).

Data Presentation and Analysis

Summary of Replies by Construction Company Project Participants

Table 1: Health, Safety and Security Management Application Test [24]

		Level of Applications/Provisions					
	Health and safety factors	**Very High**	**High**	**Average**	**Low**	**No**	**Weighted score**
1	Safety policy	11x4	12x3	14x2	13x 1	10x 0	2.0
2	Health and safety at work etc Act provisions	5x4	10x3	10x2	14x1	21x0	1.4

3	Other relevant legislations	6x4	8x3	4x2	17x1	25x0	1.2
4	Training and skills development programmes on safe systems of work	12x4	10x3	18x2	15x1	5x0	2.2
5	Company safety culture and safety management systems	8x4	16x3	20x2	12x1	4x0	2.4
6	Safety representative/committee	10x4	11x3	15x2	13x1	12x0	2.1
7	Safety meetings	11x4	13x3	15x2	14x1	7x0	2.1
8	Accident and incident reporting system	15x4	12x3	16x2	11x1	6x0	2.3
9	Job specific rules and procedures	7x4	15x3	15x2	10x1	13x0	1.9
10	Personnel protective equipment, supply and replacement	16x4	18x3	10x2	11x1	5x0	2.5
11	Emergency response procedures	13x4	12x3	18x2	10x1	7x0	2.1
12	Environmental awareness creation	8x4	14x3	17x2	9x1	12x0	1.9
13	Operations hazard audit	4x4	10x3	11x2	15x1	20x0	1.4
14	Fire/explosion prevention	5x4	9x3	10x2	15x1	21x0	1.3
15	Harmful chemical/substance safe handling	3x4	11x3	8x2	18x1	20x0	1.3
16	Confined site operation safe practice	12x4	12x3	20x2	2x1	10x0	2.2
17	Electricity hazard prevention	7x4	14x3	16x2	10x1	13x0	1.9
18	Crane operations, lifting and slinging hazards provisions	10x4	15x3	8x2	20x1	7x0	2.0
19	Noise/particulate hazards protections	5x4	11x3	10x2	14x1	20x0	1.6
20	Scaffolding hazards protection	18x4	17x3	11x2	8x1	6x0	2.6
		Mean of weighted score					**1.92**

From table 1, it is evident that there is general low level provision and/or implementation of health and safety protection measures. Of the twenty (20) number health and safety security factors examined, only eleven (11) were implemented to an average level (i.e. 2 point score and above) by investigated companies. The mean of weighted scores of all the sixty construction companies studied is 1.92 which suggests below average safety sensitization and generally high vulnerability to health and safety risk of Nigeria construction projects. This result is corroborated by the evidences of the literature scan in which many authorities exposed low health and safety performance of construction projects.

It is revealed in the table, that on-site application of legislative provisions is weak, indicative of weak management commitment. For instance, Health and safety at work etc Act and other construction legislations trailed in implementation with 1.4 and 1.2 weighted performance scores respectively. Similarly, environmental awareness creation, fire/explosion protection, handling of chemical/explosive substances and operations' hazards auditing show obvious low provisions and implementation with weighted scores of 1.9, 1.4, 1.3 and 1.3 respectively. These among others are pointers to the need for increased management commitment to hazard, health and safety communication, training and auditing to enhance safety performance of Nigeria construction.

Summary of Replies by Consultants to Detail Questionnaires.

Table 2: Designers' level of Consideration and Provision of Design Solutions for Mitigating Project Impacts

		Sensitivity Consideration					
	Project Impacts	**Very High**	**High**	**Average**	**Low**	**No**	**Weighted Score**
A	Land Misuse	5 x 4	10 x 3	12 x 2	19 x 1	0 x0	2.05
B	Site dereliction	10 x 4	9 x 3	9 x 2	18 x 1	0 x 0	2. 26
C	Miisuse of Natural Resources	5 x 4	15 x 3	15 x 2	11 x 1	0 x 0	2.33
D	Energy Consumption	6 x 4	4 x 3	16 x 2	20 x 1	0 x 0	1.40
E	Air Emission	1 x 4	5 x 3	10 x 2	20 x 1	0 x 0	1.29
F	Waste Discharges	5 x 4	12 x 3	20 x 2	9 x 1	0 x 0	2.31
G	Misuse of water resources	4 x 4	12 x 3	20 x 2	10 x 1	0 x 0	2.02

H	Site Material wastages	6 x 4	10 x 3	21 x 2	5 x 1	0 x 0	2. 13
I	Comfort Disturbance	5 x 4	12 x 3	25 x 2	4 x 1	0 x 0	2.46
J	Health and Safety	4 x 4	20 x 3	15 x2	7 x1	0 x0	2.48
		Mean of weighted score					**2.07**

Source: Culled from Author (2000).

On the management of environmental challenges of construction projects, table 2 reveals that designers have below average consideration/provisions (1.4 and 1.29) for mitigating high energy consumption (D) and emission of noxious gases (E) by plants and machineries in projects sites. Also the mean design solution for mitigating construction degradation is marginally 2.07. This low threshold is considered unhealthy for our construction sector which is yet to develop on-site environmental management skill.

Conclusion and Recommendation

Our construction planners, designers and operators must brace up to the issue of providing, maintaining and sustaining hazard, health and safety systems and safety practices in construction project delivery. We must catch up with the new wave of change towards environment-friendly design and construction, which projects construction health and safety and environmental benignness as an imperative project goal. Construction managers must commit to health and safety and permeate it through the entire organization. Communicate, train, monitor/audit and reward safety performance and ensure that construction operations take place with appropriate safety systems in place i.e.

Implement the canons of safety management:

- Management commits to safety.
- Develop safety polices.
- Appoint safety advisers.
- Create/domesticate high safety standards.
- Make safety targets realistic.
- Audit safety standards and practices.
- Train/retrain and certify employees, workers, plant/equipments operators.
- Investigate/audit accidents, injuries and unsafe practices.
- Reward and motivate excellent safety performance.

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