**TOPIC: ENGINEERING LAW AND MANAGERIAL ECONOMICS FOR INFRASTRUCTURAL DEVELOPMENT IN NIGERIA: CHALLENGES AND A WAY FORWARD**

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**Abstract**

Engineering law refers to the application of laws applying to the practice of professional engineering. Engineering law is the study of how ethics and legal frameworks should be adopted to ensure public safety surrounding the practice of engineering.

Managerial Economics can be defined as amalgamation of economic theory with business practices so as to ease decision-making and future planning by management. Managerial Economics assists the engineers in a rational solution of obstacles faced in their activities.

The objective of this report is to examine the benefits and hindrances of taking advantage of engineering law and economics in infrastructural development.

**TABLE OF CONTENTS**

**INTRODUCTION**.……………...……………………….……………….………………………..………Page 5

**1. ENGINEERING LAW**…………………………………………………………………………………..Page 6

**1.1 DEFINITIONS**…………………………………………………………………………………………..Page 6

**1.2 SOURCES OF LAW**……..……………………………………………………………………………Page 6

**1.3 KINDS OF LAW**…………………………………………………...…...………………………….…Page 6

**1.4 DIFFERENCES BETWEEN CIVIL AND CRIMINAL LAW**……………………………....Page 7

**2. ENGINEERING LAW CASES**………………………..……….…………………………………….Page 8

**3. BENEFITS OF ENGINEERING LAW**…..……………………………………………………….Page 12

**4. HINDRANCES TO ENGINEERING LAW**……………………………………………..…..…Page 12

**5. SOLUTION** ………………………………………………………….………………………………….Page 13

**6. MANAGERIAL ECONOMICS**……..………….…………………….…………………………..Page 13

**6.1 APPPLICATION OF MANAGERIAL ECONOMICS**……………………..…….……….Page 13

**6.2 DEMAND DECISION** ………………………………………………………….………………….Page 15

**7. CONCLUSION** ………………………………………………………….……………………………..Page 15

**Introduction**

The practice of engineering is largely separated from the practice of a natural scientist by engineering law. A semiconductor physicist and an electrical engineer, practising at a large company are mainly differentiated by the laws they are practising under and the licence they carry. The laws and the licence will affect the tasks that can be performed by the engineer compared with the tasks that can be performed by a natural scientist. Engineers are held to a specific legal standard for ethics and performance while a natural scientist is not. Engineers are subject to disciplinary measures such as fines or loss of licence for professional misconduct and negligence as seen in the cases we will examine.

**1. Engineering Law**

**1.1 Definitions**

A law is a system of rules which a particular country or community recognizes as regulating the actions of its members and which it may enforce by the imposition of penalties.

It is a rule of conduct developed by the government or society over a certain territory. Law follows certain practices and customs in order to deal with crime, business, social relationships, property, finance, etc. The Law is controlled and enforced by the controlling authority.

Engineering law (or law in engineering) is the empirical study of the application of laws and legal strategy in engineering.

**1.2 Sources of Law**

Sources of law are the origins of laws, the binding rules that enable any state to govern its territory. The term "source of law" may sometimes refer to the sovereign or to the seat of power from which the law derives its validity.

Examples are;

* Constitution law
* Customary law
* Common law
* Legislation Case law
* Statutory law
* Treaties
* Administrative regulations

**1.3 Kinds of Law**

There are two main kinds of Laws;

* **Civil Laws**

Civil law deals with the disputes between individuals, organizations, or between the two, in which compensation is awarded to the victim.

* **Criminal Laws**

Criminal law is the body of law that deals with crime and the legal punishment of criminal offenses.

**1.4 Differences between civil and criminal cases**

Criminal law and civil law differ with respect to how cases are initiated (who may bring charges or file suit), how cases are decided (by a judge or a jury), what kinds of punishment or penalty may be imposed, what standards of proof must be met, and what legal protections may be available to the defendant.

In criminal cases, for example, only the federal or a state government (the prosecution) may initiate a case; cases are almost always decided by a jury; punishment for serious (felony) charges often consists of imprisonment but may also include a fine paid to the government; to secure conviction, the prosecution must establish the guilt of the defendant "beyond a reasonable doubt"; and defendants are protected against conduct by police or prosecutors that violates their constitutional rights, including the right against unreasonable searches and seizures (Fourth Amendment) and the right against compelled self-incrimination (Fifth Amendment).

In civil cases, by contrast, cases are initiated (suits are filed) by a private party (the plaintiff); cases are usually decided by a judge (though significant cases may involve juries); punishment almost always consists of a monetary award and never consists of imprisonment; to prevail, the plaintiff must establish the defendant's liability only according to the "preponderance of evidence"; and defendants are not entitled to the same legal protections as are the criminally accused.

Importantly, because a single wrongful act may constitute both a public offense and a private injury, it may give rise to both criminal and civil charges. A widely cited example is that of the former American football player O.J. Simpson: in 1995 he was acquitted of having murdered his wife and her friend, but two years later he was found liable for their killings in a civil suit for wrongful death.

O.J. was prosecuted for two counts of murder after the stabbing deaths of his ex-wife and her friend. That was a criminal case, meaning the case involved the government's prosecution of a crime. O.J. was famously acquitted of the murders. That means he was found not guilty.

But that was not the end of the story! The victims' families then sued O.J. in a wrongful death lawsuit. That was a civil case, meaning the case involved a legal dispute between private parties. O.J. was held civilly liable, meaning he was found to be legally responsible for the damage done to the other party. As a result, O.J. was ultimately ordered to pay over $30 million to the victims' families.

How can there be two cases for the same crime? Criminal and civil law are not mutually exclusive; both can be used for a single event. Although these two cases involved the same act and the same parties, the cases were handled very differently and had contrasting results.

**2. Engineering Law Cases**

**CASE 1**

Hyper Eutetoid Steal Inc. ("HESI") is a company which produces various types of style for industrial applications. In order to increase the strength of its steel products, HESI uses a process of quenching and tempering.

During the quenching stage, hot steel is quickly cooled with water. During the tempering phase, the steel is then heat treated for an appropriate time. The process requires large amounts of water and heat.

Faced with rising costs for energy, HESI decides to install a heat recovery system. The system would include a heat exchanger by which heat could be recovered from the cooling water in the quenching stage, combined with additional heat from a steam line in the plant that was otherwise not being fully utilized. The recovery heat, then, would be used to heat the steel in the tempering stage.

HESI entered into an equipment supply contract with Energy Recovery and Recycling Systems Inc. ("ERRS"). ERRS agreed to design, supply and install a heat recovery unit for a contract price of $600 000. After an analysis of HESI's process, ERRS determined and guaranteed in the contract that the heat recovery system would recover 40% of the heat in the cooling water and that this would result in substantial savings in energy costs.

The contract also contained a provision limiting ERRS's total liability to $600 000 for any loss, damage or injury resulting from ERRS's performance and its services under the contract.

The heat recover system was installed and operation; however, certain defects in the heat exchanger prevented the system from recovering more than 5% of the heat in the cooling water. After repeated unsuccessful attempts by ERRS to remedy the defects, HESI hired another supplier, who, for an additional $800 000 replaced the heat exchanger and was able to achieve the level of performance originally promised by ERRS. The total amount received by ERRS under its contract was $500 000.

Relevant case law includes the concept of fundamental breach with *Harbutt's Plasticine Ltd. v. Wayne Tank and Pump Co. Ltd.* where the defendant used "thoroughly" and "wholly" unsuitable for is purpose. The concept of fundamental breach has not been overruled; however, in the case of *Hunter Engineering Company Inc. v. Syncrude Canada Ltd.*, the decision was to accept the freedom of contract and true "construction approach". In this case, the heat exchanger did recover at 5% of the heat in the cooling water and it would be unlikely that the concept of a fundamental breach would be applicable here and therefore the limitation clause would be enforced.

In *Tercon Contractors Ltd. v. The Queen in right of British Columbia*, the Supreme Court of Canada stated that "With respect to the appropriate framework of analysis the doctrine of fundamental breach should be 'laid to rest'."

**Analysis**

In this case, through its performance, ERRS breached its contract with HESI and therefore HESI may repudiated the contract by the breach and seek another party to fulfill the contract and may also begin an action to claim for those direct damages. (This is based on my understanding that the heat recovery is a condition of the contract and not a warranty.) ERRS may be able to demonstrate that additional work has been performed and may be paid *quantum meruit* for such work; however, no evidence of such work is given in the case.

**Verdict**

Therefore, HESI may claim $600 000 in direct damages however, it must absorb the $100 000 difference between the original contract amount of $600 000 and the total cost of $700 000 once damages by ERRS are paid. ERRS may still be able to claim *quantum meruit* for at least part of the $100 000 difference between what it was paid and the monetary benefits stated in the contract.

**Case 2**

Mammoth Undertaking Ltd. ("Mammoth"), a development company, retain an architectural firm to design a twenty-storey office building. The architect also agreed with Mammoth that the architect would provide or arrange for inspection services during the course of the construction of the project in order to ensure that construction was carried out in accordance with the project plans and specifications.

The architect prepared a conceptual design and retained a structural engineering firm to prepare the detailed structural design for the project and also to carry out the inspection services to ensure that all structural aspects of the construction of the project were carried out in accordance with the project plans and specifications.

The engineering firm prepared the structural design and eventually Mammoth awarded the contract for the construction of the project to a general contractor, Swift Construction Ltd. ("Swift").

The engineering firm appointed one of its employee engineers, Jim Neophyte, a recent engineering graduate, as the engineering firm's representative and inspector on the construction site.

Construction commenced during the month of October and soon thereafter Swift recommended to Mammoth that a substantial cost savings could be achieved if the specified fill material around the foundation was changed to a more readily available material. Mammoth sought the architect's advice on the suitability of the proposed alternative fill material and indicated to the architect that it was most important that a decision be made as soon as possible in order to complete as much of the foundation and back-filling as possible prior to frost conditions setting in.

The architect, in turn, referred the matter to the structural engineering firm through its representative Jim Neophyte, requesting that the structural engineering firm approve the proposed changes as quickly as possible in the circumstances. Jim Neophyte determined that the original fill material had been specified by an engineer who no longer worked for the structural engineering firm and that the specification had been made on the basis of a careful investigation of soil conditions at the site. Jim Neophyte contacted on of the structural engineering firm's vice-presidents as was authorized to advise the architect as to the suitability of the alternative fill material after conducting an appropriate investigation.

Under significant pressure from both Mammoth and Swift to approve the proposed fill material without delaying the construction schedule, Jim Neophyte approved the change of materials without giving due consideration to the possible repercussions.

The substitute material did not drain as well as the material originally specified; in fact, it retained some water and, as it expanded during freeze up, it caused significant cracking in the foundation walls, necessitating remedial work resulting in substantial additional expense being incurred by Mammoth. In addition, the completion of the project was considerably delayed as a result.

**Analysis**

To demonstrate liability in tort, one must demonstrate that

* the defendant owed the plaintiff a duty of care,
* the defendant breached that duty by his or her conduct, and
* the defendant's conduct caused the injury to the plaintiff.

The purpose of tort law is to compensate the injured party for the damages and not to punish the tortfeasor.

Reference: Marston, p.39.

**Verdict**

The professional engineer is expected to apply reasonable care and prudence in the practice of professional engineering and thereby owes a duty of care to the development company even if no contractual relationship exists between the two.

The professional engineer Jim Neophyte negligently approved the alternative fill material. The general contractor Swift was negligent in proposing an alternative fill material on the basis of availability and not suitability.

The structural engineering firm is vicariously liable for the actions of its employees and therefore the firm must take responsibility for the negligence of its employee.

NOTE: Under circumstances where gross negligence has been proven, an engineering firm may no longer be considered to be vicariously liable for an individual engineer's gross negligence.

As you can see in the two cases above, parties that breech contracts or cause damage to a project due to negligence or any other factor will face the consequences of the law to attempt to amend the wrongdoing.

**3. Benefits of Engineering Law**

* It forces the engineer to hold herself or himself to the highest level of moral conduct.
* Health and safety laws can be especially important in the engineering field.
* There laws preventing discrimination in the workplace.
* It governs medical leave.
* It protects workers' rights.
* They guide appropriate and in appropriate conduct in the work place.
* They help settle disputes between two or more parties.
* The help in providing the appropriate compensation to the plaintiff.
* It helps in serving appropriate punishment to the defendant.

**4. Hindrances to Engineering Law**

* Corrupted or destroyed evidence against the defendant
* Incompetent judicial system
* Lack of ethics in the defendant
* Lack of ethics in Judicial system
* Lack of ethics in the plaintiff

**5. Solution**

As we can clearly see, the major solution to the challenges engineering law face is to enforce ethics in the engineering profession.

Engineering ethics is the field of system of moral principles that apply to the practice of engineering. The field examines and sets the obligations by engineers to society, to their clients, and to the profession.

**6. Managerial Economics**

As discussed earlier, managerial Economics can be defined as amalgamation of economic theory with business practices so as to ease decision-making and future planning by management and it assists the engineers in a rational solution of obstacles faced in their activities.
**6.1 Application of managerial economists**

* Product policy- sales promotion and market strategy-The scope of managerial economics extends to some of the core managerial aspects of the firm because the decision in this regard play a very significant role in the success of the firm. If the economics aspects of these decision are not taken care of, it may prove to be disastrous. Some of these are, the product policy which explains how and what quality a product should be. The expenditure on sales promotion and its benefits also required to be studied. Market strategy has also to be planned keeping in view the economics aspects.
* Demand Analysis and Forecasting-A business firm is the economic unit which operates to transform productive resources into goods and services for sales in a market. Thus the first task in the managerial decision-making is to get accurate estimates of demand for the product of the firm. Until the firm has clear idea of the demand for its product it is not possible to prepare production schedules and employ resources for management, as it highlights the factor on which demand for their product depends.
* Cost Analysis-The study of the data about costs made available from the firm accounting record yield significant cost estimation for the management’s decision-making. The managerial economics identifies the factors causing cost uncertainty exists because all the factors determine costs are not clearly known.
* Production Analysis-It is concerned with quantitative aspects of physical inputs. Given the technology and the nature of the product, the managerial economist studies the production function of the firm-the economies and diseconomies of scale, the minimum efficient scale of the plant etc. The behavior of costs of a firm depends directly on the nature of its production function.
* Pricing decisions- policies and Practices-Pricing of a product is an important element of the marketing mix of a firm. Besides the knowledge of fixed and variable costs of inputs, a scientific decision about price needs the knowledge of various elasticity of demand and the potential rivals who may enter the market. The price policy of a firm is based on such analysis. The area of study deals with the analysis of market structures, pricing methods, differential pricing, product pricing and pricing forecasting.
* Profit Management-Business firms not only want to make profits but also want to make more profits. They want profit maximization or sales revenue maximization. According to Drucker, profit is the measure of business success in the long run. However, an important point worth considering is the element of uncertainty existing about profits because the variations in costs and revenues. If knowledge about future were perfect, profit analysis would have been a very easy task. Break-even analysis and profit elasticity calculations are of great use in pricing and profit management.
* Capital Management-Decision about investment are most crucial for a firm because the funds involved are often huge and the behavior of the capital market is least predictable. A firm can raise funds by issuing shares or debentures and debt instruments. It can also choose to employ its own cash reserves. But the most difficult part is the choice of the investment projects. This is the choice of the top-management because the committed expenditures cannot be recalled

Managerial economics to a certain degree is prescriptive in nature as it suggests course of action to a managerial problem. Problems can be related to various departments in a firm like production, accounts, sales, etc. and it can also help in decision making.

(a) Operational issues

1. Demand decision
2. Production decision
3. Theory of exchange or price theory
4. All human economic activity

(b) Environmental issues

1. Nature and trend of domestic business/ international environment
2. Nature and impact of social costs and government policy

**6.2 Demand decision**

Demand is the willingness of potential customers to buy a commodity. It defines the market size for a commodity, and at a disaggregated level the composition of the customer base. Analysis of demand is important for a firm as its revenue, profits, and income of its employees depend on it.

**7. Conclusion**

A good engineer would need a very extensive knowledge of the law and ethics and how it affects him/her and the people around him directly or indirectly. He/she would also need basic knowledge of managerial duties to perform specific tasks like to analyse the financial outcome of his or her decision. Quality and cost control are basic requirements for successful engineering projects and so we should take them with the seriousness that they deserve.