# CONSTRAINTS OF INDUSTRIALIZATION AND TECHNOLOGY TRANSFER IN GHANA

**By**

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## DECLARATION

I hereby declare that this submission is my own work towards the award of the Master of Science (MSc.) degree and that to the best of my knowledge, it contains no material which has been accepted for the award of any other degree of the university or any other university, except where due acknowledgement has been made in the text.

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## ABSTRACT

Industrialization and Technology Transfer (TT) are important for the socio-economic development of any country. Successful Technology Transfer (TT) was a key factor in the rapid industrialization of the newly industrialized economies (NIEs) of Asia. Ghana's inability to develop industrially is due in part, to the lack of effective technology transfer beneficial to the industrial sectors of its economy. The objective of this thesis was to identify constraints of industrialization and technology transfer in Ghana. The study made use of a combination of quantitative and qualitative methods and interviews in collecting data. The study reveals that, the lack of national priority areas for effective technology transfer, inadequate science and technology infrastructure, insufficient research and development (R&D) initiatives, under developed entrepreneurial skills, and inadequate R&D funding are collectively hindering successful transfer in Ghana. Furthermore, low technology adoption and diffusion in critical sectors of manufacturing industry among others are some of the constraints that the study found.

**DEDICATION**

I dedicate

this thesis to my lovely wife

**SUSIE ASUAKO LARSON**,

and my adorable son

**JOSHUA ASUAKO LARSON**.



## ACKNOWLEDGEMENT

I will like to express my sincerest gratitude first and foremost, to the almighty GOD who has blessed me with Solomonic wisdom and good health.

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I humbly take responsibility of this study or if any shortcomings emanating from this research.



**ASUAKO, ENOCH LARSON**

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**TABLE OF CONTENTS**

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ACRONYMS

**Acronyms/Abbreviations**

| | | |
|---|---|---|
| TOT | - | Transfer of Technology |
| TT | - | Technology Transfer |
| NICs | - | Newly industrialized Countries |
| ERP | - | Enterprise Resource Planning |
| GNP | - | Gross National Product |
| R&D | - | Research and Development |
| ELI | - | Export Led Industrialization |
| EOI | - | Export Oriented Industrialization |
| ISI | - | Import Substitution Industrialization |
| NIEs | - | Newly Industrialized Economies |
| FDI | - | Foreign Direct Investment |
| ICT | - | Information Communication Technology |
| RMTRC | - | Regional Manufacturing Technology Research Centre |
| MRC | - | Manufacturing Research Centre |
| MIRI | - | Municipal Industrial Research Institute |
| KNUST | - | Kwame Nkrumah University of Science and Technology |
| UMaT | - | University of Mines and Technology |
| NBSSI | - | National Board for Small Scale Industries |
| IIR | - | Institute of Industrial Research |
| MEST | - | Ministry of Environment, Science & Technology |
| MTI | - | Ministry of Trade and Industry |
| CAD | - | Computer-Aided Design |
| FMS | - | Flexible-Manufacturing Systems |

CAM - Computer Aided Manufacturing

CNC - Computer Numerical Control

ITTU - Integrated Technology Transfer Units

TTRC - Technology Transfer Research Centre

RTTC - Regional Technology Transfer Consortium

MoTI - Ministry of Trade and Industry

S&T - Science and Technology

S&TR&D - Science and Technology Research and Development

TCC - Technology Consultancy Centre

GRI - Government Research Institute

IHL - Institution of Higher Learning

GSB - Ghana Standard Boards

GSS - Ghana Statistical Service

ERP - Enterprise Resource Planning

GDP - Gross Domestic Product

QGDP - Quarterly Gross Domestic Product

IMF - International Monitoring Fund

SMEs - Small and Medium-Sized Enterprises

UNCTAD - United Nations Conference on Trade and Development

MVA - Manufacturing Value Added

KMTI - Korean Ministry of Trade and Industry

NRF - National Research Fund

GRATIS - Ghana Regional Appropriate Technology Service

MNCs - Multi-National Corporations

DAIT - Development and application of Intermediate Technology

VALCO - Volta Aluminium Company

USA - United States of America

PhD - Doctor of Philosophy

MoSTE - Ministry of Science, technology and Environment

GoG - Government of Ghana

QGDP - Quarterly Gross Domestic Product

CSIR - Centre for Scientific and Industrial Research

IRI - Industrial Research Institute

FRI - Food Research Institute

RET - Rural Enterprise Project

USAID - United States Agency for international Development

IGF - Internally Generated Fund

NARP - National Agricultural Research Project

PSDP - Public Sector Development Project

PPP - Public Private Partnership

TTO - Technology Transfer Office

CSRPM - Centre for Scientific Research into Plant Medicine

CRIG - Cocoa Research Institute of Ghana

GRATIS - Ghana Regional Appropriate Technology Industrial Service

ISSER - Institute of Statistical, Social and Economic Research

# CHAPTER ONE

# INTRODUCTION

This chapter gives a brief description of the background to this work. It also presents the problem statement, the objectives of the study, methodology, significance of the study, and organization of the chapters.

## 1.1 Background



Traditionally, industrialization in its broad sense includes manufacturing, mining, construction and provision of utilities such as electricity, water and gas, among others. Industrialization can be defined as a system of sustained economic development based on factory production, division of labour, concentration of industries and population in certain geographical areas, and urbanization. (Business dictionary.com, 2014).

Technology Transfer (TT) is the process of transferring skills, knowledge, technologies and methods of manufacturing among governments or universities as well as other institutions and industry, to ensure that scientific and technological advancements are exploited in the development of new products, processes, applications, materials or services (Nzumo, 2010).

The challenges confronting most under-industrialized countries vary from country to country and have social, political, economic and psychological dimensions. It is important to note that the issues of industrialization and TT constraints are relevant not only in under-developed countries but also in industrially advanced countries as well.

Technology transfer is an important issue for any country's industrialization. Efforts to realize this goal must be encouraged and sustained despite any constraints or

challenges. The successful implementation of technology depends not only technical issues, but also on the right social, political, and institutional environment.

Ghana's industrialization process is largely "state-centric"; meaning the state is the central player in the country's industrialization process. Over the years, bad political culture, weak social institutions, poor leadership and bad governance have impacted negatively on this phenomenon. However, a lot of potential still remains in terms of human, material and natural resources that can enable Ghana rise to the level of the industrialized countries in Europe, North America and that of the newly industrialized economies of South East Asia (Nzuno. 2010).

In recent times some institutions and governmental agencies in Ghana have established Technology Transfer Offices (TTO) or centres dedicated to identifying appropriate research and development strategies. Examples of such institutions are the Technology Consultancy Centre (TCC) of the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, the Development and Application of Intermediate Technology (DAPIT) in the Greater Accra region, and the Ghana Regional Appropriate Technology Industrial Service (GRATIS) in Accra-Tema among others.

## 1.2 Problem Statement

Industrialization through technology transfer contributed substantial gains for the Newly Industrialized Countries (NICs) of South-East Asia in terms of increased productivity, job creation, adequate technological infrastructure, skilled technical workforce (i.e. engineers, scientists, and researchers), adequate R&D funding for science and technology and collaborative research between research institutions and the universities.

However, Ghana is yet to make strides as the NICs through industrialization and TT. In this regard, the main aim of this study is to identify the constraints of industrialization and TT in Ghana in order to unearth the constraints hindering the achievement of this goal.

### 1.3 Objectives of the study

The main objective of this study is to identify the constraints of industrialization and technology transfer in Ghana and propose some solutions through comparison with South-East Asia Economies.



#### 1.3.1 Specific objectives

These include:

1. Conduct a review of Ghana's industrial growth from 1980 to 2013 and to identify the industrial sectors that contribute the most to the country's economy as compared to the NIEs.
2. Provide an overview of TT in identified sectors of Ghanaian industry as compared to the NIEs.
3. Identify the factors hindering effective technology transfer (TT) in the relevant sectors of the economy.
4. Identify the industrial sectors that contributed to the fast industrial growth of the newly industrialized economies (NIEs) and the technologies to be transferred.

### 1.4 Methodology

To achieve the set objectives, literature on technology transfer and industrialization of South-East Asian countries among others, was gathered and reviewed to identify the

necessary data to collect and analyse. Primary and Secondary data, both qualitative and quantitative, were collected in the study.

- Primary data was obtained through access to records and interviews with workers from some leading academic and research institutions in the country. Reports from both government and non-governmental organisations and agencies were critically studied in addition to journal articles, books, and newspapers. Relevant websites were also visited for information on the subject. As well as conference and seminar papers, books, journal articles and internet sources.
- Secondary data was obtained through literature review (i.e. books, journal articles, government reports and the internet), university and research institutions documents.



### 1.5 Significance of the Study

Findings of the study have the potential of drawing the attention of key players in the industrialization process to focus more on the relevant issues regarding industrialization and TT among industries, research institutions, policy makers (government), small and medium enterprises (SMEs), and other stakeholders.

For organisations, academic and research institutions, the findings of this study will provide a reliable measure and perspective for describing the state of industrialization and technology transfer in Ghana.

The research will bring to the fore the strengths and weaknesses of Ghana's industrialization and technology transfer efforts to benefit government agencies such as the Ministry of Trade and Industry (MoTI), Ministry of Environment, Science and Technology (MEST) and the private sector for needed action.

The research will also provide information to stakeholders like investors, entrepreneurs and others to enable them provide useful recommendations for the improvement of Ghana's local industries and strengthening of its institutions.

### 1.6 Organization of the Study

The study consists of five chapters. Chapter One, describes the background of the study, statement of the research problem, objectives of the study, methodology, significance of the study and organization of the report. Chapter Two comprises a review of related literature of the newly industrialized countries (NIC) of Asia. Chapter Three outlines the methodology employed in carrying out the study; it includes the research design, research strategy, sources of information, target institutions and sources of information. Chapter four presents the findings arising from the study and based on them. Chapter five concludes the report by summarizing of the findings and offering appropriate recommendations for future work.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter presents a review of literature on studies related to industrialization and technology transfer in the Newly Industrialized Countries (NICs) of South-East Asia.

It presents definitions of industrialization and technology transfer and reviews the history and importance of industrialization and technology transfer for the socio-economic development of Ghana.

## 2.2 Definition of Industrialization and Technology Transfer and Brief Historical Perspectives

### 2.2.1 Industrialization

Industrialization and Technology Transfer have been subjected to various definitions by different scholars. Todora (1997), views it as the process of building up a country's capacity to process raw materials and to manufacture goods for consumption or further production. Industrialization is seen as part of a broader modernization process, where social change and economic development are closely related with technological innovation and development, particularly with development of large-scale energy and materials production such as iron, bauxite, gold, and manganese (Anonymous, 2010).

The Industrial Revolution in part, was a technological revolution. New inventions led to other and better inventions. Items that were manually made started to be made in factories. The change brought about extreme social and economic transformation in

many nations. The industrialized nations then moved from agricultural and rural economies to capitalist, manufacturing and urban economies.

### 2.2.2 Technology Transfer (TT)

The definition of TT depends largely on how the user defines technology and in what context (Gorman, 2002). However, Technology Transfer (TT), also called Transfer of Technology, (TOT) can be defined as the process of movement of technology from one entity to another (Souder, 1994; Ramanathan, 1994). It is the process or movement of technology from the laboratory to industry, developed to developing countries, or from one application to another domain (Philips, 2002).The movement may involve physical assets, know-how, and technical knowledge (Bozeman, 2000).And the acquisition of "inventive activity" by secondary users (Madu, 1992). TT may not always involve the transfer of machinery or physical equipment and books among other things, but also knowledge, through formal or informal training and education which can include training on how to effectively manage technological transformation and changes.

Although technology transfer is not a new development, it has proven to be difficult to manage due to the complexity of the technology transfer process (Spivery, 1997). There are several fundamental characteristics of technology transfer worthy of mention. First of all, technology has so many components and dimensions and always involves more than one element of technology. Various elements of technology involved in a particular case interact with each other as if they form a system. In addition, the technology package must be periodically re-evaluated as conditions change, as the project cycle advances, and as new information and technology becomes available. Thus, technology transfer is a dynamic process. Secondly, the

efficient transfer of technology requires good infrastructure, which includes R&D institutions, vocational, technical and training institutes, and skilled personnel of different specialisations, within the recipient country.

TT may be said to be successful if the receiving entity, thus the transferee, can effectively utilize it and eventually absorb it (Ramanathan, 1994).

TT occurs through written languages, which are supplemented by mathematical equations and diagrams comprising the major means of explicit transfer of technological knowledge (Gorman, 2002). Unwritten or oral language and gestures have significantly transferred technology in friendly encounters. However, much of pre-historic TT amongst humans occurred when people with superior agricultural technology absorbed or eliminated those who could not reproduce as rapidly (Diamond, 1997).

Also, despite an English law forbidding knowledge migration in the 18th century, France eventually managed to obtain 'specialized steel making know-how' by importing English workers through industrial undercover work. Between the 18th and 19th century, the successes of the American textile industry was due to TT and expertise by the English textile industry (Irwin, 1991). Industries can collapse due to a lack of TT. For example, the English clock and watch industry collapsed due to the industry's resistance to the opportunities of TT (Irwin, 1991).

**2.3 Ways in which Technology may be transferred**

Various studies and reports point to the fact that Technology is primarily transferred in three forms. Technology transfer may be confined in some cases as relocating and exchanging personnel (Osman-Gani, 1999) or the movement of a specific set of

capabilities (Lundquist, 2003). This is normally used for manufacturing purposes where the type of technology is not complex and where no proprietary techniques or processes are involved.

Technology can also be transferred via individual experts. Although this technique is employed relatively often, it normally goes unpublicized. TT through a competent or qualified expert has the advantage of cost-savings to the recipient, but it is more preferable only for small and medium-sized projects where the technology transferred is simple and unpatented.



Furthermore, TT is the movement of knowledge, skills, organization, values and capital from the point of generation to the site of adaptation and application (Mittleman and Pasha, 1997).

Finally, the transfer is said to be successful if the receiving entity, the transferee, can effectively utilised the technology transferred and eventually assimilate it (Ramanathan, 2000).

## 2.4 Industrialization and Technology Transfer in the Newly Industrialized Economies (NIEs).

Newly Industrialized Economies (NIEs) are countries whose economies have not yet reached developed countries status but have, in a macro-economic sense, outpaced their developing counterparts (Anonymous, 2013). Another characterization of the NIEs is that of nations undergoing rapid economic growth, usually export-oriented.

The term was originally applied to four emerging South East Asian countries: Hong Kong, Taiwan, South Korea, Singapore and Malaysia. The success of the NIEs has enhanced confidence in imitative development, based on the view that other

developing countries can replicate the NIEs experience by adopting export-oriented industrialization and relying on privatization to encourage foreign investment and technology transfers.

These countries carefully crafted regulations to promote foreign investment in accordance with predetermined social policies. They are the pro-model, actually reflecting a powerful government-business partnership in industrialization whereby monopolies and oligopolies act jointly.



Researchers have accepted the fact that the economic success of the East Asian NIEs is linked to the shift to export-led growth but criticize the voluntarism tone between the newly industrialized economies (Diamond, 1997).

In Malaysia and Taiwan, a non-neutral trade regime was dominant and both governments promoted and forced private producers to export. In Singapore, the state used 'carrot' and 'sticks' to push forward exports, one main mechanism being, to give access to the profitable domestic markets in exchange for improved export performance (Irwin, 1991). Similarly, in Taiwan, export was supported but in ways that differed significantly from free trade or neutral trade regimes (Mathews et. al. 1997).

Although one should not ignore the vital importance of the expansion of domestic demand for economic growth, export of manufactured goods has been important for economic development in the South East Asian countries. The exports of manufacturers became a vital source of foreign exchange. Particularly in South Korea, export industries constituted a means of converting unskilled labour into sophisticated imports. Moreover, export also served to relieve the demand constraint in the fairly small domestic market in Taiwan. Finally, export undoubtedly made firms to improve

upon their product quality and increased labour utilization, thus leading to a higher market pressure on wages (Laurids, 1993).

The South East Asian Countries and the Asian tigers used Import Substitution Industrialization (ISI) to build up an industrial technological competences starting with low-skill and labour intensive manufacturing, these countries gradually moved on to manufacture more technologically complex products for export using competencies and skills acquired in the ISI phase. This is simply the industrial development programme based on the protection of local infant industries through protective tariffs, import quotas, exchange rate controls, special preferential licensing for capital goods import, subsidized loans to local infant industries (Kanayo et. el., 2011).

The process of industrial development in the twentieth century can be said to be one in which otherwise "backward" countries such as the South-East Asian economies have employed extant technologies to overcome the wide gaps between them and the industrial forerunners. The key to the successful industrialization and TT of countries that are now referred to as NIEs has been not only a willingness to imitate and copy but more importantly the will to learn.

As most South-East Asian economies achieved extraordinary rates of growth, income per capita increased more than tenfold during that period. It is widely acknowledged that, transfer of technology played a key role in their socio-economic and industrial development. These countries have increased their output, upgraded the skills of their labour force, and accelerated the process of industrialization through the adoption, adaptation, and absorption of imported technology (Hamidu, 2001).

The experience of the South-East Asian economies demonstrates that developing countries like Ghana can also catch up with the technologically advanced countries if the right measures are taken and followed. It can be said that Ghana in her current situation can take the most advantage of the availability of existing technological resources and does not need to reinvent the wheel.

### 2.4.1 The Economic Agents of Development in the Newly Industrialized Economies (NIEs)



Three most important economic agents of development of the South East Asian countries were their governments, entrepreneurs, and workers. The workers were united and this unity was responsible for the initial success of South East Asian countries' export-led growth strategy.

### 2.4.2 The Workers

The major economic agents in the south East Asia's development were the workers. Not just those employed by modern firms but all other workers as well. During this period, they worked very hard, and even under incredible conditions. The high growth was sustained by an abundant supply of cheap labour, low wages, and high increase in labour productivity. The expertise of workers was excellent in terms of their ability to learn, adapt and adjust to the industrial world. This was supported by high level of education for the workers which is higher than in most countries (Cho, 1994).

### 2.4.3 The Government

Till the 1960, South-East Asia and the 'Four tigers' did not achieve considerable growth. However, some noteworthy achievements were made for eventual growths. Massive advancement and investment were made in the area of education and import substitution in light industries (Cho, 1994).

After unsuccessful attempts at industrialization, Koreas' economy finally attained her growth of industrialization, and the role of government then was the main contributing factor in bringing about the present economic structure (Cho, 1994).

Governments that have led economic development had both successes and failures. These played the role of motivating the citizenry and introducing export-led growth (Cho, 1994). Korea's industrialization success has been attributed to non-neutral industrial policies on the part of the state (Yasheng, 1997). Selective intervention has greatly contributed to Korea's remarkable success (Wesphal, 1990).



### 2.4.4 The Entrepreneurs

One of the important economic agents of development was entrepreneurs, who led the economy's industrial take-off. The South-East Asian countries enjoyed energetic entrepreneurs in the country's history. The quality of entrepreneurs was excellent, both in terms of drive and business acumen. In the earlier part of the development process, capital and technology could be easily imported from abroad, and the cost of labour and capital was low so the prospects for profit were high (Cho, 1994). Furthermore, the government supported entrepreneurs with monetary, fiscal, and other means of reducing the risk of their investment (Cho, 1994).

### 2.4.5 Challenges of the NIEs during their Formative Years

The NIEs countries were each faced with different challenges during their formative years. These included; the lack of strengthening of their secondary and tertiary education thus universal literacy and high-school equivalency of education essential for a national manufacturing capability and providing a skilled manufacturing workforce, the lack of industrial infrastructure and training, and finally inadequate R&D.

The transfer of manufacturing operations was made possible by establishing strong educational infrastructures that supported development of the required skilled and literate labour force. Furthermore, as more automation systems were employed in the manufacturing processes, higher level of education was required not only skilled labour force but skilled engineering labour force.

## 2.5 Brief history of industrialization and technology transfer in Ghana

### Industrialization in Ghana



Ghana attained her independence in 1957, the government then launched an industrialization drive that increased manufacturing's share of GDP from 10 per cent in 1960 to 14 per cent in 1970. This expansion resulted in the creation of a relatively wide range of industrial enterprises, the largest among which included the Volta Aluminium Company (VALCO), saw-mills and timber processing plants, cocoa processing plants, breweries, cement manufacturing firms, oil drilling, textile manufacturing operations, and vehicle assembly plants (Clark, 1994).

Ghana's record with industrialization projects since independence is also exemplified by her experience with aluminium, the country's most conspicuous effort to promote capital-intensive industry. This venture began with the construction of a 1,186-megawatt hydroelectric dam on the lower Volta River at Akosombo (Clark, 1994).

However, in stark contrast to South East Asia, Ghana's Import Substitution Industrialization (ISI) ended up nowhere. It failed to develop capacities for export manufacturing and even failed to produce enough to serve expanding domestic demand (Kanayo, 2011).

Many of the enterprises survived only through protection (protectionism). The overestimation of the cedi, shortages of hard-currency for raw materials and spare parts, and poor management in the state sector led to a stagnation of the economy (Clark, 1994).

Thereafter, the manufacturing sector never fully recovered, and performance remained weak. Under-utilization of industrial capacity, which had been endemic since the 60s increased alarmingly, with average capacity utilization in large and medium-scale factories falling from 40% to 21%. Once the Enterprise Resource Planning (ERP) began in 1990, the supply of foreign exchange for imported machinery and fuel substantially improved, and capacity utilization climbed steadily from 30% to about 40% in 1989. Nevertheless, production from the manufacturing sector slumped to 35% and subsequently to 26% in 1980 (Clark, 1994).

### 2.5.1 Technology Transfer in Ghana

The history of TT from developed countries to Ghana over the past years cannot boast of many successes. It has occasionally been channelled through small, medium and large (SME) enterprises.

Most of the installed machinery ceased to function, for the lack of know-how and spare parts that with proper determination could be locally manufactured. It became increasingly evident that for Ghana to develop, the government needed to become the central driver of national development. The emergence of an innovation-driven economy brings changes in public policy such as public sector reform, education reform and privatization (Jacob et al., 2003).

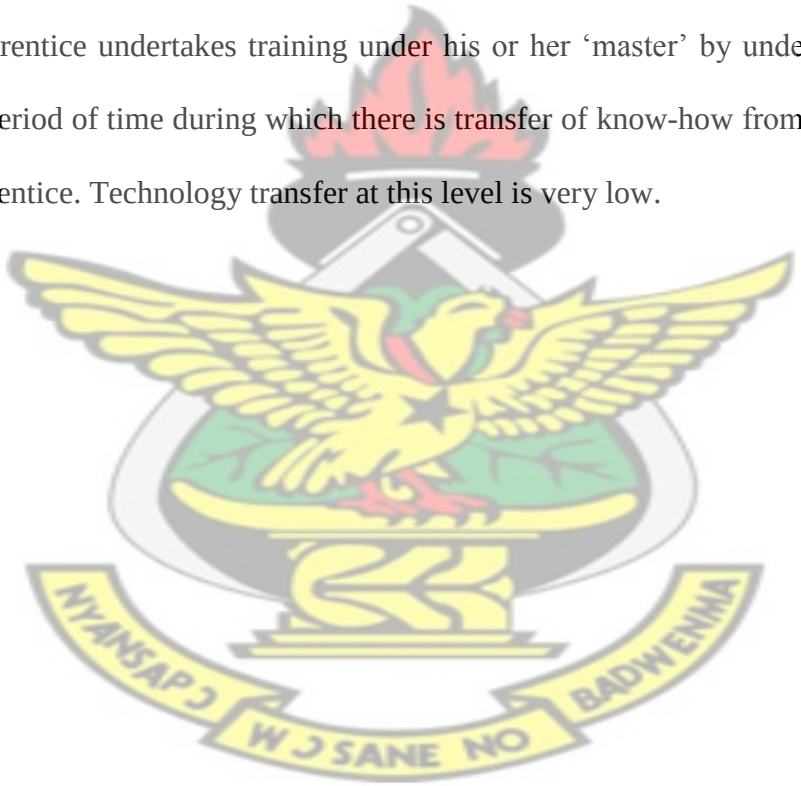
In Ghana, the universities and polytechnics have traditionally been thought of as places for higher education, research and technology transfer. Technology transfer in

these institutions has taken place through activities such as technical assistance through human resource provision, import of machinery and equipment, technical collaboration, etc. whiles a lot of technology gets transferred informally through journals, books, personal contacts, promotional literature, conference publications etc.

In higher academic institutions, technology transfer is carried out through projects based on lecturer/student collaboration and provision of consultancy services to the public and other private institutions etc.



Furthermore, technology transfer sometimes happens through apprenticeship training. The apprentice undertakes training under his or her 'master' by understudying them over a period of time during which there is transfer of know-how from the 'master' to the apprentice. Technology transfer at this level is very low.



# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter presents the research design, research strategy, sources of information and research tools and methods. To achieve the research objectives outlined in chapter one, answers were sought to the following questions;



**i.** Which industrial sectors contributed to the fast growth of the NIEs?

**ii.** What key factors aided the development of these sectors?

**iii.** What constraints hinder technology transfer activities in these target institutions of Ghana (i.e. Ministry of Environment, Science and Technology (MEST), Ministry of Trade and Industry (MoTI), the technical university thus the Kwame Nkrumah University of Science and Technology (KNUST) and The Centre for Scientific and Industrial Research (CSIR)?

**iv.** What constraints do government agencies or departments encounter in allocating funds to support technology transfer and R&D?

## 3.2 Research Design

This research consisted of five stages; the first stage was the proposal stage for identifying, defining the problems and establishing the objectives of the study. The second stage of the research was the review of literature on industrialization and technology transfer in the newly industrialized economies (NIEs) of South-East Asia such as Malaysia, Taiwan, Indonesia, Singapore and South Korea.

The third stage of the research was the methodology. This phase covers the methods and procedure for obtaining and analysing information from the target institutions for the study.

The fourth phase of the research consists of eliciting findings and discussing them. Tables and graphs were employed to aid the discussions. Finally, the fifth phase of the research covered a summary of findings and recommendations stemming from thereof. A brief overview of the research process consisting of essential actions to effectively carry out the research is illustrated in Figure 3.1

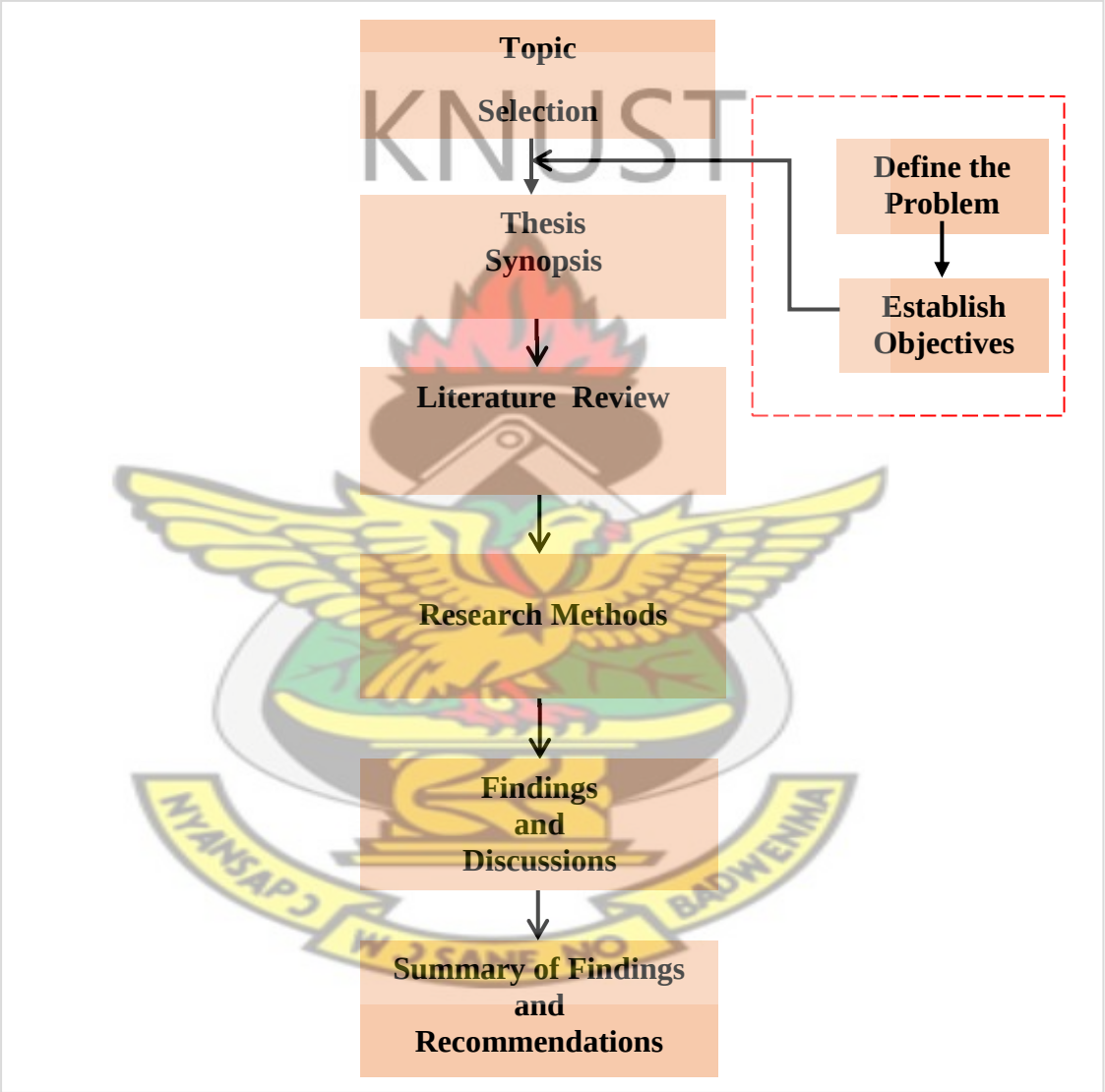



Figure 3.1: Thesis methodology flowchart
(Source: Author's construct, 2013)

### 3.3 research strategy

Research Strategy is defined as the way in which research objectives can be determined (Naoum, 1998). Two main research methods were used; qualitative and quantitative research methods.

- Qualitative research methods seek to gain insight and understanding of perceptions of "the world" whether as individuals or group (Fellows and Liu, 1997). These were interviews conducted in research and academic institutions in the country such as KNUST, CSIR and amongst others
- Quantitative methods were used to gather primary data and to study relationships between facts and how such facts and relationships harmonize with theories and the findings of any previous research works. For this reason, a combination of qualitative and quantitative methods was used. Charts and figures were gathered from the Ghana Statistical Service (GSS), the Ministry of Trade and Industry (MoTI) and the Ministry of Environment, Science and Technology (MEST).

### 3.4 Target Institutions

The research focused on technical universities, research institutions in Ghana and government departments. These included; Kwame Nkrumah University of Science and Technology (KNUST) and the Council for Scientific and Industrial Research (CSIR) in the Ashanti region, the Ministry of Environment, Science & Technology (MEST), the Ministry of Trade and Industry (MoTI), and the Institute of Industrial Research (IIR) in the Greater Accra region.

### 3.5 Sources of Information

Both primary and secondary data were used for this study.

#### 3.5.1 Primary Data

The primary data consisted of materials collected directly by the researcher for the purposes of this research. Primarily, the researcher personally conducted face to face interviews and focus group discussions with officials of the target institutions and or department, and telephone interviews with a check list of questions.



#### 3.5.2 Secondary Data

Secondary data was obtained through reading of materials obtained from the KNUST library, journal articles, statistical data, related literature, company and organizational records, unpublished documents, and the internet. Other available sources of information included unpublished dissertations on related topics, reviewed to obtain information on industrialization and technology transfer in the Newly Industrialized Countries (NICs) including the challenges they have faced.

### 3.6 Data Collection

#### 3.6.1 Questionnaire

The researcher used a list of questions that enabled him collect information (appendix 1).

### 3.7 Data Analysis

Data obtained from the field were processed and entered into the Stata analysis software. And the use of tables and graphs were employed for interpretations.

# CHAPTER FOUR

# PRESENTATION OF FINDINGS AND DISCUSSION

## 4.1 Introduction

This chapter presents the findings and discussion for the study. It looks at industrial growth in Ghana, importation of foreign technology, foreign direct investment in Ghana, research and development and amongst others.



## 4.2 Industrial Growth in Ghana

Manufacturing levels of Ghana's industrial growth is rising at a rate of 7.8 per cent, making it the 38th fastest industrial production growing in the world due to government industrialization policies (CIA World fact book, 2008). Manufacturing industries in Ghana includes; aluminium smelting, small ship building and cement production. From the Tarkwa mining area is a relatively small glass-making industry which has developed due to high-quality sand availability.

Progress of Ghana's industrialization efforts over the past decades has been mixed. Electrical equipment, garment, textiles, tobacco and chemicals suffered the most in the 1980s as evident in Table 4.1. However, this industrial development did not show any sustenance. Manufacturing, by 1992 had still not regained the peak of 11.3 per cent of Gross Domestic Product (GDP) that it had attained earlier in 1971.

Table 4.1: Estimated rate of capacity utilization in Manufacturing in Ghana from 1984-93

(Large and medium-scale factories, %)

| | 1984 | 1987 | 1989 | 1991 | 1993 |
|---|---|---|---|---|---|
| Textiles | 17.3 | 24.0 | 45.0 | 45.0 | 41.3 |
| Garments | 20.2 | 25.0 | 22.0 | 30.0 | 53.3 |
| Food processing | 22.9 | 42.0 | 51.0 | 51.0 | 52.3 |
| Metals | 20.1 | 42.0 | 45.0 | 58.0 | 80.0 |
| Leather | 11.9 | 15.0 | 25.0 | 7.0 | 10.0 |
| Chemicals | 22.3 | 30.0 | 30.0 | 30.2 | 40.0 |
| Wood processing | 28.1 | 43.0 | 70.0 | 65.0 | 65.0 |
| All Manufacturing | **18.0** | **35.0** | **10.6** | **40.5** | **45.7** |



Source: Ghana Statistical Service, Quarterly Digest of Statistics, 1993

Figure 4.1 indicates the estimated rate of capacity utilization in manufacturing in Ghana for the period of 1984-1993. In a quick comparative analysis, the total manufacturing value added (MVA) in Ghana was 2 per cent of Malaysia's (Pietrobelli, 1994). A study on manufacturing industries comparing Ghana with Malaysia revealed that, labour-intensive industries propelled export growth but manufacturing in garments, textiles among others experienced no growth in Ghana (Teal, 1999).The modern industrial sector in Ghana is largely owned by foreign companies, has focused on beverage processing (Pietrobelli, 1994).

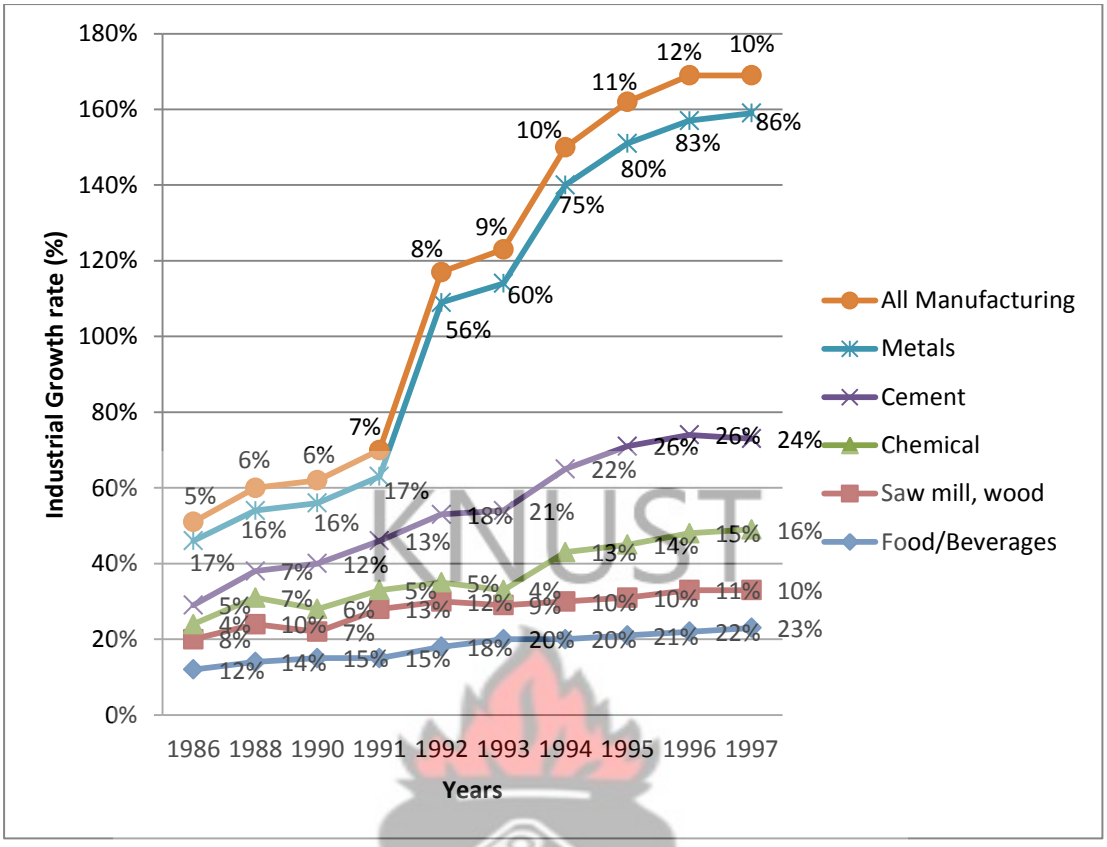



Figure 4.1: Growth Rate of selected industries in Ghana, 1986-1997

*Index Numbers (1977=100)*

Source: Statistical Service Ghana, Quarterly Digest of Statistics, (1998)

The service sector has been the largest contributor to Ghana's GDP in recent times. The sector contributed 31.8 per cent of GDP in 2008. From 2004-2008, the average contribution for GDP was 32.6 per cent. The sector grew by 9.3 per cent as compared with the growth rate of 8.1 per cent for the industrial sector which included automotive manufacturing, aluminium smelting, and light manufacturing amongst others. In addition, Ghana's estimates of real quarterly Gross Domestic Product (GDP) for the second quarter of 2013 grew by 6.1 per cent. The services sector recorded the highest growth of 9.2 per cent, followed by the manufacturing sector with 2.5 per cent (GSS, 2013), as indicated in Figure 4.2.

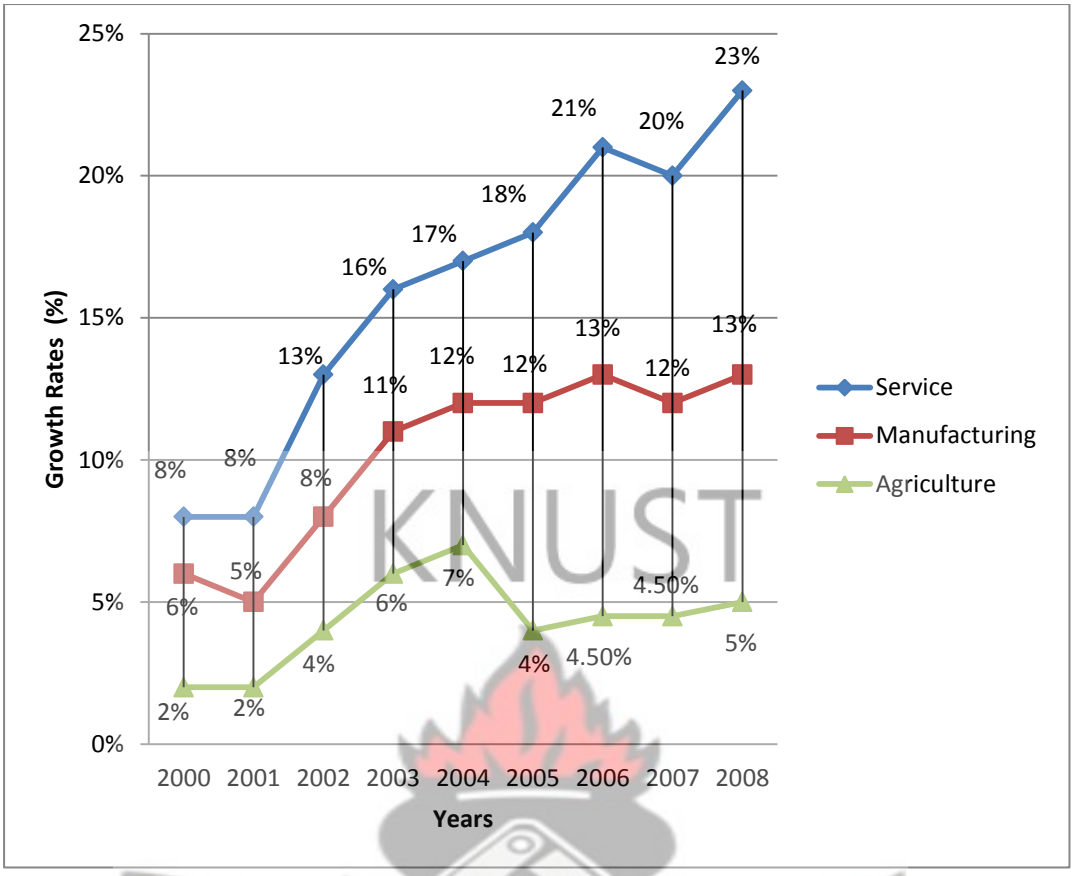



Figure 4.2: Industrial Sector Growth Performance (2000 – 2008)

Source: Ghana Statistical Service (GSS), (2013)

Furthermore, beyond Figure 4.2 performance activities in the 2nd quarter of 2013 compared with the 2nd quarter of 2012 reveals that the main contributors to the industrial sector were mining and quarrying (29.1%); followed by Electricity (9.4%) and construction (6.8%) as seen in Figures 4.3 and 4.4 respectively.

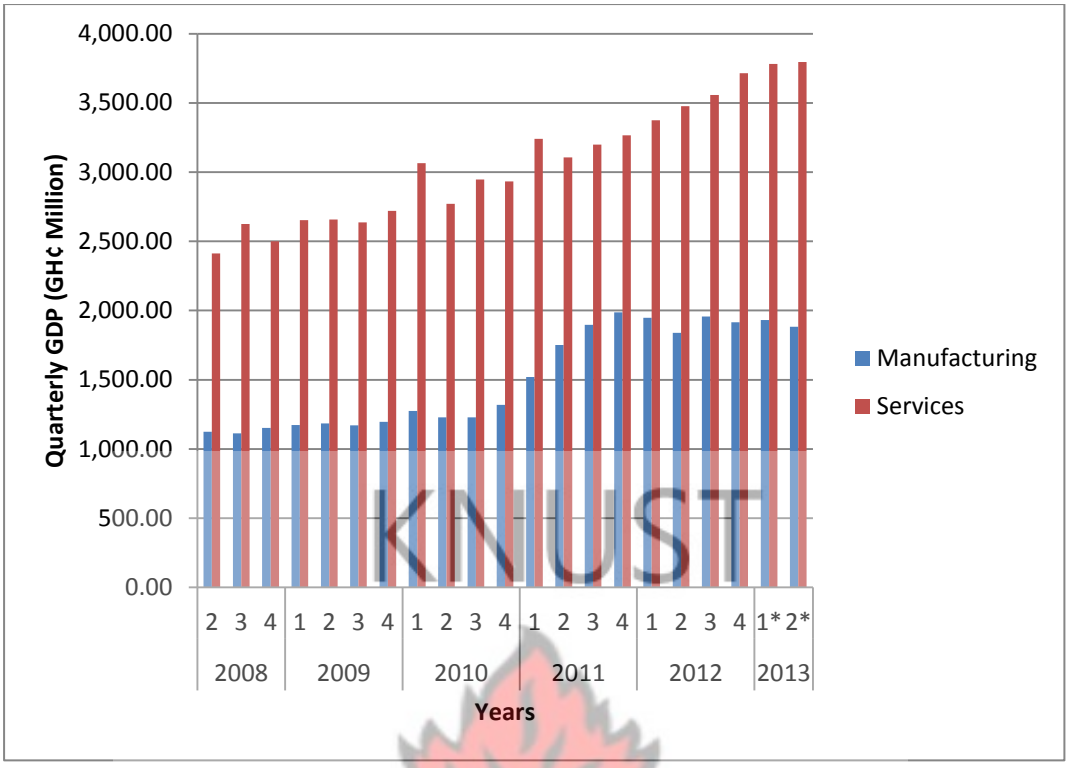



Figure 4.3: Quarterly Gross Domestic Product at Constant 2006 Prices for Ghana

Source: Ghana Statistical Service (GSS), (2013)

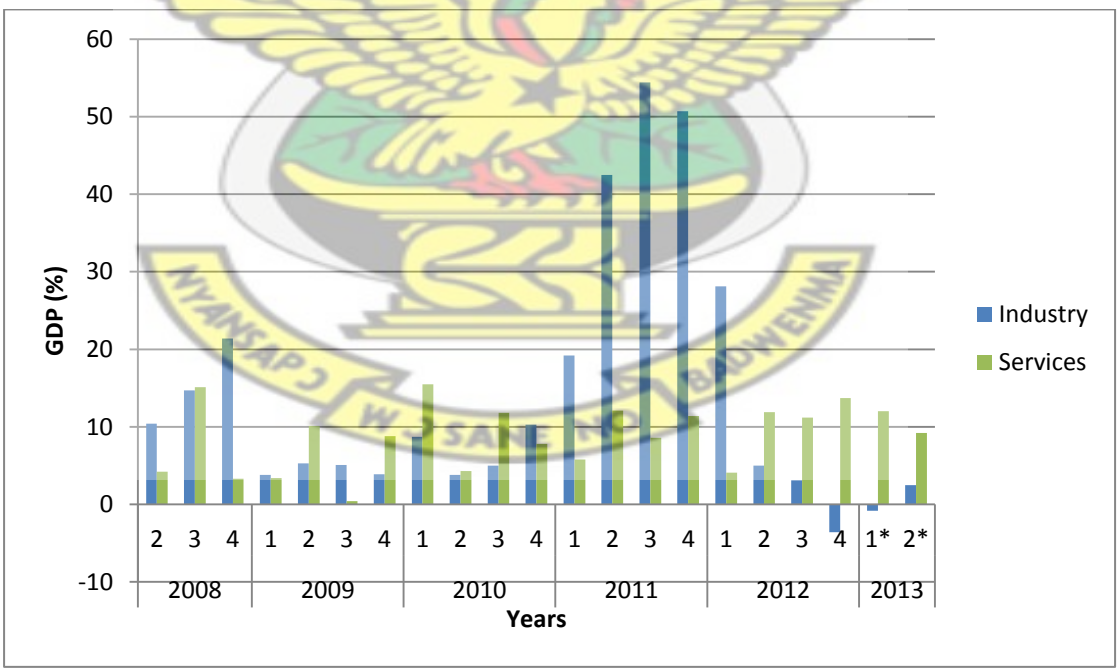



Figure 4.4: Year-on-year growth in GDP (%) for Ghana

Source: Ghana Statistical Service (GSS), (2013)

The manufacturing sector recorded a decline of 2.5 per cent in 2013, as compared to its 5.0 per cent growth in 2012, as indicated in Table 4.3. Manufacturing remains one of the weakest contributors to Ghana's economic growth. The sector's performance has been very disappointing as evidenced in Table 4.4. A major cause is the weak exports from manufacturing, attributable to low technical skills and training at the various firm levels.

Table 4.2: Ghana's industrial Sector Growth (2011-2013)

| **Activity** | **2011** | **2012** | **2013** | |
|---|---|---|---|---|
| | | | **Target** | **Outturn** |
| | **Per cent** | | | |
| **Industry** | 4.6 | 7.0 | 8.7 | 9.1 |
| **Mining and Quarrying** | 4.5 | 5.0 | 8.0 | 17.6 |
| **Petroleum** | 3.4 | 9.1 | 10.1 | 37.5 |
| **Manufacturing** | 17.0 | 5.0 | 5.0 | 2.5 |
| **Electricity (Generation & Supply)** | -0.8 | 11.1 | 15.0 | 13.3 |
| **Water and Sewerage (Generation & Supply)** | 2.9 | 2.0 | 4.0 | 2.4 |
| **Construction** | 17.2 | 11.2 | 12.5 | 8.4 |

Source: Ghana Statistical Service (GSS), 2013

Table 4.3: Manufactured exports of Ghana and other Sub-Sahara Africa (SSA) countries (1980-1995)

| | Manufactured exports as % of total exports | | Manufactured exports (million $) | | Manufactured exports per capita ($) | |
|---|---|---|---|---|---|---|
| | **1980/90** | **1990/95** | **1980/90** | **1990/95** | **1980/90** | **1990/95** |
| **Ghana** | 9% | 13% | 83 | 147 | 6 | 9 |
| **Cameroon** | 9% | 13% | | 224 | 15 | 18 |
| **Kenya** | 14% | 17% | 174 | 232 | 8 | 9 |
| **Mauritius** | 48% | 67% | 352 | 899 | 341 | 823 |
| **Zambia** | 6% | 16% | 70 | 132 | 9 | 16 |
| **Zimbabwe** | 33% | 34% | 492 | 573 | 56 | 56 |
| **South Africa** | 50% | 71% | 410 | 915 | 360 | 900 |

Source: World Bank Data

Table 4.4: Industry shares of GDP at current prices (%)

| **Industry** | **1953-61** | **1962-66** | **1967-71** | **1972-76** | **1977-81** | **1982-86** | **1987-91** |
|---|---|---|---|---|---|---|---|
| **Agriculture, forestry and fishing** | 40.4 | 39.6 | 27.8 | 24.7 | 17.7 | 12.7 | 9.4 |
| **Mining and manufacturing** | 14.4 | 18.7 | 22.0 | 27.3 | 30.4 | 31.6 | 30.6 |
| **Manufacturing only** | 12.7 | 16.8 | 20.5 | 26.1 | 29.1 | 30.4 | 30.0 |
| **Construction, electricity, gas, and water** | 4.0 | 4.5 | 6.6 | 5.8 | 9.4 | 10.4 | 13.8 |
| **Other services** | 41.2 | 37.2 | 43.6 | 42.2 | 42.5 | 45.1 | 46.2 |

Source: Bank of Korea, National income in Korea, 1982; National Accounts, 1990; Economic Statistics Yearbook, 1991 and 1992

In this light, it is clear that the industrial growth which was the backbone of the rapid development of Korea is lacking in the case of Ghana (Fig. 4.3& Fig.4.4). The low

rate of industrial growth can be attributed to several reasons including the lack of an enabling environment for the development and growth of the manufacturing sector, inadequate research funding, lack of application of research results and inadequate technological infrastructure among other reasons.

### 4.3 Importation of Foreign Technology

Ghana imports technology mainly via royalties, inward Foreign Direct Investment (FDI) and capital goods and licensing (See Figure 4.5). As compared to East Asian countries, technology imports in is on a low scale.



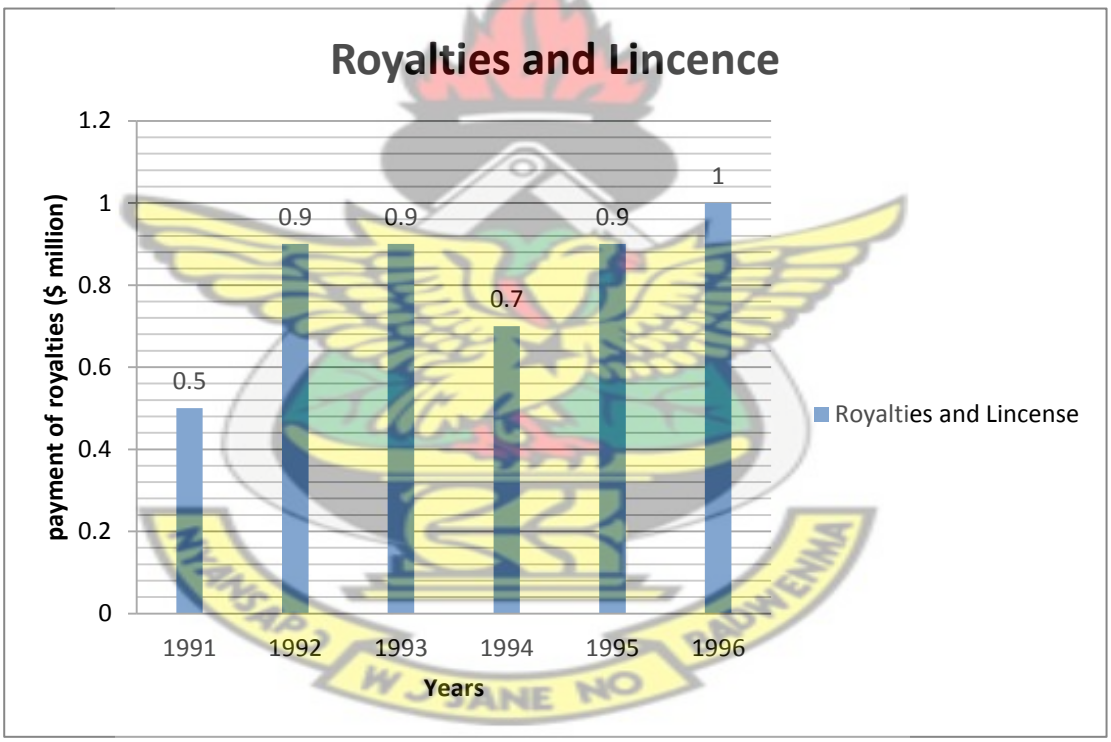



Figure 4.5: Ghana: Payments of royalties and license fee (US$ million)

Source: IMF, Balance of payments Statistics

### 4.4 Foreign direct investment (FDI) in Ghana

Foreign direct investment (FDI) basically, can be defined as the investment made by a firm or company outside its country. It is the flow based on long term capital on long term profit consideration involved in international production (Caves, 1996). FDI in most cases does not inculcate all investments across countries.

Corporate tax rates have decreased incredibly to promote FDI, although this remains high as compared to the average rates in the newly industrialized economies of Asia. Ghana was ranked tenth from 1987 to 1998 in terms of FDI inflows in Africa. During this period, the manufacturing sector accounted for only 25 per cent of total in flows in Ghana. However, the current presence of foreign affiliates does not seem to have had much impact on domestic technology development. Thus, the foreign associates are operating in the services and the primary sector (Gogo, 2003).

### 4.5 Royalties

Royalties and technical fee payments are the second avenue for formal technology imports. Data available indicates that Sub-Saharan Africa as a whole paid royalties to the tune of$84 million in 1997, of which $78million was from Kenya and Swaziland (UNCTAD, 2011). Royalties and licence fees for Ghana revealed that only a dribble of new technology in the form of royalties and licenses are imported into the country (as indicated in Figure 4.6). This is insignificant in comparison to those of the NICs of Asia. For example, China spent $543 million, Korea $2,413 million, and Thailand $813 million on royalties and license fees (Gogo, 2003).

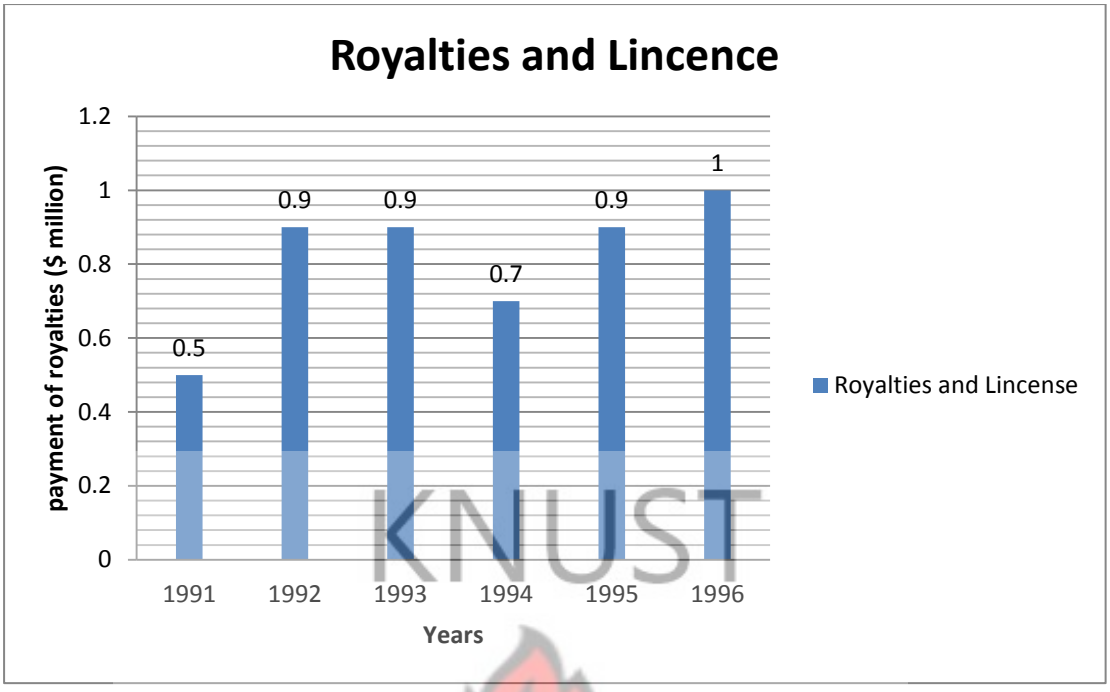



Figure 4.6: Ghana: Payments of royalties and license fee (US$ million)

Source: IMF, Balance of payments Statistics

### 4.6 Research and development (R&D) in Ghana

Successful technology transfer (TT) in the NIEs was also subject to availability of well trained and skilled engineers, researchers and technicians. This called for availability of well-funded academic and research institutions. At the moment, South Korea is reputed to have one of the best educational systems in the whole world.

After independence in 1957, the educational system of Ghana was better than the NIEs. However, as measured by the engineering enrolment index in terms of technical education, Ghana has performed badly. Moreover, like other case study countries of Asia, Ghana has performed poorly on the international arena (Gogo, 2003).

Over the years, student enrolment in science and engineering courses has not increased considerably in comparison to other programmes. A study conducted on Kwame Nkrumah University of Science and Technology (KNUST) in 2002 revealed that enrolment in Bachelor of Arts and management programs as a percentage of total

enrolment in the university has been more than 60 per cent and still increasing; engineering and the sciences declined by 0.5 per cent (Boateng et al., 2002). And this is a worrying trend in an attempt to develop Ghana into an industrial, scientific and technological hub.

Majority of workers in the formal manufacturing sector have either completed technical or secondary education. Employee training in Ghana has been more predominant in the Ghanaian manufacturing sector than the NIEs (Verner,1999). Figure 4.7 show that about two-thirds of Ghana's industrial workers receive formal structured training. In-house training does not seem to have productivity enhancing effect on manufacturing thus the need for creativity, innovation and entrepreneurship.

Advanced skills are those used intensively in a successful industrial sector, the relative scarcity of such skills explains the failure of Ghana to develop into a successful manufacturing sector (Bigsten, et al. 1998).

As in other South-East Asian countries, in Ghana, 90% of research activities are undertaken by the public institutions and financed by the government. In contrast with the NIEs, the private sector finance and undertake research and development. Most enterprises on small scale operate using relatively simple machinery to produce low-quality goods. Technical skills are comparatively low, and there are few signs of product or process innovation. Compared to the NICs, Ghana has smaller firms with a less educated workforce (Bigsten et al. (1998).

Furthermore, there is optimal use of imported technology because of low technological capability. For that matter, few resources are used in adapting, absorbing and improving new technology. But, the NICs are said to have reached and

maintained international competiveness through optimal use of imported technology, though, they are not at the frontier of innovation.

Majority of Ghanaian enterprises are very reluctant to pay for technological services, which endangers or sabotages the commercialization drive of the CSIR and other science and technology institutions. This reluctance is as a result of the lack of awareness creation of the significance of science and technology activities and technological capacity for industrial competiveness.



The Association of Ghana Industries (AGI) and other equally relevant associations can play a critical role in this directive, as happened in the newly industrialized countries (NICs) of South-East Asia.

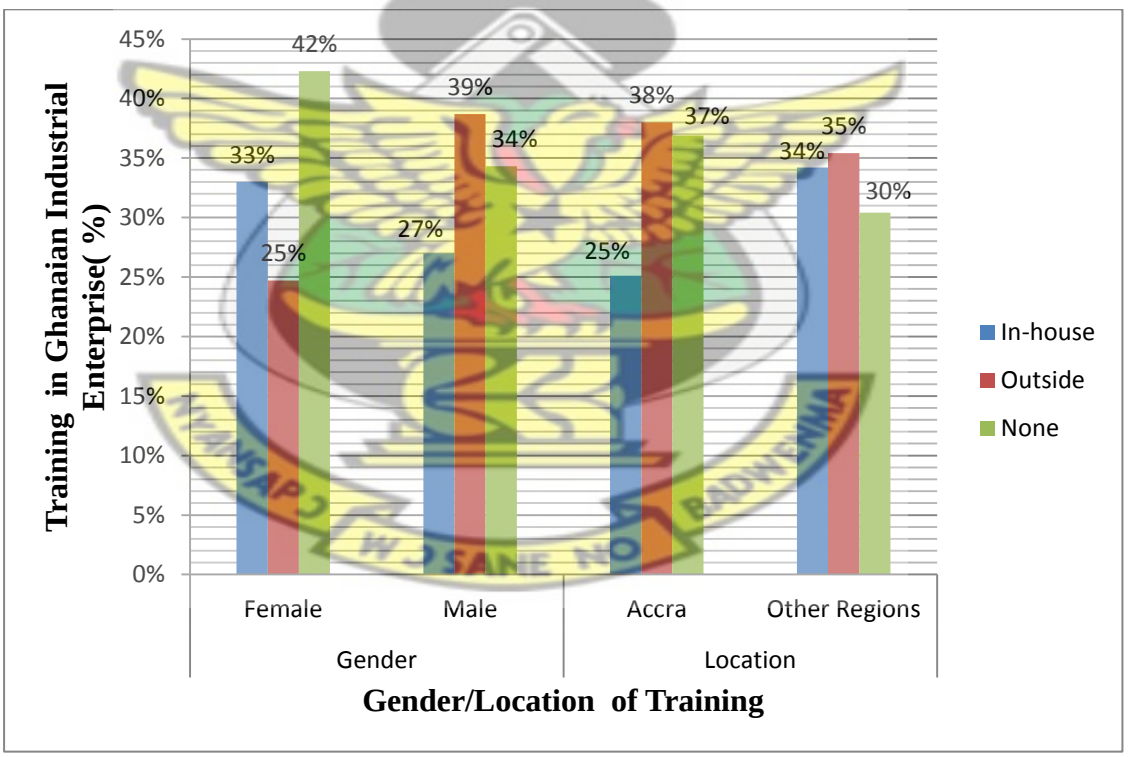



Figure 4.7: Training in Ghanaian Industrial Enterprises

Source: Verner, G. K., (1999)

With a gross expenditure on R&D (GERD)/GDP of less than 0.5% during the period 1990-2000 for the NICs (Table 4.5), certainly Ghana's R&D investment was

considered insignificant. The two common factors that limit R&D activities in the NICs are insufficient financial resources and the lack of skilled R&D personnel. Inadequate market research has also been cited as an important eternal factor that greatly curtails R&D activities in the private sector. Lack of emphasis on the importance of R&D for long-term benefit also has impeded higher growth of R&D activities in the government research institution and institutes of higher learning (IHLs) (MoSTE, 2000).



Table 4.5: R&D GERD/GDP (%)

| | 1990 | 1992 | 1994 | 1996 | 1998 | 2000 |
|---|---|---|---|---|---|---|
| **Korea** | 1.90 | 2.03 | 2.44 | 2.60 | 2.55 | 2.69 |
| **Singapore** | 0.90 | 0.97 | 1.13 | 1.45 | 1.76 | 1.92 |
| **Taiwan Province of China** | 1.70 | 1.75 | 1.82 | 1.88 | 1.98 | 1.96 |
| **Malaysia** | 0.37 | 0.37 | 0.34 | 0.22 | 0.39 | 0.49 |

Source: MoSTE, 2002

### 4.7 The Science and Technology (S&T) infrastructure in Ghana

The science and technology infrastructure in Ghana is fundamentally composed of public institutions, majority of which are under the auspices of the Council for Scientific and Industrial Research (CSIR). Their functions range from provision of scientific information to establishment, and promotion of industrial standards, and R&D. Some institutions have support from foreign-funded projects.

The technology transfer centre of CSIR was established in 1981 to stimulate technology transfer. With centres in all the ten regions of Ghana, the institute provides advice on technology transfer agreements, technology choices and negotiations, and technology management. Some other institutions are; the Institute of Industrial

Research (IIR), Rural Enterprise Technology (RET) and the Ghana Standards Authority (GSA).

### 4.7.1 Ghana Standards Authority (GSA)

The Ghana Standard Authority (GSA) is the national statutory body for controlling industrial quality through standards, metrology, testing and quality assurance. Relatively, industrial standards are a new feature in industrial development. Standards within and across industries contribute to diffusion of technology. In Newly Industrialized Economies, a standards institution disseminates best practices to industry by helping and encouraging firms to assimilate and apply new standards. Standards for example may facilitate inter-firm technical linkages and collaboration and reduce expenses. However, the authority is faced with several constraints and weaknesses, particularly inadequate budgetary resources for improving technical competence and capacity to assist the local industries (See Figure 4.8 and 4.9 respectively).

Salaries alone account for an increasingly high share of the budget (from 60 per cent in 1994/1995 to 77 per cent to in 1998/1999), while only 2 per cent is spent on staff training, as shown in Figure 4.10. Figure 4.10 also indicates that there was no allocation available for R&D. As there were no allocations for purchase of new equipment, the Boards' equipment are old, obsolete and probably mal-functioning. The Board is believed to have the best equipment for diffusing industrialization and TT concept in the country, but this may be a sign of the overall effect of low technological level of Ghana's industry, rather than of the boards' technical excellence (Gogo, 2003).

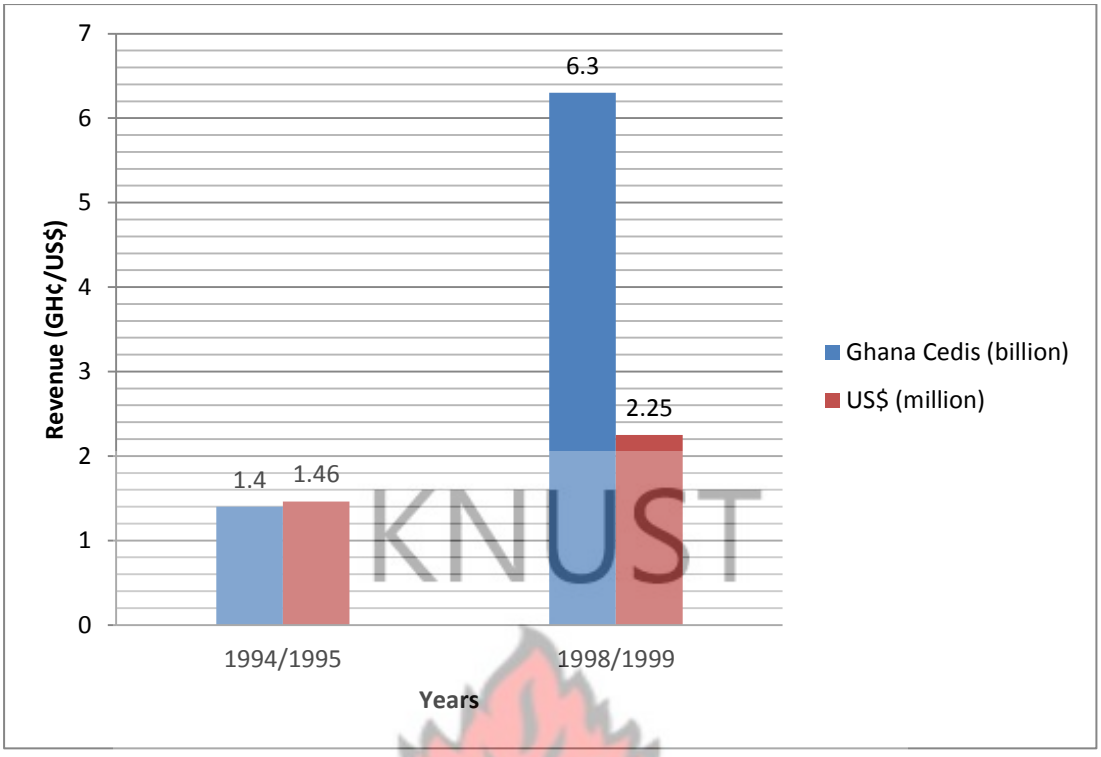



Figure 4.8: Revenues of the Ghana Standards Authority

Note: IGH¢ then was equal to 1US$
Source: Ghana Standards Authority, (1999)

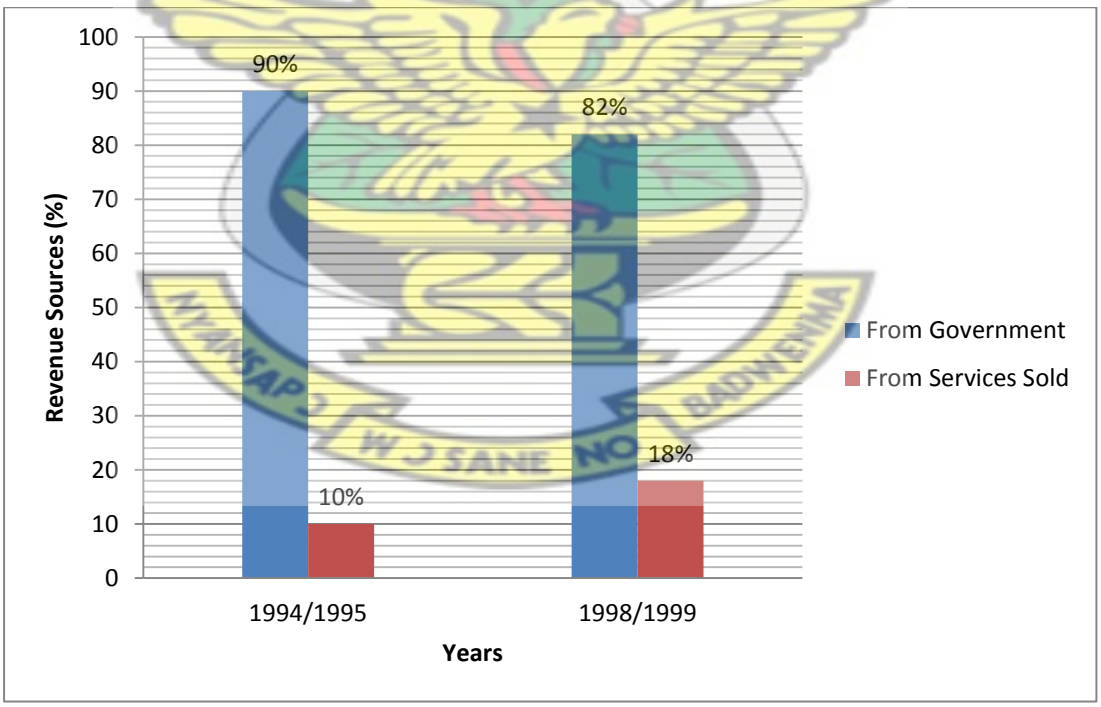



Figure 4.9: Sources of Revenues of the Ghana Standards Authority (GSA)

Source: Ghana Standards Authority, (1999)

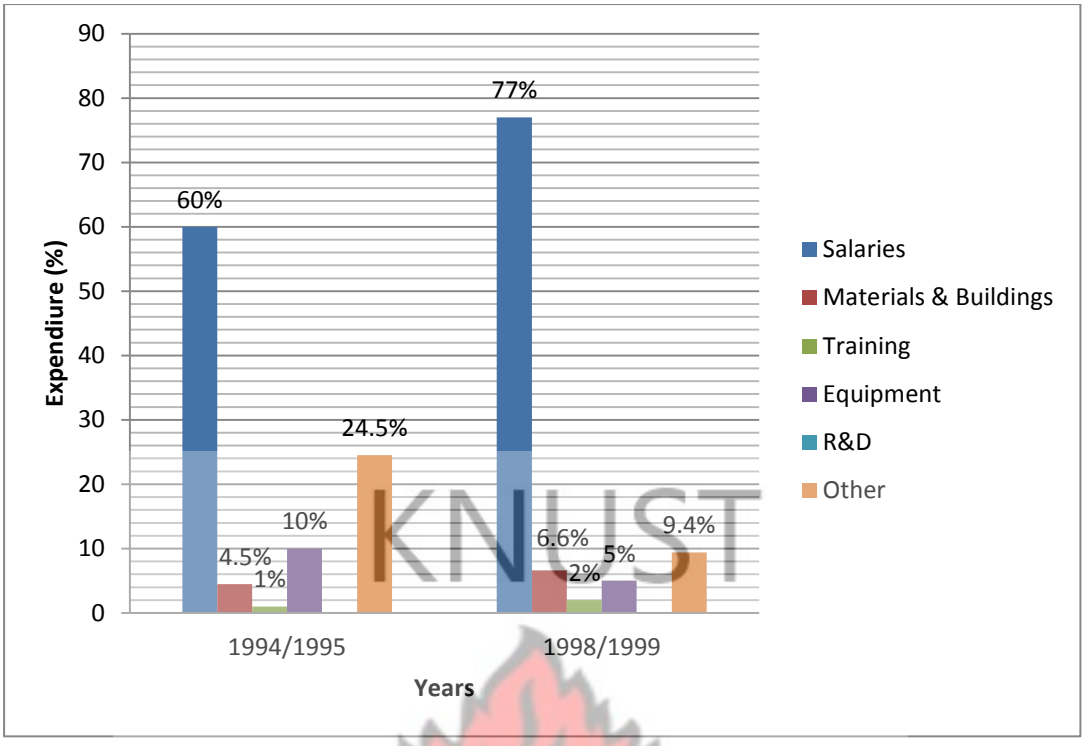



Figure 4.10: Expenditures of the Ghana Standards Authority

Source: Ghana Standards Authority (GSA), (1999)

### 4.7.2 The Institute of Industrial Research (IIR)

The Institute of Industrial Research (IIR) was founded to streamline the CSIR drive for research commercialization. Its mandate is to; (a) undertake research into process and product design and development; (b) promote adaptive technology, scientific instrumentation and calibration; and (c) repair precision equipment. The institution's mandate is to respond to the national need for technological support in adapting foreign technologies to industrial needs, and ensuring industrial application of research findings. However, the institution does not have a strategy for reaching out to entrepreneurs and enterprises.

Basically, its mandate is related to calibration of equipment and machinery, maintenance, with emphasis on servicing manufacturing enterprises and repair. The institutes programme is consistent with recent commercialization drive that is focused on development than basic research, especially in the process of technology,

development of agro-industrial machinery, maintenance, installation, material studies, development of science and technology equipment, and calibration of sophisticated industrial equipment.

Of approximately GH¢1,300,000.00 (equivalent of $370,000) at a rate of $0.2933USD to GH¢1 of government financing of the institutes allocation in 1999, only 6% was allocated to research and development (R&D) activities. The IIR offers consulting services ranging from provision of industrial and technological information among others.



Furthermore, the institutes mandate is to respond to national concerns for technological support in adapting foreign technologies to meet the needs of the local industries and also ensures effective industrial application of research findings from the institute and the universities. Nonetheless, the institute lacks the financial resources to purchase new equipment. Its challenges include lack of strategies for reaching out to the broader industries and entrepreneurs and linking programmes activities to meet the needs of the manufacturing sector.

### 4.8 Other Leading Research and Development (R&D) institutions involved in TT in Ghana

#### 4.8.1 The Technology Consultancy Centre (TCC) of KNUST

This is a unit of the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi. Currently, the centre serves as an interface between the research and development activities taking place at the university, and the entrepreneurial aspirations of the Ghanaian public.

Through great effort, the centre established the intermediate Technology Transfer Unit (TTU) at the Suame Magazine in August 1980. Through this, sustainable

industrial development and employment creation were systematically promoted at the grass roots for the first time in Ghana.

Majority of its clients are small and medium-sized enterprises in the informal sector, and technology transfer is mainly on fabrication of small scale machinery and parts, food processing, ceramic manufacture and foundry works.

Generally, the centre is considered useful in facilitating the transfer and adaptation of technology and to boost the entrepreneurial aspiration of the Ghanaian public. The centre benefits from financial assistance from international organizations (Gogo, 2003).

The centre's effectiveness is constrained due to its size and coverage and inadequate funds for other research.

### 4.8.2 The Rural Enterprise Project (RET)

This is another technology transfer project in Ghana designed to focus on rural development. The rural enterprise project (RET) specializes in upgrading agro-based and small-scale industries, replacing inefficient, obsolete technologies with modern and more efficient ones.

### 4.8.3 Ghana Regional Appropriate Technology Service

The Ghana Regional Appropriate Technology Service is one of the leading institutions in Ghana promoting TT and use of technology in industry. It was created with funding from the Canadian Agency for International Development and the European Commission to promote grass-root industrialization and TT in Ghana through consultancy services and training of micro and small-scale industrialists and as a channel for transferring intermediate technology to the ten (10) regions of Ghana.

### 4.9 Funding S&T in Academic and Research Institutions of Ghana

Ghana's Science and Technology (S&T) programme is hampered by a number of constraints, mainly inadequate R&D funding and lack of infrastructure development. Sources of these funds include government budgetary allocations, and donor grants.

As Figure 4.11 indicates, the Ministry of Environment Science and Technology (MEST) is exclusively financed from the central government. Allocations to MEST for science and technology form only 0.25% of the country's GDP, a reflection of the importance accorded to S&T in Ghana. However, only a token of two-fifths of the ministry's budget is used for research and development (R&D) (Gogo, 2003). Government-funded institutions such as CSIR and others undertake about 90 per cent of the research carried out in the country, in contrast to the dominance of both public and private institutions in R&D activities among the NIEs of Asia.

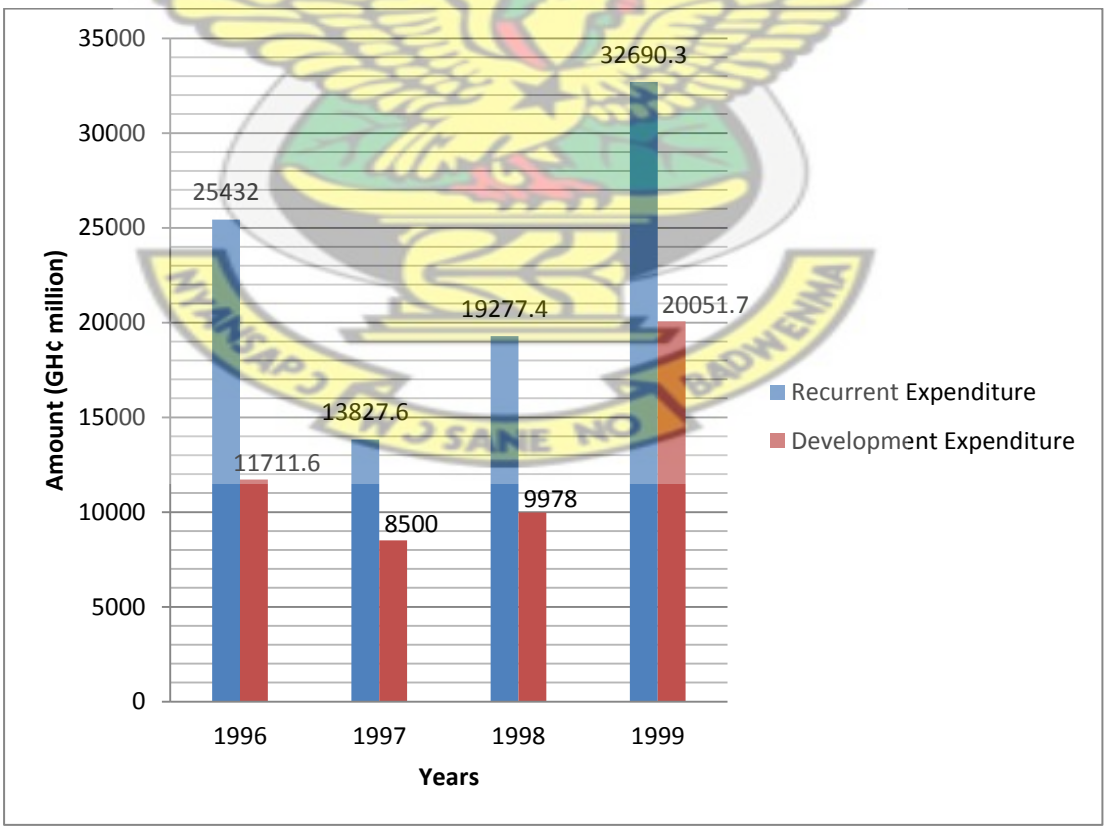



Figure 4.11: MEST Annual Budget, 1996-99 (million GH¢)

Source: Ministry of Finance Annual Budget Estimates, (2000)

Figure 4.12 and 4.13 respectively, further underscores the grossly inadequate funding from government sources. Government commitments in terms of research grants for S&T programs have been inadequate. Funding for CSIR is not appreciably different from funding for other government research institutions such as the IIR, TCC, GRATIS and academic institutions in Ghana. Only a range of 13% - 18% of the requested development funds was released from the period of 1996 to 1998, while a little larger percentage of 18 to 30 per cent of the requested operational funds was released from the same period (see Table 4.5). This amount is less than 1% of GDP, with a diminishing trend in both operational and R&D expenditures.



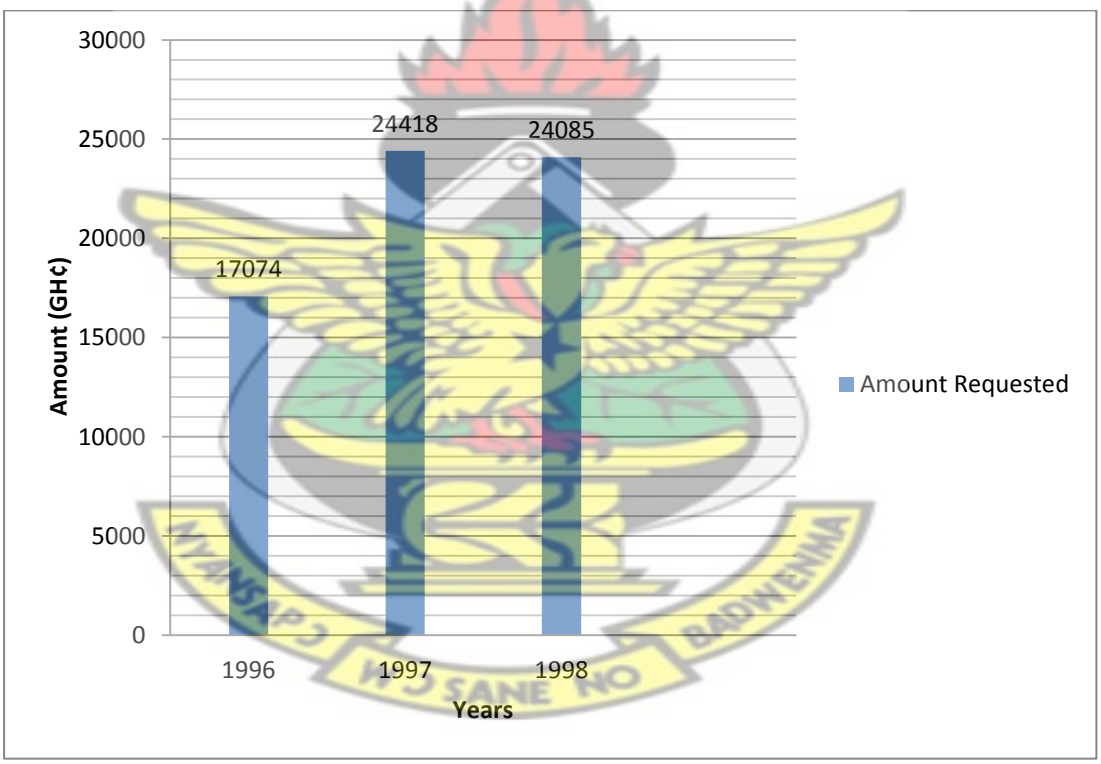



Figure 4.12: Development funds, Total Government Funding of CSIR, 1996-98 (in million GH¢)

Source: Council for Scientific and Industrial Research, (2000)

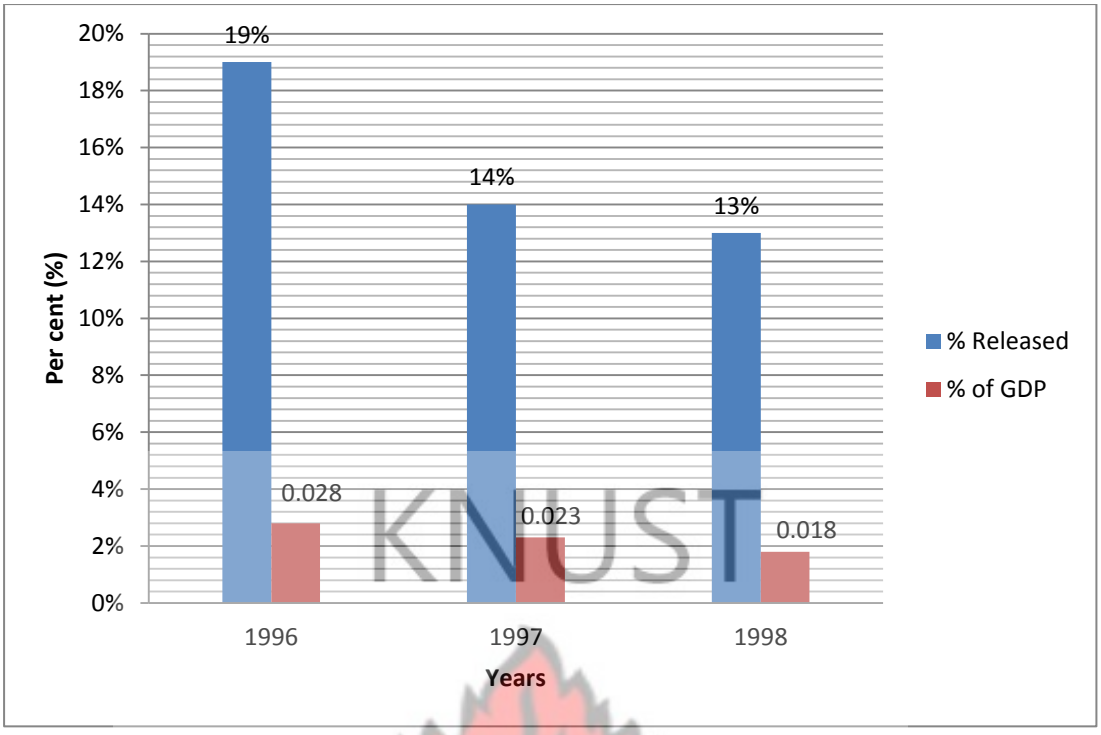



Figure 4.13: Development funds, Percentage of Funding Released of CSIR, 1996-98 (in million GH¢)

Source: Council for Scientific and Industrial Research, (2000)

Table 4.6: Operational Funds, Percentage of Funding Requested of CSIR, 1996-98 (in million GH¢)

***Operational Funds***

| Year | Requested (million GH¢) | Percentage released (%) | Percentage of GDP (%) |
|---|---|---|---|
| **1996** | 7,038.00 | 30% | 0.018 |
| **1997** | 9,485.00 | 20% | 0.013 |
| **1998** | 9,790.00 | 18% | 0.010 |

Source: Council for Scientific and Industrial Research, (2000)

Utilization of the released funds was also a source of concern. A large quantum of these funds is spent on personal emoluments as evident in Figure 4.14 and 4.15. In the public universities, the funds allocated are over 82 per cent, and at the CSIR, it is 76 per cent on average. In either case, administrative expenses and others make up more

than 90 per cent of the budget, leaving between 4 per cent and 8 per cent for CSIR and Universities respectively for operational and capital expenses related to research and development (Figure 4.16 and 4.17).

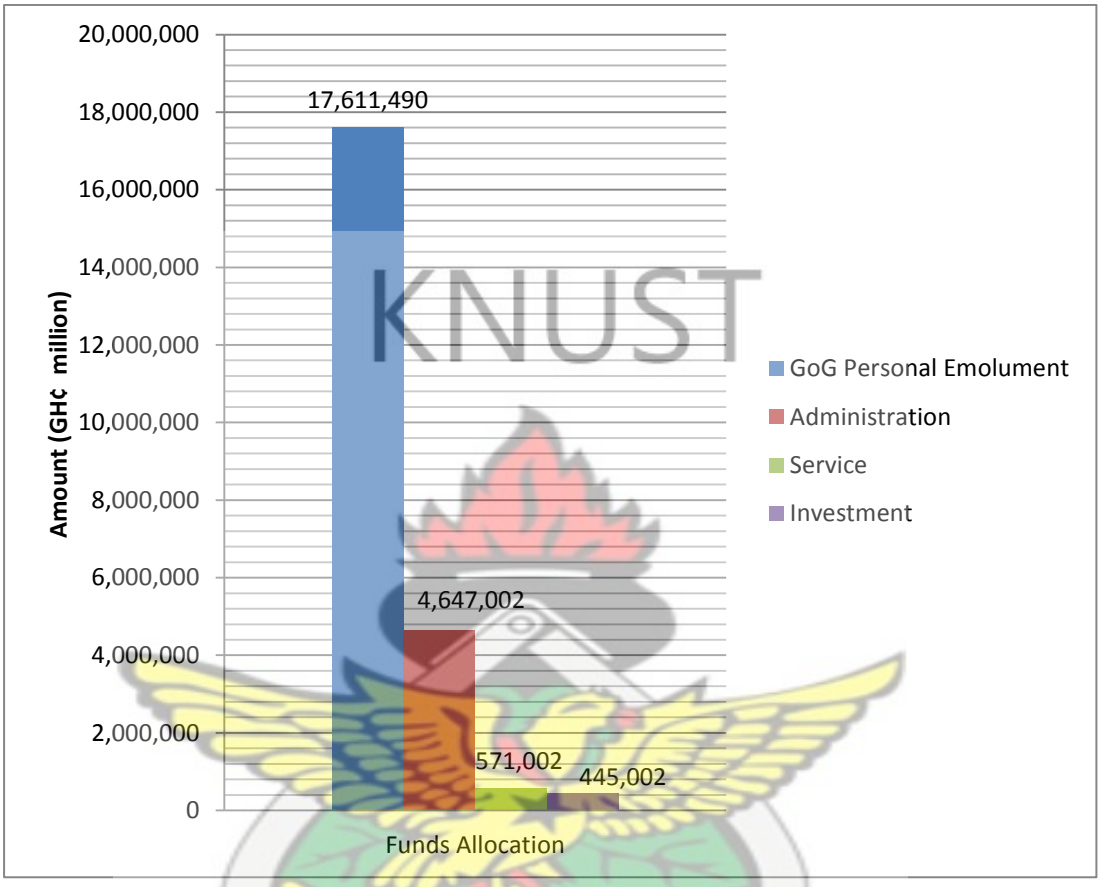



Figure 4.14: Allocation of funds, CSIR in Ghana

Source: Republic of Ghana, (2008)

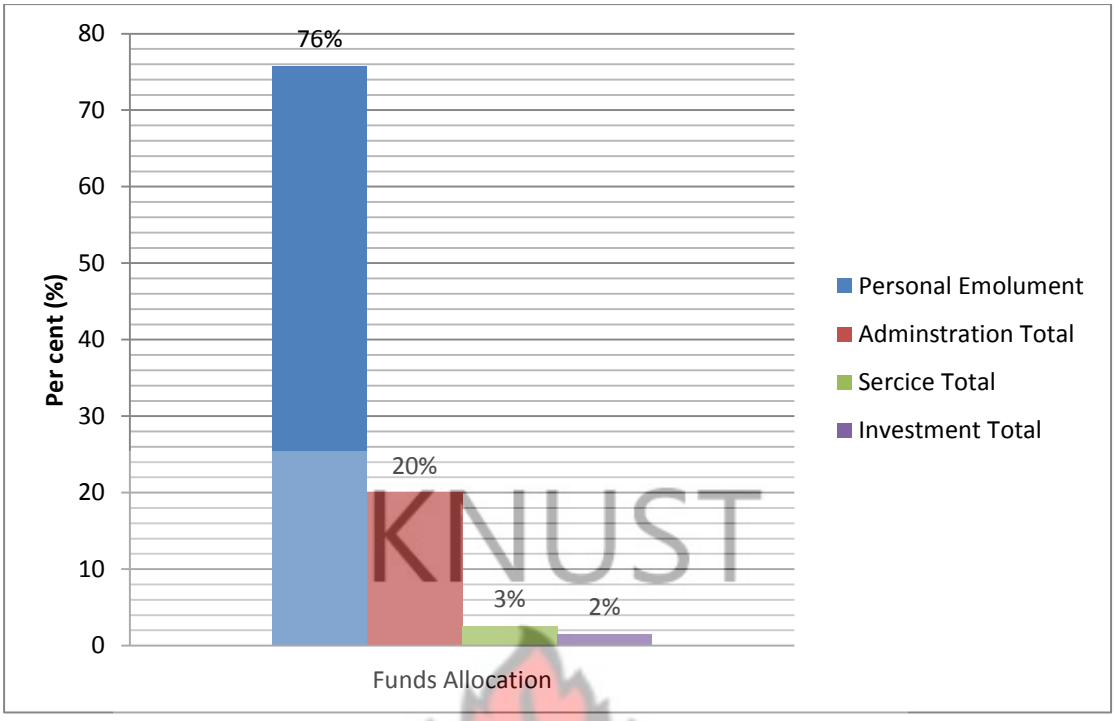



Figure 4.15: Percentage of funds allocation, CSIR in Ghana

Source: Republic of Ghana (2008)

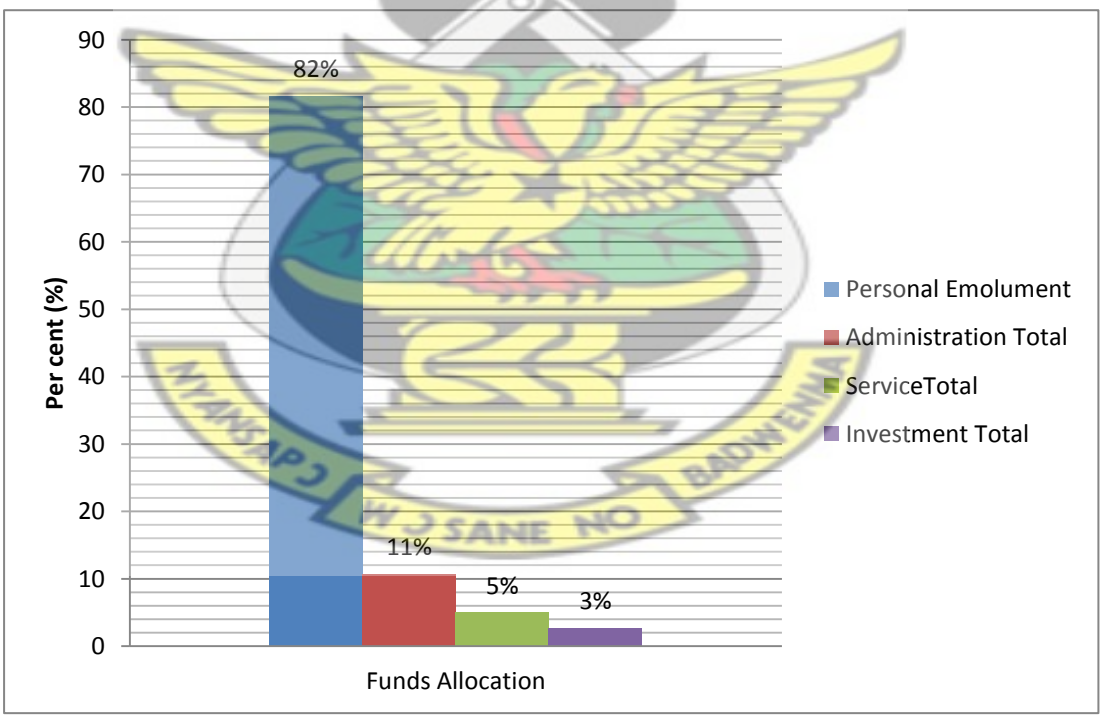



Figure 4.16: Percentage of funds allocation, Universities in Ghana

Source: Republic of Ghana, (2008)

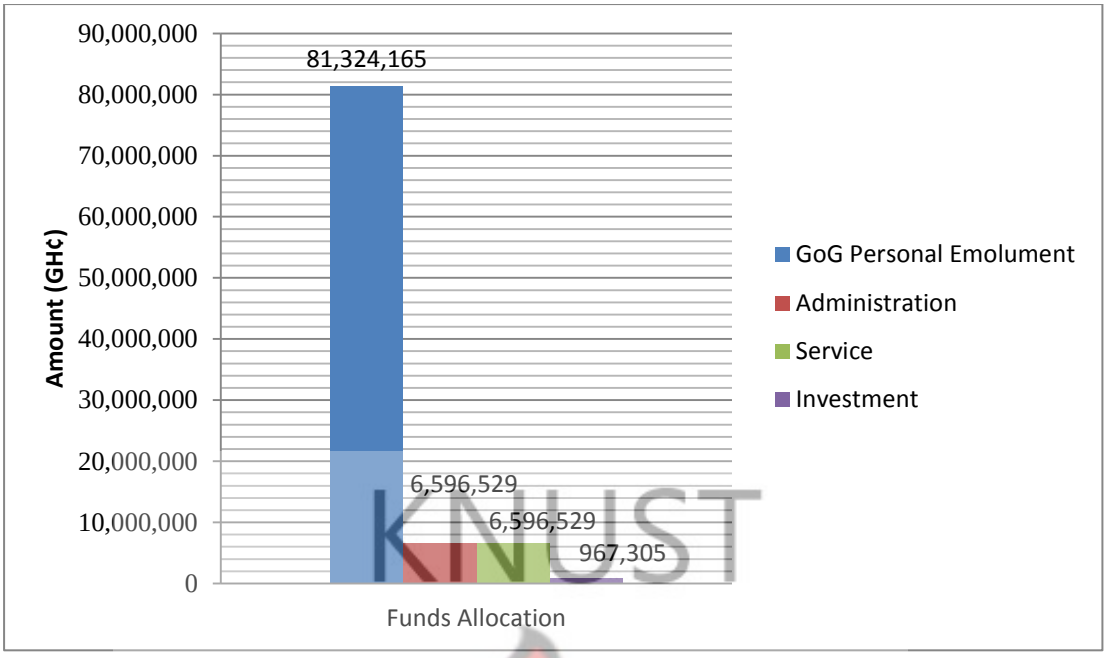



Figure 4.17: Allocation of funds, Universities in Ghana

Source: Republic of Ghana, (2008)

One can therefore argue that, Ghana does not fund innovation, technological development and research on a competitive basis. The country does not have the equivalent of the national and innovation research funds of the NICs of Asia to oversee and review the implementation of competitive research and innovation funding activities.

Furthermore, there is no clear coordination and programs for research priorities. The yet to be established National Research and Innovation Fund (NRIF) for the country could likely fill this gap, but it is not known for sure whether the funds would be enough for the universities, polytechnics and the private sector.

Most research institutions and the universities including S&T institutions are not doing enough to foster technological development and collaboration in the country. Funding for S&T is very low by international standards.

Ghana's budget amounted to $4.3billion in 2008 (see Table 4.7). And only just less over 1 per cent is dedicated to R&D. Most of this research is devoted to economic affairs that consist of applied research programs undertaken by CSIR ($44.4 million), seconded by health R&D ($3.9 million) (Republic of Ghana, 2008).

Table 4.7: Science and Technology in Ghana's total budget, 2008 (in GH¢)

| Budget item | GH¢ | Per cent (%) |
|---|---|---|
| **Total government expenditure** | 4,292,084,203 | 100 |
| **Basic research (Science and Technology)** | 201,500 | 0.005 |
| **R&D General public services** | 151,412 | 0.004 |
| **R&D economic Affairs** | 44,314,486 | 1.032 |
| **R&D Health** | 3,942,081 | 0.092 |
| **Total** | **48,609,479** | **1.133** |

**New Ghanaian Cedi and USD were close to 1:1 exchange rate during the 2008 budget.
Source: Republic of Ghana, (2008)

Only three quarters of these funds come from government budget, while the remaining come from contract work, commonly referred to as internally generated funds (IGF) (Figure 4.18 and Figure 4.19 respectively).

Health research draws in 75 per cent of its own share of the funding from external contracts, economic affairs R&D, only 29 per cent. The average share of IGF funds for the entire research is 23 per cent.

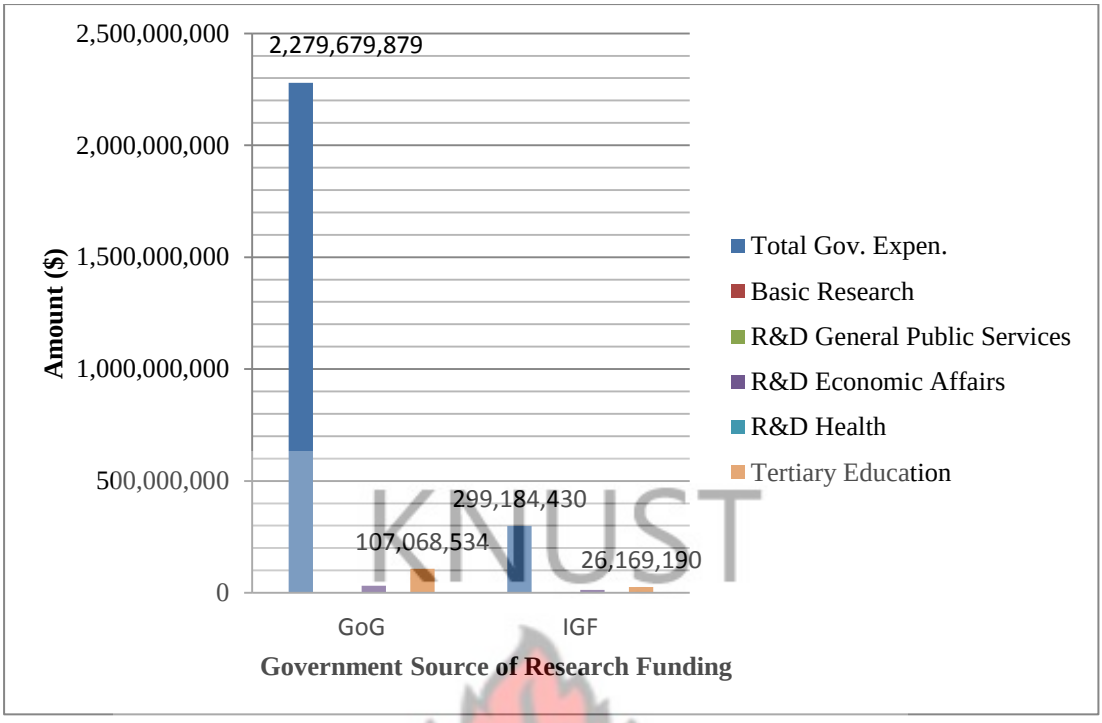



Figure 4.18: Source of R&D Funding, GoG and IGF, (GH¢)

Source: Republic of Ghana, (2008)

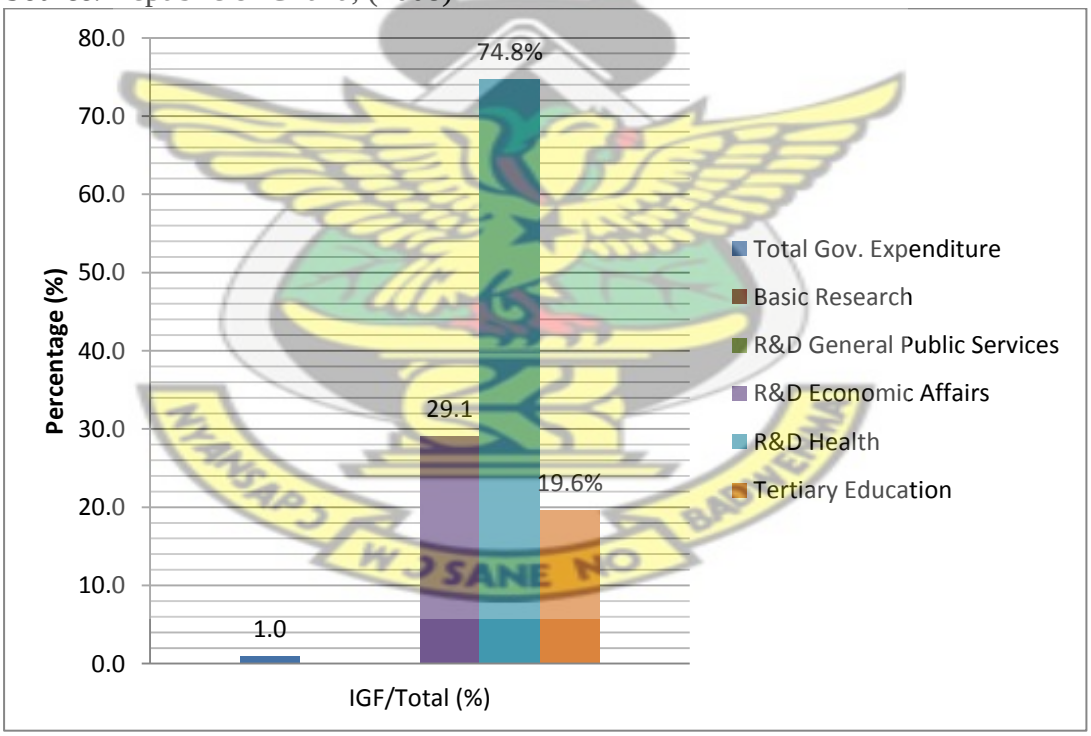



Figure 4.19: Percentage IGF Funding, 2008

Source: Republic of Ghana, (2008)

In 1998, only about half of the requested budget was released, and personnel payments were made up of 90.2 per cent of the total budget. Releases of development

funds, the most significant for R&D, only reached 13 to 18 per cent of requested values, while those for current operations reached 19 to 30 per cent. In 1999, expenditure on development from multilateral donor sources provided the bulk of funds for R&D (Figure 4.20).

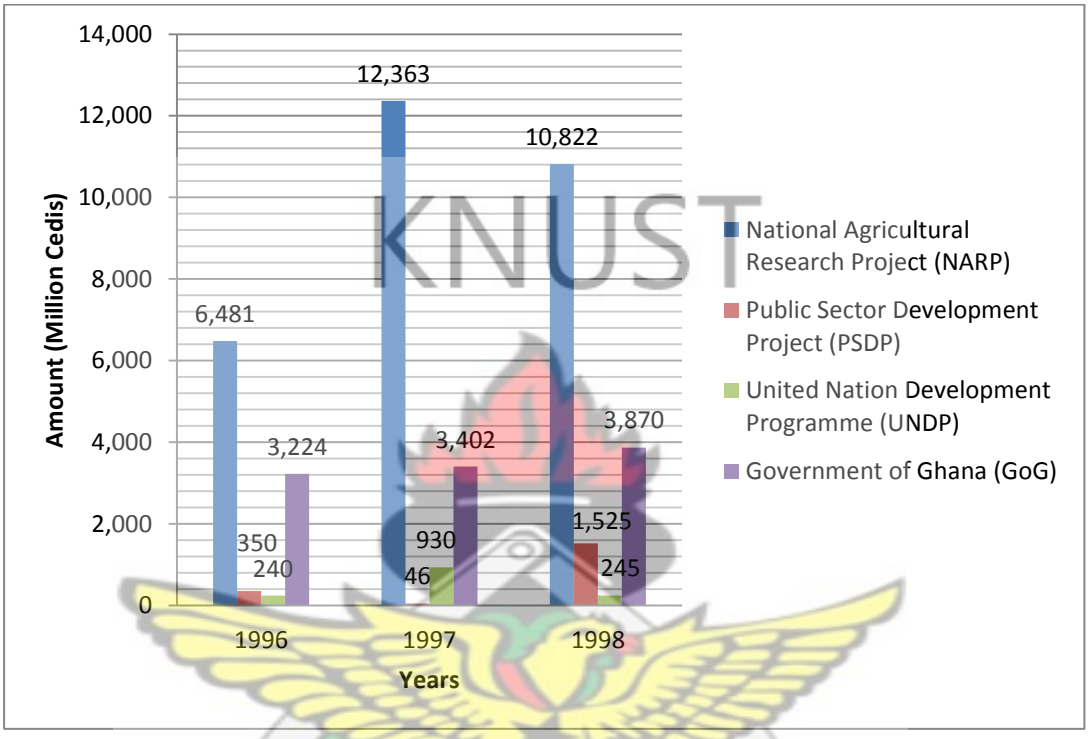



Figure 4.20: R&D Funding Released: Government of Ghana and its Development partners, (1996-1998) (in million Cedis)
Source: CSIR Secretariat, (1999)

**4.10 Research and Development (R&D) in the NIEs**

A major benefit of Research and development (R&D) is the making of discoveries that can either lead to the development of new product or services, or to the improvement of existing procedures or products.

The development and application of new technologies have been proven to be driven by R&D, and is one aspect of spending that develops and drives the development of industries. The number of patents granted in the NIEs was quite small during the period of 1990-2000. This was largely due to insufficient financial resources and a

lack of well trained and skilled personnel, which limited R&D activities in the NIEs. Also, the lack of emphasis placed on the importance of R&D for long-term benefit obstructed higher growth of R&D activities in Government Research Institutions (GRIs) and the academic institutions of Higher Learning (IHL) (MoSTE, 2000).

Throughout the same period, majority share of R&D expenditure went to the private sector whilst both GRIs and IHLs held only a moderate and very low share, respectively (see Table 4.8 ).



Table 4.8: R&D expenditure by Sector (%) 1990-2000

| | Private Sector | | Government research Institutions (GRIs) | | Institute of higher Learning (IHLs) | |
|---|---|---|---|---|---|---|
| | **1990** | **2000** | **1990** | **2000** | **1990** | **2000** |
| **Korea** | 71 | 75 | 22 | 15 | 8 | 10 |
| **Singapore** | 54 | 63 | 15 | 19 | 31 | 18 |
| **Taiwan province of China** | 67 | 73 | 24 | 14 | 9 | 13 |
| **Malaysia** | 37 | 66 | 55 | 22 | 8 | 12 |

Source: Ministry of Science and technology (Republic of Korea), Executive Yuan Council (Taiwan Province of China), National Science and Technology Board (Singapore) and Ministry of Science, Technology and the Environment (Malaysia) (2000)

Research and development (R&D) activities became a focus of companies in the NIEs in time. This is evident in the higher number of qualified researchers employed in some of these companies from the periods of 1990 to 2000. For instance, R&D was a major area car makers spent much (Mo-Joon et al., 2006). It is interesting to note that 10 per cent of South Korea's Hyundai Motor Company employees in 1993 were researchers, as can be seen in Table 4.9. Kia in 1990 recruited 7.9 per cent researchers while Daewoo in 1993 recruited 10.1 per cent researchers (Mo-Joon et al., 2006). Furthermore, the total number of Doctor of Philosophy (PhD) holders among the

researchers kept on increasing in the aforementioned car makers' establishment (Mo-Joon et al., 2006).

Table 4.9: Researchers in South Korea Automobile Industry

| **Company** | **Hyundai** | | | **Kia** | | | **Daewoo** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1990** | **1993** | **2000** | **1990** | **1993** | **2000** | **1990** | **1993** | **2000** |
| **Researchers share in total** | 3418 | 4100 | 8000 | 15000 | 1700 | 5000 | 916 | 1373 | 3185 |
| **Employees (%)** | - | 10.0 | - | 7.6 | 6.7 | - | 5.1 | 10.1 | 16.1 |
| **PhD holders** | 14 | 16 | 80 | 11 | 20 | - | 12 | 25 | 64 |
| **Master's Degree Holders** | 256 | 313 | 1000 | 105 | 135 | - | 61 | 255 | 704 |
| **Share of PhD's in the total researchers (%)** | 0.4 | 0.4 | 1.0 | 0.7 | 1.2 | - | 1.3 | 1.8 | 20 |

Source: Kim et al., (1999)

Furthermore, Table 4.10 informs us that Korea's performance in S&T research and development as of 2004 left much to be desired. Less scientific and technical papers were published in china, and the number of industrial property rights granted was also small (Mo-Joon et al., 2006). Korea's economy was able to take advantage of ICT by providing a relatively good ICT infrastructure, but the knowledge bas needs to be upgraded in order to support sustainable economic growth.

Table 4.10: Comparison of Science and Technology R&D performance

| | **Korea** | **Japan** | **China** |
|---|---|---|---|
| Scientific and technical papers published (2001) | 14,673 (15) | 70,655 (2) | 29,441 (8) |
| R&D Funds (2001)<br>Ratio to GDP | 12.5bil$ | 127.9bil$ | 1042.5 100mil Yuan |
| Industrial property rights granted (2000) | 2.92%<br>126,395 | 3.09%<br>274,646 | 1.23%<br>258,313 |
| Technology trade (2001) | 619.1-2642.7 | 10178-11278 | |

Source: KITA (2004)

### 4.11 Adoption of foreign technology

Adoption of foreign technology involves the acquisition and use of new inventions or innovations from a host country. Adoption and diffusion of selected imported technology which enhanced TT between the local industries as well as between local and foreign firms was encouraged by governments of the NIEs. In this direction, majority of the NIEs government developed preference ratings for selecting technology that could be imported.



An important aspect of technology adoption and diffusion in the NICs is the adoption of foreign technology; the NICs mostly hired technology but did not hire production. They welcomed adoption of foreign technology but did not promote foreign ownership of technology. In this manner, firms in the NICs were able to fortify their negotiating positions with multi-nationals, forcing them to sell technology, and at low prices.

The major contributory factors behind the NICs successful adoption and diffusion of imported technology included; availability of local entrepreneurs, well trained and skilled engineers, researchers and technicians, and well thought out and planned government developmental policies among others. The experiences of the NIEs show that, industrially backward countries can adopt, and assimilate foreign technology, and develop according to the requirements of industrialization.

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

This chapter presents major conclusions drawn from the study. It also highlights issues that may require further research in future.

## 5.2 Conclusion



This study set out to identify the constraints to industrialization and technology transfer in Ghana, comparing them with the newly industrialized economies (NIEs) of South-East Asia.

From the objectives set out, some of the key constraints identified included inadequate allocation of funds to science and technology, research and development (R&D), improving technical competence and capacity to assist the local industries and the lack of collaborative research among others.

Findings from the study point to the fact that, inadequate R&D funding, inadequate technically proficiency workforce, inadequate S&T infrastructure and the lack of collaborative research between the research institution and industries among others, constituted the main impediments to the development and growth of the manufacturing sector in Ghana. This seems to be a major reason for the country's inability to achieve the fast track industrial and economic growth as seen in the NIEs of Asian.

The East Asian economies achieved rapid industrial growth through massive investment in R&D to meet the needs of their local industries, collaborative research

between academic and research institutions, and innovative entrepreneurs among others.

### 5.3 Recommendations

For Ghana to succeed through industrialization and technology (TT), there are some critical constraints that have to be addressed to develop as an industrialized nation. These include having a more effective technology transfer (TT) processes, acquisition and adoption of foreign and investing more into R&D funding to address the challenges of the industrial sector of Ghana. Some steps that can be taken in this direction include:

**1.** Improving the co-ordination between government research institutions and industry for effective management of science, technology and innovation (ST&I).

Linkages of an international sort should be fostered across ST&I system, most especially at government research institutes (GRI) and firm levels. GRIs and the universities need to increase their applications to local and international research tenders to boost the co-ordination between research institutions.

**2.** The need to develop a better educated, trained and skilled workforce.

To meet the needs of an industrialized economy, emphasis must be placed on the importance of higher education and training at all levels. Undergraduate and post-graduate support should be increased for science, technical and engineering education with innovative scholarship and loan schemes and other means to meet the stated goal for Ghana for the 40:60 ratio of social science to science and technology (S&T) in the public universities. Training outside the formal education system should be encouraged with increased availability of opportunities. This implies that apprenticeship training, in-service training, technical education, among

others, should be ensured that, technical workforce is properly skilled to master new technologies and to meet the needs of modern industry.

**3.** The overall objectives of government research institutions should focus on research and development (R&D). The universities must not only be producing an educated workforce but must be fully utilized for industrial development by working more closely with private sector, undertaking industry-oriented research to support the needs of society.

**4.** There is need to develop incentives and appropriate public-private-partnership (PPP), entrepreneurial innovation, technology absorption and adaptation, and industry driven research base.

Ghana's science, technology and innovation (ST&I) should be directed actively towards a demand-driven orientation. Thus, the private sector should be the main engine and focus on technological development, supported by an effective government attention. Innovation and technology adoption should be market-driven that can create incentives backed up by effective public support measures.

**5.** The need for university-industry linkages should be strengthened, especially in industrial research and development (R&D). Furthermore, Government and donor agencies should help the universities in carrying out research activities through financing.

### 5.4 Suggestions for Future Research

Further research could be carried out in identifying the constraints of technology transfer from the polytechnics and universities to industry.

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## APPENDIX 1

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**COLLEGE OF ENGINEERING**

**FACULTY OF MECHNAICL ENGINEERING**

**MSc. Mechanical Engineering**

**QUESTIONNAIRE**

***Constraints of industrialization and technology transfer in Ghana***



1. Name of company/institution……...
2. Name of department/section……..…
3. Inadequate research and development (R&D) funding.
4. Inadequate budget funding for technical education and training.
5. Inadequate government commitment in promoting science and technology learning
6. Inadequate technological institutions for training human resources.
7. Insufficient collaboration between research institutions and industry.
8. Constraints in assessing funding for research.
9. Inadequate allocation of funds to research institutions.
10. What is government budgetary allocation for technological development?