

A Study on the Readjustment of the Nigerian National Innovation System through Korean Case Analysis

한국 사례분석을 통한 나이지리아 국가 혁신 시스템 개선 방안 고찰

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목 차

I. Introduction	V. The Nigerian National Innovation System
II. NIS and Development Trajectory	VI. Revised Development Trajectory for Nigeria
III. Methodology	VII. Conclusion
IV. The Korean National Innovation System	

국 문 요 약

한국은 1945년 광복 후 개발도상국의 단계를 거쳐 선진국의 대열에 이르기 까지 지속적인 경제성장을 가져왔지만, 한국보다 15년 뒤인 1960년에 독립한 나이지리아는 매우 풍부한 자연자원을 가지고 있음에도 불구하고 여전히 빈곤을 극복하지 못한 개발도상국의 위치에서 머물고 있다. 본 연구에서는 한국에서의 국가혁신체제와 경제개발계획이 경제발전애 끼친 영향을 고찰하여 개발도상국에 대한 시사점을 제공하고자 하였다. 검토 결과, 경제개발계획의 핵심적 성공요인은 구성요소간 유기적 커뮤니케이션, 지식 교환 및 국가혁신체제의 지속적 개선이었다. 특히 경제발전 관점에서 단계별 국가혁신체제는 매우 중요한 위치를 차지하고 있었다. 본 연구에서는 한국의 혁신체제관점에서의 발전경로를 기반으로 “multiple skipping”을 제안하고, 현재 나이지리아의 상황과 국가 수준의 지향점을 고려할 때 이를 통한 국가 발전을 계획하는 것이 보다 유용한 방법이 될 수 있을 것이라는 결론을 제시하였다.

핵심어 : 경제 성장, 경제 발전 계획, 국가혁신체제, 과학기술정책, 나이지리아

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ABSTRACT

After independence in 1945, the South Korean economy rose steadily from a developing country to a developed country while, after independence in 1960, Nigeria is still a developing country with poverty on the increase, despite its large amount of natural resources. This research seeks to find a viable solution to this issue while studying the relationship that exist amongst Economic Development Plans (EDPs), National Innovation System (NIS) and economic development in Korea. The methodology used herein is a mixture of a systematic literature review and a semi-structured interview. The results of this study show that EDPs are essential to the enhancement of communication, and the flow of knowledge and innovation of the NIS. Furthermore, our result shows that the efficiency of the NIS is relevant to drive economic growth and development. Therefore, based on our analysis of the current situation in Nigeria and the development trajectory of Korea, we developed, introduced and recommended a theoretical framework called the “Multiple skipping” development trajectory as a model for development in Nigeria.

Key Words : Economic development, National Innovation System, Science and Technology policy, Nigeria

I. Introduction

For developed and developing countries to sustain a vibrant economy, an efficient National Innovation System (NIS) is necessary. The structure, framework, and interaction of key players is very important to the success or failure of the NIS. This is because innovation systems introduce essential knowledge into the economy which require learning of all players in the system. NIS is an essential framework that drives national technological and scientific activities to enhance international competitiveness and economic development while various components work together to achieve a singular objective. According to Carlsson et al. (2002), a system is made up of components (operational parts), relationship (component links) and attributes (component property). The NIS concentrates on the major components of the economy (private firms, university and public organizations), and their dynamic relationship in-addition to studying their relationship with social and institutional infrastructure that encompass them. NIS place emphasis on innovation as a continuous and non-linear accumulative process that merges radical and incremental innovation, diffusion, absorption and use of innovation (Varblane et al., 2007). But the NIS cannot be enhanced without conscious effort by government to integrate the plan for its development within its Economic Development Plans (EDPs). EDPs work to bridge the gap between humans and resources within a community to match global and regional markets by creating new jobs that will suit the people and their environment (Blakely and Bradshaw, 2002). Furthermore, according to Fargerberg and Srholec (2008), NIS, governance and economic development have a strong relationship. Through the development and implementation of policies in addition to R&D funding, EDPs have enhanced the education sector and the development of human capital for economic development.

However, the process involved in the enhancement of the NIS is not without challenges because, while some countries (for example South Korea) have succeeded, others (for instance Sub-Saharan Countries) are finding it difficult to replicate this success. Several factors are responsible for this variation; one of which is the increase in competition of global economies that leads to competitive pressures. These competitive pressures are exerting great pressure on labour costs in developed countries, thereby

affecting their growth prospects (Fagerberg and Srholec, 2008). As such, for countries to develop their economies as well as remain competitive globally, their NIS must be empowered to facilitate this task. According to Amabile (1988), innovation emanates from creative ideas. When an idea is successfully implemented and has commercial value an innovation has been borne. In the 1980s, Nigeria and Korea were both developing countries, however, today, Korea is a developed country with an enviable economy, credited to its viable and effective model of the NIS that drove technological innovation while, Nigeria remains a developing country with many policy experts referring to it as a failing state.

But how can the NIS be enhanced to drive economic growth? Niosi (2002) posits that one of the methods of improving the performance of the NIS is benchmarking. Benchmarking involves the development of indicators that will be used to determine performance in order to discover better systems of organization and enhance learning. However, in this study, we seek to prove that there is a relationship between EDPs, NIS and economic development. According to Freeman (1995), NIS are collections of public and private institutions in-addition to organizations within an economy that provides financial support and perform R&D, in-addition to transforming the results of R&D into commercial innovations, which affects the diffusion of new technologies. Therefore, in this research, we shall be concentrating on three elements of the NIS, which are the university, government and the industry. This will be used to examine the Korea experience and based on lessons learnt from this examination, we will develop, introduce and recommend a theoretical framework called “multiple skipping” as a model for development in Nigeria.

II. NIS and Development Trajectory

1. National Innovation System

EDPs are drafts of strategies to achieve economic development. According to Dang and Pheng (2015), the goal of economic development is to create national wealth. One

of the indexes used to measure national economic performance of a country is the Gross Domestic Product (GDP) which means, countries with very high GDP are economically strong, while those of low GDP like countries in sub-Saharan Africa, Latin America and Central Asia are economically weak. Therefore, EDPs are important in shaping the performance and development trajectory of NIS for national development. According to Swinburn et al. (2012), the EDPs main goal is to develop the capacity (economic) of local economies in-order to improve their economic future, and general wellbeing. EDPs enhance cooperation between the private, and public sector in a partnership to foster economic development. On a general note, development plans are governmental tools of communication (Healey, 1993).

NIS are important instruments for economic development and competitiveness and they concentrate on the major components of the economy (private firms and public organizations), their dynamic relationship and their relationship with the social and institutional infrastructure that the system houses within a nation state. The main aim of this relationship and communication is to drive knowledge and enhance innovation in the economy. The actions and activities of knowledge-intensive business services (KIBS) are essential to the production and diffusion of knowledge within the NIS (Muller and Zenker, 2001). The introduction of knowledge into a system is set on the mandatory pre-condition that each and every player in the system is an active learner. The concept of the NIS was created simultaneously within Europe and the United States (US); hence the origin cannot be limited to one particular location. According to Godin (2009), NIS was the new conceptual framework of innovation that appeared after the linear model was introduced, previously. Unlike its predecessor the NIS introduced the idea of Research and Development (R&D). One of the key important factors in the success of the US NIS is the post-war R&D expenditure of government, others include; antitrust laws, the role of small, medium enterprises and commercialization of technology (Mowery, 1992). The book by Christopher Freeman on Japan in 1987 and his work with other authors helped diffuse the knowledge of NIS (Lundvall, 2007). A very important point to note is the fact that the NIS drew ideas from already existing previous work of past scientist.

According to Lundvall et al. (2002), the NIS drew knowledge from the ideas of Adam

Smith's 1776 evaluation of the division of labour as a relationship between knowledge creation, production activities and services of scientists, however, he did not consider innovation and competence building as independent and systematic. On the other hand, Fredrick List in 1841, carried out a research on a wide range of national institutions and he pointed out that it was important to develop national infrastructures and institutions which challenged the ideas of Adam Smith. While the German economy was trailing behind the economies of other countries in the mid-80s, Fredrick List developed a system called the national systems of production as a response to the German economy's catching up strategy (Bjorn et al., 2003). While Adam Smith's idea favoured the invisible hand and free trade (as a tool of economic development), Fredrick Lasswell dismissed the notion and rather argued that building national infrastructure and institutions were important to building mental capital; which was essential to spur economic development. Meanwhile, the modern day concept was propagated by Christopher Freeman driving on the knowledge already put forward by List. Christopher Freeman was the first person to use the name National System of Innovation in his unpublished paper (Technological Infrastructure and International Competitiveness) from 1982 while working for the Organisation for Economic Co-operation and Development (OECD) expert group of Science and Technology and Competitiveness. According to Fagerberg and Srholec (2008), a country can only succeed if they develop the appropriate level of technological capabilities and other complimentary factors; such as social capability, absorption capability and an innovation system.

Since the development of the concept of NIS, it has spread from Europe and the US to other parts of the world. Many researchers have been studying the diffusion process of the NIS using various criteria's. Intarakumnerd et al. (2002) in their research divided the diffusion process into 2; namely, for industrialized countries and for developing countries as well. NIS diffusion in industrialized countries took place as a result of the work of Lundvall in the mid-1980s on national systems of innovation, national policies of innovation and other works, while in developing countries the knowledge and study of NIS are yet to develop into the maturity stage, as they are built to facilitate catching up process of developing and under-developed countries. Watkins et al. (2015), studied the NIS in developing countries and concluded that the NIS had evolved through three

major waves. The first wave was studied by carrying out a literature review of researchers like Freeman, Lundvall and Nelson. While Freeman's contribution was on the importance of knowledge and network, Lundvall's contribution was on the importance of intermediate firms, research councils and funding bodies, and super organizations. On the other hand, Nelson's contribution was on the general role of NIS in development. The focus of this wave was to study institutional structure, and collective learning and path dependency mainly within OECD countries like; Korea, Taiwan, Singapore, Mexico and Argentina.

The second wave had literature contribution from Carlsson and Stankiewicz, Breschi and Malerba, Asheim and Isaksen, and Cooke. Carlsson and Stankiewicz's contribution was a further emphasis on the role of intermediary organization in the NIS while Breschi and Malerba's contributions was on the role of industrial organizations in the NIS. On the other hand, Asheim and Isaksen's contribution was on the benefits of advocacy, lobbying and knowledge transfer in the NIS while, Cooke's contributions were on knowledge exchange towards innovation in the NIS. The focus of this wave was on the importance of national dimension in innovation systems, and the shift towards technology, sectoral, and regional innovation systems in India, Brazil, China, Indonesia, and the Philippines. On the other hand, the study of the third wave had contributions from researchers such as; Pavitt and Patel, and Carlsson. Pavitt and Patel's contributions highlighted the increasing yet limited work on the role of industry associations in developing countries, while, Carlsson's contribution emphasized the importance of global knowledge flows and the market. The focus of the third wave was on growing emphasis on the internationalisation of innovation systems and the role of multinational companies (MNCs) and global knowledge flows and markets. The countries under study were India and South-Africa. So far, various studies have been carried out in studying the long run dynamics and historic changes of the NIS and these studies have mainly been qualitative and historic in nature (Bjorn et al., 2003). However, there is a paucity of information and study of NIS in Africa, as well as, how to integrate the system to the complex economic systems available in Africa. Hence this study presents itself as one of the earliest research into the subject matter.

In this study, we shall focus on studying the interaction between EDPs and NIS for

economic development. In-addition, we shall be using the NIS as a tool for enhancing development. This is because, the importance of NIS as a tool of development has been proven by previous research. For example, Feinson (2002) concludes that one of the many factors important for a country to succeed is a vibrant NIS. According to Intarakumnerd et al. (2002), the study of NIS in developing countries is still at its early stage. Compared to other continents of the world, Africa has been lagging behind in development and measures to aid its development. In-order to make Africa productive, build the capital of minds, and organise institutions for intellectual and research orientation development, a national innovation system will be needed (Muchie, 2006).

2. Catch-up Strategies in the Development Trajectory

Today, the development trajectories of many developed countries are different and has been on a case by case situation. However, there exist in each development path a clear indication of catch-up. According to Mathews (2006), the essence of catch-up strategies is to close the gap between advanced countries and backward countries. As such catching up is an essential process for poor and developing countries like Nigeria and other sub-Saharan countries to engage in an aggressive catching up process for effective development of their economies to the standard of developed countries. Stel et al. (2005), concludes that entrepreneurial activity is the key driver to push innovation and economic growth in a leapfrogging situation. These entrepreneurial activities are responsible for advancing technological capabilities of catching up countries. Drysdale and Huang (2007), in their research of some East Asian countries (Japan, Korea, Taiwan and Hong Kong) concludes that technical progress was the driving force to the exceptional catch-up of these countries.

Furthermore, Tidd et al. (2005), in their book "Managing Innovation" outlined two methods of propagating innovation (learning from the market and learning through alliance). Learning can be defined as a continuous interactive process that exist between two unique entities to cumulate in a change of behaviour, therefore countries, organizations, individuals etc. can actively learn from each other on a daily basis. They were able to show using empirical studies of various countries the two methods in practice.

Innovation capacity and technologies developed in-house are key to domestic firm's catching up with multinational corporations in China (Fan, 2006). The importance of innovation in catching up has been emphasized by these authors. For example, Malerba and Nelson (2011) while studying India and Brazil (pharmaceutical companies); Korea, China, and Brazil (automobile companies); Brazil, China, India, Israel, Ireland, and others (software companies); India and Korea (telecommunication equipment companies); Malaysia, China, Taiwan, and Korea (semiconductor companies); and Nigeria, Costa Rica, Brazil, and China (agricultural firms) posits that the process of catching-up involves continuous learning over a long period of time and the difference between economic sectors has an effect on its success or failure. Meanwhile, catching-up process may be hindered by various factors; one of which is uncertainty in the learning process (Lee, 2005).

Lee and Lim (2001), after their study of Korean industries found 3 unique trajectories for catching up, namely, the path following, stage skipping and path creation catch-up. The path following catch-up involves an imitation process whereby the catching up country follows the same path of the developed country without changing direction or focus. On the other hand, the stage skipping catch-up involves jumping of specific stages by the catching up countries in order to attain the same level of advancement with the developed country. Path creation catch-up involves countries thinking outside the box and creating new opportunities that have never been explored previous to advance development while following a newly developed pathway. Other authors have argued that the pathway to catching-up varies, and sometimes a latecomer's pathway of catching-up is in the reverse direction to the traditional path of development starting from the maturity stage and working itself backwards (Hobday, 2010). However, in this research, our aim is to study how the relationship between EDPs and NIS in Korea was able to facilitate the catching up process. Furthermore, based on the current situation of Nigeria and lessons learnt from the Korean experience, we shall develop, introduce and recommend a new theoretical framework called "Multiple skipping" as a blueprint for Nigeria's development trajectory.

III. Methodology

Because research relating to NIS is limited in Nigeria, getting information, literature and expert in this field is a major challenge. Based on this, we utilized two unique methods in obtaining data used in this study; these include, a systematic review of literatures and the use of a semi- structured interview. Also, because of the paucity in the number of available experts in this field (in Nigeria), we selected and interviewed one expert representing each of the primary players in the NIS (university, government, and industry). While research on NIS in Korea is in its advanced stage and many literatures abound, we carried out a systematic review of literature review and still did a few interviews (one interviewee for each NIS player) to balance results obtained from our literature review. The interviews were semi-structured and key guidelines were used to determine the direction of the conversations. The interview method ranged from one-on-one interviews, to Skype interviews. The interview lasted between 30mins to 2hours depending on the situation and time schedule of our interviewee. Before the interviews, we sent out a semi-structured questionnaire to help interviewees understand the range of questions to be asked and to understand the scope of the research. During

〈Table 1〉 List of interviewees

Country	Institutional Affiliation at the time of the interview	Job Role	Representative	Date of Interview
Nigeria	Abuja Technology Village	Incubation Manager (Abuja Technology Village Science Park)	Industry	2018/05/10
	Ministry of Science and Technology	Director (Ministry of Science and Technology)	Government	2018/05/15
	Covenant University	Lecturer	University	2018/05/09
Korea	Science and Technology Knowledge research Institute, Chungnam National University Daejeon Korea.	Principal Researcher	Industry	2018/05/14
	Chungnam National University	Professor of Economics and International Trade	Government	2018/05/11
	Changwon National University	Professor of Advanced Industry Fusion	University	2018/08/30

the interview notes were taken to record key information communicated (See Table 1 for more information).

IV. The Korean National Innovation System

1. Brief History of South Korea

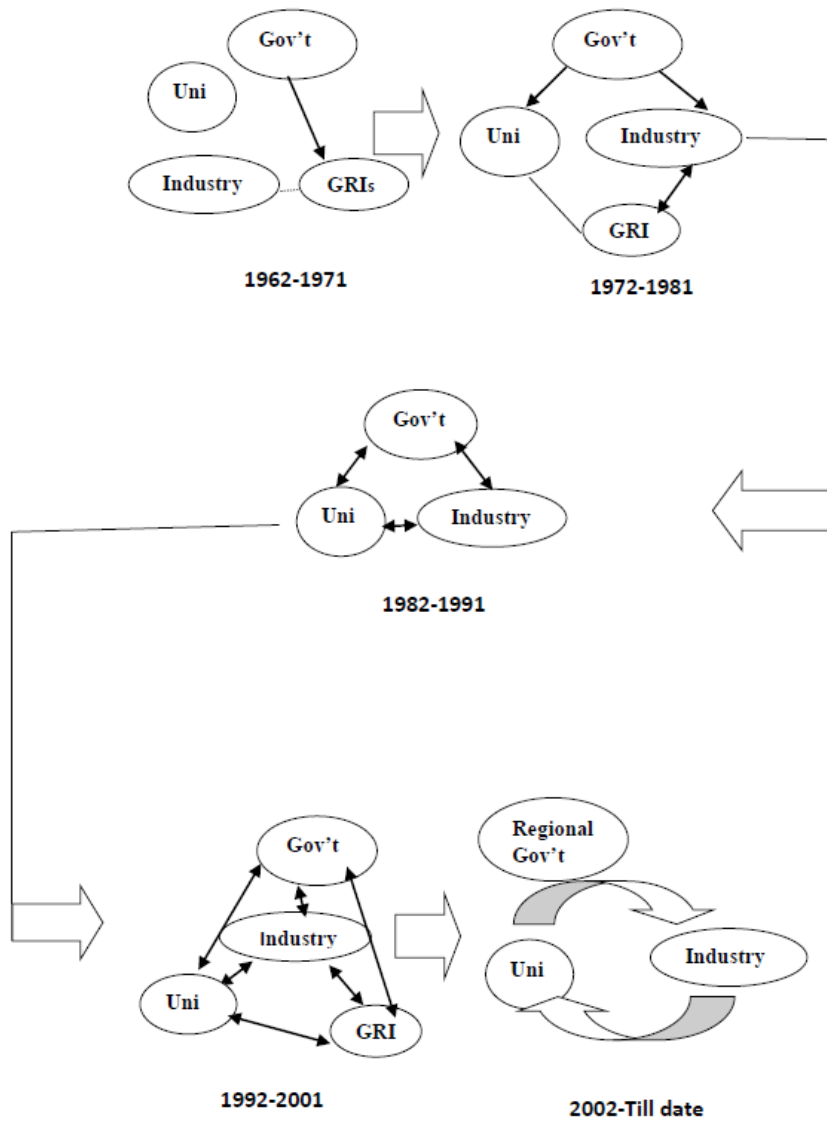
In this study, we will divide the history of Korea into four groups. The first group is the pre-colonial era. In this era, the Korean peninsula was government by various dynasties. The most notable of them is the Choson Dynasty, which ruled between 1392 and 1910 (Wilson, 2002). Then we have the colonial era, when the Korean peninsula was occupied by Japan in 1905. This period lasted for 35years (1910-1945) before Japan was defeated at the end of the Second World War (Miller, 2018). The third group was the post-colonial era. After liberation from the Japanese, internal scuffle within the Korea peninsula lead to the Korean War. The Korean peninsula was un-officially divided into north and south, with the north been in favour of communism and the south in favour of democracy. The Korean War (1950-1953) started when the North Korean army invaded the south and lasted for three years (Hickey, 2011). At the end of the Korean War, the Korean peninsula was officially divided into North Korea and South Korea with each having its own independence. This marked the current day era in which two countries North and South Korea exist within the Korean peninsula (the post-independence era). In this paper, our concentration is on South Korea, however, the terminology Korea and South Korea will be used interchangeably to mean the same thing (South Korea).

2. Success story of South Korea

We shall present our results from our literature review and then present the results of our expert review afterwards. First, from our literature review, we discovered that; South Korea's development trajectory has been outstanding based on the number of years it took to make the transition from a developing country to a developed country.

In this study, the word trajectory, used herein means the part way to development or economic progress. According to Mazzarol (2012), Korea has one of the most successful economies in the world. In 1960, the South Korean economy was at a rate less than that of an average sub-Saharan country today. Put simple, the Korean economy was worse than that of our current day Sub-Saharan country riddled with poverty. Korea's rapid development is a man-made miracle (Kim, 1991). The major factor responsible for this progress is the Korean policy evolution that enhanced foreign direct investment, over 30years (Sachwald, 2001). In the late 19th century, while the industrial revolution had taken shape in Europe, parts of America and the rest of the world, Korea was yet to start its race. Korea was a late comer to industrialization and was referred to as a late industrialized country (Amsden, 1992). However, it was able to quickly catch-up and become a developed country in some few decades. Amongst many reasons, one of the reasons for our choice of Korea (in this study) is its development trajectory path and the short time it took to make the transition from a developing to a developed country. This success was recorded through the concerted effort of government. One reason for this unprecedented catch-up was the strategic EDP of the Korean government that re-enforced and fortified its NIS and educational systems which led to technological innovation. Two important factors responsible for the success of the Korean NIS in the 20th century, were the educational system and the effective EDPs of the government (Lim, 2006). It is important to note that the efficiency of the Korean NIS was driven by its learning process which it used to drive innovation for economic growth. First, the Korean government and firms bought foreign technology, then assimilated them, went further to master the skills required to develop them, and started to assemble parts gradually, until they could assemble full systems.

But, how was the government able to use EDPs to enhance the NIS in Korea? The Korean government identified education as a primary tool for internal innovation and economic development, hence the government developed EDPs that fostered the promotion of quality education. Each EDP developed by the Korean government had elements promoting education like the development of research institutions and science and technology universities (See Table 2 for more details). Later, they enacted effective policies in the field of education. Kim (2001), concludes, that in just about 30years, Korea has



Note: Redraw and Revised from Shin et al. (2012)

(Figure 1) Evolution of the Structure of the Korean National Innovation System

been able to achieve an excellent record in primary and secondary education of its citizens. One of such policies recommended that people should be regarded as equals regardless of gender, religion, geographic location, or socioeconomic status (Kim, 2001). Furthermore, using EDPs the government focused on funding R&D and the development of the government research institute to promote research. The Korean government's

investment in R&D over the years was an important factor to its international competitiveness, which resulted in its economic growth. Cho et al. (2011), in their research findings concluded that R&D investments have a strong correlation (positive) relationship with firm performance (productivity, profits, growth rates, number of patent applications, and market value) of firms. The impact of the targets of the EDPs led to the strong relationship between the three major players in the NIS; Government, University, and Industry (GUI) to advance the innovativeness of Korea.

At the end of the Korean War in 1956, the Korean economy was in shambles and poverty ravaged its citizens. The five year EDP of government had an underlining aim, which was to build science and technological innovation of Korea. Unlike, developed countries, Korea's technology trajectory took a reverse direction of development in its initial stage (Choi, 2007). The earliest EDP was the 1962 government five year EDP, that basically focused on R&D in labour intensive export industries like textiles, clothing, and footwear and the founding of the Korea Institute of Science and Technology (KIST) and the Korea Advanced Institute of Science (KAIS) (Mazzarol, 2012). Further down the line between 1972 and 1976, the government's economic plans focused on R&D in heavy industries such as petrochemicals, shipbuilding, automotive manufacturing and consumer electronics. Success stories that emerged from this plan were large conglomerates called Chaebols. Between 1977 and 1981, the government rewrote its EDP to encourage R&D in high technology industries. Consequently, between 1982 and 1986, this plan had transitioned into a knowledge based industry (Mazzarol, 2012). The change in EDPs not only promoted synergy amongst the major players, it also changed the way they communicated and interacted (See Figure 1, for more information). By 1992, after the introduction of a regional governing system in Korean, the government started to embrace the concept of Regional Innovation Systems (RIS) like the rest of the developed world (Chung, 2002). RIS are collaboration of economic, social, political and institutional organizations working together collectively to aid collective learning within a defined technological or functional area for quick diffusion of skill, knowledge and best practice within a geographical area. In-order to drive Korean competitiveness, technology and innovation, various regional the government has developed regional innovation systems (See Table 2 for more information).

〈Table 2〉 Historic summary of the Korea EDP

Period /Factor	Main Focus	EDP Aims	Major Pathway dependency	Problems Encountered	Innovation Model	Learning Process
1962-1971	Manufacturing and construction industries	To drive economic growth through intensive export industries like textiles, clothing, and footwear and to establish research complex for Government Research Institutes (GRIs) and the establishment of the Korea Advanced Institute of Science (KAIS), Korea Institute of Science and Technology (KIST) plus the Ministry of Science and Technology.	Developed countries.	The reluctance of Foreign to share their technologies	Technology imitation and Turnkey model	Learning through foreign licensing, technical training, adaptation and absorption,
1972-1981	Manufacturing and construction industries, tourism, banking, software industries	To promote the development and capacity of six heavy industries, namely, steel, electronics, chemical, shipbuilding, and nonferrous metal and the development of the first science part in Korea (Daeduk Science Town). In-addition, to promote high technology industries and boost open market.	Local innovation, developed countries and national innovation through GRIs.	Low international competitiveness and slow economic development.	Technology catch-up and initiation of Knowledge based model	Learning by doing and using. More-so, Open innovation (knowledge circulation, technology diffusion, technology usage and learning from the market.)
1982-1991	Tourism, banking, software industries	To promote law and order in the economy through free, open competition, to improve income distribution through national R&D programs by funding GRIs and to promote the implementation and development of core strategic technology.	National innovation through GRIs	Stiff competition from technology and innovation giants all across the world.	Knowledge based	Open innovation (knowledge circulation, technology diffusion, technology usage and learning from the market.)
1992-2001	Tourism, banking, software industries	To promote the development of industrial technology by implementing technology projects.	National development	Stiff competition from technology and innovation giants all across the world.	Knowledge based	Open innovation (knowledge circulation, technology diffusion, technology usage and learning from the market.)
2002-till date	Tourism, banking, software industries	To improve the global competitiveness of Korean companies, develop regional clusters, drive social equity and balanced development, promote internationalization, technology start-ups and unification of Korea	National innovation	Cheap labour from China and other countries, made cheap products available and hindered sales of more expensive Korean products	Creative economy	Open innovation (knowledge circulation, technology diffusion, technology usage and learning from the market.)

Second, the result of our interview support results obtained from our literature review. All our experts identified the role of the Korean government EDPs in developing its NIS and its impact of development. They particularly emphasized the importance of setting the right targets because, if priorities are misplaced effective results cannot be

expected or achieved. Our Korean expert within the university sector stressed the importance of the government EDPs in building the educational sector in Korea and thus enhancing the exchange of knowledge and the transfer of information amongst the players within the NIS while, our expert that represents private institutions underlined the importance of R&D funding from government on driving innovation in the NIS. Finally, our expert representing the government underscores the importance of formulation, implementation and evaluation of EDPs as a learning process to improve policy making and development (See Table 3 for more information).

〈Table 3〉 Summary of interview results with Korean experts

Country	Institutional Affiliation at the time of the interview	Job Role	Representative	Date of Interview	Summary of interview Result
Korea	Science and Technology Knowledge research Institute, Chungnam National University Daejeon Korea,	Principal Researcher	Industry	2018/05/14	The NIS in Korea for many decades has been effective because of the EDPs of various governments. However, in recent times the efficiency has wavered due to the change in targets of the EDPs (i.e. the area of knowledge specialization within the NIS). Hence, the current situation in Korea signifies the importance of getting the EDP targets right of fostering development.
	Chungnam National University	Professor of Economics and International Trade	Government	2018/05/11	Economic development plans and NIS are related in terms of driving economic growth. While this is true, the rate at which development is achieved varies on the implementation of the EDPs and the whether the targets of EDPs create an enabling environment for development. In the Korean case this was true, hence it was able to make a quick economic growth.
	Changwon National University	Professor of Advanced Industry Fusion	University	2018/08/30	The five-year government plan that spanned many decades was essential to the coordination of the Korean NIS and its rapid growth. The EDPs were essential in facilitation Foreign Direct Investment and Official Development Assistant (ODA) into Korea and building the system of education. This enhancement made Korea become a developed country that no longer receives bail out from other countries, but is now a giver of ODAs.

V. The Nigerian National Innovation System

We shall present our results from our literature review and then present the results of our expert review afterwards. Firstly, from our literature review, we found out that; Nigeria has a population of over 180 million people. According to the International Monetary Fund (2016), Nigeria has the largest economy in Africa. Nigeria got its independence from the United Kingdom in 1960 and became a sovereign nation. In this research, we will be dividing the economic structure of Nigeria into five distinct parts, based on the factors such as a change in government and their EDPs. The first part is the economic structure of the country between 1962 and 1971. At this point, the structure of the economy, was basically primary and focused mainly in agriculture, fishing and mining of natural resources, however, these set goals were unachieved as a result of the Nigerian civil war (1967-1970) followed by two coups both in 1966. The second period was between 1972 and 1981. At this time the economic development plan of government focused on reconstruction of public infrastructure damaged by the war and fostering development in the agricultural sector. Unfortunately, capitalism and military coups, worsened the disparity between the rich and the poor and the goals were not achieved. Hence the gains of this era were in the hands of less than 1% of the population, thereby subjecting majority of the population in poverty. The third period was from 1982 to 1991. The economic goal of the government was to promote international trade. Achieving the target was hindered by the inefficiency in the public sector, corruption, and military coups. The fourth period was between 1992 and 2001. The economic development of government at that time mainly targeted reforming Nigeria and to advance development by 2010. Growth was impaired by the paucity of effective policies to transform the economic plans into reality, corruption, military coups and siphoning of funds (large scale) meant for projects. The fifth period started in 2002 and is still in existence. The aim of EDPs of government is to make Nigeria a developed country (See Table 4 for more details).

〈Table 4〉 Historic summary of the Nigerian EDP

Period/ Factor	Economic structure	EDP Aims	Major pathway dependency	Problems encountered	Proposed Innovation model	Actual Innovation Model	Learning process
1962- 1971	Primary	To attain and maintain the highest possible rate of increase in the standard of living of the populace	Developed countries	The Nigerian civil war (1967-1970) and the 1 st and 2 nd military and coups both in 1966.	Technology imitation	Technology imitation	Learning by imitation
1972- 1981	Secondary (Crude oil exploration and light industry)	The aims include; reconstruction of public structures and facilities damaged by the war; rehabilitation and resettlement of war refugees and armed; creation of an efficient public administration system; improve per capita income to the level before 1985; job creation; improve manpower; and improve social services. More-so, to promote advanced research in agriculture for export and local industry; advancement in livestock breeding and husbandry; improve efficiency of the Nigerian Agricultural and Cooperative Bank (NACB); rural electrification; and the provision of housing and other public amenities.	Developed countries	Capitalism, low funding from the public sector, and the 4 th and 5 th military coups (1975 and 1976).	Technology imitation and the introduction of the Knowledge based model	Technology imitation and partial Knowledge based	Learning by imitation
1982- 1991	Secondary (Crude oil exploration and small and medium scale industry)	To promote of export; improve local production through the development of small and medium scale industries; improve the productivity of government owned enterprises and gaining technological skills. Also, to diversify the economy and reduce dependency on oil; to begin the process of sustainable development; and improve efficiency of government investment and improving public private partnerships.	Developed countries and local innovation	Inefficiency in the public sector and corruption and the 6 th , 7 th , 8 th , 9 th military coups (1983, 1985 (August and December), and 1990).	Knowledge based	Technology imitation and partial Knowledge based	Learning by imitation and learning from Alliance.
1992- 2001	Secondary (Crude oil exploration and small and medium scale industry)	Reforming Nigeria by 2010 into a united, productive, nice and God-fearing democratic society, dedicated to making the basic necessities of life affordable for everyone, and creating Africa's leading economy. Also, to create wealth, employment, poverty reduction and re-orientating individual values.	Developed countries and local innovation	Lack of effective policies to transform the economic plans into reality and large scale corruption and siphoning of funds meant for projects. Also, the 10 th Military coup (1993).	Knowledge based	Technology imitation and partial Knowledge based	Learning by imitation and learning from the market.
2002- till date	Secondary (Crude oil exploration and small and medium scale industry)	To put Nigeria's economy amongst the first 20 economies of the world and will be a developed country like: Canada, Austria, Belgium, France, Greece, Italy, Netherlands, Spain, Denmark, Norway, Poland, Russia, Sweden, Switzerland, Turkey, Australia, India, Indonesia, Malaysia and Brazil. Furthermore, to Stabilize the macroeconomic environment; realize agriculture and food security; guarantee energy sufficiency; Increase transportation infrastructure and; promote industrialization focusing on SMEs	Developed countries and local innovation	No proper outlined policy. Corruption and vague objectives are limiting factors to achieving this goal.	Knowledge based	Technology imitation and partial Knowledge based	Learning by imitation and learning from Alliance.

Secondly, the results of our expert interview (See Table 5 for more information) identified that the NIS in Nigeria has communication, knowledge and innovation sharing issues because of the lack of synergy within the key players in the system. Furthermore, it was identified that government EDPs need to be tailored to address specific issues in which the government wishes to concentrate on for economic growth to occur. Also, funding in R&D and education is a necessary target of the EDP of government if Nigeria's economy must make a leap forward from that of a developing country to a developed country. In summary, the three major players (University, Government and Industry) in the Nigerian NIS are yet to effectively manage the knowledge sharing process, as well as innovativeness. The Nigerian government's EDPs are largely vague as such are difficult to achieve and targets are almost impossible to set or even identify. While creativity is present in the Nigerian NIS, government funding of R&D is inadequate. Furthermore, innovative ideas largely end up not been commercialised because of the weak synergy between the players in the Nigerian NIS. A notable example is the

〈Table 5〉 Summary of interview results with Nigerian experts

Country	Institutional Affiliation at the time of the interview	Job Role	Representative	Date of Interview	Summary of Interview Result
Nigeria	Abuja Technology Village	Incubation Manager (enspire Incubator)	Industry	2018/05/10	Economic development plans are essential for the strengthening of the NIS to avoid system failures and promote economic growth. Nigeria's innovation ecosystem is yet to develop to the standard capable of attaining rapid development. However, with the effective development of EDPs, policy development and implementation, the NIS in Nigeria will become more efficient. This is because there is abundance of innovative ideas within the Nigerian ecosystem
	Ministry of Science and Technology	Director (Ministry of Science and Technology)	Government	2018/05/15	The NIS is important for development and economic growth. While the present government in Nigeria has taken the issue of inefficiency in the NIS seriously and is committed to making the much needed improvement, more is needed with regards to development and implementation of appropriate EDPs to facilitate this. Our EDPs need to be more specific and target oriented.
	Covenant University	Lecturer	University	2018/05/09	In the Nigeria NIS, the link that requires the most attention by government is the university government link. Government needs to increase its funding of R&D and education quality as a whole to drive development. The current allocation to education in the Nigerian budget is not sufficient to drive knowledge growth and innovation. Our EDPs must focus on education and R&D to make our NIS more efficient.

invention of a drone by an undergraduate student of the Ladoko Akintola University of Technology (LAUTECH) in 2016. This innovation is yet to get external funding from government or private sector and is likely not to see the light of day. Our “Multiple skipping” framework synergies and summarises our finding from the Korean experience for development in Nigeria.

VI. Revised Development Trajectory for Nigeria

1. Problems Identified in the Nigerian NIS and Lessons to Learn from the Korean Case

Based on our review of literature and interview of our experts within Korea and Nigeria. The following deductions were made: firstly, EDPs are important in enhancing NIS for economic growth. In Nigeria policy implementation, selection of policy tool, lack of continuity in government, vague goals in EDPs, and constrained R&D funding (government) are key factors relating to the failure of EDPs while, in Korea, the success of EDPs were achieved by judicious implementation, selection of proper policy tools to deliver the set targets, clear EDP goals, good governance and continuity in government. Secondly, while the NIS has been tested as a tool to foster development in Korea, in Nigeria there is limited evidence that NIS has a role in the economic development of the country. Thirdly, in Nigeria, poor communication and narrow learning opportunities amongst the components of the NIS was one of the key factors relating to the poor performance of the Nigerian economy. Meanwhile in Korea, good communication, transfer of knowledge and learning opportunities that abound amongst key components were identified as success factors of the Korean NIS.

Conclusively, while the Korean NIS has a framework that enhances communication amongst the various stakeholders and players involved, the Nigeria NIS is still in its infancy. The role of the Korean government EDPs in enhancing the Korean NIS cannot be over-emphasized. EDPs have been judiciously implemented by the Korean government over time, regardless of change in government, and they have been specific in their

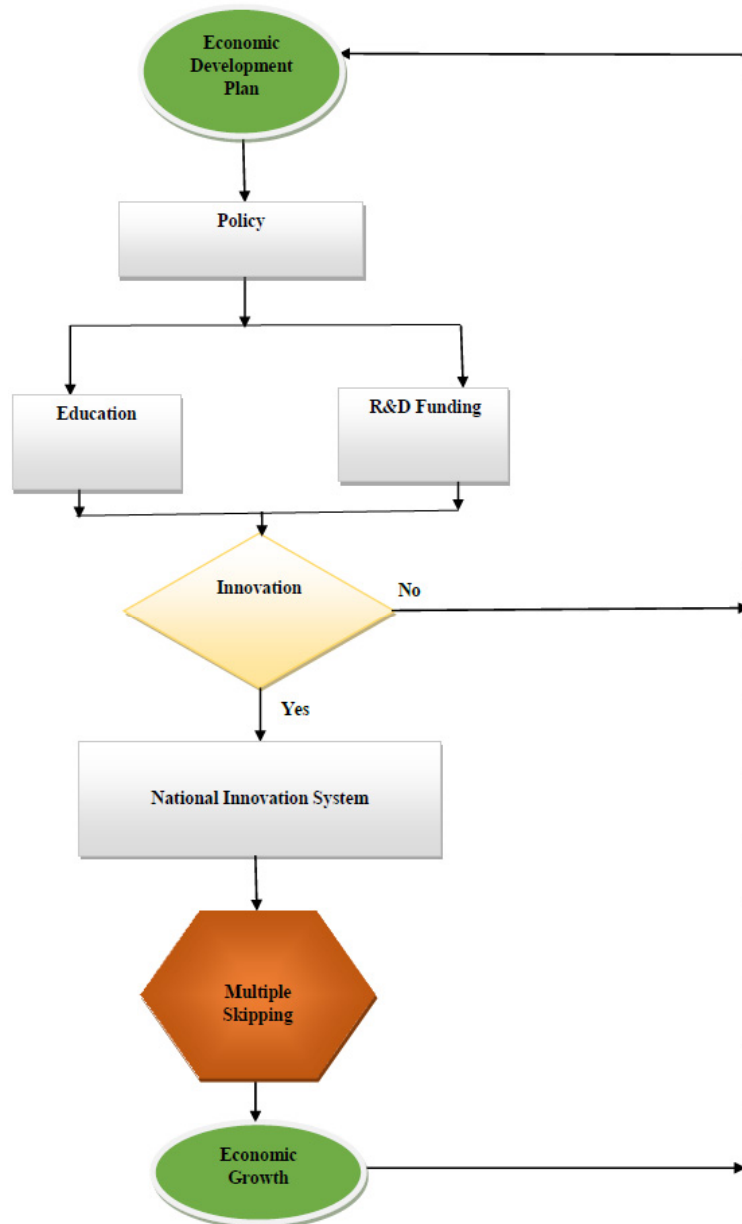
goals and target thereby making them impactful in driving economic development. On the other hand, the Nigerian government EDPs have been vague in their goals and target plus change in government usually means a discontinuity in previous EDPs set by previous governments, thereby restraining the role EDPs plays in enhancing the NIS in Nigeria.

2. Multiple Skipping and Enhancement of Nigeria's NIS for Economic Development

In order for developing countries and most especially Nigeria to grow (economically) and improve the quality of life of its people, significant progress must be made within a short time. By this we mean that development must be achieved at a tremendous speed, and requires that stages are jumped to achieve this using the theoretical framework we refer to this as “Multiple skipping”. “Multiple skipping” in this context means a geometric skipping of many concurrent and sequential stages in the development trajectory. Shin et al. (2012) concludes that the government's role is one of the most important tools in the drive to build national capacity in various sectors of the economy. For this reason, in this research, our theoretical framework for our “Multiple skipping” model starts with the development and implementation of the EDP by the government. This is followed by appropriate implementation of policies to enhance the quality of education and R&D (in various sectors of the economy) and to enhance innovation through communication and knowledge sharing amongst the key players of the NIS for “Multiple skipping” and advance economic development within a reduced timeframe (See Figure 2 and 3 for more details).

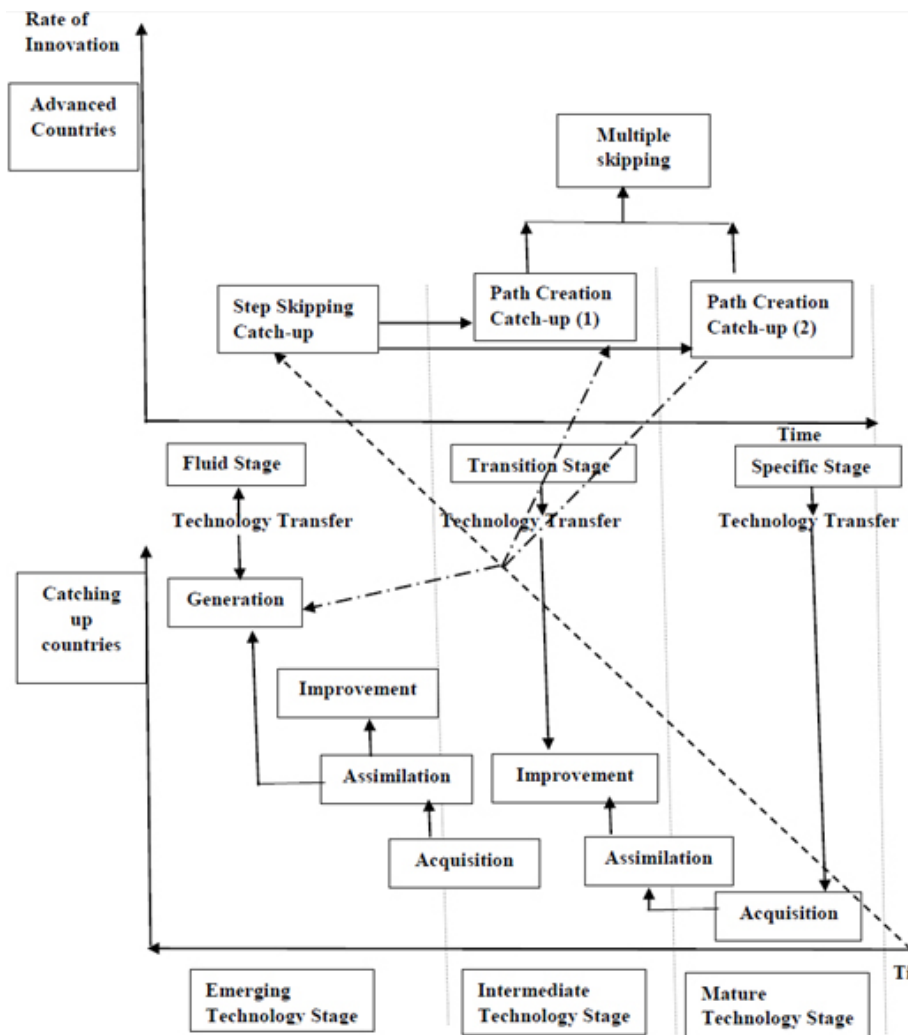
What are the steps required to implement this framework? The Nigerian government must develop a long term economic development plan with a clear target to enhance education and the government must invest massively in R&D in various sectors of the economy within 10years. Furthermore, each target must be backed up by appropriate policies to drive creativity in the economy. Wolf (1962) posits that the goals and the judicious implementation of the Korean government EDPs were essential to its rapid growth. If communication, knowledge transfer and sharing, and government investment

in R&D is enhanced, the NIS is bound to galvanize economic growth. According to Freeman (2002), the effective communication and interaction between the components of the NIS has been essential in their role to foster economic development over the



(Figure 2) "Multiple skipping" theoretical framework

last 20 years. Also, funding of R&D by the government and the industry is essential for economic growth (Berconitz and Feldmann, 2006). Powers (2004), concludes that to increase university productivity, funding must be increased by key players (federal R&D, industry R&D, state R&D, and R&D dollars from internal institution sources). In the United States, funding from government has proven to be essential to technical innovation that led to the various high profiting spin-off been rolled out from government funded



Note: This was redrawn and revised from Kim (1999)

(Figure 3) Pictorial representation of the “Multiple skipping” theoretical framework

institutions (Carayannis et al., 1998). Also, internationalization (cooperation across borders) of R&D between countries is important for the diffusion of innovation (Carlsson, 2006). Finally, a key area identified for improvement in the Nigerian NIS is the upgrade of educational policies to drive innovation for economic growth. According to Lundvall (2008), education, innovation and economic development are positively correlated. In India, the reform of the system of education has been instrumental to the fast pace of economic development in recent years (Dreze and Sen, 1999). Finally, building mental capital is essential for innovation in a national innovation system (Nelson and Rosenberg, 1993). This can be achieved by introducing technical and vocational training into the system of education.

While, there is a paucity of study showing the relationship between EDPs, NIS and economic development and a paucity of studies examining or proposing methods of improvement for NIS in Africa, this study presents itself as one of the first studies to bridge this gap. In this study, we have successfully shown that there is an important relationship between EDPs, NIS and economic development and we present the multiple skipping theoretical framework as a solution to the developmental problems plaguing the Nigerian economy and other African countries' economies.

VII. Conclusion

This research sets out to develop a theoretical framework for the development trajectory recommended for Nigeria based on the lessons learnt from the Korean experience. We started off with the aim of showing there exist a relationship between EDPs, NIS and economic development. Based on our findings (in the Korean case) EDPs were essential in the enhancement of the NIS system. The Korean government used the EDPs to strengthen its NIS. The dedication of government in implementing the outlined goals of the EDPs and continuity in governance was essential to the progress made in the communication of various stakeholders involved in the Korean NIS and ultimately led to economic growth. It is important to note that the EDPs of the Korean government were implemented through various policies that focused on different industries within

the Korean economy. Therefore, effective policy making and implementation is necessary for development. The EDPs and the efficiency of the Korean NIS were essential for the catch-up process of the Korean economy from a developing to a developed country. The results of this study suggest that there are vital policy implications, should the Nigerian government choose to implement our proposed model. The government must make long term EDPs like the ones obtained in Korea and then initiate policies that will strengthen the linkages between the university, government and industry, and subsequently develop effective legislation for them to be enforced. This will build the productivity of the NIS in the long run to activate the “Multiple skipping” development trajectory. Furthermore, a change of government should not affect the implementation of policies and continuity must be encouraged. These economic plans must promote education and the development of regional science and technology parks in various regions of the country and existing uncompleted national science and technology parks (Abuja Technology Village) must be completed as soon as possible.

In-addition, we discovered that there was a significant distance in communication and flow of knowledge between key players in the Nigeria NIS. The university and government link, and the converse relationship as well as the university and Industry link. However, the most important to us in this research is the University and Government relationship. For technology innovation to advance in Nigeria, the government must strength university research and development through effective funding and develop policies that grant universities significant autonomy. Also, policy measures to encourage medium-large firms to invest in R&D are urgently needed to alleviate R&D concentration problems at the firm level as well as at the industrial level. Providing incentives and environments for them to invest more in R&D activities will most effectively lead to a knowledge-based economy that will be balanced in both the industrial and firm level. Finally, in order to make the Nigerian economy a creative economy, the educational sector in the country must be restructured to enhance knowledge. Policy makers must make policies that drive at updating and upgrading the Nigerian educational system to the standards obtainable in advanced countries. Nigeria student’s education should equip them with both practical and functional knowledge to be innovators. As this research presents itself as one of the earliest research in NIS in Nigeria, more research is required to test and validate

the efficacy of this theoretical framework in developed countries in various parts of the world. Furthermore, more research is needed to propose areas and methods in which the NIS in Sub-Saharan Africa can be improved. A limitation of this study is the paucity in the number of literature concerning NIS in Nigeria. Hence, we recommended that more studies of NIS in Nigeria and Africa at large.

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Temitayo Shenkoya

나이지리아 마커디농업대학(University of Agriculture, Makurdi)에서 산업수학과 석사를 취득하고, 나이지리아 아부자 과학기술단지(the Abuja Technology Village Foundation) 본부장으로 근무하였으며, 현재 충남대학교 국가정책대학원 과학기술정책 박사과정 중이다. 주요 관심 분야는 국가혁신체제, 과학기술정책, 정책평가, 혁신이론 등이다.

김익석

미국 조지아공대(Georgia Institute of Technology)에서 “과학자 연구생산성 연구”로 과학기술정책 석사학위를 취득하였으며, 한국과학기술원(KAIST)에서 “기술융합의 동적패턴과 진보특성 연구”로 기술경영학 박사를 받았다. 현재 한국조폐공사에서 블록체인사업기획팀장 및 충남대학교 국가정책대학원 과학기술정책 시간강사로 있다. 주요 연구 분야는 혁신이론, 과학기술정책, 기술경영, 블록체인, 핀테크정책 등이다.