THE ROLE OF RESEARCH AND DEVELOPMENT IN THE DEVELOPMENT OF MILITARY HARDWARE: NIGERIAN AIR FORCE IN PERSPECTIVE

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ABSTRACT

The operational capability of the Nigerian Air Force (NAF) became hampered over the years due to budget constraints to induct and maintain its platforms. This made indigenous research and development (R&D) imperative to support NAF operations. The study sought to highlight the factors that were determinants of effective R&D activities in Nigeria. The research methodology was qualitative and the method adopted an ex post facto design using content analysis to review secondary data. The theoretical framework was anchored on the realist theory. The study found that cultural paradigm, education policy, leadership, acquisition policy and reverse engineering programme were germane to effective R&D for the indigenous development of military hardware to support NAF operations in Nigeria. The recommended policy actions for the NAF included pursuing deliberate policy on the training of specialists in reverse engineering as well as establishing a reverse engineering workshop.

INTRODUCTION

Research and Development (R&D) involves scientific exploration targeted at discovering knowledge and developing new technologies, products and systems or improving the performance and effectiveness of existing equipment or systems. It also constitutes a crucial ingredient in the search and development of diverse military technologies. Diligent R&D into military weapons systems, equipment and platforms would eventually lead to self-reliance in the production

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and maintenance of such weapons systems and platforms. It would ensure that appropriate spares and components are readily available for ease of equipment maintenance and operations. In addition, it would ensure that such military weapons systems and platforms conform with the required specifications to enhance their operational effectiveness both in peace or war times.

The design and production of military equipment by a nation confer upon its armed forces a technological advantage over its adversaries. Historical experiences gained from the major wars of the 20th Century have shown that military technological superiority is a strong factor for success in any armed conflict. The USA first demonstrated this during WW11 when it dropped the atomic bombs on Nagasaki and Hiroshima in retaliation for the Japanese attack on Pearl Harbour and that ended the war (Betts, 1982). The USA and the Coalition Forces were to reaffirm this during the Gulf War through the use of modern military technology to decisively defeat the Iraqi forces (Jentleson, 1994; Khadduri, 1997).

Nations strive to enhance the capabilities, capacity, effectiveness and efficiencies of their armed forces by developing domestic industrial capacity for the production of their military technology (Oshanupin, 2002). While developed countries produce most of their defence requirements, developing countries are faced with either importing their defence needs or striving to develop their own domestic industries to satisfy their military recruitments.

Yezid (1992) postulated two motives for indigenous defence production in developing countries. Firstly, is the need for national security and secondly the economic benefits derivable therefrom. Nigeria has sought to produce her military equipment locally, and this informed the establishment of the Defence Industries Corporation of Nigeria (DICON) in 1964. It was envisaged that DICON would improve the state of inventory in military hardware. It was also to conserve and earn foreign exchange for Nigeria. Several years later, DICON has not been able to meet its targets as it has not gone beyond the production of small arms and ammunition with heavy dependence on foreign partners for many requirements (Ojomo, 2000). Therefore, DICON has

fallen short in meeting the needs of the Armed Forces of Nigeria (AFN) compared to what similar establishments in China, Republic of South Africa (RSA) and Brazil have been able to do within similar periods. These countries have been able to meet a greater percentage of their military equipment holding through local production (Maldifassi and Abetti, 1994). This was because R&D, in these countries, assumed a pivotal role based on the knowledge that out of research comes technology, data, information, and hardware. R&D in Nigeria has been deficient essentially due to an underdeveloped capacity in the areas of science, technology and manpower (Obande, 2007).

Contemporary realities have made strategists acknowledge the fact that the security of nations has gone beyond mere possession of military might but now includes sustained economic development and diplomacy. This notwithstanding, the military still occupies a prime place in the security architecture of nations. Countries, therefore, strive for effectiveness in the application of their military capabilities when the need arises. Consequently, nations have continued to develop their Military Industrial Complexes (MICs) through innovations mostly driven by R&D to support their armed forces. The world has seen war arsenals transformed from simple weapons like spears, bows and arrows to precision weapons such as guided missiles, submarines and torpedoes amongst others which enhances military effectiveness.

Effectively, R&D entails the totality of man's investigative activities aimed at developing new products or processes or improving on existing ones for enhanced military power and national security. It comprises the creative work undertaken on a systematic basis in order to increase the stock of knowledge, and to use the knowledge to devise new applications and processes. The application of R&D outcomes has become imperative, especially in the face of declining defence budgets and the prohibitive costs of arms acquisitions among other factors. These have encouraged countries to invest in R&D in order to develop their military hardware and become self-reliant, especially in the face of the possible arms embargo by arms-producing nations.

The operational capability of the NAF was threatened in the late 1970s by the low serviceability of her platforms, caused by paucity of

funds among other factors. Looking inwards, the NAF resorted to R&D as a means of enhancing its operations. The NAF Directorate of R&D was therefore established in 1978 and R&D cells were created at the Command level to build technical capacity and reduce NAF dependence on foreign partners. Although the NAF recorded some R&D successes, not much was achieved due to the absence of proper coordination between the Directorate and the R&D cells.

Consequently, in 2003 the NAF R&D Centre was established by Establishment Order 2/2003. Since then, the NAF has recorded modest achievements in its R&D efforts which have in turn reasonably enhanced its operational capability. The efforts included the design and manufacture of a portable Ground Power Unit (GPU), the design and construction of Unmanned Aerial Vehicles (UAVs) –AMEBO 1, 2 and 3, and the GULMA UAV, as well as Improvised Explosive Device (IED) Robot bomb Extractor amongst others. The positive results notwithstanding, there are still outstanding problems to be addressed to optimise R&D for enhanced operational capability and effectiveness of NAF operations.

The operational capability of the Nigerian Air Force (NAF) became hampered over the years due to budget constraints to induct and maintain its platforms. This made indigenous research and development (R&D) imperative to support NAF operations. The objective of this study is to highlight the enablers or determinants of effective R&D in Nigeria and the NAF in particular. This study is covered in the following segments: Section One introduces the subject matter as given in the preceding paragraphs. The conceptual clarification of terms is in Section Two. The review of literature, theoretical framework and methodology for the study are given in Sections Three, Four and Five respectively. The R&D enablers or determinants are stated in Section Six. The policy implications and conclusion are stated in Sections Seven and Eight of the study respectively.

CONCEPTUAL CLARIFICATION

Research and Development (R&D)

R&D is "a deliberate and practical means of acquiring knowledge and the application of the knowledge for the production of goods and services" (Adiele, 2006:591). Adeniyi (2007) conceptualised R&D as the systematic utilization of the knowledge or understanding gained from research towards the production of useful materials, devices, systems, or methods including the design and development of prototypes and processes. Adeniyi's concept acknowledges the fact that knowledge and understanding are acquired from research, and that the knowledge is utilised in the production of useful materials, devices, and systems, and for the design and development of prototypes.

According to the Republic of South Africa (RSA) Department of Defence (RSA, 2006), R&D implies all scientific and engineering efforts that precede the production phase of any new item. It involves operation research, basic research, applied research, experimental development, full-scale development, industrialization and prototype manufacture. In the defence industry, R&D involves the prototyping and full product development with the production and delivery of operationally deployable equipment to the military. It also involves the continuous development and upgrading of prototypes of new military systems without necessarily going into full-scale development or production unless there is a need for the replacement of equipment due to age or obsolescence, or for force expansion (RSA, 2006).

Lee cited in Williams, sees military R&D as all "studies, experimental and theoretical, carried out in support of the defence equipment programme and includes research and production, leading to drawings and other documentation required for production in fulfilment of a staff requirement or approval specification" (Williams, 2004:3). From the above it can be inferred that military R&D is the systematic investigation and study of materials and sources as to establish facts that will lead to:

a. Designing and inventing a new weapon system from the scratch.

b. Improving the efficiency of an already existing system in terms of increasing its range, payload, lethality, manoeuvrability, versatility, accuracy and other parameters.

c. Adapting an existing weapon system to suit the particular conditions of an environment other than that for which it was originally intended.

d. Adapting and applying to military use, what originally appeared to be a purely civil-use technology.

e. Evolving plans and strategies geared towards optimal management and utilization of the resources both human and material available to the military establishment, particularly in terms of reducing cost and eliminating waste.

Hardware

The Oxford Languages Online Dictionary defines hardware as "tools, machinery and other durable equipment" or "high-tech military hardware". Also, it is the "machines, wiring and other physical components of a computer or other electronic system". The Merriam-Webster Dictionary defines hardware as "major items of equipment or their components used for a particular purpose such as military equipment, electronic and electrical devices of a vehicle such as a spacecraft or an apparatus such as computer". However, the American Department of Defense (2002) defines hardware namely: the generic term dealing with physical items as distinguished from their capability or function such as equipment, tools, implements, instruments, devices, sets, fittings, trimmings, assemblies, subassemblies, components, and parts. The term is often used regarding the stage of development, as in the passage of a device or component from the design stage into the hardware stage as the finished object. Secondly, in data automation, the American Department of Defense views hardware as the physical equipment or devices forming a computer and peripheral components. It should be noted from the foregoing definitions that hardware connotes mainly physical components and does not include software. Nevertheless, in this paper, the term military hardware would denote

both physical components as well as the software required for its operations.

REVIEW OF LITERATURE

Chukwu (2014), in his empirical study, used descriptive and analytical methods to interrogate the conduct of R&D in the NAF. He noted that the Air Force Institute of Technology (AFIT) could not access funds for R&D at that time because the enabling Act that should recognize the institution as one that qualifies and can access national research grants and funds had not been signed into law. He recommended the partnership of the NAF with local/foreign private manufacturers for civil spin-offs and mass production of R&D products. Similarly, Edem (2020), using mixed methods adopted a descriptive research approach to establish the correlation between R&D and operational efficiency in the NAF. His study found a strong and direct relationship between R&D and operational efficiency in the NAF as well as the fact that R&D has made significant positive contributions in the areas of foreign exchange saving, availability of aircraft spares and technical capacity building in NAF operations. The extent of the significant positive contributions claimed by Edem (2020) is yet to be verified with statistics and concrete evidence of the aircraft spares. He, however, recommended the training of personnel in various fields of research to ensure the availability of appropriate competencies in R&D. Gaiya (2008) adopted the descriptive and analytical methods in his study of R&D in the Nigerian Army (NA). He recommended that the NA should collaborate with universities and research institutes to develop her R&D manpower in all areas of military R&D.

Arlinghaus cited in Ogunewu (2001) asserts that arms trade provides developing countries with great opportunities for military technology transfer. Firstly, the acquisition of weapons supposedly ensures the transfer of logistical, technical, managerial, and operational skills from the producers for the development and employment of the buyers. Secondly, modifications repairs and co-production could lead to growth in indigenous industrial capacity and infrastructural development in the buyer nation if there is an appreciable industrial

base. Besides, technology transfer is dependent on the terms of trade agreed upon between the producer and the buyer. The buyer would always like to have clauses in the purchase agreement that allows technology transfer but the seller never wants to give away such trade secrets to remain relevant and in business. Ultimately, there is in reality nothing such as technology transfer but theft of technology through R&D and reverse engineering.

According to Olulade (1989), the constraints to industrialization in Nigeria are: inadequate scientists, and technologists and the failure of small businesses to undertake R&D. Other constraints are the uncoordinated efforts between defence, research institutes and the private sector. He believes a strong synergy between civil and military industries and appropriate funding can produce new knowledge, techniques, structures, and manpower for R&D and technology production. Although, Olulade (1989) attempts to present a holistic approach to tackling the problems of military R&D, his assumptions about the existence of military industries and appropriate funding are unfounded. Brzoska (1996) examined the growing importance of civil R&D over military R&D and observed that some have viewed military R&D as a very important source for the development of new civilian technology, citing the technologies that came out of WW2, such as radar, the electronic computing and the game-theory amongst others. He, however, noted that civil R&D is attracting more attention in most countries and military R&D has had considerable spin-offs for civilian technology.

Lele, (2009) in a descriptive study surveyed how the world's militaries are transforming in terms of weapons and defence systems through the application of modern technology. The work analyzed China's military efforts on information technology and the collaboration between political and military leaders in the defence industry to boost R&D efforts in the development of ships, unmanned aerial vehicles, advanced communication equipment and systems-of-systems integration that will enable the military to function. Katz and Bohbot (2017) posit that industrial R&D could help a nation's rapid economic growth. Using Israel as a case study, they noted that one of

the most critical needs of a nation besides military support, is the economic expansion and this can be achieved if the nation encourages industrial R&D. Gouré (2018) observed that the military needs to always be ready for war by ensuring that they possess appropriate equipment with capabilities to match the adversary. He raised the need for the military to prepare for future wars by ensuring that the defence industry obtains the latest technologies and should be ready to adapt them for military use. However, the study dealt with the purchase of military equipment and left out how the military could use R&D to modernize their military equipment. On the other hand, Chin (2019), explained how innovative technology dynamics have changed the world. He noted that technological developments which are products of scientific research have changed the nature of war and that new forms of conflict will emerge in the future due to technological advancements.

The literature reviewed emphasized the positive contributions of R&D to the operations of the NAF as well as the constraining factors of funding, inadequate scientists and technological base to R&D in the country. The gap in the literature that this study intends to fill is to highlight that cultural paradigm, education policy, leadership and deliberate reverse engineering programme are key enablers or determinants to effective R&D in Nigeria and the NAF in particular.

THEORETICAL FRAMEWORK

This study adopts the realist theory as its theoretical framework. Realism was considered to be the main theory that was able to regenerate a new paradigm in international relations. It emerged as a reaction to idealism (Buse, 2011:12) being specific for the interwar period and developed after the Second World War. Realism peaked in the early years of the postwar period. The outbreak of World War II provoked strong criticism of the liberal idealist paradigm. According to Kegley Jr (2008), critics blamed the cause of the war on what they believed to be the so-called idealists' naïve legalistic and moralistic assumptions about the possibility of peace and progress through human aspiration. Also, they alleged that idealists were utopians who

neglected the harsh realities of power politics and humans' innate compulsion to put their personal welfare ahead of the welfare of others (Carr, 1939). The lessons the critics drew from the period between World Wars I and II led many to construct a revised set of perceptions and beliefs. Advocates of the new paradigm also known as realism or realpolitik (Kegley Jr, 2008:29) emerged to frame an intellectual movement whose message reads like the antithesis of idealism. Among the principal prophets were EH Carr (1939), George F Kennan (1951, 1954), Hans J Morgenthau (1948), Reinhold Neibuhr (1947), and Kenneth W Thompson (1960), G Schwarzenberger, M Wight, N Spykman, and later were noted; R Aron, H Bull, H Kissinger, RE Osgood, R Rosecrance, KN Waltz (1979), and John J Mearsheimer.

For realism, the state is the most important actor on the world stage because it answers to no higher political authority. The states are sovereign; they have supreme power over their territory and populace, and no other actor stands above them wielding the legitimacy and coercive capability to govern the global system (Kegley Jr and Blanton, 2011). Therefore, since there is no higher authority to which states can turn for protection and resolve conflicts, realists depict world politics as "a ceaseless, repetitive struggle for power where the strong dominate the weak and there is inherently a constant possibility of war" (Kegley and Blanton, 2011:32). Each state is responsible for its survival and suspicious of its neighbours' intentions. Hence, realism posits that prudent political leaders seek arms and allies to enhance national security. The international environment is anarchical which makes leaders to pue self-help, increase their military strength and align opportunistically with others to deter potential threats. The realist does not preclude cooperation of rival powers on common interest but argues that "leaders should never entrust the task of self-protection to international security organizations or international law, and should resist efforts to regulate international behaviour through global governance" (Kegley Jr and Blanton, 2011:32).

Critics argue that no matter how persuasive the realists' image of the essential properties of international politics has been, their policy recommendations suffered from a lack of precision in the way they used

such key terms as power and national interest. They contend that once the analysis moved beyond the assertion that national leaders should acquire the power to serve the national interest, important questions beg for answers. For example: What uses of power best served the national interest? Did arms furnish protection or provoke costly arms races? Did alliances enhance defences or encourage threatening counter-alliances? Therefore, from the perspective of realism's critics, seeking security by amassing power was self-defeating. The quest for absolute security by one state would be perceived as creating absolute insecurity for other members of the system, with the result that everyone would become locked in an upward spiral of countermeasures that jeopardized the security of all (Vasquez 1998 in Kegley Jr and Blanton, 2011).

The need for Nigeria to develop its capacity to guarantee its security through R&D and technological development of military hardware becomes even more compelling in the current security challenges. In other words, the immediate and remote context of security environments in Nigeria dictates the need for it to take full control of its technological requirements because relying on other nations for the supply of techno-military devices and equipment will mean entrusting its security in the hands of such suppliers. Withholding supply at critical times of need jeopardises its security permutations and equation. This is the main reason for the choice of the realist theory as the theoretical framework in this study. The political leaders of the country cannot afford to rely on favourable bilateral agreements to procure defence needs for the security of the nation to the detriment of indigenous production achievable through effective R&D. Therefore, the realist theory is very relevant to this study.

METHODOLOGY

The qualitative method of research is adopted in this study. The ex-post facto research design was adopted using a content analysis approach to make meaning of the data. Data was collected for this study from secondary sources. The sources include; journal articles, textbooks,

reliable web sources, conference or lecture papers, and policy documents.

ENABLERS OF RESEARCH & DEVELOPMENT

There are several factors that can enable the development of R&D aptitude in an organization or a nation. Some of these factors may include: cultural paradigm, education policy, industrial base and political will of the management or government, strategic leadership, co-production, license acquisition and reverse engineering.

Cultural Paradigm

A paradigm should be likened to a manufacturer's mould into which they pour the fluid substance to be shaped into a solid form. The moulds are shaped according to the object to be manufactured for example cups, plates and wheels. The shape of the mould determines the shape of the object produced. One mould produces many replicates. Likewise, cultural paradigms or moulds shape the peoples and nations into which they have been immersed. Just as one mould produces thousands of products, one cultural paradigm produces thousands of peoples and many nations. If the mould is good, the people are good; if bad, then so is the outcome. If the paradigms are faulty, the persons and nations moulded by the faulty paradigm will come out faulty; apple begets apple; we reap what we sow. This concept equally applies to the R&D culture because any culture that stimulates and promotes research would breed thousands of R&D researchers and those with cultural values that only consume R&D products cannot breed R&D researchers.

Yinka (NN104) cited in (Dii, 2022:122) argued that one of the ways to revamp the operations of the Defence Industries Corporation (DICON) should be to proscribe DICON as he maintains that:

> Any scientific idea that is disconnected from the culture of a people may not find a place to germinate there. That is what happened to DICON…For me DICON was a good idea but situated in a wrong environment without respect to the culture of the people…The government should completely divest from DICON, privatize it and maintain

> government control. The government should look for a smart man maybe from Nnewi who can buy DICON and pay the government of Nigeria and run it. DICON can just exist as a facilitator; it should not go into production and have factories and laboratories. It should rather go to universities and begin to lobby government funding to drive engineering development in these schools (Dii, 2022:122).

The view on culture and technology (Yinka NN104) raises an important dimension in the debate about the successful penetration of technology in the country. Would the prospects of DICON meeting its established goals have been any different if it were located in Nnewi or Umuahia? Are the other government agencies dealing with science and technology located in the Eastern part of the country such as the Projects Development Institute (PRODA) the and National Agency for Science and Engineering Infrastructure (NASENI) doing any better in their established roles than DICON? These are some issues that need to be studied in-depth before agreeing with Yinka (NN104) that what may have happened to DICON is that any scientific idea that is disconnected from the culture of a people may not find a place to germinate there. The preponderance of opinions favoured a review of the DICON Constitutive Act to permit private sector participation in defence production in the country. Others include a review or overhaul of DICON management board, consistency in partnership agreements, the political will to enforce patronage of DICON products and the deftness to understand and play global politics on defence productions well if DICON's fortunes would turn around. As it stands, the evidence on ground in Nigeria tends to support the notion that culture has much to do with the penetration of technology and domestication of R&D for the production of military hardware.

Education Policy and Research Structure

The education policy of a nation is a key enabler of R&D as it forms the bedrock of knowledge acquired by the citizens of the state. For

education to produce the needed breakthrough in R&D as it relates to the manufacture of military hardware, there has to be a real collaboration between the defence sector education, the academia and the industrial sector of the state. The position advanced by Gaiya (2008) in the literature for the NA to collaborate with universities and research institutes to build R&D manpower capacity supports this enabler. Furthermore, it is also aptly stated in O'Hanlon (2009) that the American Department of Defense collaborates with educational institutions to further research exploits by stating:

. To anticipate future breakthroughs, and help decide which technologies are worth pursuing, the Department of Defense has numerous expert scientific advisory groups and consultants … ranging from the notorious JASON group and the Defense Science Board, to the main weapons laboratories run by DoD (like Lincoln laboratories at MIT) and the military Services as well as the Department of Energy, to many individual scientists or groups of scientists working either for the Defense industry or for universities (O'Hanlon 2009:170).

The defunct Republic of Biafra achieved a commendable feat with regard to the indigenous development of technology to support their war efforts during the Nigerian Civil War. What is termed the Biafran Model in this paper is the organizational setup that integrates scientific expertise alongside economic development activities to produce weaponry and manufacturers for the armed forces as well as other products for the civilian populace. Inarguably, credit is given to the Biafran scientists referred to as the Research and Production (RAP) unit who organized themselves to produce weapons and equipment under very arduous circumstances. Many chose to refer to their achievements as a child of necessity. According to one of the veterans, who was an active participant and a scientist in Biafra, Arene (ND), identifying and assembling a corps of scientists, academia, mathematicians, engineers, technologists, biologists, agriculturist, microbiologists and physicists was the first step by the defunct Republic

of Biafra in setting up a war-fighting machine. The group was assembled and named 'Biafra Scientists' under a military coordinator, to the late Major Ifeajuna, who himself was a scientist. At an inaugural meeting, the scientists were told "we know you; we have looked at your curriculum vitae. None of you academia has made an explosive or rocket before, but you all have the theoretical knowledge. The time has come to put your theory into practice" (Arene, ND:18). In response, Arene was said to have cautioned that "…I must warn right away that a lot of experimentation has to be done before we embark on any large scale production of various hazardous chemicals. If we don't do this, we may find that while the Nigerian Army is killing off our soldiers at the battlefront, we shall be killing off our civilians in the hinterland, where our factories will be set up". Thus, the order was given by the defunct Biafra Head of State for the scientists to commandeer all the resources within their area of control to conduct research to get solid rocket fuels or starters for rocket fuels before the war actually commenced.

The scientists then needed a military-industrial complex which they improvised by converting the Ministry of Commerce laboratory into a war chemical laboratory; converting the Nigerian Railway Corporation workshop and the Nigerian Coal Corporation workshop into war engineering workshops; and commandeering secondary schools' laboratories and their chemicals for experiments. In addition, a sheltered workshop was constructed in the Iva Valley for chemical warfare and the production of MUSTARD GAS. The workshops were used to make mortar barrels and shells and disused coal mines were used for testing various rocket fuels. As diverse and scattered as the facilities were, there was a good organization among the scientists which enhanced their delivery and success. After the death of Major Ifeajuna, the main Enugu Science Group was re-constituted and renamed Research and Production (RAP) Directorate with several units under Dr Ben Nwosu as the new civilian coordinator.

Therefore, as it obtained in the US and the defunct Republic of Biafra, education policy and a functional research structure are quite necessary for the production of military hardware through R&D. The

NAF R&D centre (AFRDC) would seriously need to study these models to be more effective in R&D activities that can support NAF operations on a sustained role.

Political Will

The issue of political will is germane if any country is desirous to have technological breakthrough R&D. It is the political will that will determine how much sacrifice and support the people are ready to give. We have people who are hardworking, highly intelligent and who can actually do anything because the intuitive and survival instincts that spurred the people of Biafra into R&D are still much present in many parts of the country and the very people of Biafra are still in Nigeria. In fact, we have today people from that part of the country that are even much more knowledgeable than the engineers that worked during the Biafra era. We can see the things they have been producing from there. They make engines in Aba now and there are even some motor companies coming out from there. So these are all the potentials we have to harness as a nation if we really want to boost the prospect of having a viable military-industrial complex in Nigeria.

A strong political will breeds psychology in the people that are favourable for R&D and any defence production. One primary thing we can learn from Biafra is psychological preparedness. The psychological aspect is that the people in Biafra then adopted the can-do attitude. When faced with no other alternative, you have to adopt the can-do attitude meaning if you don't get it right you sink because there is no other way. So to prevent yourself from sinking, which becomes the attitude of the people, it gets into your national framework. However, most of the time for the fact that we fail to cultivate the lack of expertise and local skills available, we depend on foreign technologies and kill indigenous efforts. For instance, you would often read defence information on the arrest of local arms manufacturers and operators of illegal refineries. Their setup is destroyed and the operators are prosecuted and jailed. Yet, our defence sector is in dire need of what these locals try to produce. As a nation in search of the production of military hardware, could this expertise not have been harnessed,

studied and mainstreamed to aid indigenous defence production in Nigeria?

Ejike (CIV105) cited in (Dii, 2002:134), asserts that the Research and Production Units (RAP) of Biafra were given the mandate to study guns, armoured cars and even aircraft…to see how they can fabricate such machinery. They assembled some engineers, craftsmen not well schooled and even welders…The RAP scientists came up with various models of armoured personnel carriers nicknamed Red Devils. Also, they produced some mines and explosives which they nicknamed Ogbunigwe (an Ibo word meaning mass killer). They used it as mines, mortars and bombs. Therefore, they had different types of Ogbunigwe: the bucket type called Ojukwu Bucket, the flying Ogbunigwe which they used as rocket propellers and the shelling type of Ogbunigwe. The RAP scientists also attempted manufacturing their own guns which they called Igbokwe. Therefore, if military hardware would be produced in Nigeria through R&D, every bias and sentiment against the defunct Republic of Biafra has to be laid aside and there has to be a strong political will to revisit that model of defence production to have a sustainable breakthrough in technological development.

Strong Economic and Industrial Base

Efforts in R&D that pays off handsomely are not cheap but very expensive. It requires enormous resources to fund R&D activities which can only be supported by the strong and virile economic development of the state. A good reflection of how strong a national economy is would be found in the nature of the industrial base that the nation exhibits. The strategic importance of how a strong economic and industrial base can determine success in warfare is aptly captured by the story of the sword and the revolver.

Engels (1947) in espousing Herr Duhring's story of Robinson Crusoe and Friday's sword and the revolver asserts that it is Crusoe who has to drudge because the revolver triumphs over the sword. He contends that force is no mere act of the will, but requires the existence of very real preliminary conditions before it can come into operation namely, instruments which have to be produced. The producer of more

perfect instruments of force, commonly called arms, gets the better of the producer of the less perfect instruments. Thus he concludes that the triumph of force is based on the production of arms which in turn is based on "economic power", on the "economic situation", and on the material means which force has at its disposal. This assertion by Engels (1947) corroborates Thucydides claims in Lowry (1991), in his writings on the 'History of the Peloponnesian War' that Athens lost the Peloponnesian War at the end of the fifth century partly because her economy, the group identity of her population, and her military strength ceased to coincide. The coincidence between economic might, technological inventiveness of a population and military strength is crucial to the defence of any nation. In contemporary times, Engels' position that the producer of more perfect instruments of force, commonly called arms, gets the better of the producer of the less perfect instruments was amply demonstrated in the Iraqi Gulf War of 1991.

However, Engels went on to state that force meant the army and navy to the exclusion of the air force. This may have been because at the time that Engels lived; airpower was not yet an independent arm in the armed forces of the world. According to him, force is "devilishly expensive" (Engels, 1947:205) as "force cannot make any money; at most it can take away money that has already been made…" It is a fact that supporting an operational and effective military that will win wars is very expensive. According to Dii (2016), the defence budget of the US alone in one year far outstrips the national budgets of many Third World countries put together. However, the military-industrial complex in the US is one of the largest contributors to their economic development. The advent of dual-use technology has meant the commercialization of many military technologies by the US military leading to the current revolution in information and communications technologies. Thus, although the cost of military spending is very high, the US military counterbalances with concrete technological development that yields money to the US economy.

Nevertheless, Engels (1947) is right in his claim that "nothing is more dependent on economic pre-requisites than precisely army and navy. Armament, composition, organization, tactics and strategy

depend above all on the stage reached at the time in production and communications". All the nations with very strong militaries have very strong and robust economies in production and communications. Hence, economic development is vital to national defence and defence transformation involving concepts, strategy, doctrine, organization, equipment and manpower development in the AFN. Engels (1947) argues that "it is not the 'free creations of the mind' of generals of genius that have had a revolutionizing effect here, but the invention of better weapons and the change in the human material, the soldiers, at the very most, the part played by generals of genius is limited to adapting methods of fighting to new weapons and combatants" (Engels, 1947:205). The US experience in the Vietnam War and the war against the Taliban in Afghanistan does not wholly support Engels' argument. In the post-Cold War security environment, asymmetric warfare is being waged against militaries possessing sophisticated weapons purely by the 'free creations of the mind' of generals of genius'. This does not however undermine the fact that military strategies in conventional as well as unconventional warfare are mostly dictated by the type of weapon systems inducted at the time. The proposition by Engels reinforces the theoretical relevance of realism to the focus of this paper. The fact that countries with more prosperous economies have advanced technologies and superior militaries validates the theory of realism and the ontological claim of this research that effective defence can only be based on indigenous technological development through R&D and vibrant economic development.

Strategic Leadership

The strategic leadership model adopted in any country largely determines the R&D atmosphere and culture of the people. In explaining this concept, this paper will borrow from the McKinsey 7-S Strategy Implementation Framework (Figure 1). McKinsey 7S model was developed in the 1980s by McKinsey consultants Tom Peters, Robert Waterman and Julien Philips with a help from Richard Pascale and Anthony G. Athos. Since the introduction, the model has been widely used by academics and practitioners and remains one of the

most popular strategic planning tools. It sought to present an emphasis on human resources (Soft S), rather than the traditional mass production tangibles of capital, infrastructure and equipment, as a key to higher organizational performance (McKinsey Consultants, 1980).

Figure 1: McKinsey 7-S Strategy Implementation Framework.



Source: McKinsey Consultants (1980) website accessed 18 April 2022.

There are seven internal aspects of an organization that need to be aligned if the organization is to be successful. These seven elements are interdependent and can be categorized as either "hard" or "soft" elements. They are interdependent to the extent that making changes to one affects all of the others. For an organization to perform well each of these elements must fit with and be consistent with one another. These elements include: Strategy, Structure, Systems, Shared Values, Style, Staff, and Skills. The goal of the model was to show how 7 elements of the company can be aligned together to achieve effectiveness in a

company. The key point of the model is that all seven areas are interconnected and a change in one area requires a change in the rest of a firm for it to function effectively.

The 7S model is a strategic model that can be used for any of the following purposes:

- Organizational alignment or performance improvement
- Understanding the core and most influential factors in an organization's strategy
- Determining how best to realign an organization to a new strategy or other organization design • Examining the current workings and relations an organization exhibits

The model, made famous by the McKinsey consulting company, is good for a thorough discussion around an organizations activities, infrastructure, and interactions.

The elements are defined as follows:

Strategy – This is the organization's alignment of resources and capabilities to "win" in its market. **Structure** – This describes how the organization is organized. This includes roles, responsibilities and accountability relationships.

Systems – This is the business and technical infrastructure that employees use on a day-to-day basis to accomplish their aims and goals.

Shared Values – This is a set of traits, behaviours, and characteristics that the organization believes in. This would include the organization's mission and vision.

Style –This is the behavioural elements the organizational leadership uses and culture of interaction. **Staff** –This is the employee base, staffing plans and talent management.

Skills –This is the ability to do the organization's work. It reflects in the performance of the organization (McKinsey Consultants, 1980).

Adapting this model to the subject of discussion, the S that will represent an R&D culture in the country is the Shared Value. If there is an alignment of all sectors of the leadership in the country to the shared value of R&D, there will definitely be sustainable development of

indigenous military hardware manufacture to support not only the NAF but the AFN and the country at large.

Co-Production

Co-production is an enabler of R&D and it involves the participation of two countries or companies in the production of a product on a shared responsibility basis hinged on the principle of comparative advantage. It entails a chance to train the local human resources, indigenize components and establish cooperative relations between the countries or companies. Co-production with the aim of indigenizing local science and technological base to accommodate the transfusion of learning is preferable. For example, this strategy was adopted by Embraer, a Brazilian aircraft manufacturing firm that co-produces with the British Prat and Whitney aircraft engines for the Brazilian aircraft industry (Raimo, 1992). The Turkish model adopts a similar form of partnership to achieve the production of military hardware such as aircraft, and battle tanks among others. The recent engagement between Turkish Barer Holding and DICON offers promise in for Nigeria in this regard.

License Acquisition

License acquisition is another enabler of R&D and it entails buying of manufacturing license from countries that have attained high level of production of certain products. If this is backed up with sound R&D outfit, the country stands to benefit as she will develop an independent and self-sustaining defence industry with the capacity to make desired modifications, alterations and adoptions. DICON was established through this strategy (DICON, 1999) but because Nigeria failed to pursue a rigorous R&D programme for the Corporation, further development of DICON was stalled. The Corporation could take advantage of the FGN's current favourable disposition to step up robust R&D initiatives to support the Military Industrial Complex drive.

Reverse Engineering

Reverse Engineering is also called "backward integration" or "copy technology" and it is a key enabler of R&D in any country. It entails

sourcing an equipment and stripping it with the aim of studying how to assemble and produce the same product or component. This method was adopted by countries that sought quick take-off in arms production. Such effort was a common practice with newly captured weapons during wars. In the 1950s, Japan and many Asian Tiger countries adopted this strategy. Since the details of the engineering designs and composition of the metals and materials may not be known, the quality of such products is not guaranteed. The revived effort by DICON to reverse engineer RPG-7, mortar tubes and artillery guns is a step in the right direction and need to be sustained.

POLICY IMPLICATIONS

There are definite policy implications for the country and the NAF to undertake in order to mount an effective R&D that can produce military hardware to support military operations on sustainable basis. These include but are not limited to the following:

1. The NAF should:
   a. Encourage R&D culture in its schools and workshops through competitions, reward of innovations and trainings.
   b. As a deliberate policy embark on specialist education and trainings of personnel in reverse engineering of military hardware in order to replicate the items. The recommendation in the literature from Edem (2020) for the NAF to train personnel in various fields of R&D corroborates this point.
   c. Establish a workshop specially equipped for reverse engineering of parts and military armaments.
2. The AFRDC should:
   a. Liaise with AFIT, NAF institutions and universities for R&D activities.
   b. Identify key artisans, factories and industries that can build moulds and fabricate parts and models. The position advanced in the literature by Chukwu (2014) for

partnership with local/foreign private manufacturers on R&D corroborates this view point.

c. Liaise with DRDB to access research grants and funds to support R&D activities.

3. AFWC should continue to stress and encourage research efforts of participants and staff members to nurture R&D culture in the NAF.

CONCLUSION

The role of R&D in the development of military hardware cannot be overstated. The fact is that no military hardware has been produced without R&D and none will certainly will. The issue in this study was not to explain the role of R&D in the development of military hardware but to put forward thoughts and factors that can enable indigenous and sustainable R&D in the NAF to support its operations. The research methodology was qualitative and the method adopted was ex-post facto using content analysis to review existing literature. The theoretical framework was anchored on the Realist Theory. The key determinants of R&D discussed include cultural paradigm, education policy and research structure, and political will. Others include strong economic and industrial base, strategic leadership model that supports R&D and a suggested model considered effective for R&D in the NAF, AFN and the country at large. Some policy implications were given for the NAF, AFRDC and AFWC to undertake for R&D activities in the NAF to be able to develop military hardware to support military operations.

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