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The Place of Urban Planning and Its Principles in The Development and Sustenance of Technology Clusters in The Global South

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***Abstract*—Tech clusters have become one of the agents of improvement in the technology sector; they have been a major catalyst to national economic growth in various countries exemplified by the resultant effect of Silicon Valley on San Francisco, California and also, how Tech City improved East London. This sector, in turn, has grown to profound heights and has seriously improved every other facet of the economy of nations and the planet as a whole. The ever-increasing cluster in a region produces diminishing returns over the years on ever-increasing businesses, population and human activities, and this is no different for technology clusters. Overcoming such constraints has helped the success of many clusters, hence, the need for planning. The paper expands on the overall knowledge of technology clusters and its effect on national development: looking into how planning principles and guidelines can affect the viability, efficiency and future growth of such technology clusters from the perspective of urbanism. In the global south, we take a look at the current state of a case-study tech clusters and outline planning principles that can help in the subsequent growth and development of similar clusters. Studies into two iconic tech clusters: Silicon Valley, California from the Global North and Computer Village, Ikeja from the Global South reveal that planning plays a vital role in long- and short-term dynamics for the success of tech clusters. As such, the paper also establishes planning principles within the architectural and urban design context. These principles understand the working of technology clusters, their challenges and provide propositions into the building elements of tech clusters towards boosting productivity. These principles also show that incorporating proper 'tech-specialized' building and urban elements like signage, sustainable materials and concepts can reduce tech cluster saturation. These principles can also help to improve technology clusters by reducing the adverse effects of technology on the environment and improve overall sustainability and comfort. They can also lead to massive job creation, especially in fast-developing third-world countries like Nigeria, improving the nation's economy and solve other pressing issues. Challenges that can occur in planning tech clusters were identified although these challenges are predominantly a result of these clusters being in the Global South.**

***Keywords*—Architecture, Planning, Tech Cluster, Cluster Research, Information & Communication Technology**

I. INTRODUCTION (*HEADING 1*)

The terms 'Technology' and 'Architecture' have, over the years, become very important to globalization and urbanization; their professional applications have been evident in human social growth and enormous computerization. Architecture and technology have wide scopes and are linked to various other professions and sectors such as Design, Psychology, Art, Engineering, Finance, Manufacturing, Medicine, Military, Oil & Gas and much more. This is evident in the following ways: the design of refineries, computers, and smartphones, (ICT) building design, car factories, home appliances, architectural technology equipment and more recently, biotechnology for Ebola treatment. The concept of technology in economic development in the form of tech clusters is slowly becoming a crucial agent in the industrialization of regions (Baily & Montalbano, 2017). Research at Brooking Institutes has established that there is a strong cause-and-effect relationship between productivity and the cluster phenomenon. This is as a result of increased collaboration, or better put, symbiosis, between firms sharing knowledge and benefiting as a result of proximity to one another. The result of clusters providing economic development was first seen in San Francisco, California; and later on, in other parts of the world like London (Tech City), Brazil (Sao Carlos), and Colorado (Denver Technology Center). Tech clusters are usually business clusters with a technology focus and/or niche like biotech, car manufacturing and ICT. Information and Communication Technology is fast becoming the crown jewel of globalization: the rate of ICT development has been exponential right from the times of Microsoft by Bill Gates, further expanding to the Apple times of Steve Jobs and up to the times of Jawbones, to phones with heartbeat monitors and iris scanners, to virtual reality, to holographic and now, artificial intelligence and now, ICT Tech clusters have been a huge advantage to areas/regions in which they evolve and their respective economies. Common examples of ICT tech clusters apart from the ones already listed include Washington (Dulles Tech Corridor), Optics Valley (Tucson, Arizona), Silicon Alley (New York City), Silicon Hills (Austin, Texas), Silicon Forest (Portland, Oregon), Silicon Prairie (Dallas), Silicon Slopes (Utah), Tech Cost (Southern California) and so many more.

Tech clusters are agglomerations that usually form naturally when an inventor/innovator (mostly innovator) tends to commercialize his product; the startup grows and increases industrialization within that area. This development usually attracts more similar 'startups' and establishes companies as an avenue for a new market niche and competition. Over time, usually a long period, a cluster of companies begin to gather; startups that have a similar outlook in technological terms. This particular niche type is mostly formed from the market demand

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of that area and if that area has the available resources that are needed to support that kind of technology. Over time, tech clusters can evolve to high tech clusters, which are extremely networked and highly sustainable, filled with very large companies leading a highly sophisticated tech ecology. The benefits of location economies are the prime agents in the formation of clusters. Location economies is an extensively studied phenomenon in the economic development literature; the value on location economies is particularly high as key processes involve networks and interaction based on proximity. Clusters and cluster forms have been found to increase efficiency and productivity with which participating companies can compete, nationally and globally (Porter M, 1998)). Tech clusters, such as Silicon Valley have a lot of advantages for themselves and other sectors, like the possibility of exponential innovation through the formation of pseudo-knowledge clusters. Entrepreneurs can get easier access to capital through well-structured investment and likewise, investors can get entrepreneurs to finance. What is remarkable about tech clusters is the resulting development of the area in terms of infrastructure, operation, and economy. Also, firms that makeup clusters are high-valued, have strong intellectual property protection, liberal immigration laws, and equal-rights/inclusive policies, as well as an excellent entrepreneurial culture. In recent times, tech clusters have evolved based on varying ideologies and planning. A good factor for the evolution of a tech cluster is to be able to develop a knowledge and/or research cluster for constant innovation; an excellent example remains Silicon Valley when the Stanford Leadership decided to form a knowledge cluster with its graduates as it was the Valley's major workforce and also as a form of practical field for them. In most cases, tech clusters are usually made for the formation of knowledge and research purposes in a particular field of technology but in other cases, they may evolve to product commercialization mostly due to sustainability and even profitability; this is when tech markets can be formed. Every tech cluster must have at least a tech market since one of its product objectives is commercialization (Gilbert, 2015).

II. SILICON VALLEY – THE BIRTH, TRANSFORMATION AND SUSTENANCE OF TECH CLUSTERS

The history of a tech cluster dates back to the beginning of Silicon Valley. Silicon Valley is internationally known as the major founders of the tech cluster phenomenon and is considered a fundamental landmark in the evolution of other tech clusters. Piero Scaruffi and Rao Arun give a detailed history of Silicon Valley. It was reportedly termed Silicon Valley by Don Hoefler in the Electronic news newspaper on January 11, 1971 (Arun Rao & Piero Scaruffi, 2010). Silicon Valley founded by the University of Stanford is a nickname given to the technology cluster that overlooks the southern San Francisco Bay in California, it is now home to a lot of high-tech companies as well as a multitude of start-ups. Stanford University through its leadership, affiliates and graduates were a key role in the development of the Silicon Valley area (Adams, 2005). Another theory attributes the origin and development of Silicon Valley to the founding of the Federal Telegraph in California in 1908 and the resulting invention of Wireless technology, Stanford university factor, and military relationships at that time (Huggins, 2008). The advancement of this cluster was facilitated by the semiconductor sector with firms such as Eitel-McCullogh (Eimac), Litton Industries, Fairchild Semiconductor, and Intel; at the same time improving a lot of other sectors as well (Lecuyer, 2005). In the 1980s the semiconductor industrial sector experienced a serious crisis but the evolution of the Silicon Valley developed massively and became an economic blueprint for other cities to follow; it brought a lot of economic development to the area. Its growth was so massive that in 1999 after the Initial Public Offering (IPOs) that was carried out in Silicon Valley in 1998, the 41 IPOs had a combined market capitalization of $27 billion (Hamel, 1999). The post-2000s saw Silicon Valley go from a tech cluster to a high-tech cluster and established 'high-tech' clusters such as Silicon Valley have a lot of advantages for itself and other sectors like the possibilities for further innovation. The creation and evolution of Silicon Valley have led to the creation of other clusters either naturally or by the government. Although numerous clusters have been formed, we cannot try to collate a comprehensive view of these tech clusters, this is mainly because it is not productive to begin labeling these tech clusters based on their 'label' (Breshnashaw, 2004).

However, as a result of the overpricing of the IPOs in 1998, especially NASDAQ, it led to its crash and a disruption of the Silicon Valley model. This led to the sacking of twenty-five thousand Silicon Valley jobs in 2001 and two hundred thousand jobs in 2006 and a total workforce of one hundred thousand (Joint Venture, 2007). Despite this setback, there is still a considerable workforce growth in Silicon Valley: the average size of the traditional hardware firm in the Valley was 200 employees and the average size of the software firm was 27 (Henton, 2000). In the past 27 years, only three of the top 40 companies that were located in Silicon Valley have remained in that same location. Others have either failed, relocated, replaced and/or have been bought over by new companies (Kearney, 2004). This highlights the inevitable law of diminishing returns to cluster operation and eventual sustenance. A tech cluster begins to grow exponentially due to companies seeing and trying to exploit a market niche. The competition increases and is healthy but slowly the area tends to become too congested for use, creating huge issues like an increase in crime, reduced efficiency especially in transport route/links due to disorganization and worst of them all: Pollution.

Kearney, 2004, identified that there was a shift in focus from further tech cluster evolution to policymaking and planning in existing technology clusters; and the local and national policy-makers can keep in control the development of these tech clusters (Max Nathan & Emma Vandore, 2014). The timeline progression of Silicon Valley over the years have established a fact: Planning plays a vital role in long and short terms dynamics for the success of tech clusters. As has been established from previous experiences, we see that tech clusters can bring a lot of innovation and development to a region with more resource usage and jobs improving the economy. These clusters over time can also bring a lot of issues that can reduce efficiency, and if not properly handled and planned can derail its aforementioned development. In the early stages of tech cluster formation, there are lesser and smaller tech companies. At this stage, the region is less

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cumbersome and usually, there is no noticeable bad effect of the cluster on the ecosystem. But as the cluster begins to grow and develop, the area starts becoming dense due to constraints, such as space, which can ultimately lead to reduced productivity and a growing negative influence on the environment with the attendant issues leading to pollution, product, space and region overuse. Therefore, proper planning of spaces in this business cluster is expedient. This can help to reduce land overuse, increase maximum land use in areas with space constraints and also increase productivity and sustainability.

III. COMPUTER VILLAGE, IKEJA, NIGERIA – TECH CLUSTERS OF THE GLOBAL SOUTH

The Information and technology market sector, which includes hardware and software sales and services and other value-added services, is rapidly growing in most modern economies (Choe & Roberts, 2011) and this has been evident in Nigeria. Due to the ever-growing ICT market particularly in Nigeria, it has enabled the organic formation of tech clusters; this natural cluster formation in Nigeria was first identified in Lagos as 'Computer Village'. It is best described as an ICT market as this cluster is much more focused on ICT trade. Its history dated back to a small marketplace in the 1960s and continued through the 1990s at Ogunlana Drive, Surulere. There was a remarkable growth between 1998 and 2001, as narrated by Muyiwa Matuluko who grew up in the area, and this formed the ICT market cluster which was then settled at Ikeja, Nigeria (TechPoint Africa, 2017). This tech cluster formation was accelerated due to a huge demand in mobile networking from GSM entry in the Nigerian market in 2001. Over the years, the technology sector has encouraged the growth and development of similar tech clusters in Nigeria and the formation of new ones. Research from StearsBusiness has found that there has been government acknowledgment of the benefits of a tech cluster in this region and some government efforts were put in place to this effect. The Ikeja local government created road construction and, office spaces began to spring up as a result of the economies always offered by infrastructure development (StearsBusiness, 2018). Over the years it has been estimated that the ICT market cluster generates up to 1.5billion naira daily.

Computer Village has become a densely populated tech cluster in the past decade. This is a known problem of an organic cluster: since it is difficult to appraise how much a cluster can grow, there is usually no provision for unexpected expansion and growth. Therefore, this ICT market cluster is on the pollution brink that needs a total urban revamp plan. A prime example of the mess in Computer Village is the pollution that is being caused by waste from computer and phone scrap parts - that are mostly non-biodegradable, and the extremely poor route management within that area. Government actions over the years have involved moving the cluster away to a larger location that can handle its current capacity but has received very negative responses; highlighting such response as quite inefficient. The place of Architecture and Urban Design/planning can be used to efficiently mitigate and/or remove the negative impact of these problems. Other problems noticed in the Computer Village cluster include, but are not limited to: area congestion, lack of population control, poor noise levels, pollution and security.

IV. TECH CLUSTERS AND PLANNING

It has already been established that tech clusters always tend to grow and give room for more urbanization, leading to economic development. A tech cluster can always lead to a high-tech cluster and can have a lot of positive trade-offs; they have, in recent times, been seen as agents to accelerate development in an area. In the post-2000s, highly globalized countries begun to experience two situations: diminishing of the old traditional industries of the R.C. (Reinforced Concrete) days and the birth of newer innovative companies (Maggioni, 2004). These changes are caused by economic interdependence as is evidenced in the deepening of regional differentiation (Doz, 1987), whether this is seen as positive or negative to tech-clusters is rooted in planning. The incredible success of the Silicon Valley tech cluster model led to a lot of policymakers trying to clone that model for the development of another successful cluster through regional innovation policies. The major success of Silicon Valley as a high-tech cluster has been attributed to a set of powerful planning policies aimed at linking the existing local resources to international demand and supply (Blakely, 1989).

Max Nathan in his piece "*here be start-ups: exploring London's 'Tech City' digital cluster*" tries to ascertain the place of planning, its policies, and regulations in relation to the success of a tech cluster programme. Tech clusters tend to gather in inner urban space, which is perfectly normal for typical business clusters (Jacobs & Marshall, 1969;1918), this is what is called 'cultural cognitive capitalism' (Scott, 2014). Max found that these clusters grow organically but that they can be barriers to growth which mostly include lack of access to finance, unskilled labour, and lack of management capacity. Policymaking can be used to fix these barriers (with respect to planning) through Clustering around small production zones, improving small firms' competitiveness/growth by minimizing the level of FDI (Foreign direct investment) for indigenous firm development, improving short term economy development by maximizing the level of FDI.

Chris Green in his article '*Planning Policies for high tech clusters*' outlines the possibilities of the growth of high-tech clusters in areas of restraints and subsequent sustainable developments. He outlined Cambridge as a prime example and concluded that the conflict between economic development and environmental consideration becomes an issue in small and medium-tech cluster, and not so much an issue to high tech clusters (Green, 2016). While planning is quite a broad term to discuss towards achieving sustainable tech clusters and transformation into a high-tech cluster, the focus on planning will be from the Architecture perspective. The use of Architecture, its principles and its problem-solving capabilities can help in short- and long-term sustenance of tech clusters, whether they are formed organically or systematically.

V. PLANNING PRINCIPLES IN TECH CLUSTERS

Planning a tech cluster is usually been set out and implemented as policies and strategies based on principles. These principles understand the working of technology clusters, its challenges and provide propositions into the building elements of tech clusters towards boosting productivity. Planning in Information technology centers is a long process that must be systematically followed. A lack of

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patience in following this systematic approach can lead to very grievous issues in the future (Chiara & E., 2001).

The planning principles should guide planning tech clusters within the architectural context, these principles should also provide an avenue for equitable development at all levels of tech cluster formation and operation.

- Project goals should be properly defined and mapped to infrastructure. This usually involves a profound understanding of building concepts and functions and how best to juxtapose functions to buildings.
- An economic analysis of the cluster should be carried out classifying the spatial areas based on the market sub-sector categories and zoning. With this information and some other, critical evaluation of spatial allocation can be carried out based on land uses (Chiara, Joseph De; Crosbie, Michael J., 2001).
- Buildings and general infrastructure built should be as adaptable as is possible. The building must be able to fit associated uses whether they be trade, research or collaboration.
- Planning must facilitate sustained economic growth and development through the provision of adequate infrastructure.
- Use materials, systems and construction methods that are resilient and sustainable.
- All infrastructures and ambient environment should create a sense of place and relate to iconic forms, culture as well as an integration to the natural landscape.
- Maintain moderate visual expression of the building design with relation to the skyline. That is commonly achieved through the design and construction of high-rise buildings.
- Incorporate beautiful landscaping into clusters. Proper landscaping usually has ‘expressive, aesthetic, natural and cultural qualities’ that is valued by people and provides symbiotic positive outcomes for people and outcomes (Nassauer, 2014).
- Transportation infrastructure should foremostly provide for the comfort of motorists and pedestrians through providing efficient transport routes in terms of safety, convenience and usability.
- Provide specialized spatial management and arrangement with standardized routes and transport schemes.
- Planning must include a systematic research, and framework, for the preservation, protection and enhancement of the natural environment. This systematic approach tries to help the natural and built environment.
- Potential future expansion must be considered in planning tech clusters. To plan for future expansion certain criteria must be met such as the potential of the public road to be able to absorb additional traffic loads; the cluster area must have a suitable reserve area; the income to be created must be able to justify capital investment, and other relevant factors must be carefully considered.
- Planning tech clusters should be carried out in stages, and stage results should be regularly assessed.

VI. CHALLENGES THAT OCCUR WHEN PLANNING TECH MARKETS

Despite the widely established fact that tech clusters offer excellent returns in economic growth and sustainability, probable challenges can occur as a result of a wide range of issues. Lack of finance can limit urban planning implementation; urban planning policy remains the backbone of an effectively planned tech cluster but the creation and implementation of such policies can be stifled due to lack of funds to pay agencies and/or professionals. In a typical tech cluster, market stall leased to individuals by the government can lead to less control over such space and can be much more difficult to execute urban planning policies. There can also be arbitrary political boundaries issues. Urban planning policies takes into consideration landscape features, but this can become a challenge due to differences in landscape features. These differences can include Soil differences, Differences in topography, Differences in characteristics of the physical site, Differences in amenities features, Lack of a comprehensive master plan in existing land uses, Poor level of predictability of terrain (Mondals, 2015).

VII. CONCLUSION

Business clusters have become a widely researched and implemented strategy, as Silicon Valley have set intelligent pathway of city formation, growth and/or development. Tech clusters, which are business clusters with a focus of the Tech theme, have been created across the world and is a well-documented source of revenue to countries as can be seen in USA, France, Russia, England and Israel. A good example is Paris Saclay, which is a government planned and executed tech cluster was started in 2013 and is worth about $3.25 billion as at late 2015, then there is Silicon Valley: a high-tech cluster that has grown in value remarkably. The tech markets in the Global South however brings to the fore a key negative of Tech clusters: The ever-increasing cluster in a region produce diminishing returns over the years on ever increasing businesses, population and human activities. A tech cluster begins to grow exponentially due to companies seeing and trying to exploit a market niche. The competition increases and is healthy but slowly the area tends to become too congested for use, creating huge issues like an increase in crime, reduced efficiency especially in transport route/links due to disorganization and worst of them all: POLLUTION. An expository case study of Computer Village, the largest Tech cluster in Africa’s largest city highlights this negative.

The success of Silicon Valley attributed to a set of powerful planning policies basically aimed at linking the existing local resources to international demand and supply and shows the place of Planning in the development and sustenance of technology clusters in the Global South. The principles highlighted revolve around Architectural and urban planning strategies in a tech cluster life-cycle and challenges that can occur when planning a tech market were explored. Properly implemented planning principles in a typical tech cluster, whether new or existing, guarantees that the diminishing returns phenomenon is vastly reduced and will help in promoting security, increasing cluster attractiveness, prevent

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the creation of an urban slum and promotes cultural/social diversity and overall sustainability.

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