INTELLIGENT INFASTRUCTURE INTERGRATION FOR SMART CITIES

Author: Charles Nyagaka Ondiere, PMP®, GEng[1]

[1] Adrian Kenya Ltd, Fiber Networks Planner, P.O. Box 9808-00100, Nairobi
nyagaka.co@gmail.com

Abstract

Demand many times drives supply, and the Kenyan market largely operates under that principle. However, this is not always a good thing, especially in the case of housing, energy, transport as well as communication infrastructures. Whereas the telecommunication service providers have taken great strides to ensure there is sufficient bandwidth even for a projected spike in demand for the coming years, the transport counterparts are just starting to wake up and slowly catching up. This is a very healthy direction we are taking, but it is not sufficient if we desire to develop smart infrastructure.

Most entities in the private environment is already smart, from smart phones, televisions, lighting among others, but what does it take to make the public spaces smart as well? Is it too late for integrated infrastructure development models? This paper explores the benefits of having an integrated infrastructure development model, and also proposes ways in which we can work as a country to achieve the integrated systems. The future of humanity is one where we are surrounded by man-made features that are able to adopt to the humans' behaviour and trends, not only limited forcing humans to adopt to how the features are built. It is the role of engineers to smarten our public spaces and crystallise this future.

Keywords: Integrated, Infrastructure, Smart, City, Vision

1   Introduction

In historical times, cities used to be centred around a governing class, an elite few who made all the decisions from dispute resolution to deciding on city projects, and their placements. Whereas some cities greatly succeeded in advanced developments like the aqueducts of Machu Pichu (Wright, Alfredo, 2000), the Persian ice pits (*yakhchāl)* and the great pyramids of Egypt, most cities failed due to poor leadership. This trend has not changed much, most cities are still failing due to un-visionary leadership. The major difference between developed nations and developing nations is really the leadership and ability to incorporate professionals in development roadmap creation, monitoring, and implementation.

It is however important to note that involvement of professionals is not guarantee of future proof development. We tend to work from fenced viewpoints, with a perceivably noble goal of securing our line of profession, in the long run, we cocoon ourselves away not knowing what the other people are planning or doing. Professionals are protective of their own line, pride and mistrust bar us from working together effectively (Daly, 2004). This ends up hurting the present and the future in various ways:

    i.   Once there is a major project, for example a road construction, other service providers get involved at a late stage and mostly as an informative not collaborative model. All other providers are required to build their way around the road.

    ii.   Once a section of the project delays, there is a lot of back and forth and inter-stakeholder conflicts, which hurt the project. If a feature is missing in the project, everyone will try to fault someone else.

    iii.   Rigidity of mindset in the main planner will affect all the other aspects of the smart city dream, as much as they would love to have a future proof infrastructure. For example, if a street lights engineer is stuck on the traditional pole mounted street lights, yet a roads and the automobile engineers desire to explore the levitating cars concept, it will be difficult to control that traffic beyond certain heights.

Development of infrastructure and social amenities is largely decentralized. This is to, undisputedly, achieve specialization in every field, for example, a roads engineer will focus on the best material for road construction, optimal routes and such matters. That however leaves a gap, because the electrical engineer will then focus on traffic lights and their sequencing. There is no optimization of material to ensure efficiency and low cost, a study of the materials could reveal availability of road materials that can be used for lighting and maybe even traffic control.

Important to note is that the ancient cities developed in and around their environment, harnessing what they locally had to transform themselves into unique marvels in the trade routes. The world has evolved, there is no particular trade route in the age of online marketing and smart technology. The next frontier to grow is to have smart buildings, smart roads, and other smart infrastructure. This can only be achieved through internet of things, big data and data analytics. There is a lot of discussion around how to implement the various technologies, however, the most important thing we can borrow from the ancient empires is that, centralized planning can help cities achieve the impossible and to future proof themselves.

2　　Trends and Possibilities

The world is already a global village, where no one truly lives very far away from the other, safe for physical distance, we long to make the world a global city, where each city is just like an extension of the other. There has been fairly steady interest on smart cities per statistics on google as seen in the figure below.
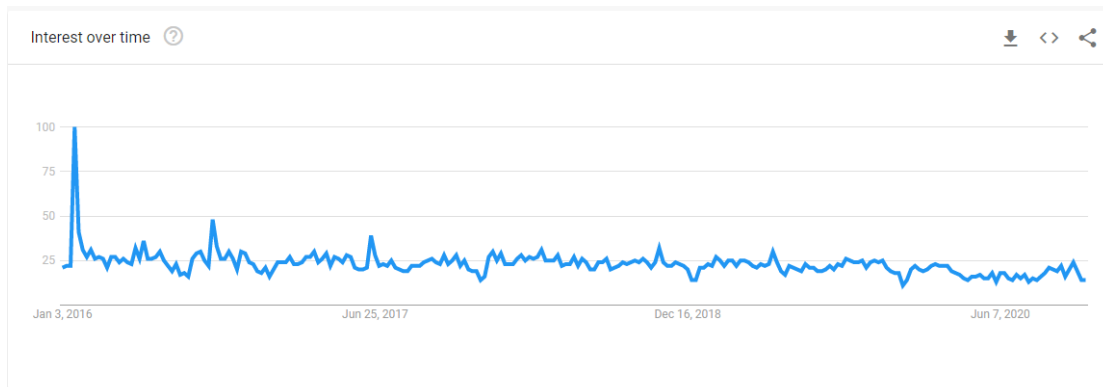

Figure 1: Trend of Interest on Smart Cities (Google)

Nairobi, the capital city of Kenya, is a high residence area as most people come to seek employment and business opportunities in the city. Nairobi County, being the most populated county, is home to about 4.4 million people (KNBS, 2019). With more and more population moving to the cities, there is a need to rethink how we interact in our day to day activities, both with each other, and with our devices and more importantly, with our infrastructure.

Smart devices currently make some level of decisions, or suggestions based on user trends and collected data. Other infrastructure too can if well integrated, some of the futuristic possibilities are as below:

Morden cities are also moving towards being smart, especially in the transport industry. A good example is Boston City. Boston city – Use of roads integrated with data gathering sensors to control traffic flow as opposed to the traditional timer-based traffic light systems. This is dynamic and is able to easily ease traffic snarl up, therefore members of the public spend much less time on traffic jams.

Moving buildings. Recently we saw the walking building in China, that moved over 60 meters in a span of under 3 weeks, while rotating, according to news reports (https://tinyurl.com/y3n3bw3t) This is an engineering marvel that gives a glimpse of the possibilities in the engineering world. The movement was slow and hectic, it however shows the possibility we have as engineers to build buildings that are easily relocatable. This calls for a radicle change in how we design our foundations and columns, and also how the street space is planned for ease of relocation if the need arises.

Levitating cars. Roads are a menace. The high cost of maintenance (Especially when it was poorly developed), the heavy traffic, pollution from fumes, dust, among other things. It is possible for cars to levitate above ground, so that the disruption we see during road constructions is a thing of the past. There are various issues that need to be addressed before that, like the policies, safety considerations, traffic control, propulsion systems among others, but these are not far-fetched as we would think (Eker et al, 2020), there are already levitating trains across different nations across the globe.

We all agree we cannot have all cars as levitating cars, because the cost of discarding the current already built cars can be pretty high, in the meantime we can develop auto-regulating lanes. Traffic snarl-ups are majorly very predictable, based on the work schedules adopted by our country, and as much as there is a push to work

from home, most businesses still operate 8am-5pm and require employees to report to physical offices. When there is heavy traffic in one direction, the other lanes are barely used, a smart median construction can relocate to bulge lanes on one side based on the traffic weight on either side. There are already pilot tests being carried out on Whangaparaoa Road, New Zealand, and there is considerable success rate saving time and reducing driver frustrations (https://at.govt.nz/projects-roadworks/whangaparaoa-road-dynamic-lanes-trial). With the help of traffic cameras and other sensors, LED lighting, and good connectivity, a lot more flexibility can be achieved.

Self-parking cars: A lot of time is lost by individuals trying to find parking in the CBD. Integrating the parking spaces and making the data available to cars can allow cars to book parking spaces in the city, and being autonomous, they can auto-drive there and park, allowing the driver and passengers to alight at their convenience. This will call for parking lot management systems that are linked to cars through applications, this will potentially reduce the uncertainty of finding parking space, time wastage, and cost as billing can be automated.

These are some of the possibilities that the future integrated infrastructure development holds for the Kenyan cities. The big question that then remains is, how do we get there from where we are? The Kenya Vision 2030 roadmap is good, however it has room for improvement if we are to build interactive infrastructure. This will need a major paradigm shift in how we do our planning and ultimately execution of development projects.

3   The Future

Smart cities are unchartered waters for almost everyone in the globe, we do not fully understand its extents or the possibilities that come with it. Thus, there is no rule book on how to handle it, no specific model on how to achieve smart infrastructure, this gives a great room for creativity and innovation. One thing we are sure is, our legacy institutions and ways of working will not earn us smart cities, or smart anything for that matter. Central to the integrated infrastructure development is the good will of the government and policy makers, as well as the engineers and architects. There is no single profession that can accomplish on its own. Among the unlimited considerations that we need to embrace as a country in order to arrive at the targeted future, a few are discussed below.

Firstly, benchmarking. Benchmarking is not copying, or duplicating other people's activities in a *"monkey see monkey do"* kind of model, rather it is more of sharing ideas and getting best practices from people who have done it, then creatively incorporating the lessons into your context. Different cities are already partnering with members of the public and private institutions and offering them platforms for piloting their ideas on how to improve the city. Case in point is Boston city. The cities are offering public internet access points. This shows a good will from the county/city council institutions, and encourages the members to come up with solutions to better their city even more than does the incubation centres and innovation hubs, because it directly impacts the direction of the cities in real life models. Kenya can borrow the model to gain various diverse, local, and original concepts.

Leveraging on IT and data analytics. Big data responsibly collected from all the smart devices in the country can help predict human behaviour and inform infrastructure development. In turn, infrastructure fitted with sensors and interconnected with other smart devices can help county governments get feedback from the infrastructure itself on how to improve, be it the roads, land use, buildings, water supply, or healthcare (Komninos et al, 2019). Various private sector institutions, for example Adrian Kenya Ltd, are already building innovation hubs to enable their employees try out their futuristic ideas and build solutions

Improved connectivity. Recently the ministry of ICT launched a project aiming to connect Eldoret to a landing point in South Sudan border, this, among other projects rolled out by the authority within our borders, seek to increase the backbone bandwidth as well as the access bandwidth to various towns in the country. The country already has more than 4,700Gbps bandwidth capacity on undersea optic cables, which is highly underutilized at under 30% according to Communication Authority (2019), smart infrastructure will ensure sufficient utilization of this bandwidth. More projects inland though are increasingly being rolled out by both public and private institutions, which is really commendable.

Central planning consortium. We can not move together unless we pull together in the same direction. We currently do not have a unit that can make decisions on infrastructure under one roof. The county government processes approvals for various infrastructure developments ranging from road construction, water and sewer line construction, buildings, drainages, street lighting among other projects. This gives the county offices a vantage position to guide the smart city development. We do not need to create a new organ to consolidate the smart infrastructure, we need to however facilitate the county governments through the ministry of public works and

urban development. Through ICTA, the county governments have sufficient resources to build connectivity to fuel the next age of connectivity, the interconnectivity of things, from roads, to buildings to cars among other things.

There are numerous players in the drive towards achieving smart cities. For example, in telecommunication industry, there are several internet service providers, all laying their cables as they see fit for their clients. It is notable that through Technology Service Providers of Kenya (TESPOK), they now have an opportunity to work together towards a common way of providing services more cheaply and efficiently, and also resolve conflicts with other authorities like roads, water and sewer planners. It is important to have these pools of industry players to make it easier to address matters and also to engage stakeholders comprehensively during planning phase. The model of having an architect independently design a building, or a civil engineer solely design and implement a road cannot take us to the future we desire.

Agreeably, we cannot get the future we dream about by continuing with old models (Zuti, 2018), one thing however we can borrow from the past is, developing centralized planning units that have an overview of the vision and oversee the execution. The proposed model below can help us achieve smart cities more efficiently, with much less conflict, and also it will cost less as all the stakeholders will be engaged for a unified and inclusive design.
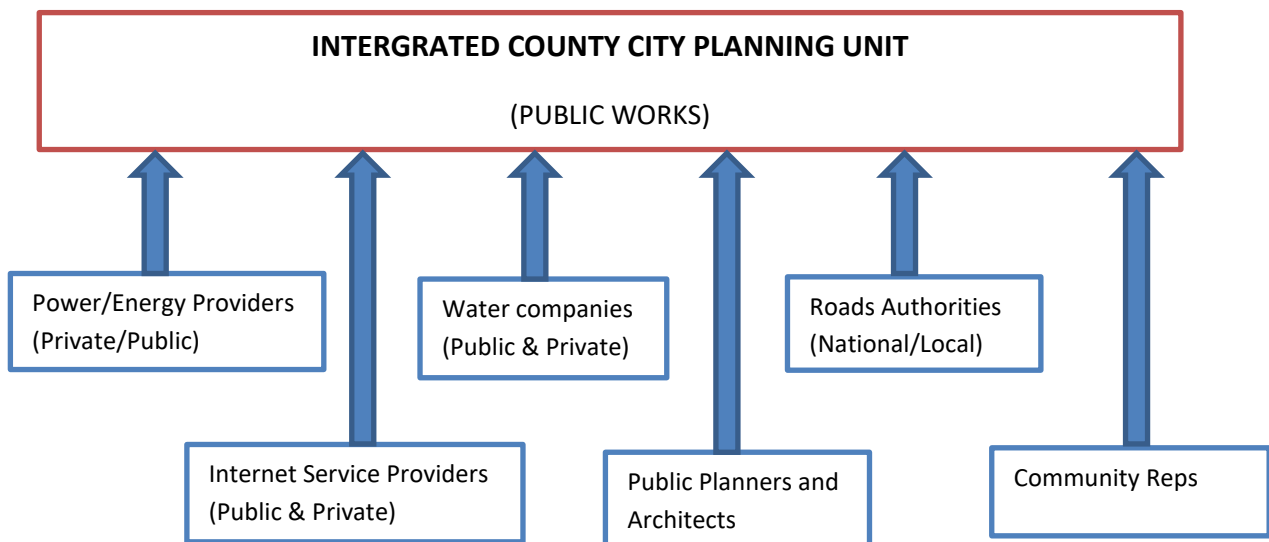

Figure 2 : Proposed Integrated Model

A road is not just a road anymore, there is need to involve the power companies, internet service providers, water and sewerage among others in the planning of a road, such that the approved road has provision for all providers. This will make data collection easy as systems are integrated, and future proofing infrastructure can be effortlessly accomplished. Also, to move the discussion from one focussed on wayleave and right of way, to a more interactive and futuristic infrastructure discussion. A building is no longer just a shelter, it needs to be an interactive building, and if the architect will not involve internet of things, and other interactive system planners, then we continue incurring more operational costs, while making little progress towards our dream of smart cities.

4   Conclusion

The private industry and businesses have a lot of insight and goodwill that may be lacking in the national authorities and county government ranks, the converse is true as well. The only way to achieve the smart cities dream is by leveraging on data analytics, internet of things, connectivity, and creativity. Above all these, there is a need to trust each other by not feeling threatened by ideas, and by allowing individuals and businesses to pilot their ideas within the city spaces, we all want the same thing. The mindset transformation as well as organizational transformation that we choose to undertake will determine how soon we future proof our cities. Smart cities can only be built one street at a time, never all at once. We may plan, and not execute, we may build and not enjoy, but all in all, we will get there. Go dream, go build, go enjoy.

Acknowledgement

References

1. Daly, Gloria. "Understanding the barriers to multiprofessional collaboration." *British Medical Journal* 323.7303, 28-31 (2004):
2. Eker, Ugur, Grigorios Fountas, and Panagiotis Ch Anastasopoulos. "An exploratory empirical analysis of willingness to pay for and use flying cars." *Aerospace Science and Technology* 104 (2020): 105993.
3. Kenya, Communication Authority of. *Annual Report for Financil Year 2018-2019*. Nairobi: Communication Authority of Kenya, 2019.
4. KNBS. *2019 Kenya Population And Housing Census Volume 1*. Census. Nairobi: Kenya National Bureau of Statistics, 2019. Print.
5. KNBS. *2019 Kenya Population And Housing Census Volume 4*. Census. Nairobi: Kenya National Bureau of Statistics, 2019. Print.
6. Prince K. Guma & Jochen Monstadt (2020) Smart city making? The spread of ICT-driven plans and infrastructures in Nairobi, Urban Geography, DOI: 10.1080/02723638.2020.1715050
7. Wright, Kenneth R., and Alfredo Valencia Zegarra. "Machu Picchu: A civil engineering marvel." American Society of Civil Engineers, 2000.
8. N. Komninos, C. Kakderi, A. Panori & P. Tsarchopoulos. "Smart City Planning from an Evolutionary Perspective", *Journal of Urban Technology*, 26:2, 3-20, (2019)
9. Zuti, B. (2018). Digitalization, regional competitiveness and the governments of the future.