

The Development of a Smart Campus – African Universities Point of View

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Abstract—The current smart campus frameworks available does not fully suit African universities, there is a need to develop a smart campus framework that will suits African universities. The framework used in European univerties is modified to suits African universities. A South African university was used as case study and the results show the strength and shortcomings of this campus in becoming a smart campus.

Keywords—Smart campus, Smart city; Initiatives; charecteristics

I. INTRODUCTION

The idea of smart campus came from the smart city idea which can be associated with smart grids. It is also suggested that in a heart of a smart city is a smart campus and Dr Simon Easson from IBM sum it up by saying “*Behind every smart city is a smart university*” [1]. In the recent times the world is moving towards being smart. From a smart phone, smart watch, smart TV to smart car. The word smart means the ability to show or demonstrate intelligence. The smart city is a city that intelligently interact with the people staying in it and also the environment that it is at. The same applies for a smart campus which can be described as campus that intelligently interact with students/stakeholders and the environment that it is at.

There are a lot of technological components that are associated with smart campus, from social media to smart card which will replace the student card in the bigger concept of smart campus. Even with this technology advancements the main aim of a smart campus is to make the student/stakeholders leaves better. The environment must also be the biggest benefactor. There is indeed a big relationship or similarities between smart campuses and smart cities as mentioned in [2]. There are some requirements for building a smart campus and cities, a clear vision is needed, proper and advanced infrastructure, utilization of technology and skilled workforce. In general smart campus have an upper edge on smart cities in the sense that campuses have a skilled workforce and advanced infrastructure as compared to cities. In order to build a smart campuses there is a need for a frame work that can clearly define these campuses. The research in [2] developed a matrix which will help to select efficient procedures in the development of these campuses. A model for a sustainable campus is developed in [3], this model can assist institutions of higher education in increasing the performance

of smart campuses. A roadmap of a smart campus is developed in [4], this roadmap can be extrapolated and be applied to different campuses. In [5] the smart campus is refered as an intelligent campus (iCampus). In this research the iCampus consist of six functional pillars which are evaluated in order to access their impact on the Key Performance Indicators (KPI) of the campus. There is no a definite framework for a smart campus but its characteristics will resemble that of smart city. The characteristics of a smart city are defined in the research presented in [5] were six characteristics are identified. The characteristics are as follows:

- Smart governance
- Smart people
- Smart mobility
- Smart living
- Smart Economy
- Smart Environment

The researches in [4],[5],[7],[8] also defined the characteristics of a smart campus and they both have minor difference. The naming and the grouping of the characteristic being the main differences. The research in [4] closely show the correlation of the smart campus with the characteristics given in [6]. With governance not being the primary characteristics of a smart campus because governance is considered to be part of every characteristic.

The research in this paper adapted the frameworks given [2] and [4] to be applicable to African universities. There are fundamental differences between European and African universities. For instance people and living are grouped together in European Framework while in this research they are separated because in Africa both needs a special attention. In African context smart education must be the main pillar of smart campus which is shown in figure 1.

The remainder of the paper is organized as follows. The methodology of developing a smart campus is given is section 2. Section 3 present a case study while the results and conclusion are given in section 4. The paper end by giving the conclusions which are found in section 5.

II. METHODOLOGY OF DEVELOPING A SMART CAMPUS

The methodology in this research is adopted from the methodology presented in [4]. The methodology followed start by planning how to carry on with the research and after planning the charecterisation and ideatification of the KPIs will follow. After the KPIs are finalise data collection and analysis will commence in order to score the KPIs that were formulatted.

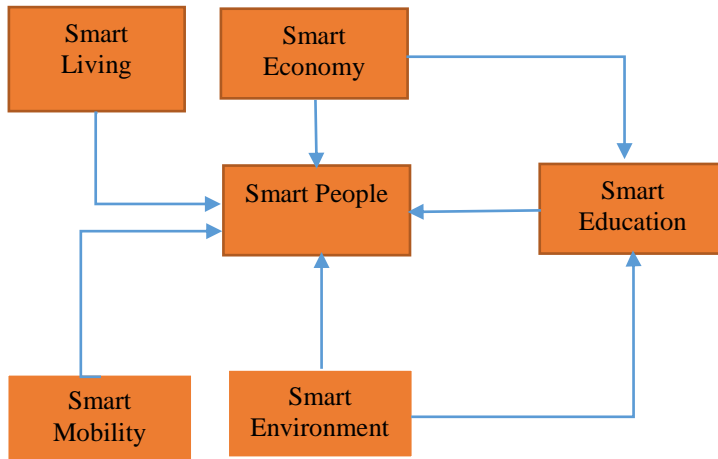


Fig. 1: Structural model of a smart campus

A. Planning phase

In the beginning of the research/project one needs to collect data that will be used to determine the campus is suitable to become a smart campus. The initial step was to conduct a walk through audit and informally interviewing some students and the university personnel, this is done in order to evaluate the status of the campus in terms of smartness. The second key step is to formally interview key personnel to find detail current and future plans regarding smart solutions.

B. Charecteristics and key performance indicators identification

The work conducted during the planning phase provided the basics of identifying the key performance indicators which will be used in the context of smart campus framework. The characteristics and the key performance indicators of a smart campus will be drafted from those of the smart city [5]. This will be used to evaluate the performance of the campus. There is no smart governance in the context of smart campus because smart governance applies to all other KPIs. There are some KPIs which will be made more feasible in the smart campus framework than they were in the smart city framework. The characteristics or KPIs of the smart campus are smart people, smart education, smart mobility, smart living, smart economy and smart environment

- **Smart Education:** The main aim of academic institutions is to give education. This is supposed to be at the center of smart campus. The smart education is the ability of a campus to employ smart solutions in order to enhance or improve the learning ability of the students and improve the performance of the researchers. There must be smart processes and systems put in place that will increase the completion rate of student and to increase the research out. The smart solutions can be implemented in terms of new and fresh ideas or by bringing new infrastructure in term of information , communication and technology (ICT)
- **Smart People:** Educational campuses aim is to educate the people. The people refers to students, staff and the visitors. Smart people should be able to interact with smart technology or they must be tech savvy. The smart people should be intelligent enough to be able to interact with the smart campus, failed for this interaction the smart campus puzzle would not be complete. The smart people together with the smart campus will form the smart community.
- **Smart Mobility:** Mobility of the people from their place of residence to campus and within campus. There is also a lot of movement between campuses of the same institution and this becomes the most problematic movement which needs a special attention. There must be a smart mode of transport with regard to smart campuses. Private and public transport should be used in a more sustainable way. In the context of smart campus public transport must be used more or it should be encouraged. Also the promotion of low carbon transportation must be encouraged.
- **Smart living:** Smart living addresses issues like the students' safety around campus residences or any accommodation mainly used by students. There should be access to school material when at the residences. The availability of health facilities like surgeries, clinics and hospital. Smart living will be the ability to receive these service by employing some smart technology. Students should be able to conduct checkups remotely some that the can save time when the need arises. There must be applications that students can use to book doctors appointment. It should be made easy to call police when the safety is compromised. One should also be able to get some warning sign if there is any danger in the surrounding. There are many intelligent solution that can be employed to making student living better.
- **Smart Economy:** In a case were an institution have multiple campuses this will apply to the whole institution. The smart way of generating

an income to the university from public or private sector by facilitating student funding in a form of bursaries and scholarships with the future view of free and quality education. Smart spending in order to drive down the education cost to the students. The ability of the campus to commercialize its research in order to generate an income.

- **Smart Environment or Green Environment:**

The characteristic of a smart campus focuses on how smart is the campus interacting with the environment. Campus should implement smart technologies that will assist in efficient use of its resources. Campus must be able to conserve, generate and use its on energy efficiently. Renewable energy sources should be considered when it comes to generation because they are environmental friendly. Other resources of environmental concern which needs smart solutions are waste management and water saving. The smart way of dealing with waste is recycling which should be encouraged in a smart campus

III. CASE STUDY- SOUTH AFRICAN UNIVERSITIES

In this research the University of Johannesburg (UJ) is considered as case study. UJ is a South African university based in Gauteng province in the heart of the metropolitan city of Johannesburg. UJ has four campus which are Doornfontein, Auckland Park Kingsway Auckland Park, the Soweto Bunting Road campus. The four campuses have a total of 45 000 square meters of the built up area. UJ have undertaken some sustainable initiatives which mostly support the smart environment. There are implementing energy efficiency and management initiatives. [10]

The following South African universities have a similar structure as UJ in term of having a multiple campus with high mobility between the campuses. University of Pretoria (UP), University of Witswatersrand (Wits), and Tshwane University of Technology (TUT).

IV. RESULTS AND DISCUSSIONS

A. *Smart Education*

UJ have introduced some smart initiatives by creating an online platform which assist in course delivery. This platform allows course coordinators/lecturers to interact by making instant announcements and uploading uploading course material. Some functionalities that this platform can offer is the ability to capture class attendance and lecturers can be able to view and book research workshops that are available. The smart solutions have been employed in the library for some time. The library have an online system were students and lecturers can be able to view books that are available. They can also borrow, place on hold and also renew books

remotely, this saves a lot of time for both the students and lecturers.

There is still a lack when it comes to solutions to support distance learning and also there still a lack in on-line course delivery (Stanford University and IIT in India are a bit ahead when it comes to on-line course delivery).

B. *Smart People*

The UJ students and staff seems to be smart enough to interact with different smart platforms that are on campuses and there are also active in different social networks. All of the have access to the internet because of the free wifi that is provided. Majority of them are tech savvy and this is supported by the fact that over 80% of them are in position of a smart device which can be either smart phone, tablet or a smart watch.

UJ support online registration for all its students and the fact that majority of the students don't find it difficult to register indicated a high level of smartness among the students. There is still a need to educate both the students and the staff to use the internet to enhance the learning & teaching abilities. For instance the students should use the wealth of online lectures that are available on the web.

C. *Smart Mobility*

UJ have a sustainable mode of transport between its four campuses, there are buses that are freely available. The problem with the buses is that there are not efficient when it comes to time, this results in delays and long ques. The other problem is that these buses still uses conventional fuels which are not environmentally friendly. There is no use of any electric cars and vehicles that utilizes clear fuels. Students seems to be the ones that utilize public transport will the lecturers turn to use their private car which contribute negatively to the environment. There is a little use of bicycles on campus which are the most environmentally friendly mode of transport.

UJ don't seem to have a policy that encourages the use of public transport between place of residence and campuses. There is no policy that restrict the number of cars that are must be allowed in the campuses. UJ must provide shuttle services from campuses to train, bus and taxi stations this will encourage staff members to make use of public transport.

D. *Smart living*

There is free wifi in campus residences which makes it possible for students to access some course materials while at their residences. In terms of security there is security at the residences but there is still a need to develop smart technologies that will make it easy for students to

communicate with security when they are in danger. There must be access to smart health for the staff and students. There are clinics at all four UJ campuses but there are no smart health solution implemented yet.

There is still a need to develop apps that will assist in providing better health solutions. There is also a need to develop apps that will be able to warn students of any danger both at campuses and residences. Other apps that can improve the students living it's the smart campus dining app which is used by students at Penn State University in the USA. The app help the students to see what is on the menu in the dining hall [9]

E. Smart Economy

UJ have managed to improve funding for the students by utilizing both public and private partnerships. Even though more funding is still need in this regard the university has made some progress. In 2012 UJ established a spinoff company with the main aim of commercializing its research out. The company have almost 20 provisional patents and developed closed to 50 advanced products. They have trained more than 340 engineering student to date.

There are also in collaboration with big companies that operate in the research and development space. They work closely with the city of Johannesburg to support it on some of its big and complicated projects. Through this company UJ have contributed positively to both Johannesburg and South African economy.

F. Smart Environment

UJ have invested heavily on the issues of sustainable environment under their flag ship of sustainability. UJ have conducted a massive energy efficiency drive over the past few years. The initiatives have been both on campuses and the university residences. The initiatives undertake was to retrofit all energy inefficient lights with Light Emitting Diodes (LED) energy efficient lighting. In order to reduce energy wastage by leaving lights on when there is no one in the lecture hall and some office the occupancy sensors were installed. Water heating is one on the high energy consumers especially in the residences. The university have installed solar heaters and heat pumps for water heating purposes. To track performances of the initiatives they use measurement and verification professionals to report of the energy savings. There is a lot that was done for energy efficiency but there is more that can be changed

The university is being moving into a direction of being self-sustainable when it comes to energy generation. Currently the university is planning to install some PV rooftops on some building to generate some energy. In a drive to push renewable

energy the university will start generating power using biogas in not so distant future.

There also great initiative with regard to waste management, there are garbage bins with different colors to able the waste separation which is very important for recycling. For water management there are smart water meters installed at the residences in order to monitor any wastage. There are plans to implement rain water harvesting techniques.

The university is committed to reducing its carbon foot print so there will be planting of tree on campuses for carbon capture.

Analysis the six characters or KPIs for the smart campus, UJ the one that is more complete for UJ or there is a lot done is the smart environment. The reason is the awareness that the university and the have embarked when it comes to sustainability. The university is planning to embark on more sustainability drives in the next few years. This will keep on strengthening the smartness of UJ's environment. There will always be a need to strengthen or improve the smartness when it comes to education because this is the number one priority of the university.

The character that is least developed is the smart living, there is a little that is been done by the university to develop it.

V. CONCLUSIONS

The framework of a smart campus have been developed to suit a typical African university. There is a little difference between the framework in this paper and the other that are found in literature. This framework will assist campus planners in designing better campus and will assist the existing campus to become more smart especially campuses in Africa.

There is still a lot of work that needs to done to finally have a fully functioning smart campus. In order for the idea of smart campus to work there is a need for good governance from management and the will to participate from the student and staff at campuses.

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