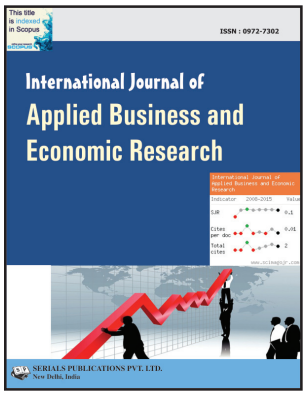

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Next Generation Indian Campuses going SMART

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Abstract: As the Internet of Things is gaining popularity and becoming a reality, of the variety of different applications the use of IoT like in logistics and transportation, healthcare, connected cars, smart cities etc., smart campus/university is probably one of the most prominent. The smart campus is one of the niche concepts that help to augment student's experience within the university. This makes it imperative to understand the smart campus dimensions and perception of respondents regarding awareness, the level of implementation of Internet of Things based smart campus initiatives. This study is based on primary survey where respondents were asked to identify importance of various Smart Campus dimensions and challenges associated with privacy in smart campus.

Keywords: Internet of Things, Smart Campus, Sensors, Smart Parking, RFID

INTRODUCTION

The Internet of Things has been gaining popularity ever since the advent of Wireless technology. The basic concept of IoT is to connect various devices using devices such as RFID, sensors, mobile phones, actuators by which these devices are able to communicate with each other (Giusto, 2010). Most of the communication in the present age of Internet is between human-human, but as technology advances, devices and objects would be able to communicate among themselves. Therefore the number of devices and objects connected to each other would be much larger than the number of humans and people (Agrawal & Vieira, 2013). Advancements in the field of nanotechnology have also played a major part in IoT gaining popularity. Nanotechnology has paved the way for new and improved sensors which act as a bridge between the physical and the information world.

The development in the trend of IoT includes three major steps: Embedded Intelligence, connectivity, and interaction. The first step embedded intelligence means that the devices can perform an action on

their own. Devices such as RFID are being used presently in the food and fashion industry to convey date and information. The controllers in washing machines and the air regulators in air conditions can work intelligently on their own and are able to make decisions based on certain rules (Pereira, 2008). Once the first step is accomplished and it is certain that the devices can work independently and on their own, the next step is to make sure that the devices are connected and integrated with each other. Since the basic concept of Internet of Things dictates that the devices should communicate to each other and not work in isolation, therefore, connectivity to various devices with each other is very essential. This can be easily done through various technologies such as Zigbee, WSN, Wi-fi, LAN, WAN, 3G etc. Even though the devices are connected to each other that does not mean that the devices would be able to communicate with each other, therefore care must be taken that the devices are integrated with each other so that they are able to share information among themselves. A rough development trend of IoT is shown below.

TECHNOLOGIES INVOLVED

Though Radio Frequency Identification RFID and sensors are the cornerstone of IoT communication there are many other technologies involved also. Some of them are mentioned below:

1. Near Field Communication(NFC)
2. Machine to Machine Communication (M2M).
3. Vehicle to Vehicle Communication (V2V)

Radio Frequency Identification (RFID)

RFID systems are generally composed of one or several RFID tags. These tags are given a specific address and then integrated with objects. These tags contain electronically stored information which the RFID reader can read, thus allowing real time monitoring without the actual need of a human presence. RFID tags are widely used in the FMCG and fashion apparel industry (Atzori, Lera & Morabito, 2010).

Near Field Communication (NFC)

NFC can be viewed as an advancement and an extension to RFID. It is basically an integration of a RFID in a mobile phone, thus making NFC very popular these days. They work on the principle of radio waves by bringing mobile phones near to each other or by touching the phones together. Though it cannot be used for long range but unlike Bluetooth technology no pairing between the devices is necessary. NFC technology is safer as data cannot be transmitted from a remote location. NFC technology is estimated to contribute heavily towards IoT in the future as it has the potential to transform mobile phones into different smart objects (Furness, 2008).

Machine to Machine Communication (M2M)

M2M communication refers to the communication between various devices. The use of M2M is increasing significantly with the advancements in the wireless and internet technology. Scientists and analysts predict that by 2020 there would be around 50 billion connected devices. M2M has found its way into many applications such as healthcare, smart robots, smart home and campus etc. (Zou, Wan, Chen,& Li, 2012).

Vehicle to Vehicle Communication (V2V)

V2V communication is a recent development in the evolution of Internet of Things. The implementation of V2V is a bit complex there is no fixed topology which can be used. V2V has been identified in many applications such as safety, collision avoidance, traffic management etc.

IoT IN A SMART CAMPUS

As the Internet of Things is gaining popularity and becoming a reality, of the variety of different applications the use of IoT in a smart campus/university is probably one of the most prominent. The concept of Smart Campus can then be implemented at a larger scale to transform a whole city by the means of connectivity. So far the concept of IoT has been effectively used in the field of Retail, Logistics, Transportation and Healthcare, but the concept of Smart Campus is slowly picking up.

Ever since the inception of magnetic strips and barcodes the use and implementation of various cards for different applications are being used. Over time the Universities in common with many organizations had introduced cards for a variety of different purposes. Some of the common type of cards include Library cards, Student ID card, Hostel cards, Laundry Cards, Canteen Cards, Special Payment related cards to be used inside the campus. At a particular instance of time a student or a faculty member would be carrying 5 to 6 different cards for different purposes. This can be change by issuing a single card known as the USCAC (Universal Smart card and Access Control).

Once the whole campus is covered via a central Wi-Fi system a majority of the applications could be taken care of such as the entry and exit of Students and Faculties. Implementing a RFID into the USCAC Card of the students and Faculty could take of the problem of when the students and faculty enter and exit the campus. The in and out timings could be monitored with ease and the administration can monitor the same without and significant efforts.

There are a wide range of uses which Internet of Things can contribute towards a Smart University. Implementing an IoT system campus wide would help and give the management an opportunity to reduce costs by improved access and monitoring thus increasing efficiency. Not only would the implementation of Internet of Things in a Campus/ University would help the administration to save costs and do long term planning it would also help the admin and the staff to automate many day to day tasks eliminating manual efforts and thus saving time and energy. Some of the main applications of IoT where studies have been conducted are described below:

Smart Car Parking

With the advancements in the V2V (vehicle to vehicle communication) on of the major application where Iot has found its way is in the field of smart car parking systems. This is true even in the context of a Campus or a University. Every big university these days has a dedicated parking space which is offered to its faculty members and students. The faculty and the students spend a lot of time and the students in finding a parking space, in the process traffic congestion is caused. This can be taken care of by implementing a smart Car parking system with the use of IoT.

A very simple model to implement a smart car parking system would include a Sensor to be fitted in a parking a lot. This sensor would be capable of collecting information about the vehicles present in the

parking lot periodically and transfer the aggregated information to a parking meter deployed in the nearby area via Wifi or Zigbee. The status can be periodically be updated on the cloud when the status of the car parking is changed (Zhanlin, Ganchev , Martin and Zhang, 2014).

The proper implementation of Car Parking system would not only help in managing the car parking efficiently but also would help to reduce the traffic jams which are generally seen in front of Campus car parking. Dedicated Parking spaces can be reserved according to the roles of the stakeholders in the campus. For example, special parking spaces can be reserved for the faculties and other important dignitaries and the space can only be provided when the particular people arrive. The information can be tracked by the ID card of the faculty, student etc. Therefore, with the use of Cloud and sensors the traffic congestion problem in a car parking system could be resolved.

Effective Water Management System

One of the major problems faced on the planet right now is the issue of water scarcity. When constructing a large campus or a university care must be taken that efficient and the optimal use of water should be done.

Since water is required in a large number of applications in a campus, from constructing buildings to watering and maintaining gardens, to filling up to water safety tanks and so on. A lot of water would be wasted if it is not used judiciously and properly which not only results in the wastage of the most precious resource available on the planet but also indirectly increases costs to the organization.

With the help of relays nodes, end nodes and gateways efficient use and detection of water levels in water tanks can be done. The circuit containing the proper elements when inserted in a water tank could gauge the current water level, the optimal water level which should always be maintained in a tank and the amount of water which can be used daily depending upon the requirements of the campus. (Verma, *et. al.*, 2015).

The information gathered from these circuits inserted in the water tanks would definitely help an organization in figuring out the total quantity of water to be stored in various seasons, the amount of water being consumed on a daily basis and the best time to water gardens so that minimum water wastage is incurred.

Tracking, Security and Surveillance

The use of RFID and Sensors can be used extensively for the Tracking and security purposes of students. Monitoring of students inside the campus can be done and their tracking data can be stored in a repository for future purposes. Moreover, the location of a student or a faculty can also be tracked in case of an emergency or an evacuation. RFID and sensors can further relay information to various security devices such as motion detectors for opening and closing of doors and windows, or to safety instruments for triggering an event (Stevens, 2011).

Unique RFID's can be inserted in the ID cards of Student and Faculties to track the behaviour and patterns of the stakeholders. It can be used effectively in managing security and ensuring that no one without the necessary access is allowed to enter the campus.

Access control restrictions can also be given depending upon the roles and responsibilities. Moreover, access control can be given to the hustlers so that only the students who have registered to stay in the hostel are able to enter the hostel and use the hostel dorms and living rooms

Automatic Roll Call of Students

One of the most common phenomenon of any classroom or a university is the act of taking manual attendance. The manual attendance process is not only time-consuming but also creates a lot of commotion in the room and is a distraction. By the effective use of RFID's and sensors a model can be created to track the ID cards of each student and the cumulative details of the class strength can be further transmitted to the admin office or to a web based system at the end of the class. If the university has a web interface for updating the attendance the information captured at the end of each lecture can be automatically updated thus reducing manual effort and thus saving time (Chang, 2011).

Smart Payment Systems

The use of RFID and sensors can be used effectively to cater to the payment needs in canteens and grocery stores in a campus. Virtual money can be stored inside the ID card of a student. The payment can be automatically debited as soon as the canteen meal has been purchased. The same concept can be applied to a smart laundry system as well.

Access Functionalities

The interconnection of devices can be used in the implementation of a smart hostel. The particular ID card of the student can be used to provide access restrictions towards certain areas of the hostel. The ID card can be substituted for a lock and key mechanism for entry inside their particular rooms and common rooms. Moreover, the night attendance and also be automatically updated by capturing the ID card details. If the location of the ID card is in the vicinity of the hostel during a particular time the hostel attendance can be automatically updated (Anwar & Mui, 2007).

Moreover, the out-pass system can also be automated from the manual paper based out pass system to a cloud-based automatic out pass system. The student can fill in the day/ night out pass online which will then be passed on to the hostel warned for verification. The QR code can then be sent to the particular phone of the student which will automatically be scanned at the time of leaving and arrival to the campus premises. The same concept of access restrictions can also be used in the space of locker management system. The respective ID card of the student can be used to open their respective lockers as well. For additional security features, an OTP code or a QR code can also be sent to the registered mobile phone number of the student (Zanella, *et. al.,* 2014)

Libraries

IoT is still at a nascent stage but it has a great potential for Libraries and library systems. With the use of RFID's and similar interacting machines information such as information of book issues to a person can be automatically recorded in the database without much human intervention and efforts. Moreover, a virtual id card can be issued to the person which would enable a person access to library and to avail the

services of the library. In case of a university, the virtual ID card can be replaced and a code can be embedded in the common ID card of the student itself (Shamprasad & Satyanarayanan, 2015). Also, having RFID's enabled on the books, CD, DVD's of the library would also help determine the in-stock issues. By proper integration of RFID's into the ID card item circulation and fine collection could be easily streamlined. Moreover, with the help of IoT technology the customers can be assisted on which books are there in the library and which book would suit their requirements based on their history of purchases. Information such as where a particular book is shelved and the different appliances present in the library can also be given.

Smart Offices and Gyms

Since, we are surrounded with various electronic gadgets which make our lives easier such as microwave ovens, refrigerators, heaters, air conditioners, fan and lights. RFID's , actuators and sensors can be installed in these devices in order to utilize the energy sufûciently and also to add more comfort in our lives. These sensors and actuators can measure the outside temperature, can determine the occupant inside a room and then can control the amount of heating/cooling and lighting thus saving energy which in the longer run would save costs. The major IoT devices such as RFID's and sensors can be connected to the various Heating Ventilation and Air Conditioning devices (HVAC) to provide optimum cooling and heating experience. IoT can be used to figure out the amount of duration an appliance should function by taking into consideration the number of people in the office and the office space. The application of IoT can also be used to enhance the Gym experience. The RFID's placed in strategic locations can help analyze the number of people currently inside the gym. Once a registered user enters the gym information such as the workout schedule to be followed that day can be displayed according to the availability of the equipments. The day wise progress information can also be provided to the user as well as the trainers which would then help them decide on the future course of training needs (Shashank Agarwal, Dario Viera, 2013).

Information Kiosks and 3D Augmented Maps of the Campus

One of the major issues for a first-time visitor to any campus is the struggle to find out where to go. With the help of IoT technology, a visitor can be given real-time information about the various facilities offered inside the campus. From the location of different departments in different buildings, to the location of canteens and the location of photocopy shops all can be provided in the form of a digital kiosk to the visitor. The visitor could just search where he wants to go and the system would be able to navigate the person to the destination (Cortez & Larios, 2015). The same information can also be displayed in the form of 3D augmented maps, the visitor's NFC- equipped phone can browse the information about the places inside a campus by connecting to an internal web service.

Smart Hostels

The integration of IoT would also be of a boon to the students specially living in **hostels**. The hostel out pass system can be automated and be moved to a digital platform wherein the students can apply for an out pass online which would go to the warden for approval. Once approved by the warden the students would receive a QR code on their registered mobile phone which can be used to enter and leave the campus. Moreover, the canteen meal system/laundry system can also be connected wherein the student can just swipe their ID card and the meal amount would be deducted from their available virtual balance. The IoT

concept can also be used in the Gyms of a campus to customize workout depending upon the health level of the participant and the availability of specific tools and equipment.

CHALLENGES

Some of the major issues and challenges that can be faced in the implementation of a Smart Campus using Internet of Things and the Internet of Things in general are:

Technological Challenges

One of the major challenges faced in the implementation of Internet of Things in a smart campus and otherwise is the role of technology. Since RFID's and sensors are the cornerstones in the implementation of the IoT, the flexibility and adaptability in terms of the technological feasibility need to be understood properly. Since every device will communicate with other devices and share date among each other it is of vital importance that the technologies between these devices match and there is cohesion between the functioning of these devices.

Another important challenge in the technological implementation of Internet of Things is the problem of network addressing. Since each device has to be addressed with an IP address, IPV4 addressing scheme is currently used, but as the IPV4 also is coming to an end very soon, IPV6 addressing scheme need to be implemented which means the sum of 128 bits to uniquely identify a device.

Another important factor while implementing IoT to keep in mind is the kind of protocol which is used to transfer information from one device to another. As in a traditional network of devices TCP (Transfer Control Protocol) is used, but in the case of IoT, TCP protocol seems to be ineffective, as the communication in IoT is generally of a very short duration , hence a considerable amount of time is wasted in the connection setup, and also the date transferred at a particular instance is generally very small (Dalal & Sunshine, 1974).

Overload and Congestion Issues

Since in the concept of Internet of Things various devices communicate with each other, there would be a large pool of data which is simultaneously been circulated. This simultaneous data from various devices can cause a peak load situation which could severely hamper the performance of the existing system.

This type of overload is typically seen in Mobile to Mobile and Vehicle to Vehicle communication. Though these type of congestion problems can be solved by advanced technologies such as using an LTE high bandwidth system but the implementation costs of such systems are huge. Moreover, good technological expertise is needed to implement the same which is generally not feasible to Campuses and Universities. The overload can even sometimes be caused by the network operator refusing to establish a connection due to high traffic (Taleb, Kunz, 2012).

Privacy Issues

One of the most important factor to deal with while implementing Internet of Things is the factor of privacy. Though the mere concept of IoT to share data between devices can indeed make our life's easier

and allows organizations to reduce costs in the longer run by proving real-time monitoring and analytics by which future planning could be done but the same concept of continuous tracking and sharing of data can be viewed as a breach of privacy by the people. For example, in an University continuous tracking of information of a student's ID card would on the one hand allow features such as automatic attendance system and automatic verification of documents and Students marks at the same time it can be viewed as a breach of privacy because the system can capture where the particular student was, at what time and with whom. The system administrator would be capable of viewing the marks and much more if he wished to.

Security Issues

Security concerns are also very important when trying to implement Internet of Things in a Smart Campus or otherwise. The mere fact that most of the IoT systems are implemented wirelessly it makes it extremely vulnerable to attack and proxy wars.

Moreover, due to the vast structure and implementation area of IoT, most of the times various areas and key socket points would remain unattended thus inviting trouble. For example in the case of a Smart Campus wherein One Universal card does all the functions from automatic attendance, to access control in hostel, libraries, and dorms, to smart canteen and fees payment, if the universal card is somehow compromised or fabricated, entire student database and data can be compromised which can lead to severe results.

There can be issues of Data Integrity and Authentication also, though encryption and cryptography like techniques are being developed to keep hackers at bay but none of these would suffice in the case of a proxy attack (Sridhar, Devi, 2011).

The Internet of Things should actually be considered as a future, where almost everything would be connected to the internet thus enabling communication between various objects, but the road to proper and practical implementation is not very easy as there are many issues and challenges to make this a reality as lots of research and technological advancements is required in this particular field. The contribution of these existing literature has provided a list of smart campus dimensions which are imperative towards implementing a fully connected campus. These factors were incorporated while framing the questionnaire for capturing primary data. The following factors were taken into consideration for the research.

Table 1
List of dimensions of IoT in a Smart Campus from Literature Reviews

• Cloud Based Document Verification	• Access control in Smart Hostels
• Smart Parking Systems	• Smart Library
• Automatic Attendance Systems	• Automated verification of admit cards
• Smart Payment of Canteens	• Access control to Smart Lockers
• Smart Payment of Laundry Services	• Real-time updates in Gym Equipment's
• Barcode based Hostel out pass system	• Surveillance/ Security
• Information Kiosks for Visitors	• E-Wallet based payments
• Enhanced Energy efficiency systems	• Privacy issues

RESEARCH METHODOLOGY

The major objective of the research is to study the implementation of different Smart Campus dimensions. This research also studies the likely difference among public and private universities/campus. The research instrument used for collecting the primary data was a self-designed questionnaire. The Questionnaire primarily consisted of close-ended questions but some open-ended questions were also present to capture the demographic information. The reliability of the questionnaire was checked using Cronbach's Alpha. The value of the alpha coefficient for the all the twenty-seven items is .839, which suggests that the items have relatively high internal consistency.

The survey was mainly conducted online but some questionnaire was filled by physical meetings as well. The data had to be collected from the main stakeholders in a Campus/University which comprise of Students, Faculty members and members of the Administration. The sample was selected on the basis of convenience sampling as the data has been collected from the Students, faculty members and members of the admins in Campuses/ Universities near Delhi-NCR. (Delhi, Gurgaon, and Noida). Though most of the responses are collected from Delhi-NCR regions but responses from all parts of the country had been incorporated for the purpose of the research. The total numbers of Questionnaires floated were more than 300 but due to certain non-sampling errors, 218 responses could be finally realized. IBM SPSS Statistics version 23, and Question Pro were used for the analysis purpose.

DATA ANALYSIS

Demographic Profile of the Respondents

Table 2
Demographic Profile of the Respondents

Profile	*Frequency*	*Percent %*	*Cumulative %*
ROLE IN THE ORGANIZATION			
Student	132	60.6	60.6
Faculty	33	15.1	75.7
Admin	53	24.3	100
Total	218	100	
TYPE OF ORGANIZATION			
Public	105	48.2	48.2
Private	113	51.8	100
Total	218	100	
GENDER			
Male	161	73.9	73.9
Female	57	26.1	100
Total	218	100	
HIGHEST EDUCATIONAL QUALIFICATION			
Graduate	101	46.3	46.3
Masters	104	47.7	94

contd. table 2

Profile	*Frequency*	*Percent %*	*Cumulative %*
Doctorate	10	4.6	98.6
Other	3	1.4	100
Total	218	100	
ANNUAL FAMILY INCOME			
0-3 lakhs	19	8.7	8.7
3-6 lakhs	18	8.3	17
6-9 lakhs	48	22	39
9 lakhs and above	133	61	100
Total	218	100	

From Table 2, it can be inferred that 60.6 % of the respondents were students, followed by Admin and Faculty members respectively with a percentage of 24.3 % and 15.1 % respectively. Most of the samples collected were from private organizations with a percentage of 51.8 %, and the rest 48.2 % samples were collected from public organizations. Most of the respondents were males with a percentage of 73.9 % and the rest of the 26.1 % were females.

47.7% of the respondents had done masters followed by Graduates, Doctorates and others with a percentage of 46.3 %, 4.6 % and 1.4% of the respondents had their family income 9 lakhs and above, 22 % of the respondents had the family income in the range of 6-9 lakhs, followed by 8.7 % of the respondents who were in the 0-3 lakhs bracket, lastly followed by 8.3 % of the respondents who were in the 3-6 lakhs bracket.

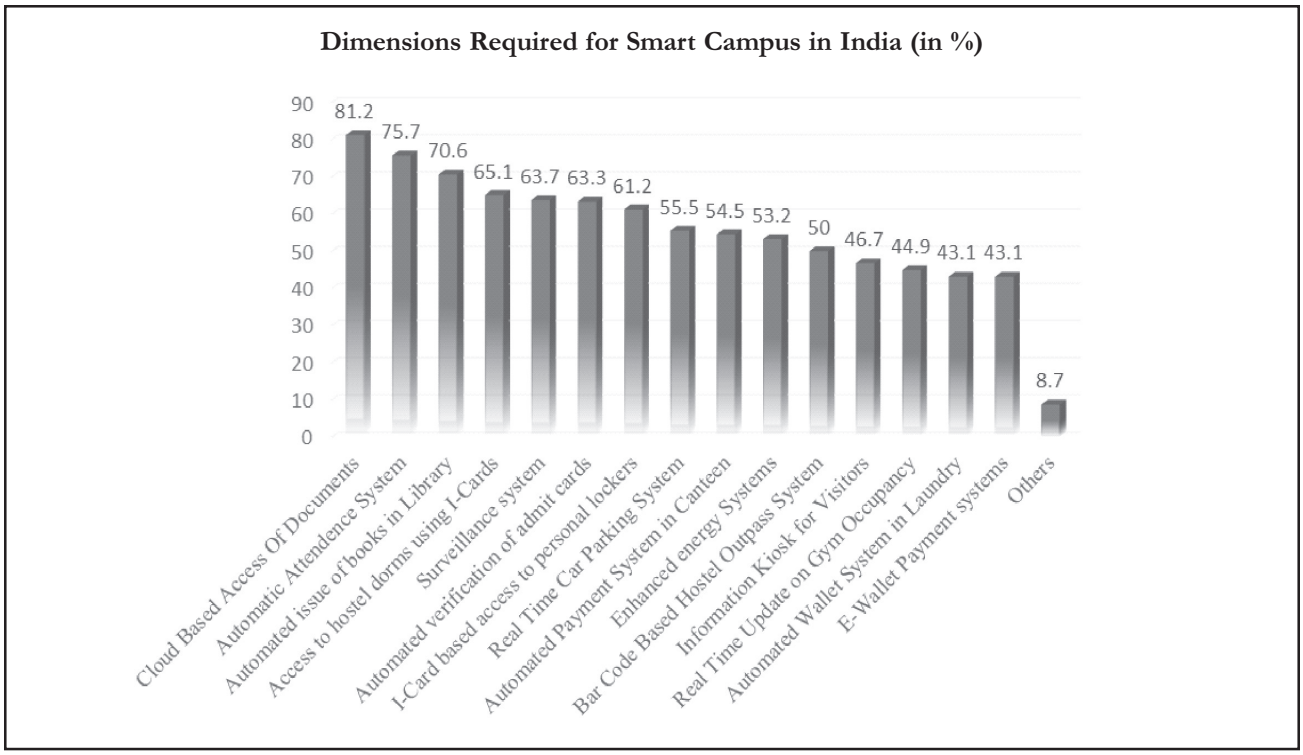

Figure 1: Parameters for Smart Campus

When respondents were asked to select various dimensions that make a smart campus; 81.2 % of the respondents thought that cloud-based access of documents was the most important parameter for a smart campus followed by Automatic attendance system, Automated Book issue in libraries and Surveillance/ Security obtaining a percent of 75.7 %, 70.6 % respectively.

Respondents were asked whether their campus was implementing Smart Campus Projects, it was found that only 28.9 percent of the respondents agreed that their campus was implementing the Smart Campus initiative, 36.7 percent of the people thought that their campus was not implementing the smart campus project whereas 34.4 percent of the respondents were not aware if their campus were adopting the smart campus initiative.

Smart campus initiative relies on the virtual workspace and on the cloud accessibility of academic services with respect to which respondents agreed that 70.2 percent of the respondents perceived that their campus could go fully virtual in the coming years whereas 29.8 percent of the respondents felt otherwise.

Table 3
Implementation of Smart campus projects with respect to type of Organization

Do you think your campus is implementing Smart campus projects? * Type of Organization? Crosstabulation

Count

		Type of Organization?		
		Public	*Private*	*Total*
Do you think your campus is implementing Smart campus projects?	Yes	17	46	63
	No	50	30	80
	Not Aware	38	37	75
Total		105	113	218

From Table 3, it can be seen that more respondents from the private organizations thought that their campus are implementing smart campus features than the respondents from the public organizations where respondents felt that their campus was implementing it found that most of the respondents felt that their campus had implemented or was working primarily on Online registration system, Automatic Attendance system, Surveillance/Security and Barcode based hostel out pass.

IMPORTANCE OF THE VARIOUS SMART CAMPUS DIMENSIONS

On doing an analysis of the means of the importance of the various parameters that constitute the dimensions of a Smart campus the following result was obtained:

From Table 4 it can be clearly seen that parameters such as Online Smart registration system, Smart Libraries, Surveillance/Security and Enhanced Energy Efficiency system are the most important factors that constitute a Smart Campus in the minds of the respondents as their means are high.

Table 4
Importance of various parameters of a Smart Campus

Importance of Parameter	*Mean*	*Std. Deviation*
Smart Parking System	3.18	1.185
Automatic Attendance System	3.85	1.106
Online Smart Registration Process	4.00	.893
Smart Payments of Canteen	3.31	1.125
Smart Laundry System	2.93	1.132
Smart Hostels	3.81	1.029
Smart Libraries	4.26	.836
Improved Gyms	3.22	1.182
Surveillance/Security	4.36	.864
Barcode based hostel Out pass	3.43	1.217
Information Kiosks for visitors	3.58	1.014
E-purse	3.37	1.104
Smart Lockers	3.66	.972
Enhanced Energy Efficiency System	4.22	.894

Table 5
Perception of Privacy of Data for Implementation of Smart Campus

	I think that data published by continuous surveillance affects my privacy	*I think that data published by constant monitoring of daily activities affects my privacy*	*I think that data published by Connected Cars affects my privacy*
Mean	3.65	3.77	3.12
Std. Deviation	1.038	1.070	1.109

IoT devices used in building smart campus raises privacy concerns which is an important issue. The respondents were asked to rate the extent to which data published by sensors affects their privacy. From the results shown in Table 5, it can be seen that data published by continuous monitoring affects the user privacy most, followed by data published by continuous surveillance and privacy is least affected by data published by connected cars.

CONCLUSION

Campuses in India are going smart to enable virtual workflow practices and improved experience for the students. This research paper presents a primary research-based analysis of data collected through the questionnaire where awareness level of on smart campus concept was relatively good which could encourage various campuses to implement smart campus dimensions which were found important by the respondents as mentioned below:

- Cloud Based Access to Documents:
- Automatic Attendance System:
- Automated Book issue System in Libraries:
- Access to Hostel Dorms using I cards:
- Surveillance/Security

The sample respondents were also asked to rate the level of implementation with regard to smart campus initiative and were found that relatively low percentage (28.9%) of the respondents thought that their campus was not implementing the Smart Campus concept. Investment is important for implementing niche initiatives like smart campus for any university and this research also tried to find the level of implementation of Smart Campus with respect to the type of Organization (Public or Private) and was found that it was better implemented in private organizations as compared to public organizations with a percentage of 40.7 % and 26.5 % respectively.

Privacy is one of the most important dimension with respect to any IoT implementation and since personal data is transmitted all the time it can be viewed as a breach of privacy and some individuals may not be comfortable with the personal data being transmitted from one device to another and with this study found that most of the respondents considered privacy of data published by various IoT sensors which form any smart city dimension as important. This finding is important for various IoT vendors which work towards developing smart campus solutions.

In the complex scenario of many in one, the application of the IoT paradigm is of particular interest, as it has become a near future reality in the minds of many institutions and universities both national governments and those in the private sector to adopt IoT solutions in the management of their enterprises.

Most of the respondent's sample were students for this research. Hence this study shows the students perception on awareness, implementation, and challenges perceived in implementing smart campus. Further studies could incorporate management level respondents from academic world and also studies based on required investments could be taken in the purview of smart campus in India.

REFERENCES

Agrawal, S., & Vieira, D. (2013), A survey on Internet of Things-DOI 10.5752/P. 2316-9451.2013 v1n2p78. *Abakós*, *1*(2), 78-95.

Anwar, T., & Mui, W. G. P. (2007), Design and Implementation of a Wireless Network System in a Smart Campus. *CommIT (Communication and Information Technology) Journal*, *1*(2), 127-139.

Atzori, L., Iera, A., & Morabito, G. (2010), The internet of things: A survey. *Computer networks*, *54*(15), 2787-2805.

Cerf, V., Dalal, Y., & Sunshine, C. (1974), *Specification of internet transmission control program* (No. RFC 675).

Chang, C. H. (2011, December), Smart classroom roll caller system with IOT architecture. In *Innovations in Bio-inspired Computing and Applications (IBICA), 2011 Second International Conference on* (pp. 356-360). IEEE.

Cortez, C. R., & Larios, V. M. (2015), Digital Interactive Kiosks Interfaces for the GDL Smart City Pilot Project.

Furness, A. (2008, December), A Framework Model for The Internet of Things. In *GRIFS/CASAGRAS Workshop, Hong Kong*.

Giusto, D. (2010), A. lera, G. Morabito, l. Atzori (Eds.) The Internet of Things. Retrieved on January 20, 2017.

Pereira, J. (2008, May), From autonomous to cooperative distributed monitoring and control: Towards the Internet of smart things. In *ERCIM Workshop on eMobility*.

Shamprasad M Pujar and K V Satyanarayanan, Internet of things and libraries ,Annal of library and information studies, Vol.62, September 2015, pp. 186-190.

Sridhar, S., & Devi, K. V. (2011, April), Nested mechanism for mutual authentication. In *Electronics Computer Technology (ICECT), 2011 3rd International Conference on* (Vol. 2, pp. 173-178). IEEE.

Stevens, A. (2011), Surveillance policies, practices and technologies in Israel and the occupied Palestinian territories: Assessing the security state. *Social Sciences and Humanities Resarch Council of Canada*.

Taleb, T., & Kunz, A. (2012), Machine type communications in 3GPP networks: potential, challenges, and solutions. *IEEE Communications Magazine*, *50*(3).

Verma, P., Kumar, A., Rathod, N., Jain, P., Mallikarjun, S., Subramanian, R., ... & Sundaresan, R. (2015, October), Towards an IoT based water management system for a campus. In *Smart Cities Conference (ISC2), 2015 IEEE First International* (pp. 1-6). IEEE.

Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014), Internet of things for smart cities. *IEEE Internet of Things journal*, *1*(1), 22-32.

Zhanlin Ji, Ivan Ganchev , Martin O'Droma and Xueji Zhang "A Cloud-Based Intelligent Car Parking Services for Smart Cities", IEEE, 2014.

Zou, C., Wan, J., Chen, M., & Li, D. (2012), Simulation modeling of cyber-physical systems exemplified by unmanned vehicles with WSNs navigation. In *Embedded and Multimedia Computing Technology and Service* (pp. 269-275). Springer Netherlands.