

**A STUDY ON INTERNET OF THINGS (IOT) APPLICATIONS OF SMART
CAMPUS IN DIU**

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This Report Presented in Partial Fulfillment of the Requirements for the
Degree of Masters of Science in Computer Science and Engineering

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DAFFODIL INTERNATIONAL UNIVERSITY

DHAKA, BANGLADESH

2019

APPROVAL

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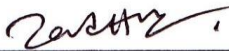
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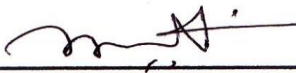
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I hereby declare that, this thesis has been done by me under the supervision of **Dr. Sheak Rashed Haider Noori, Associate Professor, Department of CSE** Daffodil International University. I also declare that neither this thesis nor any part of this thesis has been submitted elsewhere for award of any degree or diploma.

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ACKNOWLEDGEMENT

First I express my heartiest thanks and gratefulness to almighty Allah for his divine blessing made me possible to complete the final thesis successfully, May Allah's blessings and peace be up on my great teacher and messenger, Mohammed, who taught us the purpose of life.

I am really grateful and wish my profound indebtedness to my Supervisor **Dr. Sheak Rashed Haider Noori. Associate professor & Associate Head**, Department of CSE, Daffodil International University, Dhaka. For the deep knowledge & keen interest of my supervisor in the field of "*Internet of Things*" to carry out this thesis. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this thesis.

Besides my supervisor, I would like to express my heartiest gratitude to **Dr. Syed Akhter Hossain, professor & Head of Department of Computer Science and Engineering**, for giving me an opportunity to carry out the research work, and also to other faculty members and the staff of CSE department, Daffodil International University.

I thank my fellow colleagues and friends for the stimulating discussions, for the constructive criticism and for the hours of hard working together before deadlines, and for all the fun we have had throughout the last year.

Last but not the least, I would like to express my heartfelt gratitude and thanks to my family, my parents and my brothers and sister for their endless and spiritual support and prayers during my master study and throughout my entire life.

DEDICATION

I dedicate my dissertation work to my family and my friends. A special feeling of gratitude to my loving parents, My beloved Mother **Rukia Adam Hussein** a strong and gently soul who taught me to trust in Allah, believe in myself, dedication, hard work and that so much could be done with little and that her words of encouragement and push for tenacity ring in my ears each second.

I also dedicate this thesis to my brothers and sisters; particularly my dearest brother, my right wing, **Ali Haji Ibrahim**, for his heartfelt and endless support and my dear sister **Luul Haji Ibrahim** who stands by me when things look bleak. To all my family, the symbol of love and giving.

My colleagues, my friends and my roommates who encouraged and support me. I specially dedicate this research to my best friends **Sadia Hassan Ahmed, Mohamed Idris, Mohamed Yusuf Mohamed and Abdulkadir Hassan Mohamed** whom impressed this book and interest in constantly supporting and also for their inspirations.

ABSTRACT

In the recent years, innovation is affecting the learning knowledge from numerous points of view. Internet of Things (IoT) keeps on affirming its critical position with regards to Information and Communication Technologies (ICT) and the advancement of society. The motivation behind this research is to discover the capability of IoT in advanced education particularly in smart university campuses and how to expand its advantages and lessening the dangers associated with it. This research carried out a survey that examined the awareness of IoT and smart learning environment among all university stakeholders. And this survey also evaluated the extent of smartness of the current DIU campuses. All stakeholders have underlined that the university campus is not yet connected, they also expressed the necessity of IoT in education for a smart learning environment. Finally, IoT-driven learning environment requires a higher level of cooperation among administration, staff individuals, and students. Just with full commitment all things considered and their readiness to participate and work together, the possibility of the totally upgraded learning sector, innovation bolstered and financially economical is conceivable. Along these lines, the intensity of cooperation, individuals, and innovation in the modernization of the educational area with smart campuses and the utilization of completely IoT-based shared and collaborative instructive and educational practices is the main topic of research.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Today, because of the fast advancement and the developments in innovation, objects around us are getting to be more smart or connected and different businesses are getting disturbed. In any case, when contrasted areas like home automation, modern computerization and so forth, educational sector has not been in the front edge of receiving most recent advances.

The Internet of Things (IoT), the new innovative worldview is overcoming the whole world by connecting different objects around us. But as it is said prior, educational sector is falling back in utilizing IoT.

In any case, today, this began changing gradually as different educational organizations are currently understanding the centrality of presenting innovative technology, particularly IoT, into their day by day strategies and tiding their condition, Very soon, numerous colleges will have IoT implanted into their everyday exercises [1].

The thoughts of smart university (SU), connected campus (CC), intelligent classroom (IC), Smart learning environment (SLE), and related points turned into the fundamental topics of different spearheading global and national occasions and extends, administrative and corporate activities, institutional motivation, and key plans.

Smart Universities (SU) and smart Campuses (SC) can make various open doors for students and researchers to learn material in an assortment of ways. Also, they can offer access to materials in several ways [2].

1.2 Motivations

In the light of the new advancements in Internet of Things (IoT) made the degree it covers progressively increasing. With the increase of the number of the associations that have adopted or started adopting IoT based environments and remaining will adopt it. Internet of Things (IoT) advantages to all, for example people, social, organizations, businesses instruction divisions and so on.

Internet of Things (IoT) is labeling our everyday items and exercises with the assistance of machine-decipherable labels. Universities seem to be the perfect spot for making of smart environment.

1.3 Rationale of the Study

While thousands of studies have been recently conducted to study various aspects of IoT, this topic as far from being hot as a research area. Specifically, new studies can be conducted in the area of IoT in education to analyze the impacts of intelligent devices, connected objects and the overall emerging technology on education. The practical implications of this research relates to assisting high educational institution aiming to enter the new era of smart educational environments by reducing costs, increasing revenue, engaging stakeholders and improving their contribution in the scientific research.

I associate my career aspirations with becoming an IT professional, and accordingly, conducting a research in this topic can lead me gaining in-depth knowledge and motivation in this field to contribute my chances of success in this chosen career path.

1.4 Problem Statement

The Internet of Things (IoT) is seen as a valuable means of gathering data, connecting the daily objects with the use of machine-readable tags, and universities are eagerly leveraging this concept to smarten the learning environment and enhance the students' experience both indoor and outdoor.

Improving university and student experience helps the university fuel further innovation and stay on the cutting edge of research and technical advancements, driving a positive feedback cycle that is not bound to slow down any time soon.

However, there are many economical and technical challenges, such as security, connectivity, compatibility, longevity, standards and intelligent analysis.

In response to the above mentioned problems this dissertation proposes to investigate several applications of IoT in smart university, as this research plans to carry out a study of how

Daffodil International University is currently implementing the IoT technology and how to improve as well as ways to overcome the existing challenges.

1.5 Research Purpose

The purpose of this study is to explore and understand the various enabling IoT technologies that can be utilized in university environments to make it smart. And also to know about smart university and smart student concepts by examining the recent IoT applications possible to make learning environments smart.

1.6 Research Objectives

The objectives of this study are:

- To examine the extent of awareness of Daffodil International University (DIU) students and teachers about IoT based smart campus.
- To examine how DIU is implementing the IoT based technologies.
- To understand use of different IoT applications in smart campus.
- To assess the existing applications for smart campus in DIU.

1.7 Research Questions

1. What are the different IoT applications used in university campuses?
2. How Daffodil International University is capable of using IoT technologies to make smart campus and smart learning/teaching environment?
3. What are the existing IoT applications used by DIU?

1.8 Significance of the Research

IoT is applied in numerous businesses sectors including financial, travel, education, telecomm-unication, etc. With regards to adopting IoT in the learning sector, the real reason is simply the IoT upgrades the education and gives propelled and incentive to the structures of the education. A smart campus (a campus that utilizes IoT), with the offices working easily advances a larger amount of customized learning. The connected gadgets utilized in a campus use Wi-Fi for getting directions and sending information.

A computational IoT sensory system for universities and schools monitors significant assets, make more intelligent research and showing plans, structure secure grounds, improve data access, and considerably more. With its arrangement of cutting edge instruments, IoT can be viewed as another technique for colleges.

1.9 Scope of the Study

The scope of this study (A study of IoT applications on smart university campus) is Daffodil International University (DIU) and the observational units of this study are the students, teachers and the university administration. The period of this study is the academic year of 2018/2019.

1.10 Report Layout

Chapter one: represents introduction of the study, motivations, problem definition, research objectives, research questions, significance of the study, scope of the study and report layout.

Chapter two: conceptual framework, background and literature review.

Chapter three: research methodology, research population, research instruments, data collection procedures, reliability and validity of the instruments and data analysis.

Chapter four: data presentation, analysis and interpretation, demographic responses and background of the respondents.

Chapter five: summary, findings and conclusion.

CHAPTER 2

BACKGROUND

2.1 Introduction

This chapter will discuss about the literature review and the background of this study, where I will bring some of the most recent and hot topics of IoT and smart campus that has been carried out by researchers.

2.2 Literature review

In this paper, the author divides the whole system into three layers. The IoT is import some portion of new data and it interfaces everything through RFID, sensors QR code and constant situating innovation and understands the wise distinguishing proof of area and the board for merchandise, IoT of instruction completely sees the specialists, assets and gear's of school in a perceptual layer. At that point the system layer is in charge of solid transmission of data from perceptual layer, at that point IoT understands the clever investigation, early admonitions and insightful planning for application layer. Here the secluded frameworks, for example, instructive administration framework, fund the executives framework and office the executives framework are coordinated by IoT innovation. This paper focuses on office the executives more than on educational or research [3].

The author here focuses on the campuses that are spread over fairly large area and it is difficult to control for management to track everything happened. This paper educates us regarding the need of receiving IoT innovation in campus utilizing verified savvy framework for campus scholastics. In this framework sensors are empowered and arrange gadgets work constantly and cooperatively to give people more solace. The brilliant homeroom gathers data, stores it as digitalized information in a memory of e-grounds stage. Here stage is made for entrancing learning by methods for keen study hall environment and security for e-grounds. The paper essentially considers the security angles abandoning numerous other critical features [4].

The author here mainly describes IoT enabled classrooms in which data collection can be made possible by using devices for e-learning application. The information is brought continuously movement. The smart classroom information are put away in advanced information e-learning stage. Students outside the classroom can get to subject information notes utilizing data sharing showcase board and it tends to be constrained by directors for including refreshes. Utilizing IoT learning application gives basic and financially savvy notes to any side of the world. The creator here says the proficient method for structuring keen learning through IoT. It in this way plausible collaboration to quickly expanding auspicious conveyance of subject notes, simple method for learning and information comes to expediently. This paper concentrates just on improving viable method for classroom showing system not towards smart campus [5].

Smart University. Tikhomirov in (6) presented his vision of smart education as follows: “Smart University is an idea that includes a thorough modernization of every single instructive procedure. ... The smart instruction can give another university, where a lot of ICT and personnel prompts all together new nature of the procedures and results of the instructive, research, business and other university exercises. ... The idea of Smart in training territory involves the development of advancements, for example, smart sheets, smart screens and remote Internet access from all over the place” [6].

Smart Learning Environments. Hwang (7) presented a concept of smart learning environments “... that can be viewed as the innovation bolstered learning conditions that make adjustments and give proper help (e.g., direction, input, insights or instruments) in the correct spots and at the opportune time dependent on individual learners' needs, which may be resolved by means of breaking down their learning practices, execution and the on the web and certifiable settings in which they are arranged. ... (1) A smart learning condition is setting mindful; that is, the student's circumstance or the settings of this present reality condition in which the student is found are detected... (2) A smart learning condition can offer moment and versatile help to learners by prompt examinations of the requirements of individual learners from alternate points of view... (3) A smart learning condition can adjust the UI (i.e., the methods for showing data) and the subject substance to meet the individual

elements (e.g., learning styles and inclinations) and learning status (e.g., learning execution) of individual learners” [7].

Smart Education. IBM (8) defines smart education as follows: “A smart, multi-disciplinary student-centric instruction framework—connected crosswise over schools, tertiary foundations and workforce preparing, utilizing: (1) versatile learning projects and learning portfolios for understudies, (2) community advancements and computerized learning assets for instructors and understudies, (3) modernized organization, observing and answering to keep educators in the classroom, (4) better data on our learners, (5) web based learning assets for understudies all over” [8].

Smart Campus. Kwok (9) defines intelligent campus (i-campus) as “... another worldview of reasoning relating to a comprehensive keen campus condition which incorporates in any event, yet not restricted to, a few subjects of campus knowledge, for example, all-encompassing e-learning, person to person communication and interchanges for work coordinated effort, green and ICT maintainability with insightful sensor the executives frameworks, defensive and protection medicinal services, smart structure the executives with computerized security control and observation, and unmistakable campus administration and announcing” [9].

Smart Teachers. Abueyalaman, contends that "A smart campus depends upon a bigger strategy including people, offices, and nonstop staff bolster similarly as suitable use of advancement... A splendid grounds passes on clever instructors and gives them shrewd gadgets and nonstop help to do their duties while looking over their informational sufficiency using sharp evaluation outlines” [10].

Smart Learning Communities. Adamko et al. Describe features of smart learning community applications as follows: “... the necessities of the smart network applications are the accompanying: (1) reasonable—the earth is detected by sensors; (2) connectable—organizing gadgets convey the detecting data to the web; (3) available—the data is distributed on the web, and open to the clients; (4) universal—the clients can gain admittance to the data through the web, yet more significantly in portable whenever and wherever; (5) amiable—a client can distribute the data through his interpersonal organization; (6)

sharable—the information, yet the article itself must be open and addressable; (7) noticeable/increased—make the concealed data seen by retrofitting the physical condition”[10].

Pishva and Nishantha, Define a smart classroom as an intelligent classroom for educators associated with inaccessible training that empowers instructors to utilize a genuine classroom type instructing way to deal with teach far off understudies. "Smart study halls coordinate voice-acknowledgment, PC vision, and different advancements, all in all alluded to as keen specialists, to give a tele-training background like a conventional classroom experience” [10].

2.3 Background of IoT and Smart Environment

2.3.1 Concept of IoT

Kevin Ashton firstly proposed the concept of IoT in 1999 where IoT was referred as unique recognizable bury operable associated objects with radio-frequency identifier (RFID) innovation. Be that as it may, the meaning of IoT is as yet developing but then to develop. IoT was recognized as a dynamic worldwide system framework that is fit for self-design dependent on principles and interoperable correspondence conventions. Things in IoT could be physical or virtual which have characters and traits and are fit for utilizing smart interfaces and speak with an IP network [11].

2.3.2 The Internet of Things Application Areas:

The IoT can be applied in a whole range of domains as follows:

1. Medical and Healthcare Technology:

The IoT has diversity applications in the medical sector. These may include wearable things to detect reaction to drugs in patients. IoT is also used in the managing and measuring of important functionalities of the body such as temperature, blood pressure, heart beat, and cholesterol levels and to stimulate the heart muscle in case of a heart attack or failure and various disease.

2. Retail, Logistics and Supply Chain Management:

Implementing the IoT in retail, logistics and supply chain management has its own greater advantages. IoT can be used to control the current present items in real-time to inform when to make new orders. Immediate payment solutions can be offered through tag reading check-out points. IoT provides the opportunity to trace goods across the supply chain, so that recalls can be issued when quality problems arise.

3. Transport:

The IoT provides a number of solutions in transportation. Some of the application areas for IoT in transport includes: Toll systems, screening of passengers and goods on an aero plane to meet security requirements, managing traffic jams, and automated tracking of passengers and cargo.

4. Insurance:

In car insurance, electronic car recorders are attached in cars to record speed, acceleration and send the information to the insurer to assess the risk.

5. Energy:

The Bits to Energy Lab, a joint research activity of the ETH Zurich and the University of St. Gallen in Switzerland, through its Amphiro venture have built up a smart water meter that gives input on water utilization legitimately at singular fixtures or shower heads. The gadget catches stream rate and temperature and infers the measure of water extricated, vitality utilized and carbon dioxide produced.

6. Information Security:

The advanced research on information security and privacy project (ARES) which is funded by the Spanish Ministry of Science seeks to bring security to the information society while preserving individual rights. It focuses on three intertwined application scenarios, that is, ubiquitous computing with emphasis on wireless sensor networks and RFID, protection of critical information infrastructures and secure electronic commerce and digital content distribution, while tackling different tactical challenges in the areas of cryptology, smart

cards, personal identification and biometrics, access control and authentication, network security and trust generation.

7. Home Automation:

As modest remote applications become bottomless, the scope of utilizations expands. For instance, smart metering is turned out to be mainstream for estimating vitality utilization and transmitting the data to the vitality supplier. Sensors for temperature and stickiness give the information to consequently modify comfort levels in a room.

8. Environment Monitoring:

Remote gadgets progressively utilized in green-related applications and ecological preservation are a promising business sector later on. Remote seeing of timberland fires, possible results of shakes, potential floods and tainting decline natural risks. The remote business offers the opportunity to screen oil personnel in fundamental conditions, the accompanying of holders and the acknowledgment of gas and oil slicks as a technique for lessening the threat of setbacks.

Manufacturing:

By linking items with connected smart devices or through unique identifiers that can interact with a smart supporting network infrastructure, production processes can be optimized.

9. Agriculture:

During outbreak of disease, real-time detection of the movement of animals through RFID tags becomes handy. To improve the efficiency of agricultural production, agricultural mechanization is a key measure.

10. Telecommunications:

The IoT creates the possibility of merging different technologies such as Global System for Mobile Communications (GSM), Near-Field Communications (NFC), Bluetooth, Global Positioning Systems (GPS), sensor networks, etc. to create new services. The border between IoT and telecommunications blurs in the long term.

11. Education:

IoT can be used in various part of education sector. Starting from taking attendance of the students, instructive asset referencing, advanced note manifestations, dissemination, sharing and so forth learning recommendation, and assessment IoT can assume an essential job in educating learning component. Since IoT is interfacing effectively existing system gadgets with recently developing smart things is making an expansive extent of use in instruction.

2.3.3. Smart University Concept using IoT

Smart university doesn't have a formal and broadly accepted definition, the fundamental idea is to build up a university campus utilizing IoT that uses the assets productively, convey brilliant administrations and security to the campus network, while the operational expense gets decreased. Smart University can bring various advantages, for example, give an intuitive situation to understudies and personnel, advance smart vitality and waste administration, bring successful observation framework and ongoing episodes admonitions, mechanize support, effective stopping framework and give secure installments frameworks.

[11]

A. Needs of Smart Campus:

A university campus is defined like a small world where ordinary a large number of students, instructors, officers, guests are available bunny. Checking and keeping up every one of those people groups with their subtleties and revealing much of the time are unrealistic constantly the time. Yet, in a shrewd college grounds utilizing IoT everything not, except numerous issues can be settled. It is workable for the utilization of improved sensors innovation. "The Internet of Things (IoT) will make a huge difference, activities and challenges from simple to the most baffling, and why not, even us individuals. Other than districts as business, transportation, essentialness, drug, agriculture and others, the Internet of Things will in like manner have a vital ramifications in instruction." [11].

B. List of IoT Enabled Services in a Smart Campus:

All possible IoT enabled services in several sectors of a smart campus are describe below.

- 1) Smart IoT Enabled Classroom: Classrooms are all around finished by new learning advances and gadgets which make it feasible for figuring out how to whenever to anyplace for understudies.
- 2) IoT Based Hotspot For Campus: The greater part of the learning point or shared purpose of a campus are associated with a system under an IoT based hotspot, which are effectively open for understudy.
- 3) Smart Inventory: Each bit of segment (CPU, printer, scanner, copier and so on.) can have a related standardized tag which speaks to stock number and a QR tag. Utilizing a gadget associated with the web with a standardized tag peruser this gear can be related to a scanner tag peruser this hardware can be recognized and it very well may probably show all related data.
- 4) Smart Parking: monitoring of the university's parking framework and discovering subtleties data and current position about the vehicles of the University for Proper Utilization.
- 5) Automated Street Light: An accumulation of electric lights are utilized in a university campus which expend a great deal of power. Consequently sensor light alters the electric lights dependent on the information sent by an outside sensor, which will decrease power utilization.
- 6) GSM Based Alerts: GSM based alert system send alerts to the authority if any unauthorized persons or unauthorized task occurred in the campus.

C. Type Of Sensors Used in Smart-Campus

Each part or zone of a smart campus utilizing IoT are associated with Sensors and new advances which can be sent information or report every single time under a few conditions for make fundamental stride for the distinguished conditions. A portion of the related sensors are given below:

- 1) Temperature: Thermistors, thermocouples, RTD's, IC and some more.
- 2) Pressure: Fiber optic, vacuum, versatile fluid based manometers, LVDT, electronic.
- 3) Flow: Electromagnetic, differential weight, positional relocation, warm mass, and so forth.
- 4) Level Sensors: Differential weight, ultrasonic radio recurrence, radar, warm relocation, and so forth.
- 5) Proximity and Displacement: LVDT, photoelectric, capacitive, attractive, ultrasonic.
- 6) Biosensors: Electrochemical, surface Plasmon reverberation, light addressable potentiometric.
- 7) Image: Charge coupled gadgets, CMOS.
- 8) Gas and Fire: Semiconductor, Infrared, Conductance, Electrochemical.
- 9) Others: Moisture, stickiness sensor, Speed sensor, mass, Tilt sensor, constrain, thickness.

2.4 Challenges in deploying IoT

2.4.1 Security

Security is a pivotal issue on the Internet, and it is presumably the hugest test for the IoT. When you increment the quantity of associated gadgets, the quantity of chances to misuse vulnerabilities through ineffectively structured gadgets can open client's information to burglary, particularly when the information streams are left with deficient insurance. In specific cases, it might even damage the security and strength of individuals.

There are different IoT game plans that moreover have gatherings of close unclear or undefined devices. This intensifies the impact of any one security weakness by the amount of devices that all have similar traits.

2.4.2 Privacy

The Internet of Things exhibits some exceptional difficulties with regards to protection, and a ton of that goes a long ways past the information security issues that exist as of now. Quite a bit of this is a result of the inconvenience coordinating gadgets into the conditions without individuals utilizing them deliberately. This is winding up significantly progressively predominant with regards to purchaser gadgets, for example, GPS beacons for vehicles and telephones and furthermore smart TVs. Truly, your TV will before long be smarter than you. Lowering, isn't that so?

Vision features and voice affirmation are right now being joined into adroit TVs. These features can listen constantly to discourses or scan for development and transmit data explicitly to cloud organizations for taking care of. These cloud organizations may all over even join outcasts. The aggregation of this information faces different regulatory and authentic challenges.

Aside from this, there are various IoT situations that include the information accumulation and the sending of gadgets with a worldwide or global extension that crosses social and social limits. However, I don't get this' meaning for the improvement of extensively appropriate security assurance models? In the event that we are to understand the chances of

the Internet of Things, techniques will must be built up that regard the individual security decisions while cultivating advancement for new administrations and innovations.

2.4.3 Standards

A lack of documented or standard best practices has had a much larger impact on Internet of Things devices that goes well past just constraining their improvement and potential. A nonappearance of gauges may well empower unseemly conduct by IoT gadgets. Without the correct guidelines to direct and control makers, engineers may structure items that work in any number of problematic ways online without respect for their effect. On the off chance that they are arranged or planned inadequately, these gadgets may have negative ramifications for systems administration assets they associate with and, in the more extensive picture, the Internet itself.

A great deal of this is brought about by cost limitations just as the need to create items and get them to showcase before their rivals. When you include the troubles of arranging and dealing with countless gadgets, the requirement for institutionalization of strategies, interfaces, setup apparatuses, and astute plan, alongside IPv6 appropriation, is fundamental for what's to come.

2.4.4 Regulations

Just like privacy, there are a number of legal and regulatory questions that surround the Internet of Things. This also needs some thoughtful consideration.

Lawful issues concerning Internet of Things gadgets aren't constrained to potential infringement of social liberties as a result of law-implementation observation.

Different issues that must be considered are cross-outskirt information stream, lawful obligation with regards to unintended use, protection slips and security ruptures. Likewise, innovation is progressing at an a lot quicker pace than administrative arrangements, and the organizations accused of setting and regulating IoT rules can't keep up.

2.4.5 Development

The broad degree of the IoT challenges won't be kept to industrialized countries. Truly, the IoT has a great deal of affirmation as for passing on cash related and social good conditions for making and making economies. Like the remainder of the world, the less-made district should address the approach prerequisites, specific tendency necessities, and market openness to manhandle the capacity of IoT. This is a colossal server issue and needs enormous scale server farms to manage all of the data. You ought to have a lightweight framework that can perfectly trade data among servers and contraptions. If IoT devices are sent without authentic reasoning ahead, there will be a great deal of past the final turning point bits of knowing the past when they cause unintended demolition. Having a versatile IoT compose that can interface servers and contraptions is fundamental for any huge scale IoT applications. It is basic to consider the above challenges just as to clarify them. For whatever period of time that these issues are would in general before setting up the establishment, everything should be fine. In case they aren't, get ready for a terrible ride.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter will focus the study methodology which will incorporate the research design and inquire about subject and instrumentation, information accumulation system, measurable investigation, unwavering quality and legitimacy of the information gathered and the strategies utilized for social event of the information.

3.2 Research Design

A research design is the general course of action or system for coordinating an investigation. The scientist picked a survey investigation structure since it best served to react to the request and the purposes behind the examination.

The review is one in which a social affair of people or things is considered by get-together and separating data from only two or three people or things saw as illustrative of the entire populace. Expressive and inferential experiences would be used for separating data and deciphering the eventual outcomes of the "A Study on IoT uses of Smart University campus in DIU".

3.3 Research Population

Although, this study intends to carry out a "Comparative Study on IoT applications of Smart University campus in DIU", the target population selected was 160 respondents, this population was divided into three groups these groups were.

1. DIU students,
2. DIU teachers and
3. DIU staff and administration.

The research population one (students) was selected to know their understanding of the IoT and reflect on the ways it could potentially be used in teaching and learning in the smart university environment.

Group two and three population (DIU teachers and Staff/Administration) were selected because they have relevant information and also understand if there are obstacles and limitations in implementing IoT based smart university campus.

Sample Size

The sample size consisted of 160 respondents including students, teachers and the staff and administration of DIU University.

The researcher distributed the sample size as 100 for students and 25 for teachers and 35 for DIU staff and management.

3.4 Research Instrument

Research instrument is characterized as the tools to be utilized for gathering information and how those apparatuses will be created. The most notable instruments for data assembling in enlightening inquires about are overviews that incorporate surveys, meetings, recognition, and record examination. Regardless, the scientist of this investigation used a survey instrument as essential device for social occasion data, which is used in quantitative research. Review may be described as an arrangement of data assembling in which each individual is drawn nearer to respond to a comparative game plan of request in destined solicitation.

3.4.1 Validity and Reliability of the Instrument

Validity refers to how much information accumulation technique precisely measures what it was required to measure or to how much investigate revelations are about what they are affirmed to be fixing in with According to Validity or authenticity demonstrates to how much examine results can be definitely made an interpretation of and summed up to various masses. It's how much analyze instruments measure what they are intended to check. Describes reliability as "how much outcomes are dependable after some time and a careful depiction of the hard and fast masses under examination is suggested as relentless quality and if the results of an examination can be reproduced under a similar reasoning then the investigation instrument is seen as strong. With the objective that authenticity and steady quality are basic for this investigation to be exact.

Along these lines, the researcher of this dissertation utilized adjusted questionnaire which has just been tried by different analysts. So as to upgrade and guarantee the instrument's legitimacy and dependability, the analyst utilized pilot test.

3.5 Data Collection Procedure

After the pilot testing and every vital alteration, the surveys were controlled straight forwardly to the picked test for the investigation. One hundred and sixty copies of the questionnaire survey given out were successfully filled and returned. The likelihood of collecting back all the survey was because of the researchers colleagues who offered some assistance.

3.6 Data Analysis

Descriptive statistical measures such as frequencies, percentages and central tendencies will be used to analyze close ended questions. The outcomes will be displayed in tables, there after information will be classified and dissected utilizing frequencies, rates, mean scores and standard deviation measures with the assistance of SPSS computer programming application (Statistical Package for Social Sciences). Cross-classification investigation will likewise be connected to start any connections between the Dependent and free factors.

3.7 Ethical Considerations.

In this study, the researcher kept the ethical issues through the research study by keeping the Privacy, confidentiality, and anonymity of the respondents in order to keep their privacy saver. To maintain ethical issues, the researcher used the information obtained from the respondents only for academic purposes.

3.8 Study Limitations

Limitations are obstructions or projected restrictions or potential weaknesses of the study imposed by the methodology of the study. The limitation of this study was time and lack of theory that supports this study as IoT is a hot topic that most of the population have no clear idea about it.

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Introduction

This chapter will cover the results of the study. Data analysis and interpreted results of the survey will also be presented and discussed. The data analysis and interpretation will be based on the aim and objectives of the research carried out which was entitled “A Study on IoT applications in smart University campus of DIU”.

Analysis of the collected data was computed using frequency and percentages and the results were presented using tables, graphs and charts.

4.2 Experimental Results

As stated in the previous chapter, the researcher selected a sample of 160 respondents. The respondents were three different categories which are 100 students, 25 teachers and 35 of the staff and administration of Daffodil International University. Based on three different respondents, a survey of three different questionnaires was carried out to find the extent of awareness of IoT and limitations in implementing smart campuses in the university. This survey questionnaire consisted of background information, awareness scale, importance of the connected campus and problems or scares related to privacy and security issues.

For the better understanding the results of the students’ questionnaire were divided into the following:

1. Background information.
2. Awareness of IoT.
3. Extent of smartness or connectedness of the current university campuses.
4. IoT applications that are currently implemented in the campus.
5. Important technologies that must be provided.
6. Rating how IoT technologies will invade students’ privacy.

The questionnaires of the teachers and staff/administration were somewhat similar in background and some general awareness questions with some different questions regarding to their different roles and activities in the university.

4.3 Descriptive Analysis

A descriptive analysis is a summary statistic that quantitatively describes or summarizes features of a collection of information.

Descriptive statistics provide simple summaries about the sample and about the observations that have been made. Such summaries may be either quantitative, i.e. summary statistics, or visual, i.e. graphs [1].

4.3.1 Demographic Information

Table 4.1 Demographic Information of Students

Gender			Age			Education level			Job title		
	N	%		N	%		N	%		N	%
Male	68	68	15—25	57	57	Bachelor	57	57	Student	100	100
Female	32	32	26—35	43	43	Master	43	43			
Total	100	100	Total	100	100	Total	100	100	Total	100	100

Table 4.2 Demographic Information of Teachers

Gender			Age			Education level			Job title		
	N	%		N	%		N	%		N	%
									Lecturer	3	12
Male	19	76	20--29	18	72	Master	21	84	Sen. Lecturer	10	40
Female	6	24	30--39	7	28	PhD	4	16	Assistant Prof	12	48
Total	25	100	Total	25	100	Total	25	100	Total	25	100

Table 4.3 Demographic Information of staff and administration

Gender			Age			Education level			Job title		
	N	%		N	%		N	%		N	%
			20—29	16	45.7	Bachelor	5	14	Manager	21	60
									Provost	2	5.7
Male	21	60	30—39	17	48.6	Master	29	83	Librarian	3	8.6
									Director	4	11.4
Female	14	40	40—49	2	5.7	PhD	1	3	CIO/CTO/IT	4	11.4
									Other	1	2.9
Total	35	100	Total	35	100	Total	35	100	Total	35	100

The above three tables summarize the demographic information of the research population. The gender section there was 68% and 32% of male and female students respectively, 19 (76%) and 6 (24%) of male and female teachers respectively and 21(60%) and 14(40%) of male and female staff respectively.

In the above mentioned three tables also summarized the age, education level and job title of all respondents.

4.3.2 Students' Awareness of IoT and Smart University

Table 4.4 Familiarity with the IoT term

	Frequency	Percent	Valid Percent	Cumulative Percent
Never heard of it	9	9	9	9
I have General idea about it	54	54	54	63
Read about it in courses and research papers	23	23	23	86
Doing research in this area	14	14	14	100
Total	100	100	100	

The above table shows how familiar the students are the concept of IoT. 9% of the respondents answered that they never heard of the term IoT, 54% of the respondents have a general idea about this technology, 23% of the respondents read research papers and course notes about IoT and 14% of the respondents are doing research in this field.

The below figure represents the graph of table 4.4.

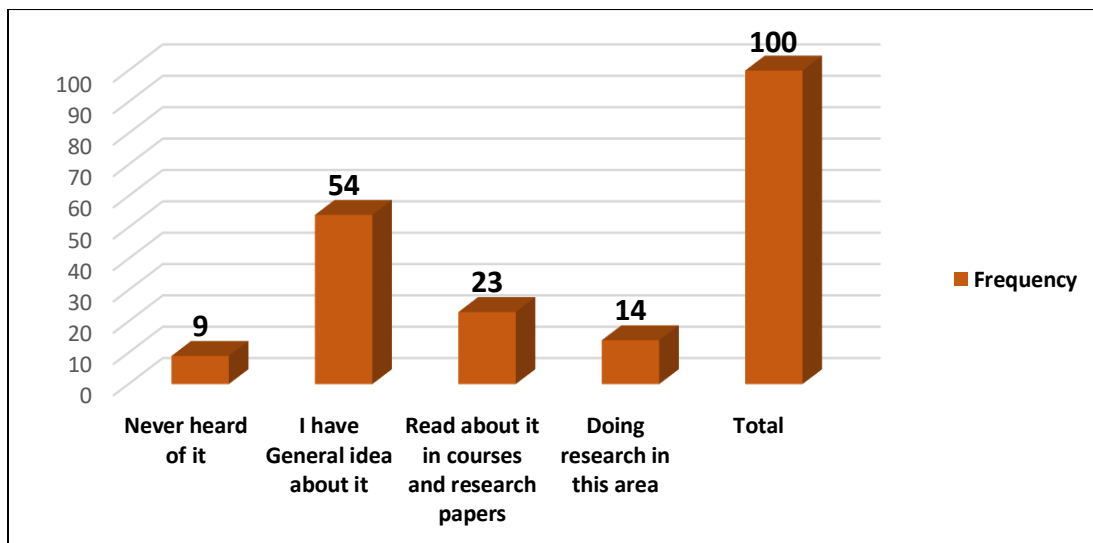


Figure 4.1 How familiar are students with the term IoT

Table 4.5 words that associate most with the term IoT

	Responses		Percent of Cases
	N	Percent	
Connected devices to the internet	62	45.60%	65.30%
Futuristic	12	8.80%	12.60%
Smart	24	17.60%	25.30%
Intelligent	21	15.40%	22.10%
Data stream	6	4.40%	6.30%
Security	11	8.10%	11.60%
Total	136	100.00%	143.20%

The above table shows the answer of the question “which word do you associate most with the term IoT”, 62(45.6%) answered that IoT means “*Connected devices to the internet*”, 12(8.80%) of the respondents answered that IoT means “Futuristic”, 24(17.60%) said that IoT means “smart”, 21(15.40%) said that IoT means “intelligent”, 6(4.40%) answered that the term IoT associates most with “data stream” and 11(8.10%) answered that the term “security” associates most with the term IoT. The below figure shows the graph of table 4.5

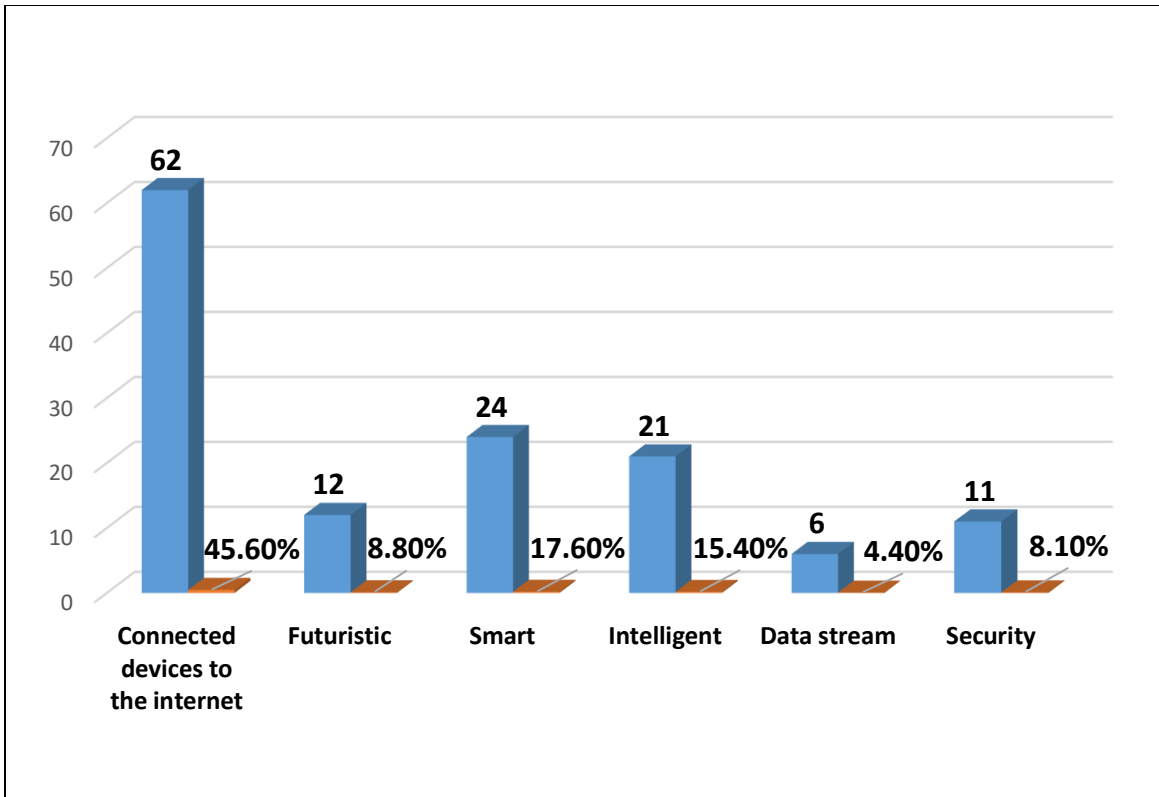


Figure 4.2 which word do you associate most with IoT

Table 4.6 Smartness of your campus?

	Frequency	Percent	Valid Percent	Cumulative Percent
Not at all	5	5	5	5
A little bit	41	41	41	46
More than little but less than pretty much	20	20	20	66
Pretty much	23	23	23	89
Completely smart	11	11	11	100
Total	100	100	100	

The above table 4.6 shows the responds of the question “How smart is your campus?” 5% of the respondents answered it is not smart at all, 41% of the respondents answered it is smart a little bit, 20% of the respondents answered that it is smart more than little bit but less than pretty much, 23% of the respondents answered it is pretty much smart, and 11% of the respondents answered said it is completely smart. The below figure shows the graph of table 4.6.

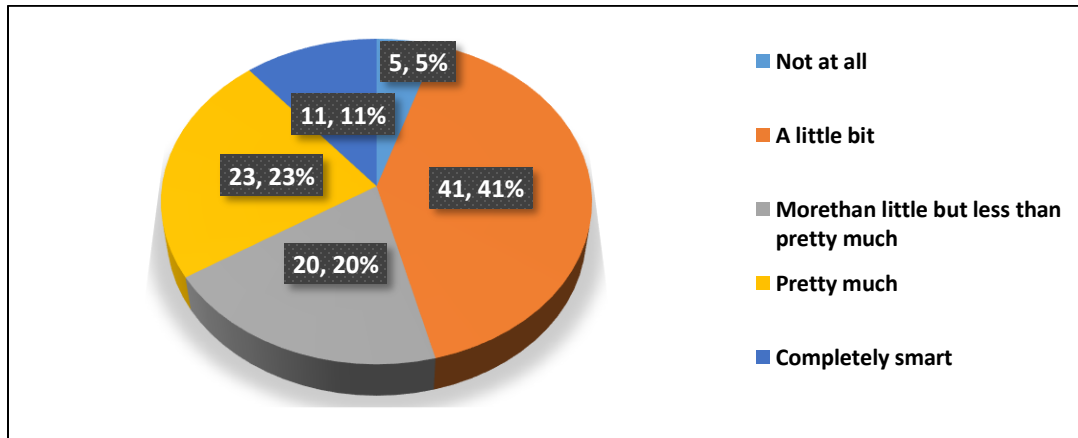


Figure 4.3 Based on your understanding how smart is your campus?

Table 4.7 Importance of Smart ID with access to classroom, library or hostel

	Frequency	Percent	Valid Percent	Cumulative Percent
Somewhat important	11	11	11	11
Neutral	2	2	2	13
Important	54	54	54	67
Very important	33	33	33	100
Total	100	100	100	

The above table 4.7 shows the responses to the Importance of Smart ID with access to classroom, library or hostel. 11% of the respondents answered that it is somewhat important. 2% of the respondents answered that they have neutral opinion, 54% of the respondents

answered that it is important and 33% of the respondents answered that it is very important. The majority that is More than 50% of the respondents said that this feature of smart student Id is important. The below figure show the graph of table 4.7

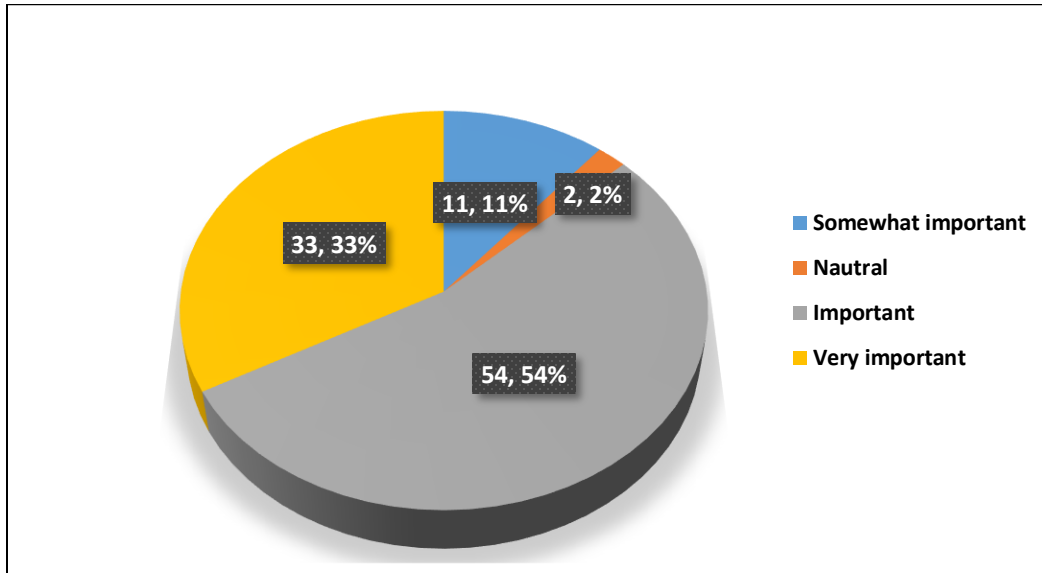


Figure 4.4 importance of Smart ID with access to classroom, library or hostel?

Table 4.8 Importance of Smart ID: with e-wallet, to pay for meals parking

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	5	5	5	5
Somewhat important	19	19	19	24
Neutral	26	26	26	50
Important	30	30	30	80
Very important	20	20	20	100
Total	100	100	100	

The above table 4.8 shows the responses to the Importance of Smart ID with e-Wallet. 5% of the respondents answered that it is not important, 19% of the respondents answered that it is somewhat important. 26% of the respondents answered that they have neutral opinion,

30% of the respondents answered that it is important and 20% of the respondents answered that it is very important. The majority of the respondents (More than 50%) said that this feature of smart student Id is either important or very important. The below figure show the graph of table 4.8

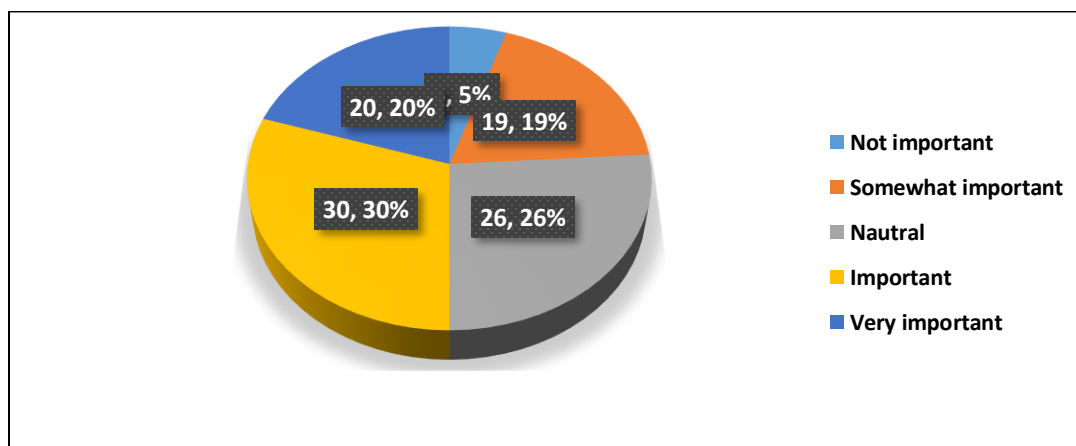


Figure 4.5 Importance to have Smart ID: with e-wallet to pay for meals, parking etc.

Table 4.9 Smart ID with automatic book issue in libraries.

	Frequency	Percent	Valid Percent	Cumulative Percent
Somewhat important	15	15	15	15
Neutral	18	18	18	33
Important	38	38	38	71
Very important	29	29	29	100
Total	100	100	100	

The above table 4.9 shows the responses to the Importance of Smart ID with automatic book issue. 15% of the respondents answered that it is somewhat important. 18% of the respondents answered that they have neutral opinion, 38% of the respondents answered that it is important and 29% of the respondents answered that it is very important. The majority

of the respondents (More than 60%) said that this feature of smart student Id is either important or very important. The below figure show the graph of table 4.9

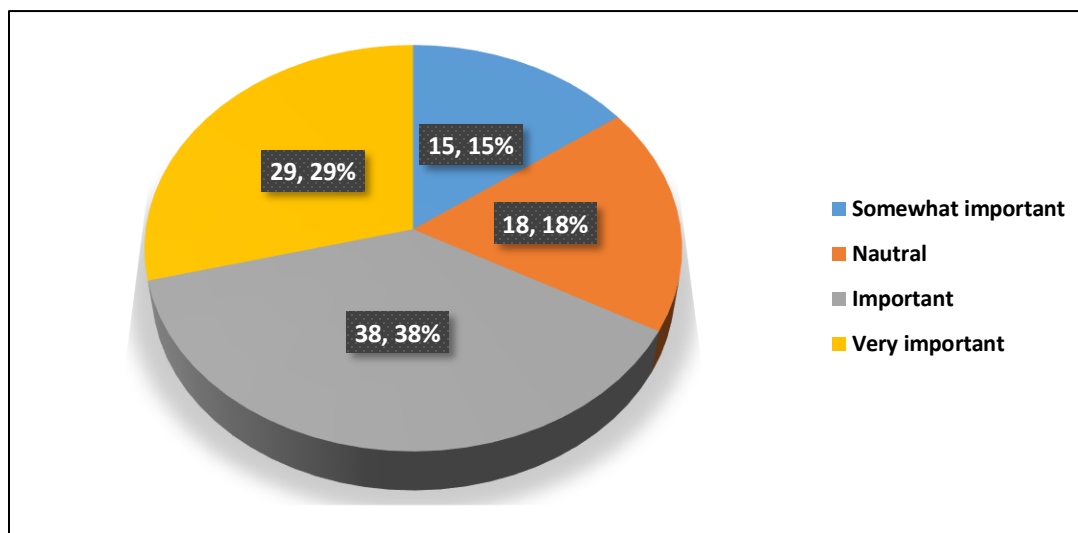


Figure 4.6 Importance of Smart ID with automatic book issue

Table 4.10 Smart ID with class attendance or identity check

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	4	4	4	4
Somewhat important	13	13	13	17
Neutral	4	4	4	21
Important	42	42	42	63
Very important	37	37	37	100
Total	100	100	100	

The above table 4.10 shows the responses to the Importance of Smart ID with class attendance or identity check. 4% of the respondents answered that it is not important, 13% of the respondents answered that it is somewhat important. 4% of the respondents answered that they have neutral opinion, 42% of the respondents answered that it is important and 37% of the respondents answered that it is very important. The majority of the respondents (More

than 79%) said that this feature of smart student Id is either important or very important. The below figure show the graph of table 4.10.

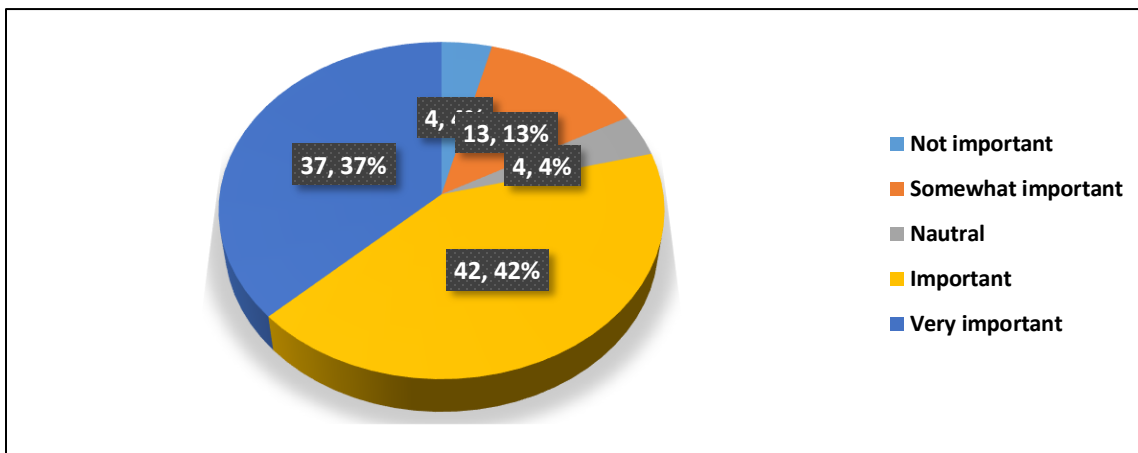


Figure 4.7 Smart ID with class attendance or identity check.

Table 4.11 type transportation to get to the university.

	Frequency	Percent	Valid Percent	Cumulative Percent
Public transport	38	38	38	38
Own car	5	5	5	43
Motorcycle/bicycle	13	13	13	56
Rickshaw/CNG	23	23	23	79
Walk	19	19	19	98
Taxi/UBER	2	2	2	100
Total	100	100	100	

The above table 4.10 shows the responses to the type transportation to get to the university. 38% of the respondents answered public transportation, 5% of the respondents answered that they have their own cars. 13% of the respondents answered that they have their motorcycle or bicycle, 23% of the respondents answered that they take a rickshaw or CNG to and from

the university, 19% of the respondents answered that they walk to go to the university and 2% of the respondents answered that they mostly hire taxi to get to the university.

Table 4.12 importance of smart mobility

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	25	25	25	25
Somewhat important	11	11	11	36
Neutral	17	17	17	53
Important	25	25	25	78
Very important	22	22	22	100
Total	100	100	100	

The above table 4.12 shows the responses to the Importance of Smart mobility with smart parking. 25% of the respondents answered that it is not important, 11% of the respondents answered that it is somewhat important. 17% of the respondents answered that they have neutral opinion, 25% of the respondents answered that it is important and 22% of the respondents answered that it is very important. The majority of the respondents (47%) said that smart parking is either important or very important. The below figure show the graph of table 4.12.

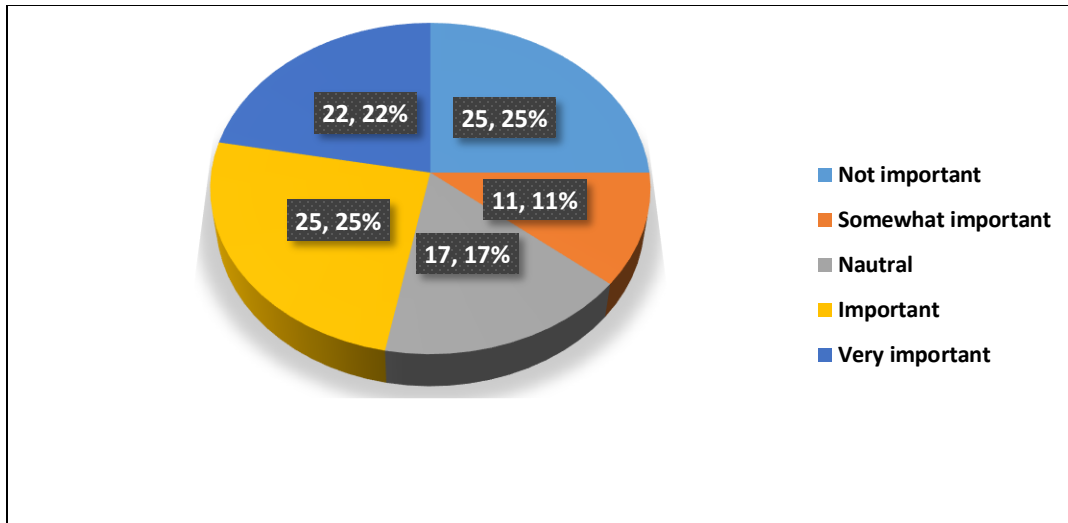


Figure 4.8 smart parking

Table 4.13 Public transit tickets in student ID

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	12	12	12	12
Somewhat important	18	18	18	30
Neutral	23	23	23	53
Important	32	32	32	85
Very important	15	15	15	100
Total	100	100	100	

The above table 4.13 shows the responses to the Importance of Public transit tickets in student ID. 12% of the respondents answered that it is not important, 18% of the respondents answered that it is somewhat important. 23% of the respondents answered that they have neutral opinion, 32% of the respondents answered that it is important and 15% of the respondents answered that it is very important. The majority of the respondents (47%) said that Public transit tickets in student ID is either important or very important. The below figure show the graph of table 4.13.

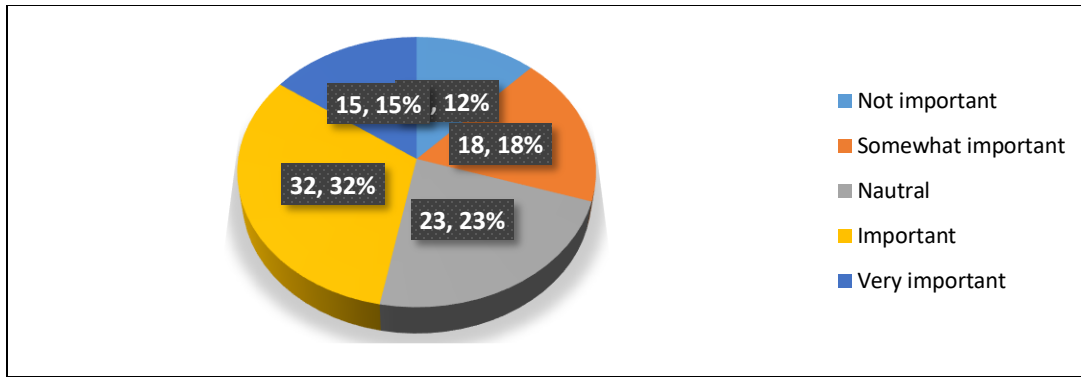


Figure 4.9 Public transit tickets in student ID

Table 4.14 Campus map and navigation

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	5	5	5	5
Somewhat important	22	22	22	27
Neutral	8	8	8	35
Important	39	39	39	74
Very important	26	26	26	100
Total	100	100	100	

The above table 4.14 shows the responses to the Importance of Campus map and navigation in smart phone. 5% of the respondents answered that it is not important, 22% of the respondents answered that it is somewhat important. 8% of the respondents answered that they have neutral opinion, 39% of the respondents answered that it is important and 26% of the respondents answered that it is very important.

The majority of the respondents about (65%) said that Campus map and navigation in smart phone is either important or very important.

Table 4.15 information kiosks in campus

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	6	6	6	6
Somewhat important	33	33	33	39
Neutral	17	17	17	56
Important	24	24	24	80
Very important	20	20	20	100
Total	100	100	100	

The above table 4.15 shows the responses to the Importance of information kiosks in campus. 6% of the respondents answered that it is not important, 33% of the respondents answered that it is somewhat important. 17% of the respondents answered that they have neutral opinion, 24% of the respondents answered that it is important and 20% of the respondents answered that it is very important.

Table 4.16 Online information system

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	5	5	5	5
Somewhat important	12	12	12	17
Neutral	4	4	4	21
Important	39	39	39	60
Very important	40	40	40	100
Total	100	100	100	

The above table 4.16 shows the responses to the Importance of online information system. 5% of the respondents answered that it is not important, 12% of the respondents answered that it is somewhat important. 4% of the respondents answered that they have neutral

opinion, 39% of the respondents answered that it is important and 40% of the respondents answered that it is very important. The below figure show the graph of table 4.16.

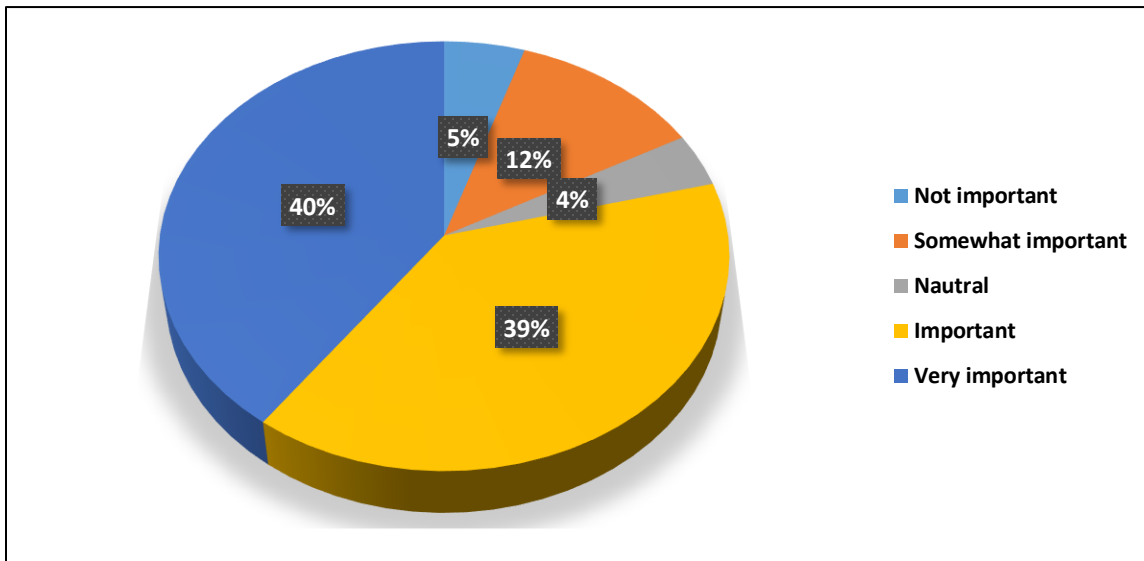


Figure 4.10 online information system

Table 4.17 Cloud-based documents and teaching materials

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	3	3	3	3
Somewhat important	15	15	15	18
Neutral	2	2	2	20
Important	48	48	48	68
Very important	32	32	32	100
Total	100	100	100	

The above table 4.17 shows the responses to the Importance of Cloud-based documents and teaching materials. 3% of the respondents answered that it is not important, 15% of the respondents answered that it is somewhat important. 2% of the respondents answered that

they have neutral opinion, 48% of the respondents answered that it is important and 32% of the respondents answered that it is very important. The below figure show the graph of table

Table 4.18 university own social media

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	4	4	4	4
Somewhat important	15	15	15	19
Neutral	6	6	6	25
Important	38	38	38	63
Very important	37	37	37	100
Total	100	100	100	

The above table 4.18 shows the responses to the Importance of university own social media. 4% of the respondents answered that it is not important, 15% of the respondents answered that it is somewhat important. 6% of the respondents answered that they have neutral opinion, 38% of the respondents answered that it is important and 37% of the respondents answered that it is very important. The below figure show the graph of table 4.18.

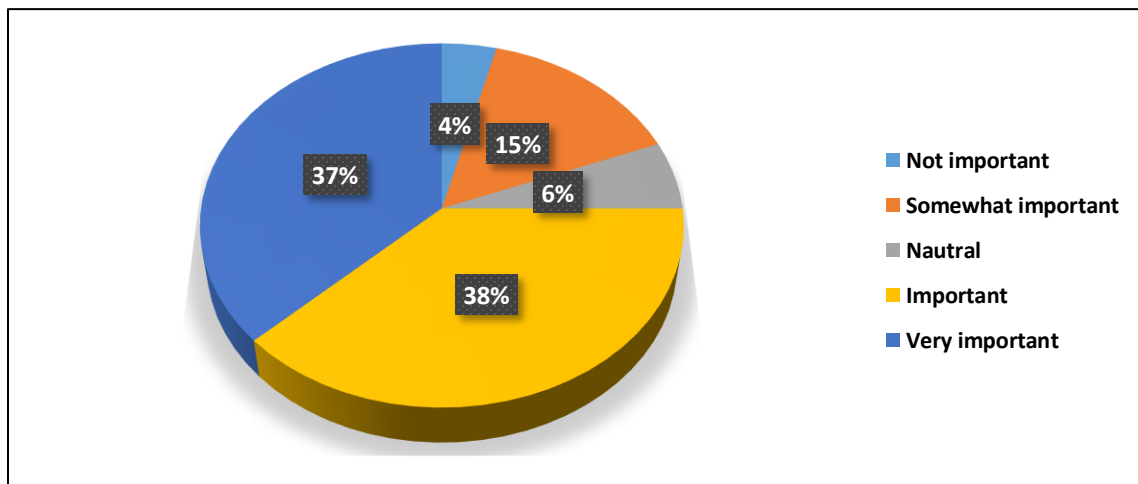


Figure 4.11 university own social media

The below figure shows the responses to the Importance of university presence on existing social media. 3% of the respondents answered that it is not important, 18% of the respondents answered that it is somewhat important. 27% of the respondents answered that they have neutral opinion, 23% of the respondents answered that it is important and 29% of the respondents answered that it is very important. The below figure show the graph of table 4.19.

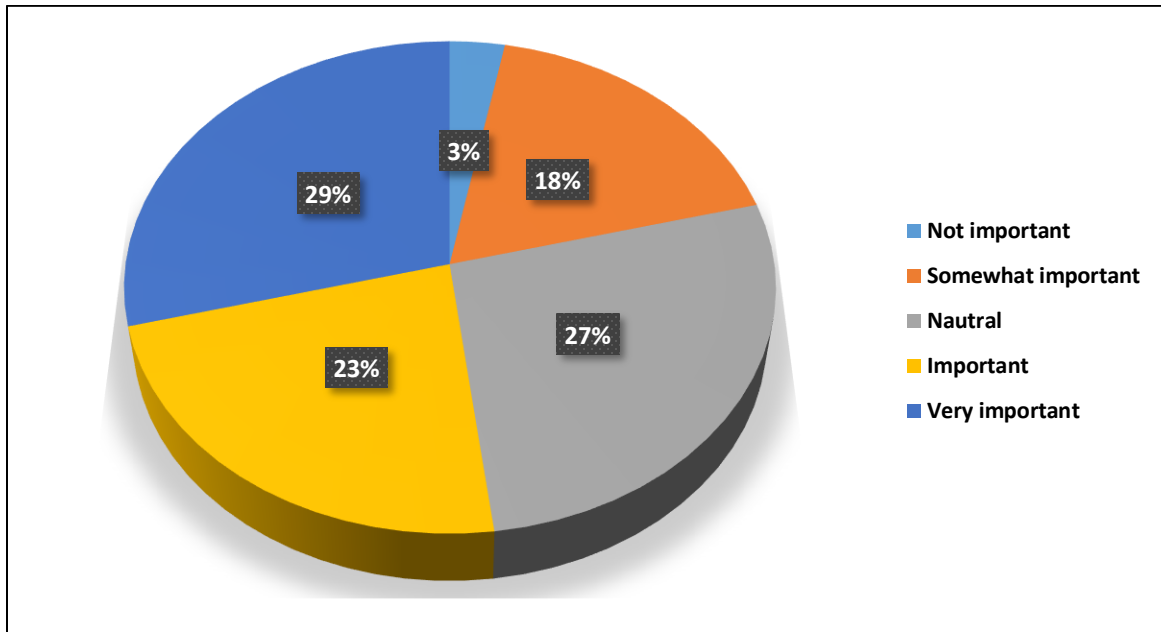


Figure 4.12 Importance of university presence on social media

The below figure shows the responses to the Importance of changing the traditional teaching way. 13% of the respondents answered that it is not important, 14% of the respondents answered that it is somewhat important. 9% of the respondents answered that they have neutral opinion, 36% of the respondents answered that it is important and 28% of the respondents answered that it is very important. The below figure show the graph of table 4.20.

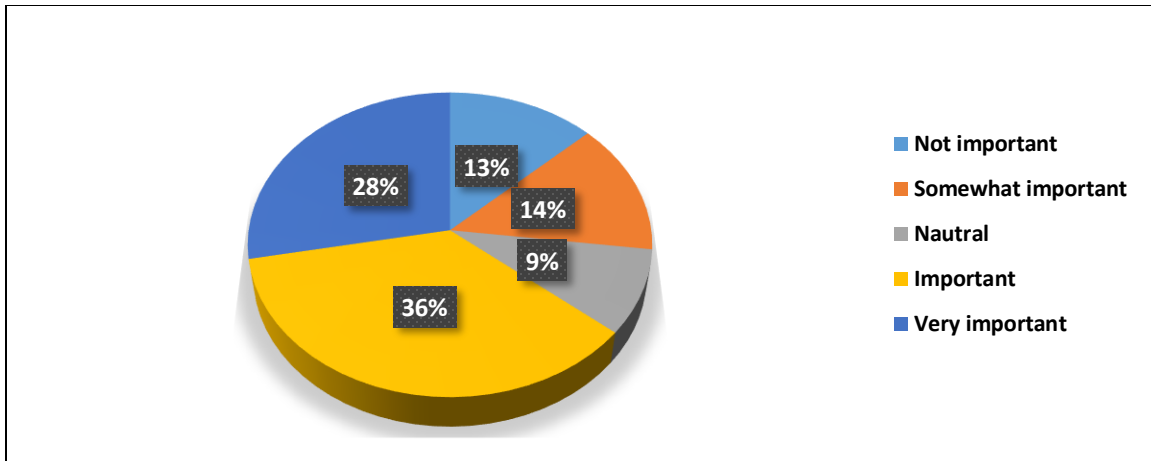


Figure 4.13 changing the traditional teaching style

The below figure shows the responses to the affordability of the teachers to use smart solutions. 49% of the respondents answered that the teachers are able to use smart solutions and 51% of the respondents answered that the teachers are not able to use smart solutions.

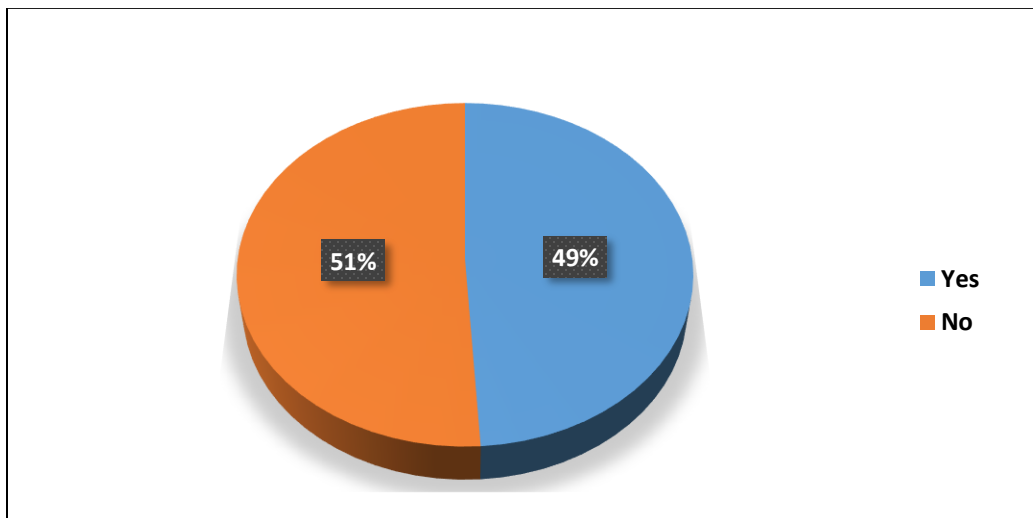


Figure 4.14 Teachers' affordability to use smart solutions

Table 4.19 use of smart solutions by teachers

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	54	54	54	54
No	46	46	46	100
Total	100	100	100	

The above table 4.19 shows the responses to the use of smart solutions by the teachers. 54% of the respondents answered that the teachers are using smart solutions and 46% of the respondents answered that the teachers are not using smart solutions.

Table 4.20 online courses (e-learning)

	Frequency	Percent	Valid Percent	Cumulative Percent
They should not be used at all	7	7	7	7
They should be used only as a complement to contact lessons	44	44	44	51
from time to time they should be used instead of contact lessons	20	20	20	71
They should be used instead of contact lessons very often	18	18	18	89
They should replace contact lessons	11	11	11	100
Total	100	100	100	

Table 4.20 shows the responses to the online courses. 7% of the respondents answered that they should not be used at all, 44% of the respondents answered that they should be used

only as a complement, 38% of the respondents answered that they should be used instead of contact lessons and very often, and 11% of the respondents answered that they should replace contact lessons. The below figure show the graph of table 4.15.

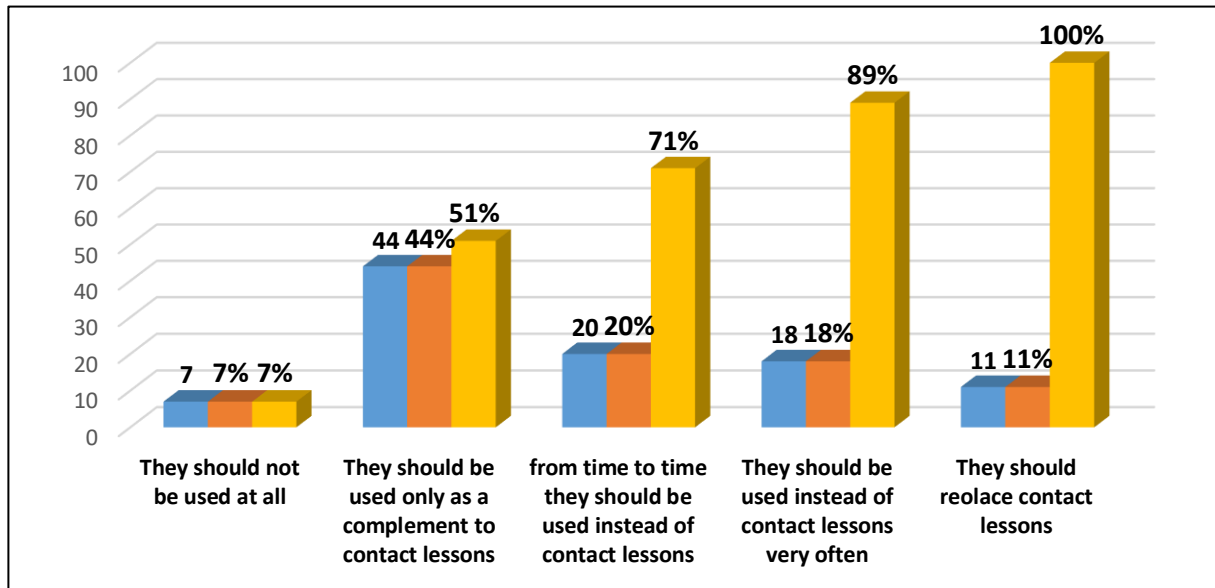


Figure 4.15 online courses (e-learning)

Table 4.21 How smart technology in education will invade privacy

	Frequency	Percent	Valid Percent	Cumulative Percent
Not at all	7	7	7	7
A little bit	15	15	15	22
Neutral	36	36	36	58
Pretty much	33	33	33	91
Completely	9	9	9	100
Total	100	100	100	

The above table 4.21 shows the responds of the question “How smart technology will invade privacy?” 7% of the respondents answered it will not invade at all, 15% of the respondents answered it will invade a little bit, 36% of the respondents answered that they have a neutral

opinion about this question, 33% of the respondents answered it will invade pretty much, 9% of the respondents answered that it will invade completely.

Table 4.22 Importance of Smart Card for smart campus

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	1	1	1	1
Somewhat important	18	18	18	19
Important	48	48	48	67
Very important	33	33	33	100
Total	100	100	100	

The above table 4.22 shows the responses to the Importance of smartcard for smart campus. 1% of the respondents answered that it is not important, 18% of the respondents answered that it is somewhat important, 48% of the respondents answered that it is important and 33% of the respondents answered that it is very important. The below figure show the graph of table 4.22.

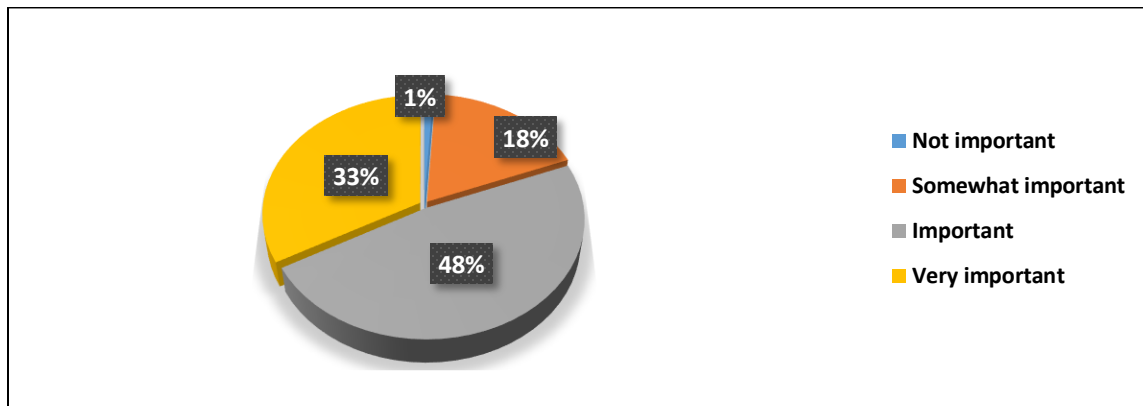


Figure 4.16 smart card for smart campus

Table 2.23 Importance smart mobility for smart campus

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	1	1	1	1
Somewhat important	11	11	11	12
Neutral	4	4	4	16
Important	40	40	40	56
Very important	44	44	44	100
Total	100	100	100	

The above table 4.23 shows the responses to the Importance of smart mobility for smart campus. 1% of the respondents answered that it is not important, 11% of the respondents answered that it is somewhat important. 4% of the respondents answered that they have neutral opinion, 40% of the respondents answered that it is important and 44% of the respondents answered that it is very important. The below figure show the graph of table 4.23.

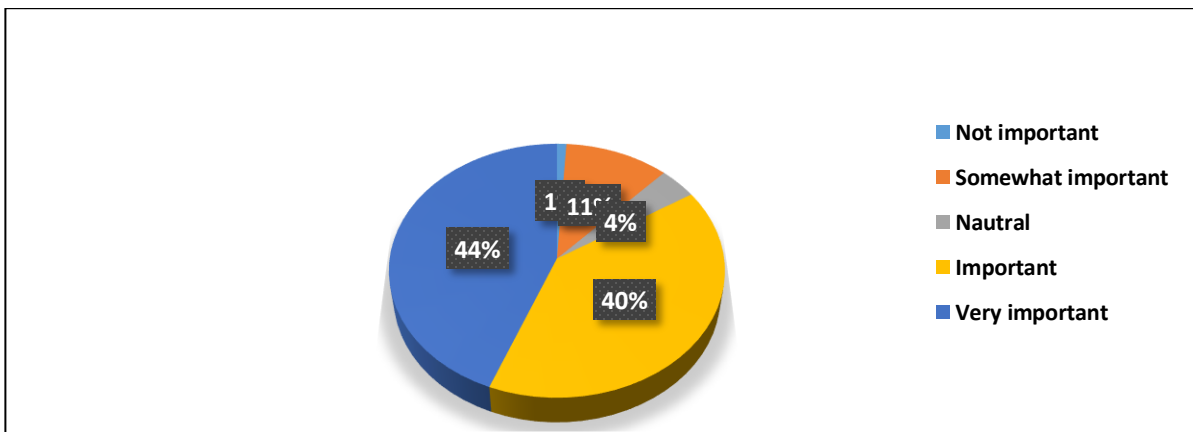


Figure 4.17 smart mobility for smart campus

Table 4.24 smartness of your campus

	Frequency	Percent	Valid Percent	Cumulative Percent
Not at all	9	9	9	9
A little bit	32	32	32	41
More than little but less than pretty much	21	21	21	62
Pretty much	25	25	25	87
Completely smart	13	13	13	100
Total	100	100	100	

The above table 4.24 shows the responds of the question “How smart is your campus now” 9% of the respondents answered it is not smart at all, 32% of the respondents answered it is smart a little bit, 21% of the respondents answered that it is smart more than a little bit and less than pretty much, 25% of the respondents answered it smart pretty much, 13% of the respondents answered that it is completely smart. The below figure shows the graph of table 4.24.

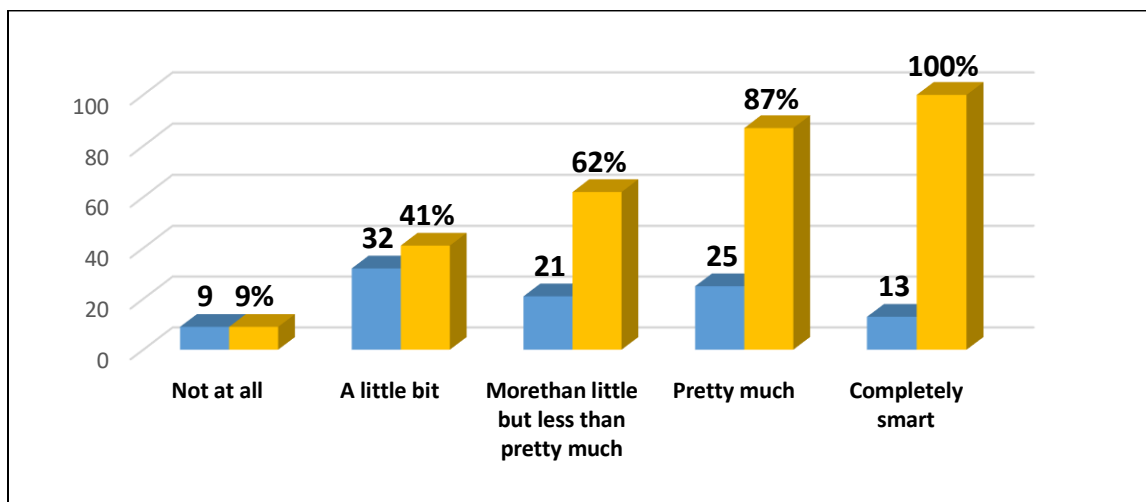


Figure 4.18 smartness of your campus now

Table 4.25 making your campus smart

	Frequency	Percent	Valid Percent	Cumulative Percent
Not important	1	1	1	1
Somewhat important	13	13	13	14
Neutral	9	9	9	23
Important	34	34	34	57
Very important	43	43	43	100
Total	100	100	100	

Table 4.25 shows the responses to the Importance of smartening the campus. 1% of the respondents answered that it is not important, 13% of the respondents answered that it is somewhat important. 9% of the respondents answered that they have neutral opinion, 34% of the respondents answered that it is important and 43% of the respondents answered that it is very important. The below figure show the graph of table 4.325.

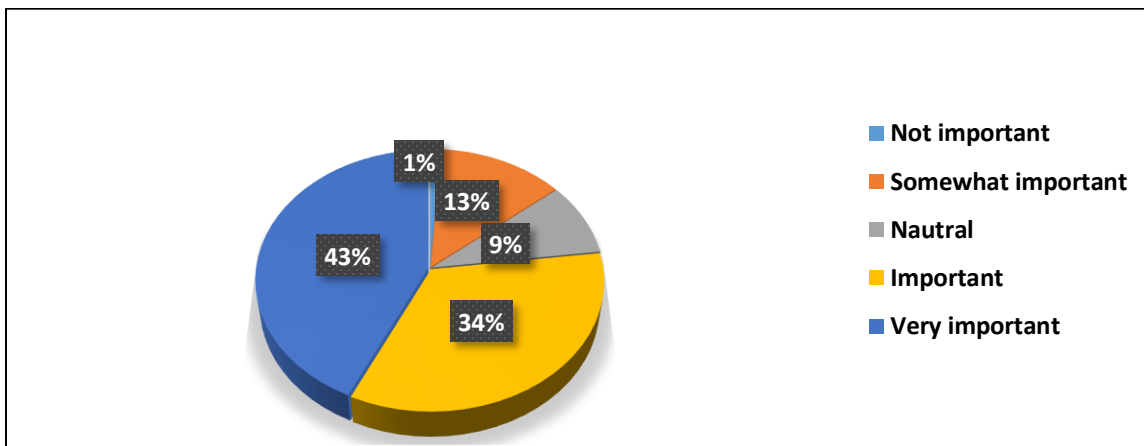


Figure 4.19 Importance of smartening the campus

4.3.2 Questionnaire Response Analysis of Teachers and Administration

Table 4.26 Understanding of teachers to the term IoT

	Frequency	Percent	Valid Percent	Cumulative Percent
Fully understand and it is relevant to my job	13	52	52	52
Fully understand and it is all about hype/advertisement	3	12	12	64
I have a vague idea what it means	9	36	36	100
Total	25	100	100	

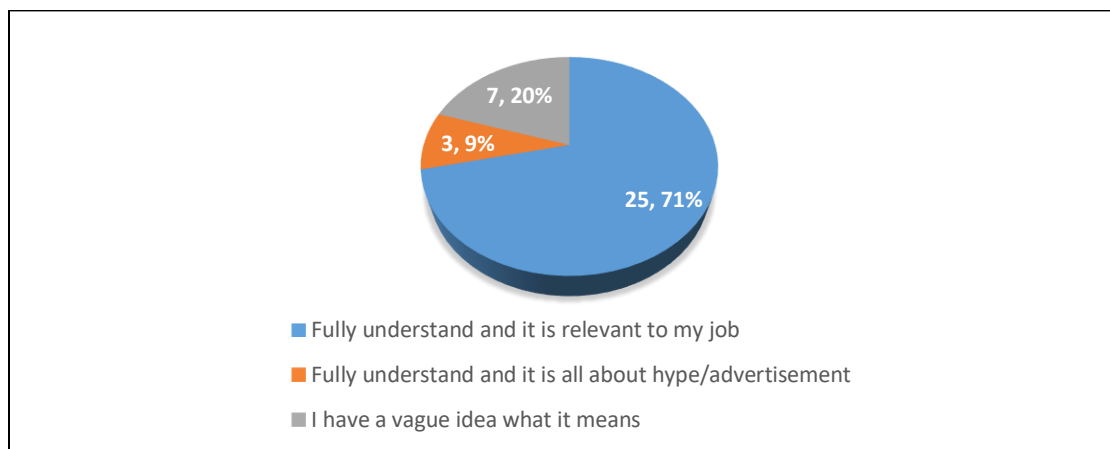


Figure 4.20 Level of understanding to IoT by staff

The above table 4.26 and figure 20 present the extend of understanding of teachers and staff/administration to the term IoT and shows that 13(52%), 25(71%) of of teachers and staff repectively answered that they fully understand the term and its relevant to their job, 3(12%) of the respondents of both answered that they fully understand the term and it is all about hype. And 9(36%) and 7(20%) of the respondents answered that they have a vague idea about what IoT means.

Table 4.27 which word associates most with IoT

		Responses		Percent of Cases
		N	Percent	
Connected devices to the internet		23	52.30%	92.00%
Futuristic		1	2.30%	4.00%
Smart		8	18.20%	32.00%
Intelligent		7	15.90%	28.00%
Data stream		1	2.30%	4.00%
Security		4	9.10%	16.00%
		44	100.00%	176.00%

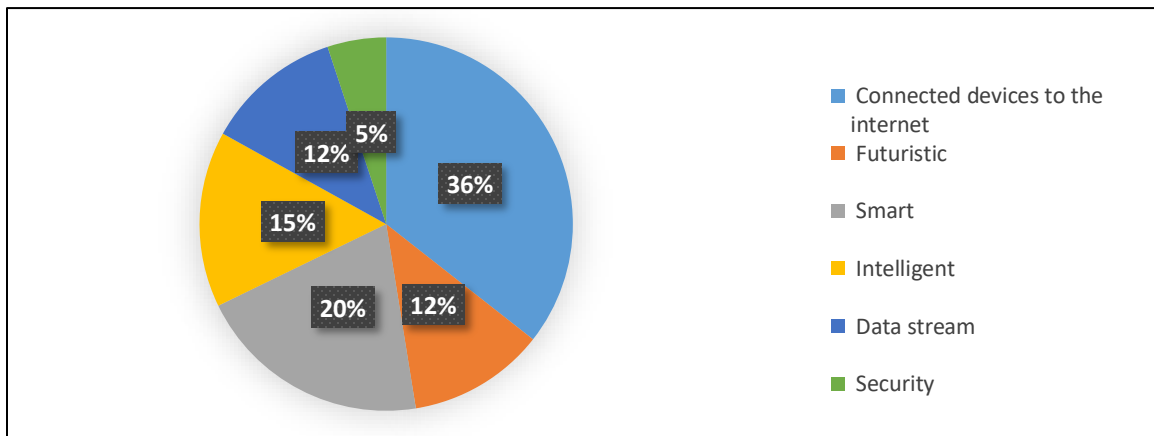


Figure 4.21 which word do staff mostly associate with IoT

The above table 4.27 and figure 4.21 for teachers and staff respectively presents the answer to the question “Which word do you associate most with IoT?” which was a multiple response question, and shows that 52.30% and 36% of respondents associated with “connected devices to the internet”, 2.30% and 12% of the respondents associated with the word “Futuristic”, 18.20% and 20% of the respondents associated with the word “Smart”, 15.90% and 15% of the respondents associated with the word “intelligent”, 2.30% and 12%

of the respondents associated with the word “Data stream”, And 9.10% and 5% of the respondents associated with the word “Security”.

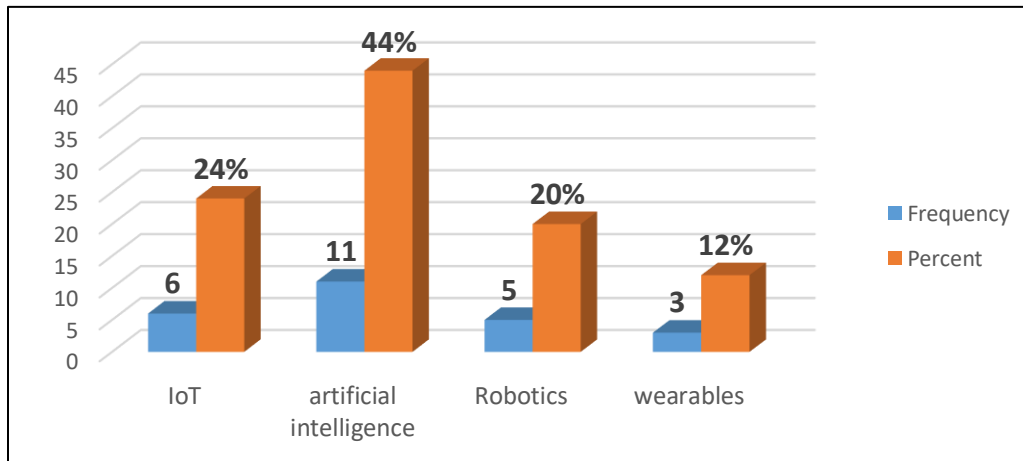


Figure 4.22 Impact Io T compared to other emerging devices for teachers

The above graph figure 4.22 shows the impact of IoT compared to other technologies, and as per the answer of the respondents artificial intelligence has the most impact with 44% of the answers among four options.

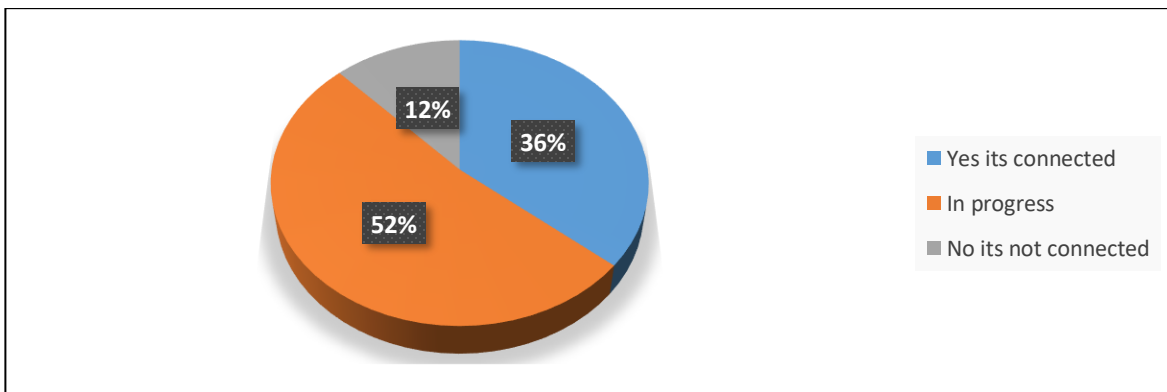


Figure 4.23 Connectedness of the current campuses

The above graph figure 4.23 shows the Connectedness of the campus, and as per the answer of the respondents 36% of the respondents answered “Yes it is connected”, while 52% of the respondents said that “it is in progress” and 12% of the respondents said “It is no connected”.

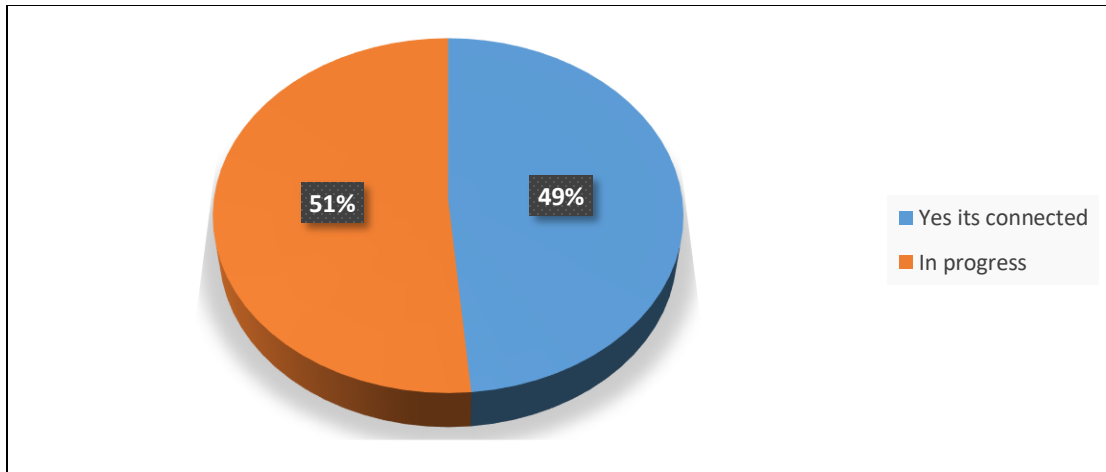


Figure 4.24 classifying your campus as a connected

Figure 4.24 above shows the answer of the question whether the current campus is smart or not. 51% of the respondents said it is not smart and 49% said it is smart.

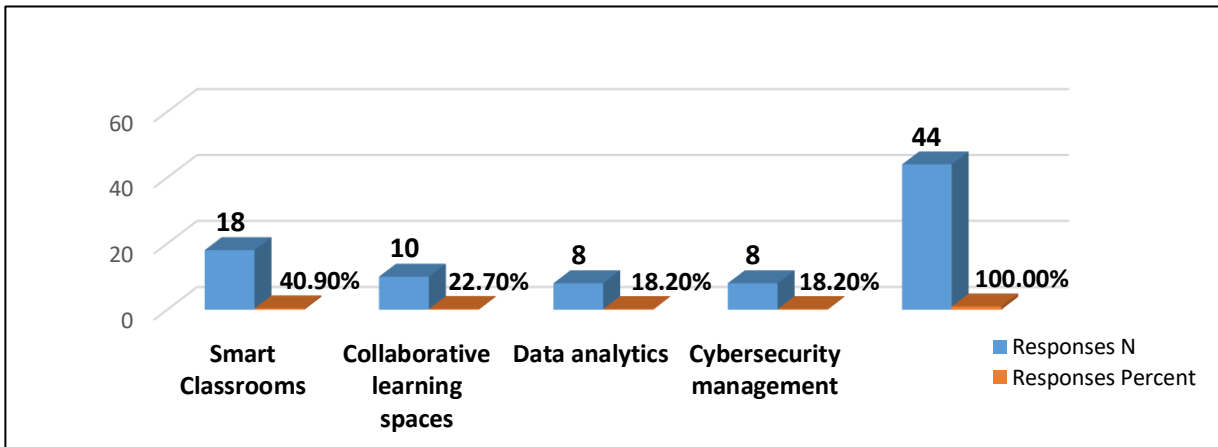


Figure 4.25 Implemented smart technologies

The above graph figure 4.25 shows the implemented smart technologies in the point of view of teachers, and as per the answer of the respondents 18(40.90%) of the respondents answered smart classrooms were already implemented, 10(22.70%) of the respondents answered collaborative learning spaces were implemented, 8(18.20%) of the respondents answered data analytics were already implemented and 8(18.20%) of the respondents answered that cybersecurity management were already implemented.

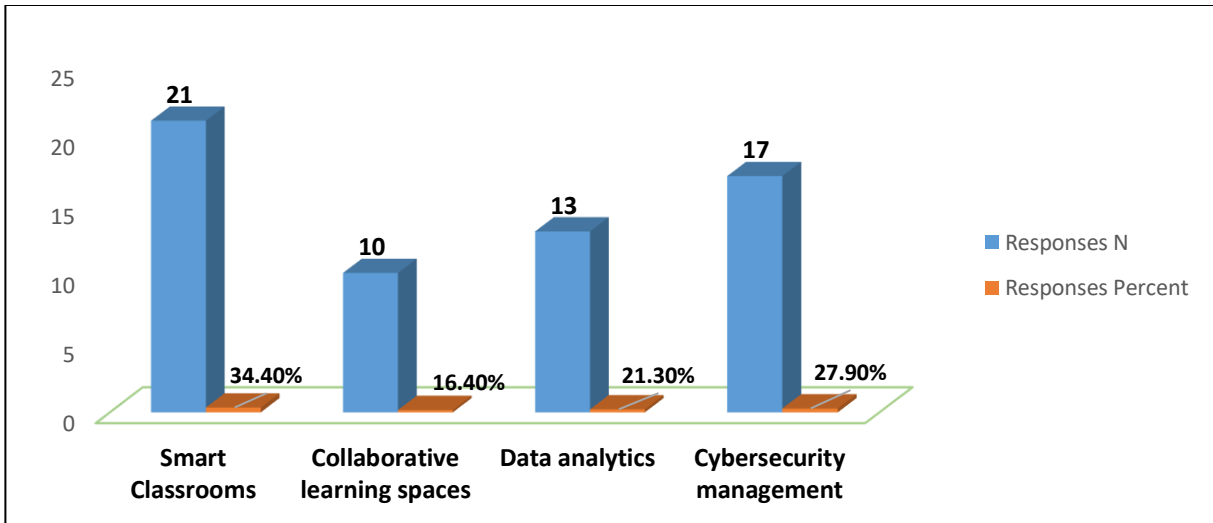


Figure 4.26 Smart Tech have been or being implemented

Figure 4.26 shows the smart technologies that have been implemented, as per the answer of the staff and administration 34% of them said smart classrooms have been implemented, 16% said collaborative learning spaces have been implemented, 21% said data analytics were implemented and 28% said cybersecurity management has been implemented.

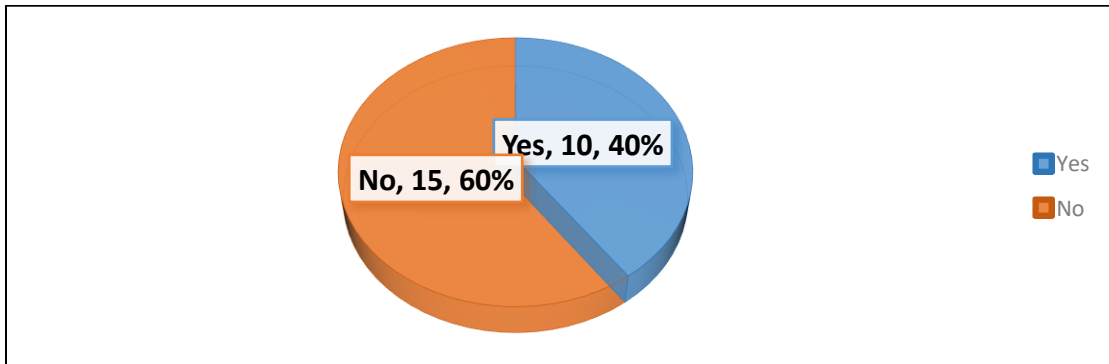


Figure 4.27 Smart technologies in classroom

The above table 4.27 shows the responses to the question if the university provides IoT technologies in classroom. 15(60%) of the respondents answered that the university does not provide IoT technology in classroom and 10(40%) of the respondents answered that the university provides IoT technology in classrooms.

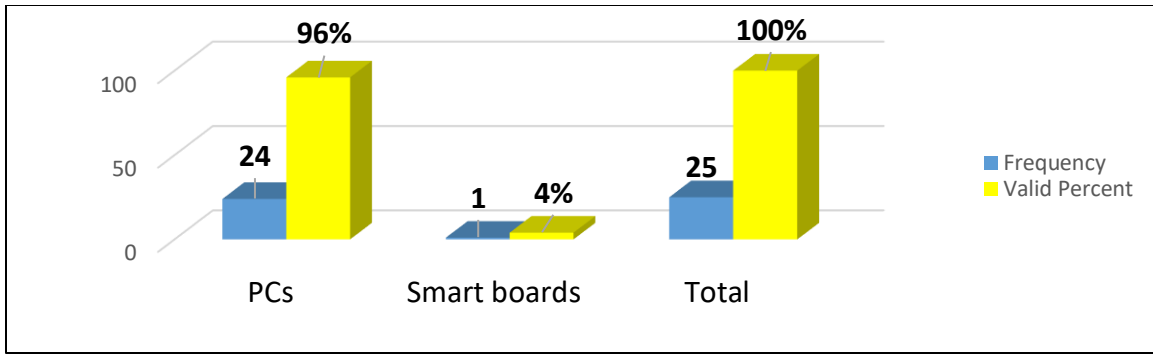


Figure 4.28 Smart technologies provided in classroom

Figure 4.28 shows that 24(96%) of the respondents have answered that the university provides only PCs in classroom to support teaching and 1(4%) of the respondents have answered that the university provides smart boards in classroom to support teaching.

Table 4.28 IoT negative consequence

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	1	4	4	4
Agree	12	48	48	52
Not sure	2	8	8	60
Partially disagree	4	16	16	76
Disagree	3	12	12	88
Strongly disagree	3	12	12	100
Total	25	100	100	

Table 4.28 above presents the degree of agreement or disagreement of the teachers that IoT can have negative impacts. More than half (13 or 52%) of the respondents agreed that IoT can have negative consequence and about 40% of the respondents disagreed that IoT can have negative impacts.

Table 4.29 Teacher's skills and IoT

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	7	28	28	28
Agree	17	68	68	96
Not sure	1	4	4	100
Total	25	100	100	

Table 4.29 above presents the degree of agreement or disagreement of the teachers that IoT can improve teacher's skills. About (7 or 28%) of the respondents said strongly agree and 17(68%) of the respondents said they agree. While 1(4%) answered he/she is not sure about that.

I prefer teaching in a campus with IoT technologies

Table 4.30 teaching in a campus with IoT technologies

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	9	36	36	36
Agree	14	56	56	92
Not sure	2	8	8	100
Total	25	100	100	

Table 4.30 above presents the degree of agreement or disagreement of the teachers that they prefer teaching in a campus with IoT technology. About (9 or 36%) of the respondents said strongly agree and 14(56%) of the respondents said they agree. While 2(8%) answered he/she is not sure about that.

Table 4.31 Automatic attendance recording

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	13	52	52	52
Agree	7	28	28	80
Not sure	5	20	20	100
Total	25	100	100	

Table 4.31 above presents the degree of agreement or disagreement of the teachers that they prefer to have the lecture attendance automatically recorded. More than a half (13 or 52%) of the respondents said strongly agree and 7(28%) of the respondents said they agree. While 5(20%) answered he/she is not sure about that.

Table 4.32 Readiness for using IoT now

	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	7	28	28	28
Not sure	5	20	20	48
Partially disagree	3	12	12	60
Disagree	8	32	32	92
Strongly disagree	2	8	8	100
Total	25	100	100	

Table 4.32 above presents the degree of agreement or disagreement of the teachers that if we are ready to use IoT now or not. About 7(28%) of the respondents said they agree, about 5(20%) of the respondents said they are not sure about. And more than 50% of the participants answered disagree.

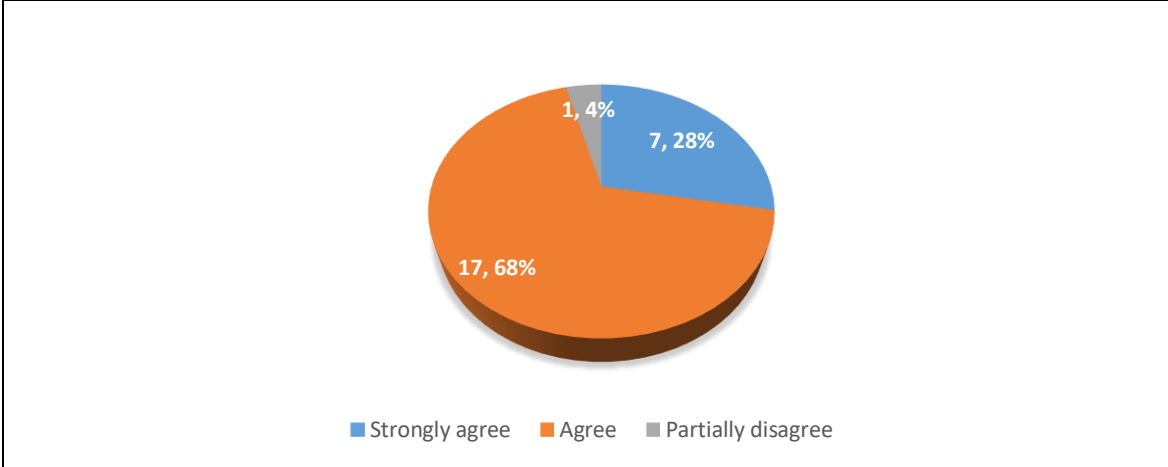


Figure 4.29 IoT encouragement of the teachers

Figure 4.29 above presents the degree of agreement or disagreement of the teachers that if IoT encourage to use latest technologies or not. About 7(28%) of the respondents said they strongly agree, about 17(68%) of the respondents said they agree. And 1% of the participants answered partially disagree.

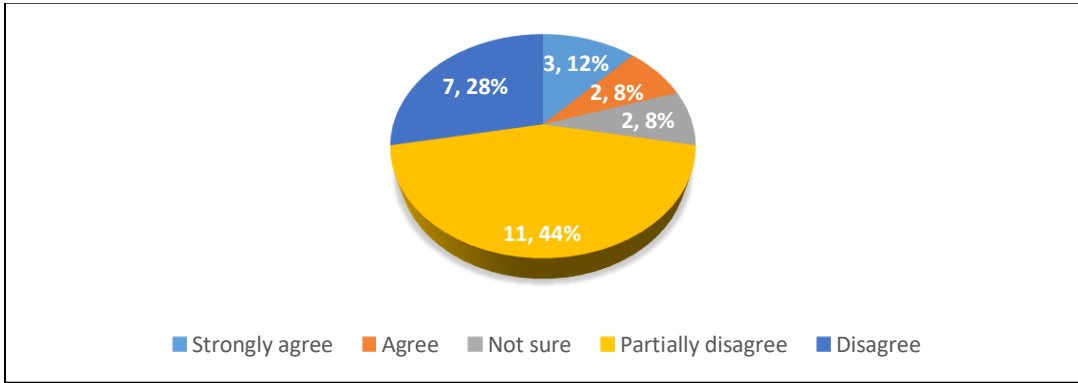


Figure 4.30 IoT and Privacy concerns

Figure 4.30 above presents the degree of agreement or disagreement if IoT should not be used for privacy reasons or not. About 18(68%) of the respondents said partially disagree or disagree.

Table 4.33 top drivers for adopting IoT in education

	Responses		Percent of Cases
	N	Percent	
Potential for cost saving and increased revenue	27	15.70%	77.10%
Reduced facilities and better resource utilization	28	16.30%	80.00%
Simplified administration and improved campus security	34	19.80%	97.10%
Higher student retention and improved learning outcomes	34	19.80%	97.10%
Improved student/faculty engagement	27	15.70%	77.10%
Policy/Legislative mandate	22	12.80%	62.90%
Total	172	100.00%	491.40%

Table 4.33 above shows the top drivers for adopting IoT in education. 15.70% of the respondents said for “Cost saving and increased revenue”, 16.30% said Reduced facilities and better resource utilization, 19.80% said “Simplified administration and improved campus security”, another 19.80% said “Higher student retention and improved learning outcomes” and 15.70 said “Improved student/faculty engagement”.

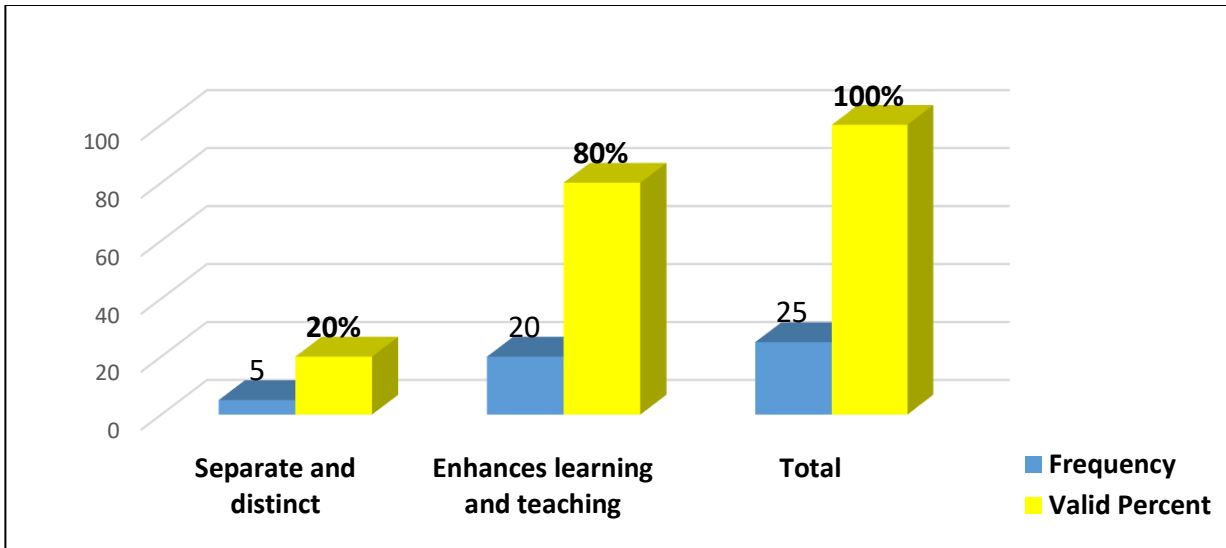


Figure 4.31 How IoT fits within education (teachers' prospective)

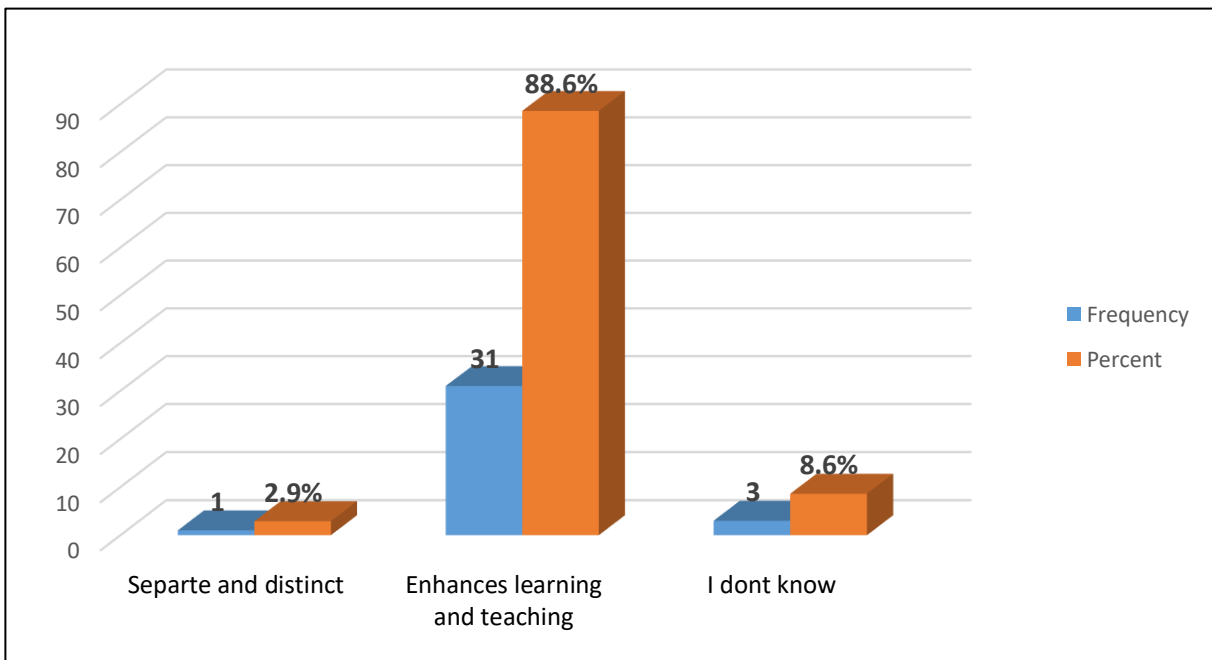


Figure 4.32 How IoT fits within education (staff prospective)

Figure 4.31 and 32 illustrate how IoT fits with in education sector in the prospective of teachers and staff respectively, as per the answer of the population, 80% of teachers 88.6% of the staff said it “Enhances learning and teaching”, 20% of the teachers and 2.9% of the staff answered it is Separate and distinct and 8.6% of staff answered “I don’t know”.

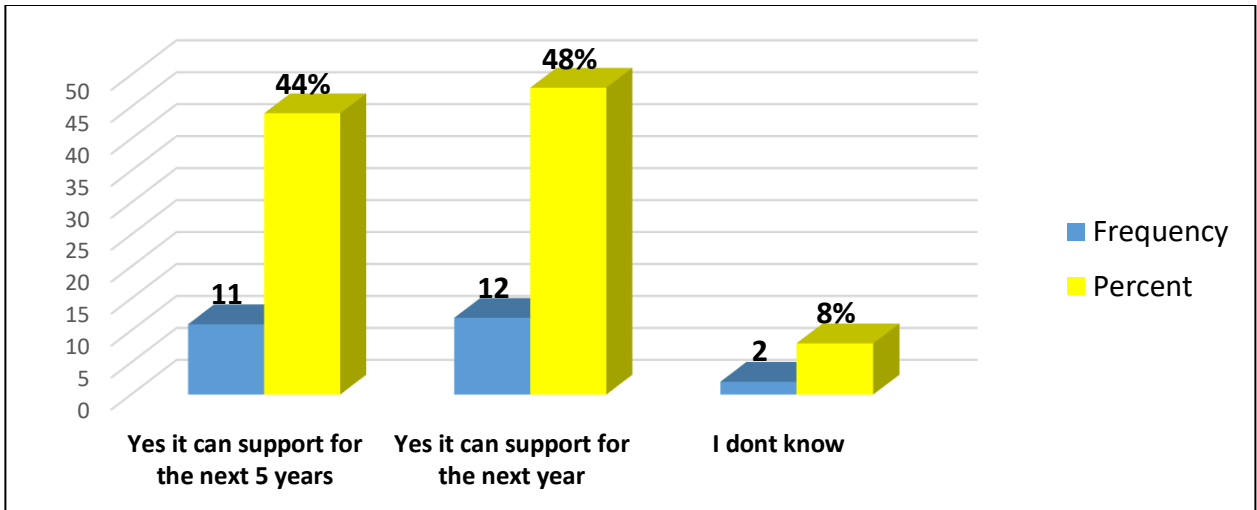


Figure 4.33 How current institution can handle emerging technologies (teachers)

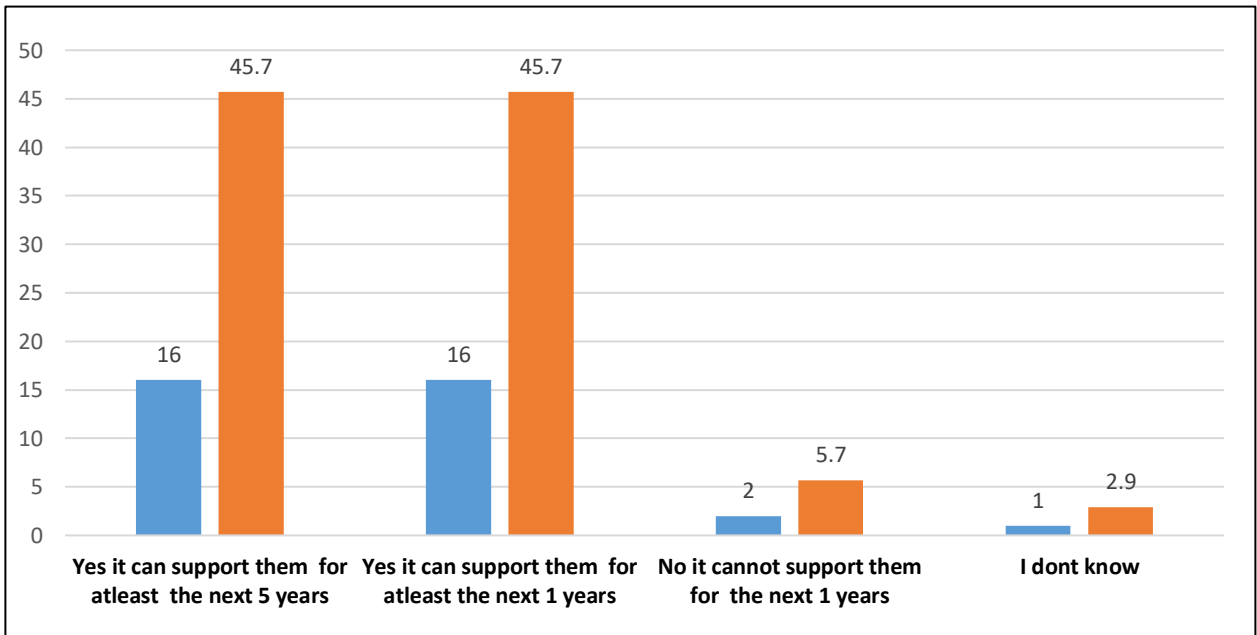


Figure 4.34 How current institution can handle emerging technologies (staff)

Figure 4.33 and figure 4.34 above showed if current institutions can handle emerging technologies. 44% of teachers and 45.7% of the staff said it can support for at least the next 5 years, another 48% of the teachers and 45.7% of the staff said it can support for at least the next year and about 8% of the teachers and 6% of the staff said it cannot support.

Table 4.34 Plans for Connected Campuses

	Responses		Percent of Cases
	N	Percent	
Bandwidth Improvements	32	18.20%	91.40%
Cloud infrastructure	32	18.20%	91.40%
Network modification	31	17.60%	88.60%
Physical security technologies	21	11.90%	60.00%
Data analytics	27	15.30%	77.10%
Cybersecurity	28	15.90%	80.00%
The plans do not require any specific technologies	5	2.80%	14.30%
Total	176	100.00%	502.90%

Table 4.34 above demonstrates the specific technologies required for connected campus procurement. 18% of the population answered Bandwidth Improvements, another 18% of the population answered Cloud Infrastructure, 17.6% answered Network modifications, about 12% of the population answered Physical Security, 15% said cybersecurity, another 16% said Data analytics, and about 3% said the plans do not require any specific technology.

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents the summary of the findings, discussion, conclusion and recommendations based on the data analyzed in the previous chapter. First the major findings of each study will be discussed confirming the research objectives, second the conclusion from the findings of the study will be presented and lastly the researcher will suggest recommendations of this study and for future work.

5.2 Summary and Discussion of the Research

In this part of the research will discuss the findings of this study. As the survey of this research was three different questionnaires for students, teachers and staff, some important questions of each questionnaire will be discussed.

From the students' prospective important questions were asking about their awareness of IoT, how smart is their current learning environments, what important technologies must be provided to smarten their campuses.

a) Awareness of IoT and Smart University

5.2.1 Familiarity of students with the term IoT?

About 54% of the students answered that they have a general idea about IoT, and 14% said they are doing research in that field.

5.2.2 Smartness of the current campus?

Asking how smart is the current campuses, based on their understanding to the term smart campus, more than 50% of the students said it is a little bit smart.

5.2.3 Importance of Smart ID

This question asked to the students how important it is to have smart ID with the following features:

Smart ID with access to classroom, library or hostel

Smart ID with e-Wallet function to pay for meals, parking, and other fees on campus.

Smart ID with automated book issue systems in library, class attendance and identity check for exams. About an average of 70% believe that smart student ID with the above mentioned features are either important or very important.

5.2.4 Importance of Smart mobility

Regarding to the importance of on campus smart mobility with the features of smart parking (real time availability, booking), public transit tickets in students' smart ID and campus map and navigations on in smart phone. More than 50% of the students answered this smart mobility is important for smart campus.

5.2.5 Importance of online information system

Teachers and students supporting ICT systems, how important it is to have the following:

Online information system (registration, exam grades, workflow and consultation)

Cloud-based documents, teaching materials and sharing platforms.

University presence on social media and university own social media.

About 70% of the students expressed that online information system and university presence on social media is very important.

5.2.6 Changing from traditional teaching style

Changing from traditional teaching style into a new way of cooperative teaching (teacher as a moderator, team work. About 64% said it is important.

5.2.7 How IoT devices can invade privacy

With the assumption that IoT devices are not built with the appropriate security precautions or features such as identity protection in an effort to keep costs low and save time due to their increasing demand, one may worry about his/her privacy, regarding to this aspect,

students were asked about, how they perceive that IoT can invade their privacy. Around 42% of the students believe that IoT will violate.

b) Teachers, Staff and Administration prospective

In this section the responses of the teachers and staff/administration will be discussed. As most questions asked to the teachers and staff/administration were similar the overall response for both of them will be discussed as a single and some different questions will be discussed as separate.

5.2.8 Which term associates most with IoT

Determining how the teachers and staff of DIU are aware of about IoT and asking them the above question that was asked both teachers and staff in their different questionnaires and answered as follows: 52.30% of the teachers and 35.6% of the staff said IoT is mostly associated with connected devices to the internet. 18.20% of teachers and 20.3% of staff said IoT is mostly associated with Smart. 15.90% and 15.3% said IoT is associated with intelligent.

5.2.9 Level of understanding he term IoT

52% of the teachers and 71.4% of staff and administration answered that they fully understand the term “Internet of Things” and it is relevant to their jobs.

5.2.9 Classify your campus as a connected or smart campus

Assessing how smart are the current campuses of the university in the point of view of teachers and staff, they answered as follows: 52% of the teachers 51.4 of staff said it is in progress while 36% of teachers and 48.6 of staff said yes it is smart.

5.2.10 Smart technologies that have been or is being implemented

To determine smart technologies that have been used in the university, teacher and staff answered as follow: 40% and 34.4% of teachers and staff respectively said smart classrooms have been implemented. 22% and 16.4% said collaborative learning spaces were implemented.

5.2.11 What are the top drivers for adopting IoT in education

As various educational institutions are now realizing the significance of introducing technology, especially IoT, into their daily teaching methods, the staff and administration of DIU were asked the top drivers for adopting this technology in education sector. 15.7% said for cost saving and increased revenue. 19.8% said for Simplified administration and improved campus security. 19.8% said for higher student retention and improved learning outcomes and 15.7% answered for improved student/faculty engagement.

5.2.12 How IoT fits within education

To know how IoT will fit in education we asked the above question to the teachers and the administration and they answered as follows: 80% and 88.6% of teachers and administration respectively said that IoT will enhance teaching and learning.

5.2.13 Smart campus procurement plans require any specific technologies

17.10% of teachers and 18.2% of staff and administration said Bandwidth improvement is required. And another 17.10% of teachers and 18.2% of staff and administration said Cloud infrastructure is required. Another 17.10% of teachers and 18.2% of staff and administration said Network m is required. Another 15% of teachers and 15.3% of staff and administration said Data analytics is required. And Another 15% of teachers and 15.9% of staff and administration said Cybersecurity technology is required.

5.3 Conclusion

This research aimed to carry out a study on IoT applications of smart campus in DIU, as well as determining the extent of knowledge that all university stakeholders such as administration, teachers and student have about IoT technology. From our work along this study and from the outcome of the survey shown that in terms of awareness of IoT and majority of the students as well as staff have a general concept about what IoT is. And this study has disclosed that more than 60% of the teachers fully understand the term IoT and how it is changing the everyday live.

Students and teachers also expressed that their campus is not smart, students are interesting about smart campus and showed their willing towards digitalized university and mentioned a number of various technology that should be implemented in the university campus such as smart student ID with a smart features like identity verification, smart e-wallet, smart book library access, book reservation and issue, smart parking real time availability, online consultation platform and so on.

Teachers also expressed their needs to have smart technologies in classroom and office to support their teaching career and skills and facilitate their interaction and guidance to their students. Finally underlined the necessity of changing from the traditional teaching style into a new way of collaborative learning for smart campus to adopt with this rapidly growing digital world.

5.4 Recommendations

The research that has been undertaken for this thesis has underlined a number of topics on which the researcher recommends. Some of these topics are recommended for university officials, these recommendations include:

Empowering students, teachers and staff with trainings and workshops to fill the gap of lacking information about digital world and IoT, also students and teachers in faculties other than CSE and Engineering should be given courses and seminars about ICT to be able to interact in the smart environment.

Smart Grid Platform, This would be a layer of sensors, communication devices, and a common cloud hosted platform – Smart sense. The platform would be capable of doing two way communication and control, Bandwidth Improvements, Cloud infrastructure, Network modification, Physical security technologies, Data analytics and Cybersecurity.

5.5 Future Work

The researcher recommends some future study or research ideas for further improvements.

Designing generic frameworks of context aware ubiquitous learning environment dealing with the IoT emerging technologies.

Learning analytics and educational data mining.

Creation of new innovative ways to assess students' achievements.

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APPENDICES

Appendix I: Questionnaire for students

Demographic Information

1. What is your sex/gender?

Male

Female

2. How old are you?

Between 15-25

Between 26-35

Between 36-45

Between 46-55

56 and above

3. Which study program are you enrolled in?

Undergraduate (Bachelor)

graduate (Master)

PhD

Diploma

Other please specify

Concept of Internet of Things (IoT) and Smart Campus.

4. How familiar are you with the term “Internet of Things” (IoT)?

Never heard of it

General idea (read about it online, heard about it on the news, etc.)

Read some research papers, heard about in courses.

Doing research in this area

Other please specify _____

5. What is Internet of Things (IoT)? Which word do you associate the most with it?

- | | | |
|--|--------------------------------------|-----------------------------------|
| <input type="checkbox"/> Connected devices to the internet | <input type="checkbox"/> Futuristic | <input type="checkbox"/> Smart |
| <input type="checkbox"/> Intelligent | <input type="checkbox"/> Data stream | <input type="checkbox"/> Security |

Other (please specify) _____

6. Based on your current understanding of the term "smart", how "smart" is your campus?

- | | |
|--|--------------------------------------|
| <input type="checkbox"/> Not at all | <input type="checkbox"/> A little |
| <input type="checkbox"/> More than a little, but less than pretty much | <input type="checkbox"/> Pretty much |
| <input type="checkbox"/> Completely smart | |

Smart Student ID

7. How important are the following Smart Card (Smart Student ID) applications for you?

i. Access to classroom, library or hostel.

- | | | |
|--|---|----------------------------------|
| <input type="checkbox"/> Not important | <input type="checkbox"/> Somewhat important | <input type="checkbox"/> Neutral |
| <input type="checkbox"/> Important | <input type="checkbox"/> Very important | |

ii. e-Wallet function to pay for meals, parking or other fees on campus.

- | | | |
|--|---|----------------------------------|
| <input type="checkbox"/> Not important | <input type="checkbox"/> Somewhat important | <input type="checkbox"/> Neutral |
| <input type="checkbox"/> Important | <input type="checkbox"/> Very important | |

iii. Automated book issue system in libraries.

- | | | |
|--|---|----------------------------------|
| <input type="checkbox"/> Not important | <input type="checkbox"/> Somewhat important | <input type="checkbox"/> Neutral |
| <input type="checkbox"/> Important | <input type="checkbox"/> Very important | |

iv. Class attendance system or identity check during exams.

- Not important Somewhat important Neutral
 Important Very important

v. Other (please specify) _____

Smart Mobility

8. What transportation mode you mostly use to get to your campus?

- Public transportation car motorcycle/bicycle
 Rickshaw/CNG walk UBER/taxi

9. How important are the following on-campus mobility concepts for you?

i. Smart Parking (real time availability, booking, irregularities).

- Not important Somewhat important Neutral
 Important Very important

ii. Public transit tickets on your Student ID.

- Not important Somewhat important Neutral
 Important Very important

iii. Campus map and navigation in your smartphone.

- Not important somewhat important Neutral
 Important Very important

iv. Information kiosks on campus.

<input type="checkbox"/> Not important	<input type="checkbox"/> somewhat important	<input type="checkbox"/> Neutral
<input type="checkbox"/> Important	<input type="checkbox"/> Very important	

v. Other (please specify) _____

Courses / Teachers

10. In your opinion, teacher and student supporting IT systems, how important is to have...

i. Online information system (registration for exams, grades, request for consultations, workflow

<input type="checkbox"/> Not important	<input type="checkbox"/> somewhat important	<input type="checkbox"/> Neutral
<input type="checkbox"/> Important	<input type="checkbox"/> Very important	

ii. Cloud-based documents, teaching materials sharing platform.

<input type="checkbox"/> Not important	<input type="checkbox"/> somewhat important	<input type="checkbox"/> Neutral
<input type="checkbox"/> Important	<input type="checkbox"/> Very important	

iii. University own social network

<input type="checkbox"/> Not important	<input type="checkbox"/> somewhat important	<input type="checkbox"/> Neutral
<input type="checkbox"/> Important	<input type="checkbox"/> Very important	

iv. Meaningful university presence on existing major social networks

<input type="checkbox"/> Not important	<input type="checkbox"/> somewhat important	<input type="checkbox"/> Neutral
<input type="checkbox"/> Important	<input type="checkbox"/> Very important	

v. Other (please specify) _____

11. How important do you think it is necessary to change from the traditional teaching style (teacher in front of a class) to a new way of teaching - cooperation (teacher as a moderator, team work, flipped learning).

- Not important somewhat important Neutral
 Important Very important

12. Are your teachers able to use "smart" solutions?

- Not important somewhat important Neutral
 Important Very important

13. Are your teachers using smart solutions?

- Yes No

14. What is your opinion of online courses (e-learning)?

- They should not be used at all.
 They should be used only as a complement to contact lessons.
 From time to time they should be used instead of contact lessons.
 They should be used instead of contact lessons very often.
 They should replace contact lessons.

Closing Questions

15. Rate how much you perceive or feel the use of "smart" technologies in education will invade your privacy.

- Not at all
- A bit
- Neutral
- Pretty much
- Completely

16. Put weights to the following categories according to their importance with respect to "Smart Campus".

i. Smart Card

- | | | |
|--|---|----------------------------------|
| <input type="checkbox"/> Not important | <input type="checkbox"/> Somewhat important | <input type="checkbox"/> Neutral |
| <input type="checkbox"/> Important | <input type="checkbox"/> Very important | |

ii. Smart mobility

- | | | |
|--|---|----------------------------------|
| <input type="checkbox"/> Not important | <input type="checkbox"/> Somewhat important | <input type="checkbox"/> Neutral |
| <input type="checkbox"/> Important | <input type="checkbox"/> Very important | |

iii. Classroom/building

- | | | |
|--|---|----------------------------------|
| <input type="checkbox"/> Not important | <input type="checkbox"/> Somewhat important | <input type="checkbox"/> Neutral |
| <input type="checkbox"/> Important | <input type="checkbox"/> Very important | |

iv. Courses / teachers

- | | | |
|--|---|----------------------------------|
| <input type="checkbox"/> Not important | <input type="checkbox"/> Somewhat important | <input type="checkbox"/> Neutral |
| <input type="checkbox"/> Important | <input type="checkbox"/> Very important | |

17. After answering the previous questions: How "smart" is your campus now?

Not at all

A bit

More than a little, but less than pretty much

Pretty much

Completely smart

18. How important you think is for your Campus to become smarter?

Not important

Somewhat important

Neutral

Important

Very important

Turnitin Originality Report

Processed on: 18-Apr-2019 10:31 +06

ID: 1114756269
Word Count: 16166

Submitted: 1

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APPLICATIONS OF SMART CAMPUS IN DIU**

BY

Hassan Haji Ibrahim Mohamed

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