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I-CAMPUS: TOWARDS THE INFORMATION INTEGRATION FOR UITM PERAK BRANCH IMPLEMENTATION OF SMART CAMPUS

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ABSTRACT

As a result of the fast advancement of science and technology, the i-Campus initiative integrates information and communication technology (ICT) and the Internet of Things (IoT) into a traditional campus, transforming it into a smart campus. This concept aligns with the development of smart cities and aims to provide a modern and connected environment for learning, efficient administrative operations, and enhanced collaboration within the university community. This paper utilizes qualitative interviews with experts to achieve the research objective of improving the learning and teaching experience, streamlining administrative processes, and exploring the collaborative features and tools available within smart campus.

Keywords: *campus, smart campus, Internet of Things, Malaysian Campus*

1.0 INTRODUCTION

In recent years, smart campus concepts have been introduced and implemented to enrich the quality of life in the campus environment. This was also done to reduce the expense of operating a campus. Smart campuses are technologies and software that provide new experiences, services, and improve campus operating efficiency, (Musa, 2021). University is a dynamic environment that requires management to be proactive in resolving different concerns, such as sustaining the university as a centre of knowledge creation and research excellence, increasing equity, and reacting to student needs. Universiti Teknologi MARA (UiTM), which a key player among public universities in Malaysia, needs to concentrate on reforms, innovations, and developments related to the Industrial Revolution 4.0 (IR 4.0) and Sustainable Development Goals (SDGs) which divided into eight dimension such as Smart Economy, Smart Education, Smart Environment, Smart Living, Smart Management, Smart Mobility, Smart Technology and Smart Security through its strategic plan UiTM2025 and in accordance with the national agenda of the Education Development Plan for Malaysia 2015-2025 (Adnan Ahmad Suhail, 2020).

According to Xiong (2017), People's attention has steadily been drawn to the establishment of Smart Campuses, with private universities taking the lead in developing applications. Today's Smart Campus is a digital campus renovation that may give college teachers and students with a better life and academic environment. Smart Campus is a more sophisticated kind of university information organization that also extends and improves on digital campus. It has made use of cutting-edge information technology, cloud computing, the Internet of Things (IoT), mobile Internet, big data, IntelliSense, business intelligence, knowledge management, and social networking.

In-line with the development and implementation of the Fourth Industrial Revolution (IR 4.0) and the Internet of Thing (IoT), there is a need for high institution such as UiTM Perak Branch to adapt the technology and be a connected and responsive campus. As stated from (Musa, 2021), As we can see, numerous technologies have been created to make the campus smart enough to be considered a smart campus. Different stakeholders have different kinds of intelligence that they need on campus. Not only should the implementation of the smart campus examine the intelligence of the technology, but it should also consider the quality of experience of the campus community. Infrastructure is one of the aspects that need to be considered in developing a smart campus so that it can give services that are beneficial for the campus community. The smart connected campus should also provide flexible, fast, and timely delivery of responses to the students, staff, faculty, visitors, and management authorities with better features.

With intelligent identification, Smart Campus may assist learners and educators in general perception of the physical environment of campus; knowing their study and working settings; and individual characteristics. (Xiong, 2017). It also connects the physical and digital spaces to provide an intelligent and open educational environment for teachers and students. Furthermore, it changes how instructors and students engage with school resources and the environment, bringing people-oriented personalised service innovation to fruition.

Therefore, this paper proposes a set of recommendation towards how smart campus create a technologically advanced and integrated campus environment that enhances learning, optimizes administrative processes, and fosters collaboration among the university community.

2.0 LITERATURE REVIEW

In this section, a brief explanation of some of the work related to the concept of smart campus and the activities that put it into practice, the perception of location-based services, and the data visualisation are discussed.

2.1 Smart Campus Definition

According to Polin, (2023), the digitally transformed university campus is also referred to as ‘smart **campuses**. Smart campus models the smart city ecosystem, and along with their traditional teaching, learning and research functions, they also promote lifelong learning, research, innovation, and entrepreneurship, and offer various Living Lab programs. Some scholars claim that technology advancement, as well as other challenges including the environment, economy, and social sector, make it inevitable that all educational processes will become ‘smart,**’** with campuses becoming ‘smart**’**. will become learning and living environments that are integrated with advanced technological infrastructures, such as Internet of Things,(Yang, 2018).

The smart campus capitalises on the establishment of a digital campus along with is seen as a self-contained mini version of smart cities., (Afni Deraman, 2021). Table 1 shows the comparison between the digital and smart campuses regarding the technical environment, application, and management system, (Nie, 2013). According to the study, as the IR 4.0 age approaches, a move from a digital campus to a smart campus is in order.

Table 1: Comparison of Conventional Campus and Smart Campus (Author, 2023)

Element	Conventational Campus	Smart Campus
Technical Environment	Local Area Network Internet	IoT Cloud Computing Wireless Network Mobile Platform Sensor
Application	Digital-based system (teaching platform, library, services)	A smart system with sensory ability, interoperability, control capabilities
Management System	Isolated System	Centralized System System Sharing Intelligent Push-in notification

Using the same principle as smart cities, a smart campus should follow modern technology to support the number of campus stakeholders, namely students, educators, administrators, and visitors. It exploits the on-campus Internet of Things (IoT) service providers, cloud storage, and smart systems. The idea behind this approach is to transform common structures that can usually be found in a university setting into a specific intelligent campus environment, (Liu, 2014).

Various framework has been proposed on designing smart campus. According to Adamkó & Kollár, (2014), a central intelligence layer is proposed to provide smart service at application based. The services are model based on sensor, social, research, and educational elements with the ability of data analytic processing. As reported by Jurva , (2020), The technical framework shows that sensor layer, network layer, cloud computing layer, services layer, and Internet are essential in ensuring IoT in smart campus are functioning well, (refer Figure 1). Previous studies also supported this where their proposed standard framework of smart campus comprises sensor layer, network layer, and application layer.

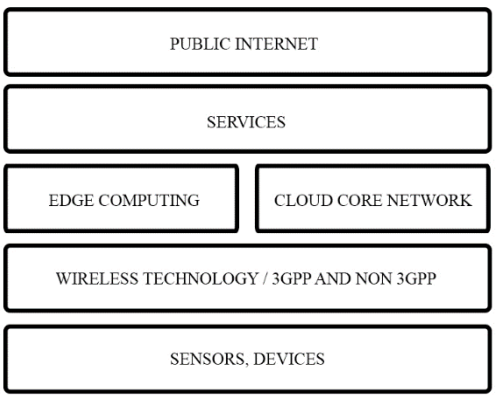

Figure 1: The technical framework of Smart Campus (Author, 2023)

2.2 Smart Campus Components

2.2.1 Location-Based Service

A location-based service (LBS) provides information depending on what user's current location. The advancement of technologies and wireless communication makes the LBS a popular "killer-application" in the future. There are two main discussions in the LBS, which are location and proximity. A precise, immovable location is often specified using a geographical coordinate system. At the same time, proximity is not an absolute location, which usually refers to a distance that has no direction. Latitude and proximity are frequently used interchangeably; yet, they function differently and are applied in various contexts, (Afni Deraman, 2021). A Bluetooth Low Energy (BLE) Beacon is a device that emits a signal of BLE to a mobile device that is nearby, (Herrera Vargas, 2016). Since BLE draws a little power for the beacon to operate, it can last long for years, depending on its configurations. The BLE beacon can operate up to 100m theoretically. However, due to walls and other kinds of physical interferences, the distances it can reach will be affected, (Rung-Shiang Cheng, 2016). Depending on the usage, the beacon sends BLE packets to the surrounding area using a particular protocol. Many protocols were developed to integrate with the beacon and the smartphone platform. The most widely used protocols are iBeacon and Eddystone. However, in the first year of the iBeacon protocol's implementation, it was only found in Apple. It is now also supported by the Android platform. According to Sarah K.White, (2017), Geofence is a virtual fence around a particular geographic area and typically represents a physical location, such as a house or site. Geofence uses GPS reading, RFID, Wi-Fi, or cellular data to trigger a pre-programmed action when a mobile device or RFID tag enters or exits a virtual boundary set up around a geographical location. Geofences and beacons have similar goals in that they both detect the user's position. However, overlapping use of both devices can lead to redundant information. The rule of thumb in the placing of both devices relies on the distance covered. Beacon is preferably used indoors areas that span less than 50 meters, whereas geofence is defined as a macro-location-based system with an area of more than 50 meters. Table 2 displays the characteristics of beacon and geofence, (Oleg Morajko, 2017). Based on these characteristics, i-CAMPUS will place the beacons for indoor navigation and geofence for outdoor.

Table 2: Characteristics of Beacon and Geofence (Oleg Morajko, 2017)

Characteristics	Beacon	Geofence
Requires additional hardware	Yes	No
Requires Bluetooth	Yes	No
Requires user to opt-in for location service	Yes	Yes
Requires GSM/WiFi/GPS	No	Yes
Good for large areas (>50 meters)	No	Yes
Good for close proximity (<50 meters)	Yes	No
100% Accuracy	Yes	Accuracy varies with location and network coverage
Available on Android	From Android 4.4+	Yes
Available on iOS	From iOS 7.0+	Yes

2.2.2 Data Visualisation

The university maintains a substantial quantity of digital data in order to function, and the data stream includes students, services, personnel, campus activities, and commercial transactions. Effective governance of university data would have huge potential to improve the experience of its stakeholders, earn income, and plan strategically, (Zhang et al., 2021). According to Martinez, (2018), The digital dashboard is an electronic platform that aggregates and shows data from various sources, such as data bases, locally hosted files, and web services. E-dashboards enable management to track key performance indicators (KPIs) for their subordinates by displaying historical patterns, actionable data, and real-time information. Using a dashboard assists management in visualising key performance indicators (KPIs) for better strategy development and communication with stakeholders.

3.0 METHODOLOGY

The first step in the methodology involves defining the research objectives for the smart campus implementation project. This includes identifying goals such as enhance learning and teaching experience, streamline administrative processes within the university and exploring the features and tools available within i-CAMPUS that promote effective collaboration and communication. Following this, a comprehensive literature review is conducted to gain insights into existing smart campus implementations, technologies, and best practices. The literature review also helps in identifying the relativeness to the concept of smart campus and the components that put it into practice.

The methodology proceeds with qualitative data collection through expert interviews. In-depth interviews are conducted with Ts. Hajah Azizah Omar, Director of Facilities Management and Dr. Atikah Fukaihah binti Amir, Green Campus Comittee, who are experts in smart campus implementation. The interview questions cover a range of topics, including their insights on issues, technological requirements, stakeholder engagement, and potential benefits and challenges. The collected data from the interviews and document analysis is then analysed through transcribe techniques. The qualitative data analysis software is utilized to identify common themes, patterns, and insights emerging from the interviews. A thematic analysis is conducted to extract key findings, challenges, and recommendations related to the implementation of a smart campus, based on the expert inputs. Table 3 shows the list of questions for the purpose of guiding the flow of the interview and the think aloud method process. The rationale for each question content is also presented to provide an idea of what was looked at in the response.

Table 3: Interview Question Guide

Questions	Rationale (What was looked at)
How familiar are you with the term "Smart Campus"?	Identify knowledge gaps, evaluate the efficacy of awareness campaigns, and assess market readiness for Smart Campus installations
In your opinion, what is the importance of implementing Smart Campus?	Gain subjective ideas and opinions from individuals who may have varied backgrounds, roles, and experiences.
Based on your current understanding of the term "smart", how "smart" is our campus?	Gather feedback on existing initiatives, identify improvement areas, tailor strategies, and engage stakeholders in building a more intelligent and technologically advanced campus.
Is there any chance of “Green Campus” to become Smart Campus? If yes/no, can you please explain further.	Examine the relation between sustainability and technology improvements, as well as how stakeholders view the feasibility and advantages of converting a Green Campus to a Smart Campus.
What measures are taken to ensure the implementation of smart campus for UiTM Seri Iskandar?	Comprehend the actual actions being taken to realise the goal of a smart campus.
How does smart campus enhance the overall learning and teaching experience for students and campus community?	Recognise the practical benefits and advantages that students and the campus community gain from a technologically advanced and interconnected campus.
What are major challenges do you think our campus will face in order to become a Smart Campus?	understand the perceived barriers from the perspective of the campus community, which can help in strategizing solutions and addressing these challenges proactively.
What type of facilities such as technological infrastructure and systems are required can be included in Smart Campus?	Identify essential elements and plan for the necessary resources to create an efficient and effective Smart Campus
How Smart Campus can give benefit to the campus community?	Highlight the value proposition of a Smart Campus and the potential improvements it offers to campus community.
What lesson can the respondent learn from the implementation of smart campus at UiTM Perak Branch?	Understand the implementation process's accomplishments, obstacles, and best practises, offering knowledge that may guide and advise similar initiatives in various situations

Based on the integrated findings, a set of recommendations and an action plan are developed. These recommendations address the technological, organizational, policy, and stakeholder engagement aspects required for the successful implementation of a smart campus. The research findings, recommendations, and action plan are shared with relevant stakeholders, such as campus administrators, decision-makers, and technology providers, to seek their input and collaboration. To ensure continuous improvement, mechanisms for ongoing monitoring and evaluation

of the smart campus implementation are established. Regular assessments are conducted to gauge the progress, impact, and effectiveness of the implemented solutions. Feedback is incorporated, and necessary adjustments are made to enhance the smart campus project.

In summary, this methodology involves a comprehensive approach that integrates qualitative data collection through expert interviews and document analysis. The findings are synthesized, and recommendations are developed to guide the implementation of a smart campus. Continuous monitoring and evaluation ensure the project's success and allow for improvements over time.

4.0 RESULT & DISCUSSION

The result and discussion section of the research, explores the findings obtained through qualitative research. In-depth interviews are conducted with Ts. Hajah Azizah Omar, Director of Facilities Management and Dr. Atikah Fukaihah binti Amir, Green Campus Comittee, who are experts in smart campus implementation. By employing the qualitative method, this study delved into the perspectives and experiences of various stakeholders within the academic community to gain a comprehensive understanding of the implementation process. This section presents the outcomes, analysis, and interpretation of the data gathered, shedding light on the advantages, deficiencies, and opportunities identified during the smart campus implementation journey. Through in-depth interviews obtained, unveiling the relativeness of key factors contributing to the success and challenges faced in the transformative endeavour. The qualitative approach enabled a thorough exploration of the complexities and nuances surrounding the Smart Campus initiative, providing valuable information for enhancing the integration of technology in education and paving the way for a more empowered and progressive learning environment. Figure 2, 3, 4, 5, 6, 7, 8, and 9 shows the process how the code from thematic process is generated to get a theme.

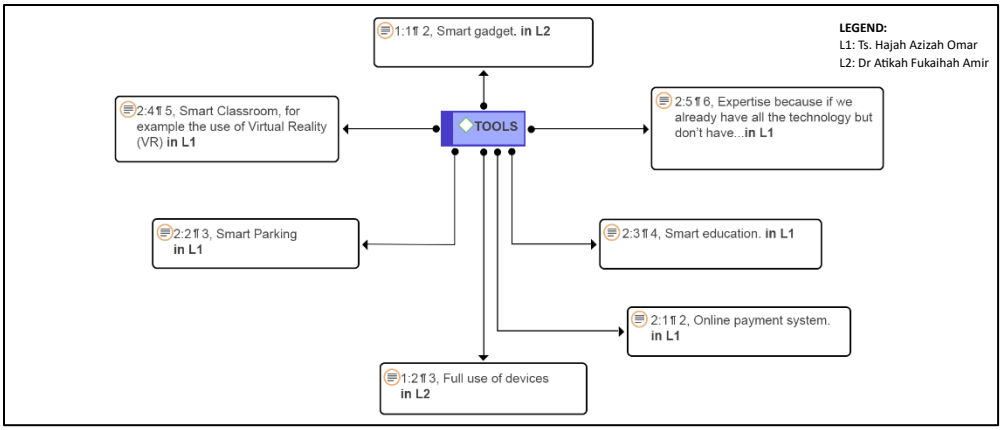

Figure 2: Tools

Figure 2 identified the research project demonstrate the multifaceted nature of technology integration in creating a Smart Campus at UiTM Perak Branch. Smart classrooms, smart gadgets, expertise, smart education platforms, online payment systems, smart parking solutions, and the full use of devices collectively contribute to a transformative and empowered learning experience, enriching education and shaping a progressive campus environment.

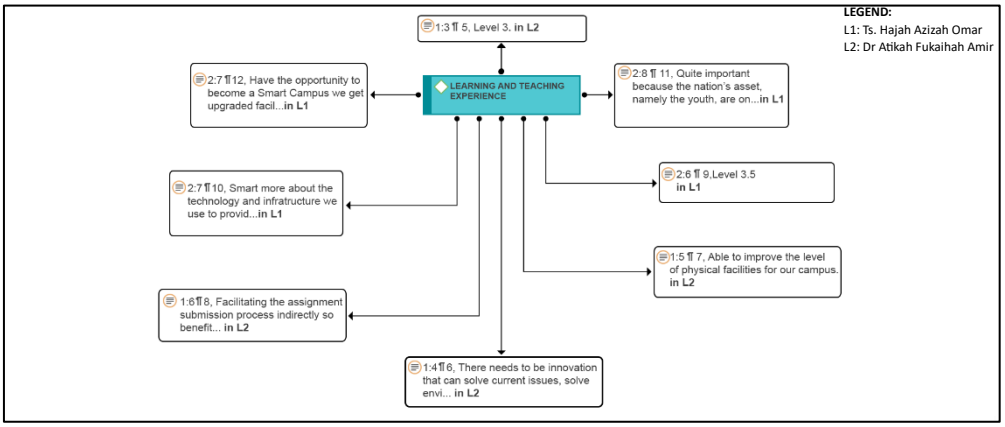

Figure 3: Learning and Teaching Experience

Figure 3 emphasizes the importance of enhancing education for the youth, who are the future of the country. The focus is on improving physical facilities, embracing innovation, and leveraging technology to address current challenges. By facilitating assignment submissions through digital tools and providing access to cutting-edge technology and infrastructure, UiTM Perak Branch aims to become a Smart Campus.

This transformation will create a dynamic learning environment, equipping students with essential skills and knowledge to thrive in the modern world and contribute to the nation's progress.

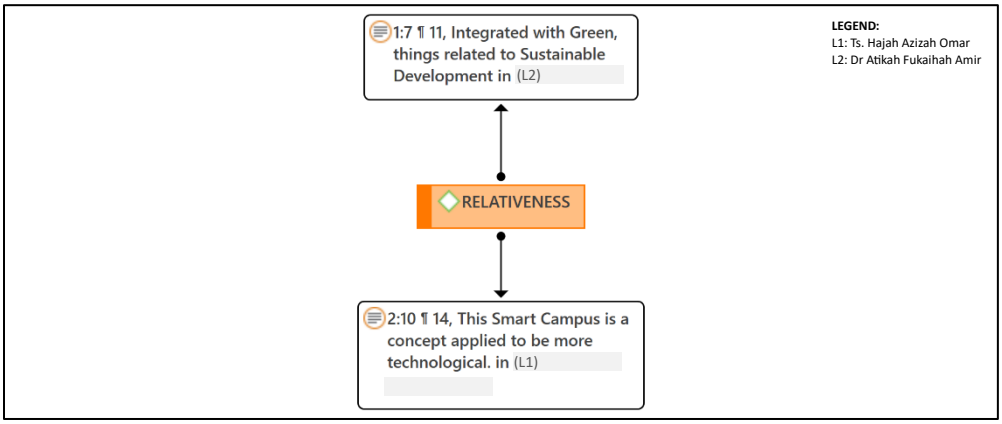

Figure 4: Relativeness

Figure 4 highlights the integration of green and sustainable development ideals with technology developments. UiTM Perak Branch hopes to establish an ecologically conscious and sustainable learning environment by implementing green practises into the Smart Campus concept. This relativeness component emphasises the significance of combining technical advancement with environmental concerns, paving the path for a Smart Campus that is not only technologically sophisticated but also ecologically friendly and geared towards a sustainable future.

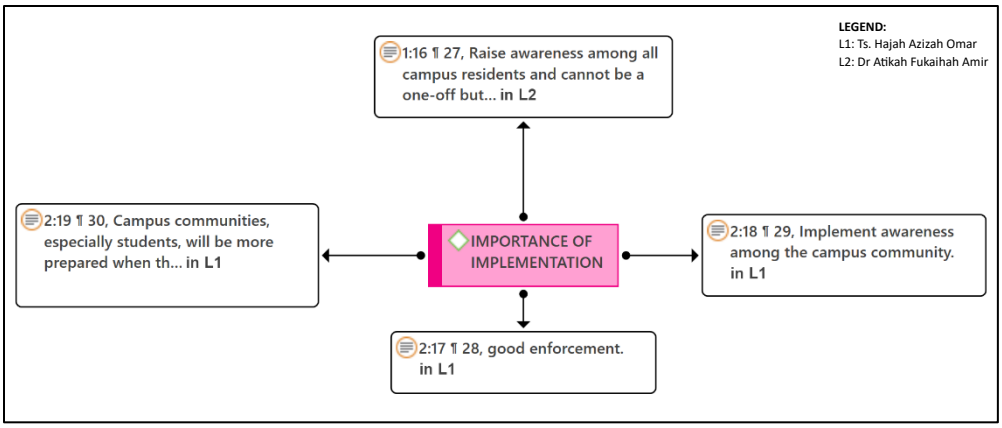

Figure 5: Importance of Implementation

Figure 5 shows that by informing the campus community about the Smart Campus initiative, they become more prepared for the changes and improvements it will bring.

The ongoing efforts to promote awareness ensure that everyone understands the significance of the initiative and actively participates in its success. This creates a strong sense of involvement and ownership within the campus community, making them integral to the Smart Campus transformation. Implementing awareness programs and good enforcement ensures that the Smart Campus becomes a collaborative and successful venture that benefits everyone at UiTM Perak Branch.

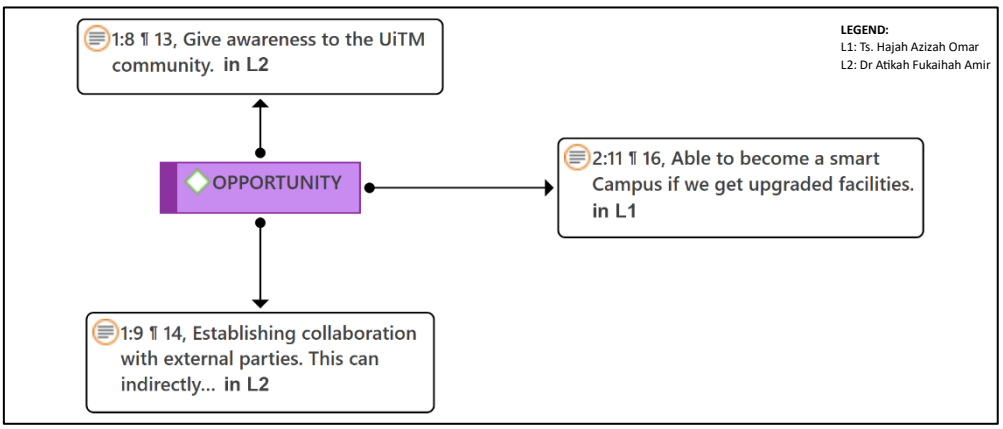

Figure 6: Opportunity

Figure 6 shows that seizing these opportunities will lead to a modern, efficient, and empowered learning environment, enhancing the overall campus experience and positively impacting the community and economy.

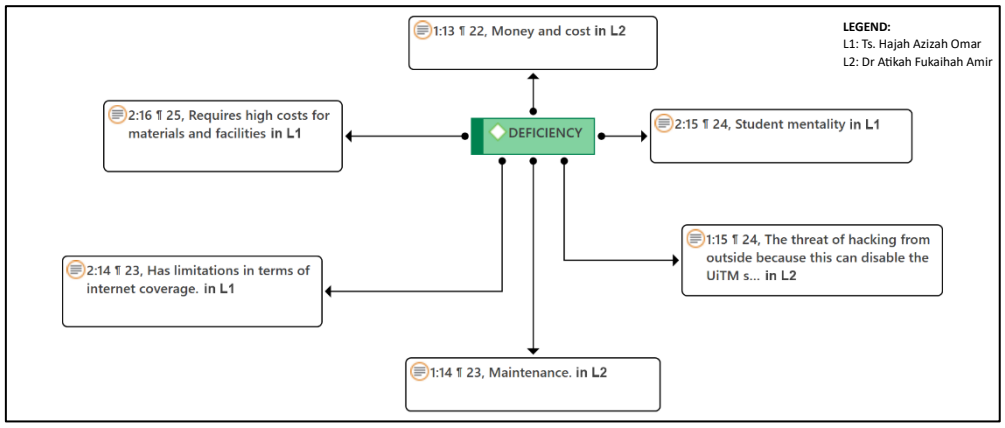

Figure 7: Deficiency

Figure 7 shows that there are a number of deficiencies that need to be highlighted to make sure the success of implementation smart campus at UiTM Perak Branch.

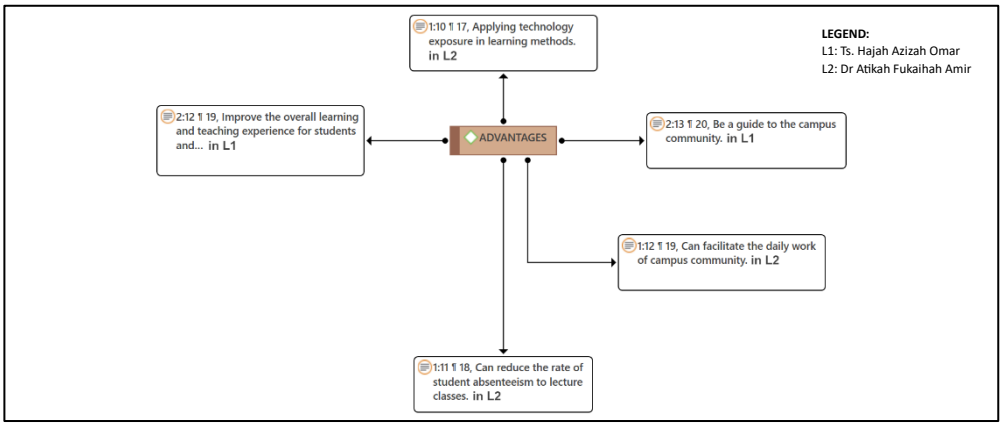

Figure 8: Advantage

Figure 8 shows the positive impact of applying technology exposure in the learning methods. By integrating technology (L2) into the teaching approach, educators can engage students more effectively and create interactive learning experiences. This modernized approach becomes a guiding force for the campus (L1) community, encouraging students and faculty to embrace technology as an essential part of their academic journey.

The combination of the code representing different aspects of the i-CAMPUS research which results in three overarching themes that encapsulate the key findings and insights of the study. Figure 9 below shows these themes capture the essence of the research findings, guiding the path towards the information integration for UiTM Perak branch implementation of smart campus.

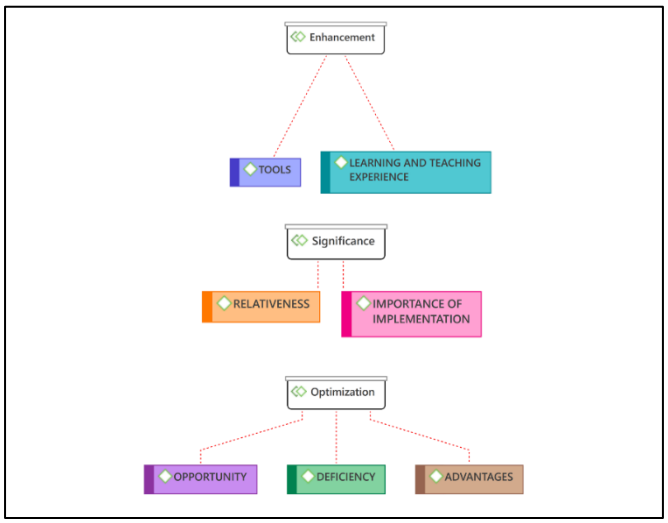

Figure 9: The result of theme

5.0 CONCLUSIONS

In conclusion, the i-CAMPUS research project focused on the implementation of a Smart Campus at UiTM Perak Branch with the objective of improving the learning and teaching experience, streamlining administrative processes, and exploring collaborative features and tools available within the smart campus framework. Through a comprehensive exploration of various aspects, this study has demonstrated the potential for transformative change in the educational landscape. By leveraging smart tools and digital resources, the Smart Campus initiative seeks to empower students and educators, creating a dynamic and engaging learning environment. The integration of technology into teaching methods enhances accessibility to educational materials, promotes collaborative learning, and fosters a student-centric approach. Additionally, by embracing data analytics tools, the campus can make informed decisions, optimizing academic processes for better efficiency.

Furthermore, the research highlighted the relativeness of the Smart Campus concept by incorporating green practices and sustainability considerations. The implementation of environmentally responsible practices ensures that technological advancements align with the broader goal of a sustainable future. The importance of implementation has been emphasized throughout the research, focusing on raising awareness among the campus community. By establishing collaborations and engaging stakeholders, UiTM Perak Branch can pave the way for successful Smart Campus integration. Streamlining administrative processes through smart solutions enhances operational efficiency, allowing staff to focus on supporting students and educators effectively.

Last but not least, the research project provides valuable insights and recommendations for the successful implementation of a Smart Campus at UiTM Perak Branch. The integration of smart tools and technologies promises to elevate the learning and teaching experience, streamline administrative processes, and unlock collaborative potentials within the academic community. By embracing the Smart Campus vision, UiTM Perak Branch can embark on a transformative journey towards a modern, sustainable, and empowered educational environment.

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