

Navigating the technological frontier: An analysis of the Smart University concept

LCDB7008 – VISIONS FOR THE FUTURE: THEORETICAL
PERSPECTIVES ON MANAGEMENT

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Executive Summary

This report critically evaluates the concept of the smart university, a transformative paradigm in higher education leveraging advanced technologies.

The report is structured into three main sections. The first section explores the theoretical foundations guiding university responses to challenges posed by recent advancements in educational technologies. The second section details the challenges faced by UK universities, highlighting contemporary practices, and providing examples. The third section synthesises insights to examine the concept of a smart university as a long-term strategy for addressing technological challenges and redefining educational responses to emerging technologies.

Smart Universities encompass various key components to enhance overall efficiency and effectiveness such as smart campus infrastructure, digital analytics, transparent and data driven decision making etc.

A smart university, driven by advanced technologies like artificial intelligence (AI), offers numerous advantages across administrative, educational, and operational aspects. Administrative tasks are streamlined through AI automation, reducing workload, and enhancing accuracy. Communication is improved with AI-driven chatbots providing instant responses to inquiries. In the educational domain, AI tailors learning experiences, adapts content delivery, and facilitates immersive learning through VR simulations. The grading process is expedited, providing quick feedback to students. Predictive analytics identify students at risk, allowing proactive interventions. Energy and resource management benefit from AI optimization, contributing to sustainability and cost savings. Smart universities thus create an efficient, adaptive, and student-centric environment.

The drawbacks associated with implementing smart technologies in universities include high costs, technological vulnerabilities, digital inequality, privacy concerns, resistance to change, ethical considerations, loss of human touch, skill gaps, continuous upgrades, and potential distractions in the learning environment. Overcoming these challenges requires strategic planning, ethical considerations, and proactive measures to strike a balance between the benefits and drawbacks of smart university initiatives.

The report concludes with the suggestion of embracing the concept of a smart university as a long-term strategy for navigating the technological frontiers in HE. An implementation plan is also presented together with anticipated challenges.

Key words:

Smart University, Technology Acceptance, Innovation Diffusion, Stake holders, Infrastructure

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Abbreviations

AI – Artificial Intelligence

CVF – Competing Value Framework

DOI – Diffusion of Innovations

ERP – Enterprise Resource Planning

HE – Higher Education

LMS – Learning Management System

NLP – Natural Language Programming

NTU – Nottingham Trent University

TAM – Technology Acceptance Model

UWTSD – University of Wales Trinity Sint David

VR – Virtual Reality

1. Introduction

The challenge

“It was a storm in a teacup”.

The above remark was made by Professor David Smith of the Sheffield Hallam University as a response to the launch of the advanced chat bot called ‘Chat GPT’ (Heaven, 2023). Since the launch of advanced language models such as Chat GPT, the responses from the Universities in the UK have varied (Celik *et al.*, 2022; Bearman *et al.*, 2023; Heaven, 2023; Singaram *et al.*, 2023). Many authors have also concluded the invention of such technologies have been a catalyst for change in the higher education (HE) sector (Bearman *et al.*, 2023; Dwivedi *et al.*, 2023; Hassoulas *et al.*, 2023; Ibrahim *et al.*, 2023).

The onset of the COVID-19 pandemic in late 2019 prompted the global closure of schools and universities in 2020. This underscored the significance of implementing versatile teaching methods to enable virtual learning and mitigate challenges associated with traditional face-to-face instruction. (Ndebele and Mbodila, 2022). This is also termed as the impact of the 4th industrial revolution on education by many experts (McKinsey, 2022; Singaram, *et al.*, 2023).

The latest technological innovations have caused ripples across the global HE sector. For example, several prominent UK universities, including Imperial College London and the University of Cambridge, released statements cautioning students against utilising ChatGPT as a means of engaging in academic dishonesty (Heaven, 2023). Whereas many other institutes in USA and Australia responded by banning the use of software (Bearman *et al.*, 2023; Dwivedi *et al.*, 2023). During the latter half of 2023, it appears that universities in the UK have begun to realise the potential of Artificial Intelligence (AI) in education. For instance, the Russell group of universities which comprise many leading universities in the UK have drawn up a set of guidelines for its members on using AI (Russell Group of Universities, 2023; The Guardian, 2023). Moreover, the industry body Advance HE has advised institutions to take a community approach in navigating the challenges of technological innovations such as AI (Stephenson and Knight, 2023).

Thus, the responses so far from the leaders of the UK HE sector seems to vary from sudden and hasty to cautious and coordinated. Nevertheless, it is certain that the rapid development of technologies such as AI has challenged the conventional practices in the HE industry. But is there a structured way of responding to challenges such as this? Or is it a matter of organic change?

The purpose of this report

This report intends to analyse the UK University responses to the challenges posed by the latest innovation of technology as mentioned above. In the process, various established theories will be used to explore the rationale behind the **strategic decisions** made by the universities in responding to technological innovations.

The report also evaluates the proposal of a '**Smart University**' as a long-term innovative management solution based on the discussions of the theoretical frameworks and recent research findings. The potential impact of the proposed solution and implementation plans will also be discussed in this report.

The structure of this report

This report is organised into three key sections as Illustrated in figure 1.

In the first section, a broader discussion covering the theoretical underpinnings of the university responses to the challenges posed by the recent development of educational technologies is included. This section will attempt to establish how the decision-making process at the face of uncertainties created by technological innovations are aligned with various theoretical foundations. Such theoretical foundations will be drawn from both seminal and recent literature on management practices.

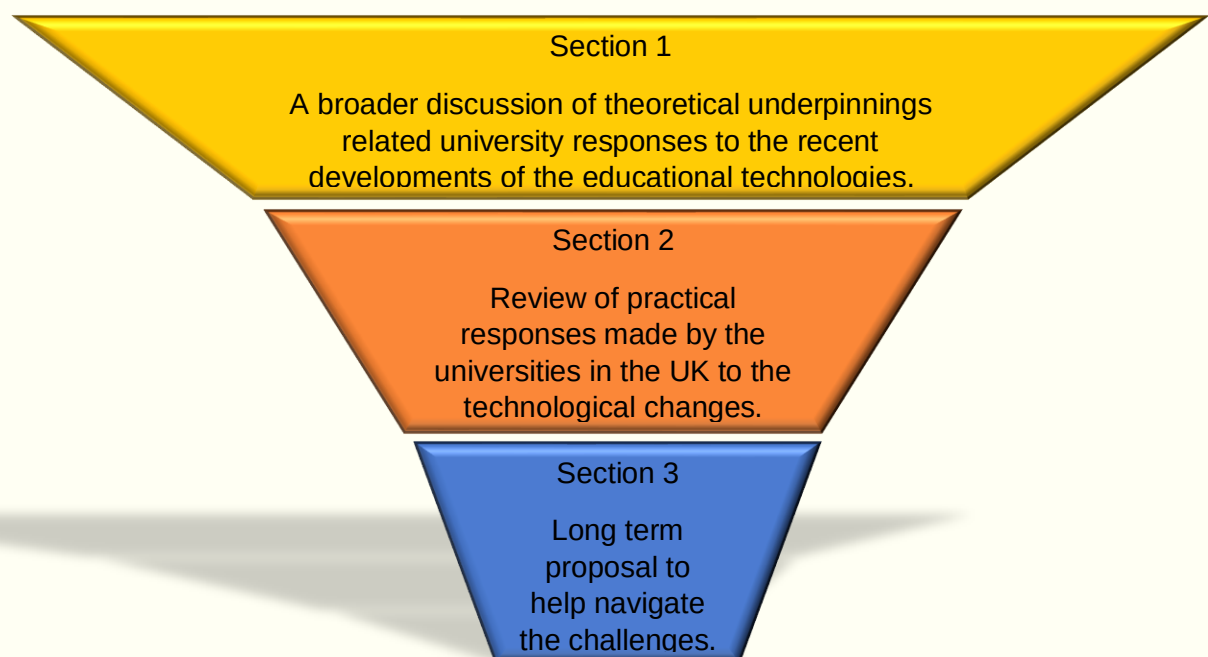


Figure 1 - The funnel structure of the report

The second section of the report will present further details of the challenges faced by the Universities in the UK. This section will highlight the contemporary practices adopted by universities in the UK supported with examples.

Drawing from the discussions on the first two sections, the final section of the report will examine the concept of a smart university as a long-term approach on tackling the challenges faced by the universities in the UK due to the rapid changes in technologies.

2. Theoretical concepts related to adopting technological innovation.

This section of the report will extensively review the seminal and contemporary management theories in relation to the way UK universities have responded to the recent changes in educational technologies.

2.1. Drivers of technology acceptance: What makes a university wanting to accept new technology?

Technological innovations in the UK HE sector is not new and has been the subject for many studies (Price and Kirkwood, 2008; Hariri, 2014; Ernest and Young, 2022). However, the Covid 19 pandemic has certainly increased the adoption and use of the technology by universities (Webb *et al.*, 2021; Zhang *et al.*, 2022). As mentioned in the introduction, the recent development in AI has also exacerbated the pressure on universities to respond (Mohamed *et al.*, 2022; Bearman *et al.*, 2023). Thus, it is imperative to investigate theories which explain how technology is adopted.

Taherdoost, (2018) identified fourteen different theoretical models used by researchers to explain technological adoptions. However, this section will analyse two of the most frequently used models by researchers. Namely, the diffusion of innovation (DOI) by Rogers, (1962) and the Technology Acceptance Model (TAM) by Davis, (1989).

2.1.1. Diffusion of innovations

The Diffusion of Innovations (DOI) model, developed by Everett Rogers, provides a comprehensive framework for understanding how innovations, including technology, are adopted, and spread within a social system (Acikgoz *et al.*, 2023). When applied to the context of UK universities, the DOI model can offer insights into the factors influencing the acceptance of technology. Analysed below are some key drivers as identified by the DOI in relation to acceptance of technology by UK universities.

- The attributes of the innovation as a driver of acceptance

Meyer, (2004) and Rogers *et al.*, (2014) outlined five characteristics of innovation: Relative Advantage, Compatibility, Complexity, Trialability, and Observability. In the context of UK universities, technology acceptance is influenced by how well a technological innovation aligns with existing practices (Compatibility), its perceived benefits over existing solutions (Relative Advantage), the ease of understanding and using it (Complexity), the ability to experiment with it (Trialability), and the visibility of its outcomes (Observability).

For example, implementing a new Learning Management System (LMS) called Aula at the Coventry university had to be delayed due to the lack of staff awareness (compatibility) and the perceived benefits of the new system. Learning coaches were then used support academic staff in developing range of materials (complexity) with the aim of improving student satisfaction (compatibility) (Aula Education, 2020).

However, Hariri, (2014) states that DOI assumes that the attributes of an innovation are static, and technology evolves rapidly, and its attributes may change over time. This dynamic nature is not adequately addressed in the model. Furthermore, as noted in the example of Coventry university LMS implementation, the adoption process can be non-linear and iterative, with continuous feedback loops and adjustments (Acikgoz *et al.*, 2023).

- Adopter categories

The DOI model classifies adopters into categories such as Innovators, Early Adopters, Early Majority, Late Majority, and Laggards as illustrated in figure 2 (Rogers *et al.*, 2014; El Malouf and Bahemia, 2023). In UK universities, understanding the characteristics of each adopter category is crucial. Innovators and Early Adopters may drive initial technology adoption, while the Majority and Laggards may follow suit based on factors like peer influence, institutional policies, or perceived risks (El Malouf and Bahemia, 2023).

UK universities are frequently considered as hubs for innovation (Belmana, 2020). However, when it comes to adopting innovations, UK universities have responded varyingly as explained in the introduction. The factors explained above can be used to analyse the reasons for such variation of responses by the universities to the latest technological developments.

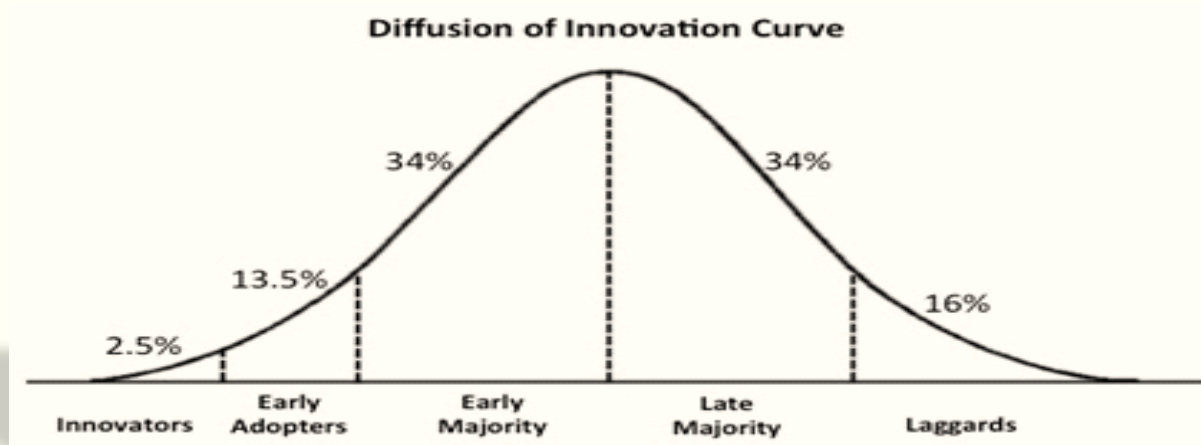


Figure 2 - Diffusion of Innovations curve

Source – Rogers *et al.*, (2014)

For example, many universities in the UK are yet to respond to the invention of generative AI models such as Chat GPT, despite it has been in existence for over a year. Throughout the previous academic year, universities implemented diverse and often impromptu strategies for adopting software, or in some instances, lacked any policy (Hack and Knight, 2023). Some professors outright banned its usage, citing concerns about plagiarism, while others sought to integrate it more deliberately into their coursework. This resulted in inconsistent approaches across various classes and departments (Bloomberg News, 2023). In general, such universities which demonstrates a strong technological focus, willing to take risks and experiment, while being proponents of change can be categorised into *innovators* or *early adopter* stages of the DOI (Wani and Wajid Ali, 2015).

However, DOI assumes a homogeneous population, where individuals and organizations are similar in their characteristics and needs. In the diverse context of UK universities, this assumption may not hold, as different departments, disciplines, and stakeholders have varied requirements and preferences. (Rogers *et al.*, 2014; Wani and Wajid Ali, 2015). Moreover, DOI places more emphasis on the attributes of the innovation itself rather than the social and cultural contexts in which it is adopted. In a university setting, social and cultural factors play a crucial role, and DOI may not sufficiently address the influence of these contextual elements (García-Avilés, 2020). Nevertheless, many universities are now acknowledging the need to find a way to coexist with artificial intelligence (Bloomberg News, 2023; The Guardian, 2023).

The DOI explains the reasons for the time lag between the responses of the universities to the technological innovations. As noted above, some universities are willing to experiment with technology more than others. Although DOI identifies these characteristics, it is necessary to have a look at other theoretical concepts to enhance the understanding of what makes some universities have a stronger appetite to change than others. The next section will explore this further.

2.1.2. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a widely recognized theoretical framework developed to understand and predict users' acceptance and adoption of technology (Marangunić and Granić, 2015). Applying TAM to the context of UK universities involves analysing its key components in relation to the factors influencing the acceptance of technology in the academic setting.

The TAM consists of four fundamental components as illustrated in figure 2. (1) user behaviour, representing the tangible actions users take with the new technology; (2) behavioural intention, signifying users' readiness to experiment with novel technologies; (3) perceived usefulness, reflecting users' subjective assessment of the value of the recently adopted technology; and 4) perceived ease of use, indicating the level of effort exerted by technology users in employing new technologies (Su and Li, 2021).

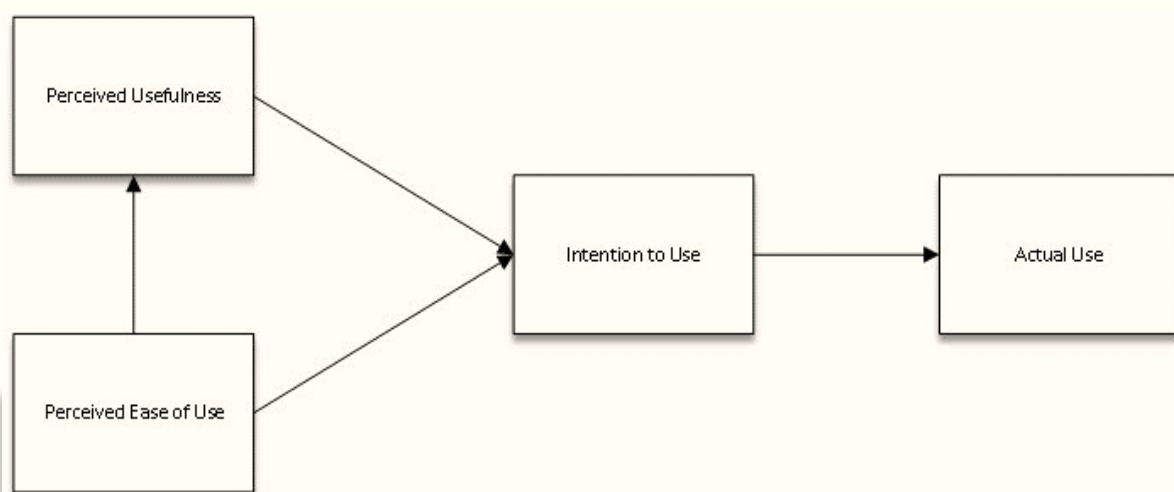


Figure 3 - Key elements of the Technology Acceptance Mode (TAM)

- 'Perceived Usefulness' as a driver of technology acceptance

According to TAM, perceived usefulness is the degree to which an individual believes that using a particular technology would enhance their job performance (Yadegari *et al.*, 2022). In the context of UK universities, the perceived usefulness of technology is crucial. Faculty members may assess how adopting digital tools or platforms could improve teaching effectiveness, streamline administrative tasks, or enhance research capabilities.

For example, Bhattacharyya *et al.*, (2020) employed the TAM to assess the utilisation of e-learning as an instructional medium. They concluded that 'perceived ease of use' had a significant impact in acceptance of learning platforms. Similarly, Su and Li, (2021) applied TAM to online entrepreneurship education. This study too concluded that 'perceived ease of use' and 'perceived usefulness' are key contributors in acceptance of the new learning platform. Also, Al-Adwan *et al.*, (2023) used TAM in explaining the acceptance of metaverse-based learning platforms. This study identified 'perceived usefulness' as a key catalyst and 'perceived risk' as an inhibitor.

As noted above and numerous other studies, factors identified by TAM explains why universities decide to accept technology or not, to a certain degree. For example, it can be argued that the Russell group of universities response to develop guidance to adopt AI was due to the facts of 'perceived usefulness' and 'perceived ease of use'.

However, critics argue that Perceived usefulness focuses on individual perceptions of usefulness and ease of use (Yadegari, *et al.*, 2022; Al-Adwan *et al.*, 2023). It may overlook the broader socio-technical factors influencing technology acceptance in universities. In the complex environment of UK universities, where various stakeholders are involved, this simplicity will not capture the full range of factors affecting technology adoption.

Marangunić and Granić, (2015) suggests that TAM does not explicitly consider cultural factors that may influence technology acceptance. For example, UK universities, with diverse student and faculty populations, may have unique cultural considerations. TAM's lack of cultural sensitivity may limit its applicability in diverse academic environments.

- 'Perceived Ease of Use' and 'intention to use' as a driver of technology acceptance

Perceived ease of use refers to the degree to which an individual believes that using a particular system would be free of effort (Mutahar *et al.*, 2022). The ease with which technology can be integrated into existing workflows is essential. Faculty, staff, and students in UK universities are more likely to accept and adopt technology that is intuitive, user-friendly, and requires minimal training.

For example, ChatGPT can assist students across various disciplines by generating content on a wide range of topics, making it a versatile tool for students in different academic fields. Students often use ChatGPT for idea generation and brainstorming and it can provide creative insights, suggestions, and help students overcome writer's block when working on assignments or projects. Students use ChatGPT to quickly retrieve information on a variety of topics. It can be a handy tool for obtaining concise explanations, definitions, or overviews, saving time compared to traditional research methods (Heaven, 2023).

However, Islam *et al.*, (2014) argues that ease of use is predominantly focused on individual attitudes and intentions, neglecting the social and organizational aspects of technology adoption in universities, decisions are often made collectively, involving faculty, administrators, and students. TAM's individual-centric approach may not fully address the collaborative and social nature of decision-making in higher education.

Furthermore, TAM does not adequately address the contextual variations across different academic disciplines, departments, or universities (Ndebele and Mbodila, 2022). Different disciplines within a university may have unique requirements and preferences for technology adoption. TAM might not account for these variations, leading to a one-size-fits-all approach (Mutahar *et al.*, 2022).

Su and Li, (2021), also highlights that focus on initial acceptance and intention to use, neglecting post-adoption behaviours and the long-term impact of technology. Understanding how technology is used over time and its sustained impact is crucial in a university setting. TAM's limitation in addressing post-adoption behaviour may hinder a comprehensive analysis of technology acceptance.

- ‘Actual System Use’ as a driver of technology acceptance

According to Malatji, Eck and Zuva, (2020), behavioural intention directly influences the actual usage of a system or technology. The goal is to observe the actual use of technology in the academic setting. Metrics such as user engagement, the frequency of technology use, and feedback on user experiences provide insights into the successful adoption of technology (George and Wooden, 2023). Although TAM does not directly explain the ‘inhibitors’ of technology acceptance, researchers frequently note that ‘perceived risk’ as one of the significant factors (Su and Li, 2021; Mutahar *et al.*, 2022). Therefore, it can be argued that responses from universities such as Cambridge and Imperial College to warn students or ban the use of AI in the short-term was due to the ‘perceived risk’ of the technology.

However, actual use does not comprehensively consider external variables that may influence technology acceptance, such as institutional policies, support structures, or external regulations (Ajibade, 2018). The absence of external variables in will limit its ability to explain how institutional contexts, external pressures, or government policies impact technology adoption in UK universities.

Moreover, system use assumes a stable and unchanging environment, not accounting for the dynamic nature of technology and evolving user expectations (Ajibade, 2018; George and Wooden, 2023). In the rapidly changing landscape of technology, where new tools and platforms continuously emerge, TAM's static nature might struggle to adapt to the dynamic and evolving technological ecosystem of universities.

In conclusion, while TAM has been a valuable model in understanding technology acceptance, its limitations in capturing the complexity, dynamics, and socio-organizational aspects of UK universities suggest the need for complementary frameworks and a more context-aware approach to studying technology adoption in higher education. This will be explored further in the next section.

2.2. What makes some universities quicker to embrace technology than others?

Having previously explored the key theoretical elements related to technology acceptance and how they relate to UK universities, it was noted that the key theories had common limitations. This section will continue to explore various other factors that has an impact on the ways universities respond to recent technological developments.

2.2.1. *The structure and culture of the university*

Experts highlight adaptability and agility are important for UK universities in responding to changes in the environmental factors (Reeves and Deimler, 2011; Benner *et al.*, 2022). Hendry, (2022), suggests adaptability of an organisation is significantly influenced by the structure and culture of it. Hence, it is important to examine how theories related to organisational structure and culture can impact the responses.

The competing value framework (CVF) is widely acknowledged as one of the prevailing frameworks designed to differentiate dimensions or theories within organizational culture (Nanayakkara and Wilkinson, 2021). CVF provides insights into the prevailing organizational culture within a specific organization. The culture, as identified by CVF, can influence how individuals within that organization perceive and accept technology. For example, a Clan culture, which emphasizes collaboration and employee development, may prioritize user satisfaction and ease of use (TAM factors) (Osei *et al.*, 2023). In contrast, an Adhocracy culture, characterized by innovation and flexibility, may be more open to adopting new technologies that enhance creativity and adaptability (ibid). Applying this to the context of UK Universities, it can be said that universities that are receptive to the recent changes in the educational technologies are externally focussed according to the CVF (Zeb *et al.*, 2021).

The values embedded in an organization's culture, as per CVF, may align with or conflict with the values represented in TAM. Organizations with a strong emphasis on external focus and competitiveness (Market culture) may prioritize technology adoption based on perceived usefulness and efficiency (Cacciattolo, 2014).

As mentioned above, organisational structure plays a significant role in the adaptability of an organisation. There are number of theories that would explain the determinants of the organisation's structure. Two such prominent theories are '*the contingency theory*' and '*the systems theory*'.

While conflict is inevitable, *contingency theory* suggests that it can be effectively managed (Shenkar and Ellis, 2022). Organizations undergo a rational, sequential, and linear evolution to fulfil their strategic needs. The success of both managers and organizations is dependent on their adaptability to environmental changes. Managers must possess the ability to make decisions based on the current circumstances (Abedin, 2022). Applying the contingency theory to the context of UK universities, it can be said that universities which recognise the strategic importance of the technological changes will evolve through the various conflicts to sustain as an organisation. Universities that do not respond to such contingencies will be faced with existential threats.

In contrast to the contingency theory, *the systems theory* articulates the interconnectedness of various elements within an organization, emphasizing that alterations in one area can have far-reaching impacts on others (Alerasoul *et al.*, 2022). Interactions within systems are not always linear, with small changes in one part potentially causing significant consequences elsewhere, and substantial changes in one domain possibly resulting in minor effects in another (Sony and Naik, 2020). Organizations operate as dynamic systems in continual interaction with their environment, with the equilibrium constantly adjusting as they adapt to environmental changes. Hence, structures of universities in the UK will need to change according to the changes of the environmental factors such as technology.

To answer why some universities embrace technology quicker than others, this section examined the role of institutional culture and structure. Based on the CVF and Handy's model, it was noted that certain institutional cultures will embrace technological changes more rapidly. Similarly, the contingency theory and systems theory explained why certain organisational structures evolve more rapidly according to environmental changes.

2.2.2. The role of leadership and management

Leadership style refers to the behavioural tendencies exhibited by a leader, influencing employees' attitudes, perceptions of the organization, manager, and overall job satisfaction (Dhamija *et al.*, 2023). The presence of various styles has broadened the understanding of leadership, considering diverse perspectives related to individuals' personalities and behaviours (*ibid.*). As identified by Lewin and Lippitt, (1938) *autocratic* leadership as dictating work methods (top down) whereas *laissez-faire* style described the leader allowed the group to make decisions and execute the work in whatever manner it deemed appropriate (bottom-up) (Robbins *et al.*, 2021).

In universities across the sector, there is already a dependence on a form of unseen leadership, as academics demonstrate an inherent professionalism and commitment to the values of the academic community (Jameson, 2011). Therefore, the traditional model of management, characterized by a top-down, performance-oriented approach, is outdated and not well-suited to meet the challenges of the ever-changing higher education sector (Waring, 2017). Bolden, *et al.* (2009) present a framework for emergent leadership, outlining an informal, bottom-up approach that was previously characteristic of academia. This method is now recognized in segments of the private sector in higher education institutes as the most effective way to navigate a dynamic environment (Konina and Nanetadze, 2019).

Dhamija *et al.*, (2023) states that organisations which have democratic or laissez-faire style of leadership shows better adaptability and thereby better response to environmental change such as technology. Translating this to the context of UK universities, it can be said that increased autonomy for academics enables them to be more creative in addressing the challenges posed by the recent technological changes (Waring, 2017). Hence adopting technological changes could become less challenging.

In a nutshell, leadership styles which provides autonomy to lower-level staff members is in a better position to adopt technological innovations. In contrast, leadership styles that demonstrates autocratic characteristics will require more time to adjust to such innovations.

2.3. What other factors affect adopting technological innovations at the Universities?

The previous sections discussed the theoretical elements underpinning the urge to accept technological changes as well as some factors that may act as catalysts or inhibitors in adopting new technological changes by the UK universities.

This section will further elaborate other theoretical concepts that will impact the UK university responses to recent technological innovations in an indirect manner.

2.3.1. Stakeholder perspective

Stakeholder Theory encourages organizations to balance the interests of various stakeholders. In the context of technology adoption, this may involve aligning the perceived usefulness and ease of use (TAM factors) with the broader organizational goals and the expectations of

different stakeholders. Balancing these interests is crucial for successful technology implementation. Freeman *et al.*, (2018) delve into the fundamental concepts and practical implementation of stakeholder management, outlining the advantages it offers to both firms and their managerial teams.

It is crucial to systematically identify stakeholders and describe their roles, interests, and relationships when studying the diffusion of innovation (Papazafeiropoulou, 2004). Mumford (1983) is among the pioneers in advocating for the engagement of end-users as a crucial element in the successful development and implementation of new technology. However, according to Lacity and Hirschheim (1995), a key challenge in aligning new technology with business strategies arises from differing expectations and perceptions of new technology among organisational stakeholders. For example, Senior management tends to prioritise cost considerations, while end-users are primarily concerned with service aspects. Managers find themselves navigating a challenging environment, needing to justify agreements made with these distinct groups of stakeholders (Mishra and Mishra, 2013).

The challenges in meeting all stakeholder expectations can be visible in how the Universities in the UK are responding to technological changes (Hickman and Akdere, 2019). For example, UK universities have established a set of guiding principles to ensure that both students and staff possess AI literacy. This comes in response to the sector's difficulties in adapting teaching and assessment methods to address the growing utilisation of generative artificial intelligence (The Guardian, 2023). This has been the result of stakeholder groups such as staff and students have expressed concerns regarding the impact of AI on academic integrity and the quality assurance of the programmes. Similarly, the vice-chancellors of the Russell Group have pledged their support for the guiding principles emphasising that this commitment will empower universities to seize the opportunities presented by AI while safeguarding academic rigor and integrity in higher education (Russell Group of Universities, 2023). Section three of this report will delve further into details on how specific universities in the UK have responded to the recent technological developments.

In essence, theoretical foundations such as the *stakeholder theory* have the capacity to broaden the scope of research and practical applications to acknowledge the broader consequences of technological advancements.

2.3.2. *Resistance to change.*

In section 2.1 of this report, the key theoretical concepts regarding technological acceptance and adaptation were discussed. Many authors agree that *resistance to innovation* is a crucial aspect of behaviour, carrying similar significance to acceptance and adoption (Laukkanen et al., 2008; Seth et al., 2020). This section of the report will focus on some of the factors that may cause some universities in the UK to resist change whereas some others would embrace change.

Many authors have identified various factors that can impede or delay the adoption of technology by organisations (Talwar et al., 2020). For example, a study conducted by Chen and Kuo, (2017) identified twenty-seven barriers which were categorised into seven dimensions of resistance. Explained below are some of the barriers which cause organisational resistance.

- *Support from senior management / leadership.*

Securing robust support from senior management is crucial for the successful implementation of innovation on campus. The absence of consistent and strong backing from senior management may lead to resistance to innovations, as individuals may perceive the need for financial resources to experiment with new ideas and take risks (Huyuan and Yang, 2012). As explained in section 2.2.2 above, the role of university leadership is a crucial factor in adopting technological innovations. Presently, university top management may appear supportive on the surface, but there is an expectation for them to enhance their knowledge and skills, along with providing the necessary funding and resources (Benner, et al., 2022).

- *Financial resources*

Financial challenges consistently rank among the top issues, encompassing tight budgets and cost-effectiveness. Within universities, competing missions may lead to the trimming of sustainability programs due to financial constraints (Huyuan and Yang, 2012).

- *Maintenance requirements*

The added expenses and human resources required for the upkeep of innovative technologies are a source of concern (Dibrov, 2015). Universities tend to favour solutions that are easily maintainable and durable over time. Consequently, they frequently opt for established technologies rather than newly emerging innovations (Chen and Kuo, 2017).

Discussed above are some of the key barriers that raise resistance to change. However, while organizational resistance may impede or halt the acceptance of an innovation, it is not always viewed as negative (Chen and Kuo, 2017). There is a suggestion that at times, encountering resistance can prompt additional scrutiny to ensure that the overall outcomes are well-received (Talwar *et al.*, 2020). It is essential for this process to be conducted openly and with adequate preparation so that individuals do not feel defensive or fearful of the impending change.

2.4. Summary of the section

The focus of this section was on identifying what determines the responses by the UK universities regarding recent technological innovations. Six theoretical concepts were used to identify what factors may trigger the responses from the universities. Figure 4 below summarises the key factors that leads to a positive response.

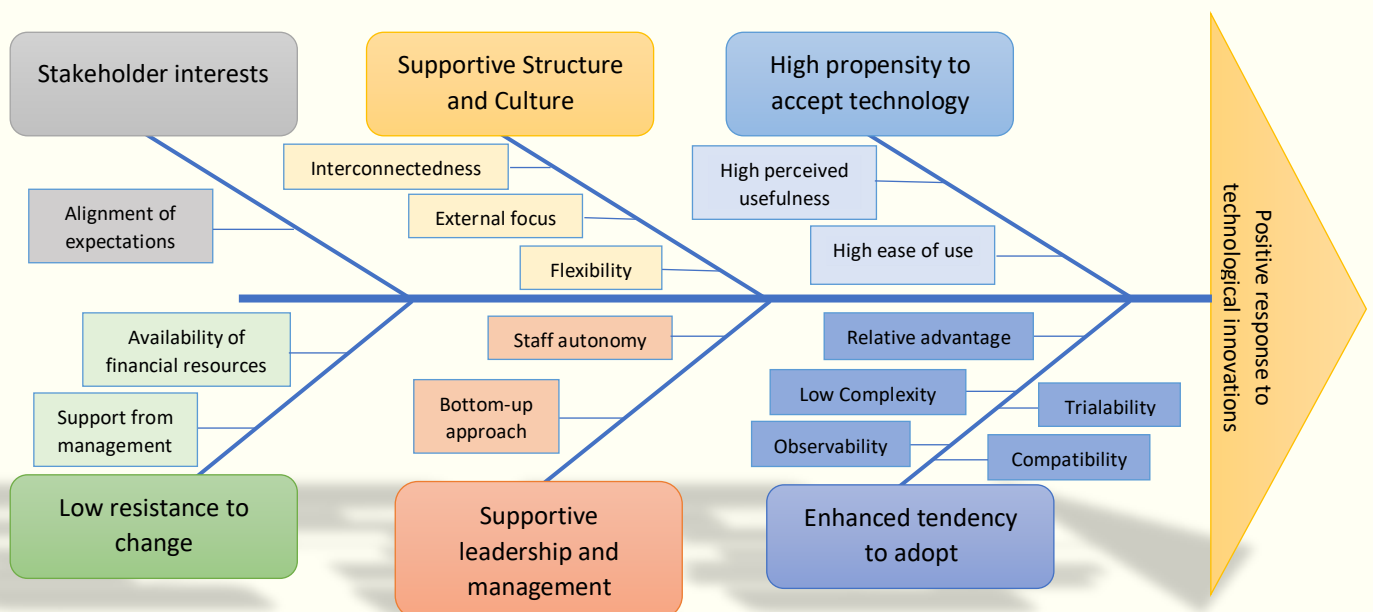


Figure 4 - Summary of determinants eliciting a positive response to technological innovations.

The TAM and DOI highlighted the immediate factors which explained if the response would be positive or negative as well as how quickly a response can be elicited. It was also noted that the prevalence of these immediate factors was determined by a collection of other factors which were explained by theoretical concepts related to organisational culture, structure, stakeholders, leadership and management attitudes, and the appetite to take risks. Figure 4 above illustrates the how these factors contribute to a positive response by the universities. The opposite of these factors can be used in explaining negative responses made by the universities.

Having identified some of the theoretical aspects which determines how UK universities respond to recent technological innovations, the next section of this report will provide details of how technological challenges manifests within UK universities.

3. Practical responses in adopting Technology by Universities the UK.

The challenges posed by COVID-19, Brexit, shifts in funding models, technological advancements, and evolving student expectations are compelling universities to reassess their strategies (Hashim, *et al.*, 2022). To thrive, they must reimagine the fundamental nature of higher education, embracing transformation to enhance flexibility and responsiveness to external pressures. Importantly, they should prioritize student-centric services and implement a comprehensive digital approach across the entire organization (PricewaterhouseCoopers, 2020).

Over the past years, technological innovations such as AI has made significant progress in various industries, including HE (George and Paul, 2020; Arogundade, 2023). The HE sector is increasingly recognizing AI as a competitive advantage (Hannan and Liu, 2023). While universities are increasingly embracing technological innovations such as AI, it also poses significant challenges (Callender, *et al.* 2020; Hashim, *et al.* 2022). This section of the report will examine the concept of the Smart University as a proposition to navigating the educational frontier.

3.1. Summary of actions taken by Universities in the UK as a response to recent technological developments.

Current literature suggests there are *pockets* of good practices across the education industry in the UK (Van Der Zwaan, 2019; El-Azar and Nelson, 2020; McKinsey and Company, 2022; Bearman *et al.*, 2023). For instance, Bolton College utilizes 'Ada', a virtual assistant that supports teaching and assessment to reduce workload. Ark Multi Academy Trust achieved significant cost reductions by migrating data and services to the cloud. Similarly, the University of Wolverhampton is enhancing the flexibility and efficiency of physician training through the adoption of virtual dissection technology (PricewaterhouseCoopers, 2020).

However, a *lack of an overarching vision* can result in fragmented programs. Siloed thinking contributes to the development of isolated IT systems, creating a complex and inflexible infrastructure that lacks the necessary nimbleness in a changing marketplace (Hashim, *et al.*, 2022). To gain support from staff and academics for new strategic programs aimed at improving digital capabilities, it is essential for them to understand the purpose of the program and their role in achieving the strategic outcomes.

Moreover, every successful change program requires a clearly articulated vision and strategy established by senior management. The digital domain is no exception; having a clear understanding of the anticipated benefits and how they align with the overall strategy is crucial for success (PricewaterhouseCoopers, 2020).

To effectively navigate both current and future challenges, it is essential to integrate digital components into the overarching institutional strategy rather than treating them as mere additions or afterthoughts. The responsibility lies with senior executive teams, who play a pivotal role in shaping the university's strategy, to prioritize the inclusion of technology in the strategic agenda (JISC, 2023b). This is reflected in the quote made by Anne Carlisle, the vice-chancellor of the Falmouth University below.

"As a vice-chancellor, you have to envisage the future. Once you relinquish the idea that your future is all about the traditional model, you start to see behaviours and your operations in a completely new light."

Jisc 2023b,

The decisions made in this regard will significantly impact the long-term strategy of any higher education institution.

3.2. The concept of the 'smart university' as a proposition to navigate long-term educational frontiers.

The concept of a Smart University represents a transformative approach to higher education, leveraging innovative technologies to create an intelligent, responsive, and efficient learning environment (Rico-Bautista, 2019). The notion of a "smart university," empowered by AI and capable of independently managing numerous tasks, is becoming more attainable with advancements in machine learning and natural language processing (NLP) technologies (Furey and Martin 2019). Such establishments have the potential to automate administrative responsibilities, curriculum development, instruction, assessments, and even the process of issuing transcripts and degrees (Hannan and Liu 2021). This comprehensive transformation aims to enhance the overall student experience, streamline operations, and prepare students for the demands of the digital age.

In this section delves into the key components of a Smart University and provide examples illustrating the implementation of these concepts. Some of the key elements are illustrated in figure 5 below.

3.2.1. Key elements of a Smart University

- **Smart Campus Infrastructure:**

A Smart University begins with the integration of cutting-edge technologies into its physical infrastructure (George and Paul, 2020). For example, the University of California, Merced, implemented a smart lighting system that adjusts based on natural light, occupancy, and time of day. This not only contributes to energy efficiency but also enhances the overall campus environment (McKinsey and Company, 2022).

- **Digital Learning Platforms:**

Smart Universities embrace advanced LMS and e-learning platforms. Arizona State University (ASU) utilises adaptive learning platforms that tailor educational content to individual students' needs. These platforms employ AI algorithms to personalize learning experiences, improving student engagement and outcomes (ASU, 2023).

- **Data Analytics for Student Success:**

Smart Universities harness the power of data analytics to monitor and enhance student success (Rico-Bautista *et al.*, 2021). Purdue University employs predictive analytics to identify students at risk of falling behind. This early warning system allows timely interventions, such as additional support or resources, contributing to improved retention rates (Symplectic, 2022).

- **Research and Innovation Hub:**

Smart Universities prioritize research and innovation (George and Paul, 2020). The University of Cambridge, for instance, utilises advanced laboratories equipped with state-of-the-art technologies. Additionally, collaborative platforms and data-sharing initiatives contribute to groundbreaking research endeavours (University of Cambridge, 2022).

- Smart governance:

Administrative processes are streamlined through the implementation of Enterprise Resource Planning (ERP) systems (Samancioglu and Nuere, 2023). The University of Melbourne, for example, adopted a comprehensive digital transformation strategy, enhancing administrative efficiency and improving service delivery through digitisation (University of Melbourne, 2022).

Smart governance involves transparent, data-driven decision-making (Mbombo and Cavus, 2021). The University of Oxford employs digital technologies for governance, ensuring that decisions are informed by real-time data. This contributes to more agile and effective university management (University of Oxford, 2023).

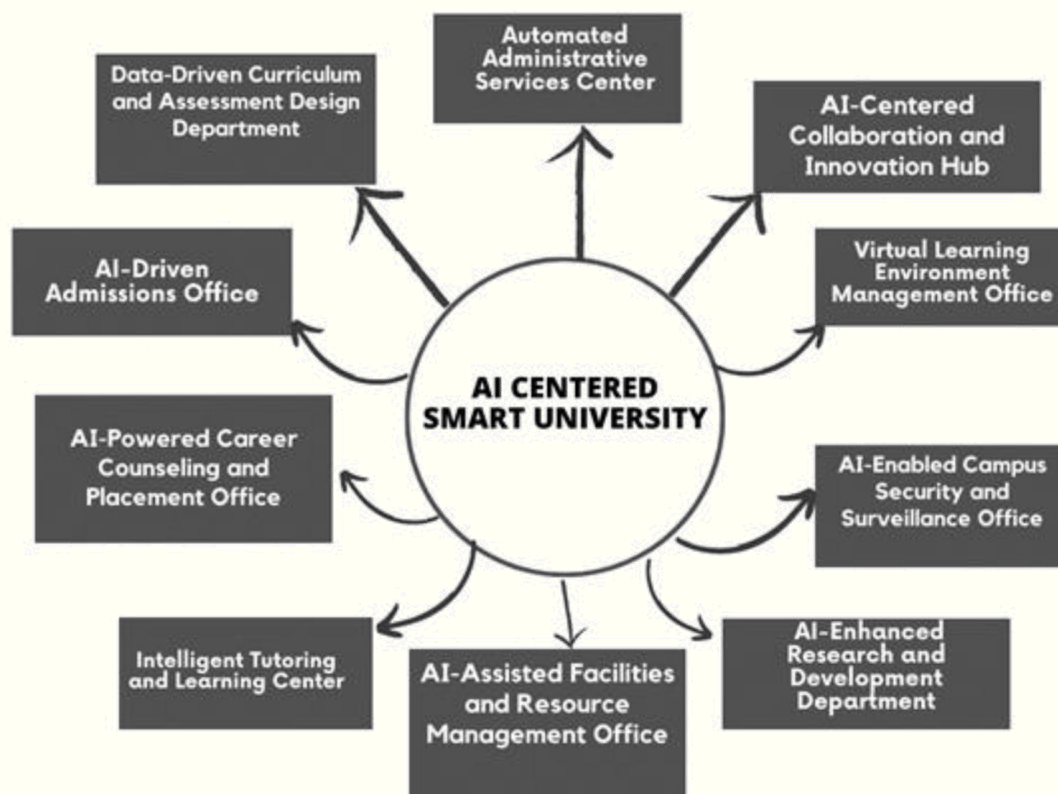


Figure 5 - AI Centred smart university

Source - (George and Wooden, 2023)

3.2.2. Advantages of a Smart University

A smart university leverages advanced technologies, particularly artificial intelligence (AI), to enhance various aspects of its operations, creating a more efficient and innovative educational environment (Polin *et al.*, 2023). The advantages of a smart university are multifaceted and extend across administrative, educational, and operational domains (Mbombo and Cavus, 2021). Explained below are some of the benefits:

- Administrative Efficiency and streamlined communication:

Smart universities can automate routine administrative tasks such as student enrolment, schedule management, and resource allocation (JISC, 2023a). This reduces the administrative burden on staff and enhances accuracy. For example, AI algorithms can automate the process of student enrolment, ensuring timely processing of applications, allocation of courses, and generation of student IDs (Deloitte, 2022). Moreover, AI-driven chatbots can handle routine inquiries, providing instant responses to students and staff regarding schedules, campus services, and general information (ASU, 2023). For instance, a university chatbot can assist students in retrieving information about course offerings, exam schedules, and campus events, etc which enhances communication efficiency.

- Enhanced Learning Experience:

AI-driven systems can analyse individual student performance data to tailor learning paths, recommending specific courses, materials, and activities based on students' strengths and weaknesses (JISC, 2023a). An adaptive learning platform using AI can identify a student's proficiency in certain subjects and suggest customized study plans to address areas that need improvement.

Moreover, Smart universities can employ AI to develop interactive and engaging instructional materials, adapting content delivery based on students' learning preferences and progress (Rico-Bautista, *et al.*, 2019; Polin *et al.*, 2023). Virtual reality (VR) simulations using AI can provide immersive learning experiences in fields like medicine or engineering, allowing students to practice skills in a controlled virtual environment (*ibid*).

Furthermore, AI can streamline the grading process for assignments and exams, providing quicker feedback to students (JISC, 2023a). NLP can also be employed to evaluate written assignments. An AI-based grading system can evaluate multiple-choice exams instantly, while NLP algorithms can assess essays and provide feedback on grammar, structure, and content (JISC, 2023b).

- Predictive Analytics for Student Success:

Using predictive analytics, smart universities can identify students at risk of academic challenges and implement timely interventions to support their success (University of Melbourne, 2022). Predictive models analysing historical student data can identify patterns indicative of potential academic difficulties, enabling proactive measures like additional tutoring or counselling (Rico-Bautista, 2019).

- Energy and Resource Management:

AI can optimize energy consumption, space utilization, and resource allocation, contributing to sustainability efforts and cost savings (Deloitte, 2022). Automated systems can adjust lighting, heating, and cooling based on real-time occupancy data, ensuring efficient energy use across campus facilities.

3.2.3. Disadvantages of a smart university

While smart universities offer numerous advantages, they also face potential drawbacks associated with the integration of advanced technologies. Explained below are some of the disadvantages of a smart university:

- High Implementation Costs:

The integration of advanced technologies such as AI, VR, and analytics demands significant financial investments (Deloitte, 2022). Budget constraints can hinder universities from achieving comprehensive adoption.

- Digital Inequality:

Uneven access to smart technologies may lead to a digital divide among students (APPA, 2023). Those with limited access to devices or stable internet connections may face challenges fully participating in digital learning experiences.

- Privacy Concerns:

The extensive collection of student data for personalized learning and administrative purposes raises privacy concerns. Striking a balance between data utilisation for improvement and safeguarding sensitive information becomes a crucial ethical challenge (Rico-Bautista *et al.*, 2021).

- Loss of Human Touch in Education:

Overreliance on technology may diminish interpersonal aspects of education (Samancioglu and Nuere, 2023). Face-to-face interactions, mentorship, and social aspects of learning can be compromised, potentially impacting the overall quality of the educational experience.

- Continuous Need for Upgrades:

The rapid pace of technological advancement necessitates ongoing investments in upgrades. Failure to keep abreast of innovations may result in outdated systems that do not deliver optimal performance (Rico-Bautista *et al.*, 2021).

In summary, the implementation of smart technologies in universities poses challenges related to high costs, technological vulnerabilities, digital inequality, privacy concerns, resistance to change, ethical considerations, loss of human touch, skill gaps, continuous upgrades, and potential distractions in the learning environment. Addressing these challenges requires strategic planning, ethical considerations, and proactive measures to balance the benefits and drawbacks of smart university initiatives.

4. Solving the ‘smart university’ puzzle.

Designing and implementing a Smart University involves a strategic, phased approach to ensure seamless integration of advanced technologies (Mbombo and Cavus, 2021; Rico-Bautista *et al.*, 2021). This comprehensive plan encompasses various key steps as explained below:

4.1. Phase 1: Needs Assessment and Goal Setting

The initial stage should focus on conducting a ‘stakeholder analysis’ with the objective of understanding the needs, expectations, and concerns of stakeholders, including students, faculty, administrative staff, and IT personnel (Adamkó, 2018; Misra and Adewumi, 2019). This can be done through surveys, focus groups, and interviews to gather insights (Simon and Murray-Webster, 2018).

As explained in sections 2.3.1 and 2.3.2, failure to address stakeholder expectations upfront will result in lack of engagement and resistance to change. Section 4.7.2 below further explores the challenge of managing stakeholder expectations.

Adamkó, (2018) recommends establishing a multidisciplinary team to brainstorm and define overarching goals for the university. The successful completion of this phase will be noted by the university being able to set SMART goals.

4.2. Phase 2: Infrastructure Development and technology selection

The key focus of this phase should be on assessing the IT Infrastructure (Misra and Adewumi, 2019). This will enable the university to decide if the existing IT infrastructure can support the integration of smart technologies.

This can be done by conducting an infrastructure audit and invest in necessary upgrades, including high-speed internet, cloud computing, and cybersecurity measures (Adamkó, 2018). However, many universities could experience challenges related to existing infrastructure as explained in section 4.7.1 below.

The successful completion of this stage will be noted by the university being able to establish data governance policies which involve IT and legal experts (JISC, 2023a). Such policies will

define guidelines for data collection, storage, and usage to ensure compliance with privacy regulations.

In line with the evaluation of infrastructure, the university can select smart technologies aligned with the defined goals and needs (Rico-Bautista, 2019). This can be completed by the formation of a technology evaluation committee, conducting pilot projects, and selecting vendors based on performance and compatibility (ibid).

The end result of this phase will be the development of an 'Integration Roadmap' which outlines a step-by-step plan for technology integration (Rico-Bautista *et al.*, 2021). The road map will enable the university to prioritise technologies, create a timeline, and designate responsible teams for each integration phase.

4.3. Phase 3: Faculty and Staff Training

The main objective of this stage is to conduct a 'training needs analysis' (Misra and Adewumi, 2019). This will assist in Identifying the digital skills gap among faculty and staff. A variety of tools such as administer skill assessments, surveys, and interviews can be used to determine training needs (Adamkó, 2018).

Once the skills gaps have been determined, suitable training programs can be developed and implemented with the aim of equipping faculty and staff with the necessary skills to leverage smart technologies (Project Management Institute, 2021). Such training programmes can take a variety of formats such as workshops, online courses, and certifications covering AI, data analytics, and technology integration (ibid).

4.4. Phase 4: Pilot Testing

Once the university has achieved a critical mass of staff training level, it will be able to conduct pilot tests with the aim of testing selected technologies on a smaller scale to identify potential challenges and gather feedback (Rico-Bautista, 2019). The key steps should include selecting specific departments or courses for pilot testing, gathering user feedback, and make necessary adjustments.

Once the data collection has begun, the university can assess the success of pilot projects against predefined benchmarks and make informed decisions regarding full-scale implementation (Project Management Institute, 2021).

4.5. Phase 5: Full-Scale Implementation

Successful completion of the pilot tests will enable the university to roll out smart technologies across the entire university. This should follow the integration roadmap, ensuring effective communication and support for all stakeholders.

A key success factor for this stage is the continuous monitoring of the performance of smart technologies and adjust for optimisation (Adamkó, 2018). The university should establish a monitoring and feedback loop to address issues promptly and enhance system efficiency (ibid).

4.6. Phase 6: Continuous evaluation and Improvement

The leadership of the university should foster a Culture of Innovation by encouraging a mindset of continuous improvement and innovation. This can be facilitated by recognising and rewarding innovative initiatives, establish innovation forums, and solicit ongoing feedback (University of Melbourne, 2022).

Furthermore, to stay abreast of technological advancements and adapt the Smart University ecosystem accordingly the university should establish a dedicated team to track emerging technologies, conduct regular technology assessments, and plan for future integrations.

It is also necessary to conduct regular evaluations to assess the overall impact of becoming a Smart University. The university should use key performance indicators (KPIs) to measure success, gather feedback from stakeholders, and adjust strategies accordingly (Rico-Bautista *et al.*, 2021).

Finally, it is essential to Iterate based on feedback by continuously refining and enhancing the Smart University model.

By following this detailed plan, universities can systematically transform into Smart Universities, fostering innovation, improving educational outcomes, and providing a cutting-edge learning environment.

4.7. Possible challenges for universities in attempting to integrate 'smart' technologies

Implementing the concept of a smart university comes with various challenges, ranging from technological hurdles to organizational and societal issues. Explained below are some potential challenges:

4.7.1. Obsolescence of existing infrastructure

As explained previously, many universities are in search of a quick digital solution. They acquire new technology platforms through their IT departments without initially grasping the broader role that digital strategies can play throughout the institution (Department for Education, 2019). Therefore, the development of IT infrastructure should in line with the digital vision as explained above.

One of the main challenges to the effective implementation of technology is the availability of internet connectivity (JISC, 2023b). The availability of high-speed internet and efficient data storage allows educational providers to enhance innovation within their digital infrastructure. For example, Nottingham Trent University (NTU) has been able to implement a learner analytics software which requires significant computational capacity and uninterrupted connectivity (Solutionpath, 2023). The sophisticated analytics software monitors and evaluates frequent digital interactions recorded when students engage in day-to-day activities at the university. These activities include using the Learning Management System (LMS), the library system, or attending lectures, and the software also considers data on academic progress. The generated analytics enable the university to identify students at risk of academic challenges much earlier, allowing staff to intervene and offer necessary help and support. In UK trials, this intervention has occurred up to 20 weeks in advance of an individual student's withdrawal (Solutionpath, 2023).

NTU was able to implement a sophisticated software due to the existence of an advance IT infrastructure. However, not all universities have strategically invested in digital initiatives over the past decade, and many grapple with substantial legacy issues and associated costs (JISC, 2023b). Thus, A change in perspective is necessary regarding the level of resources allocated to the digital infrastructure (Hashim, et al. 2022). Although precise figures are elusive, it is estimated that universities presently invest approximately 3 to 5 percent of their turnover in their digital estates (Ernest and Young, 2022).

4.7.2. Challenge: Stakeholder expectations and engagement

Technological advancements now enable highly personalized experiences on a large scale. Many enterprises, such as consumer market leaders like Netflix, Apple, or Uber, utilize data-driven decisions to provide dynamic experiences based on individual consumer information (McKinsey and Company, 2022). Applying these design principles to higher education has the potential to revolutionize how stakeholders experience learning, teaching, research, and professional services.

Universities have a multitude of stakeholders and diverse missions. Despite being centred around humans, the IT systems in the sector have traditionally been developed with an "inside-out" approach, prioritizing the institution's operational needs before creating transactional touchpoints for stakeholders (McKinsey, 2022). This could make the stakeholders feel disengaged and neglected which eventually may lead to resistance.

University staff will be interested in understanding how the adoption of digital tools, coupled with appropriate professional development, contributes to their career advancement. In some instances, there may be a perception that research activities hold more significance, or educators may feel that their current teaching methods suffice (JISC, 2023b). In these scenarios, the motivation for embracing teaching innovation may be low, serving as a substantial impediment to the execution of digital strategies.

Universities can empower their staff and students by introducing them to new technologies, but it is essential to provide continuous support and guidance. With the right attitude and approach, a university can evolve from being an impersonal organization to a vibrant institution with its unique digital identity (George and Wooden, 2023).

Furthermore, ensuring a superb customer experience requires attentive listening and adaptability to respond to criticism and feedback. Designing the digital experience in line with the university's current structure and operations, instead of aligning it with future and the expectations of upcoming stakeholders, may lead to outdated practices and avoidable administrative tasks.

Analysts at PricewaterhouseCoopers, (2020) predict that over time, students will be drawn to universities that embrace the digital era according to their preferences and anticipate future changes. The capacity to stay informed about and adapt to emerging trends in technology, along with the ability to quickly harness their potential, will set apart the '*innovators*' from the '*laggards*' in higher education.

In a time of significant changes and challenges, where the customer's voice is more influential than ever, offering a high-quality digital experience can convert the customers (Students) into

advocates for the university. This conversion can become one of the most powerful marketing tools available (Ernest and Young, 2022).

4.7.3. Challenge: Development of digital skills and capabilities of all parties

The rapid shift to online learning prompted by COVID-19 has often involved the simple transfer of existing course materials to digital platforms. This has resulted in many learning platforms becoming repositories for downloading lecture notes, providing limited benefits for students and minimal data for analytics (Webb, et al. 2021). The education sector holds substantial expertise on what constitutes effective online learning and how to deliver it successfully. In light of the impact of COVID-19 and the disruptions faced by the sector, the demand for truly effective and engaging online learning is perhaps more significant now than ever before (Zhang *et al.*, 2022).

Technology is most effective in education when introduced strategically by skilled and confident staff (JISC, 2023b). Successful leaders prioritise understanding how technology can enhance processes and teaching. They actively cultivate digital capabilities among their staff and ensure cost-effectiveness in procurement (George and Paul, 2020). However, it's common for leaders to face challenges in knowing where to begin with technology, especially if their expertise lies in education rather than digital technology. This challenge is also prevalent among teachers, where confidence and willingness are major barriers to adopting digital technologies. Overcoming this hurdle often involves addressing the need for adequate training for teachers.

5. Summary and conclusion

The purpose of this report was to evaluate the concept of the smart university as a long-term proposal for navigating the technological frontiers in HE. In conclusion, the concept of a smart university represents a transformative paradigm shift in higher education, leveraging cutting-edge technologies to enhance operational efficiency, enrich the learning experience, and foster innovation. As universities navigate the complexities of implementing a smart university, it is evident that this journey is not merely technological but encompasses multifaceted challenges and opportunities.

The technological infrastructure forms the backbone of a smart university, integrating AI, IoT, data analytics, and automation. However, the success of implementation hinges not only on overcoming technical complexities but also on addressing human factors, including faculty and staff readiness, user experience, and the broader cultural shift towards embracing technological advancements.

Ensuring the security and privacy of data emerges as a critical consideration, demanding robust frameworks and policies. Moreover, regulatory compliance, financial constraints, and the imperative to bridge the digital divide underscore the need for a comprehensive and inclusive approach.

Change management proves to be pivotal in fostering a positive attitude towards innovation, overcoming resistance, and cultivating a culture that thrives on adaptability. The impact of a smart university extends beyond the institution, influencing societal dynamics and emphasizing the importance of inclusivity and accessibility.

As universities face challenges, from interoperability issues to the ever-evolving landscape of technology, a forward-looking, agile approach is essential. Continuous evaluation, learning from experiences, and adapting strategies will be fundamental to the sustained success of smart universities.

In essence, the journey towards a smart university is a dynamic and ongoing process that requires collaborative efforts, visionary leadership, and a commitment to harnessing technology to advance education. By embracing these principles, universities can position themselves at the forefront of educational innovation, preparing students for the complexities of the digital era and contributing to the broader evolution of the global academic landscape.

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