Cloud Adoption in HEIs: A Multi-Theoretical Framework Integrating TOE, TRA, and FVT

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***Abstract*— This study aims to rigorously explore cloud computing adoption in Higher Education Institutions (HEIs) by applying a detailed analytical framework. This integrates the Technology Organization Environment (TOE) Theory, the Theory of Reasoned Action, and the Fit Viability Theory to holistically examine the factors influencing such adoption, and, as such, the research uniquely emphasises the interplay between technological capabilities, organisational readiness, and environmental factors, as well as taking into account the critical aspect of cultural fit within HEIs. By synthesising these theoretical perspectives, the study provides a comprehensive understanding of the adoption process, highlighting the nuanced interactions between technology, organisation, and the broader educational environment. This approach facilitates the development of a deeper insight alongside the development of valuable guidance for effective implementation and integration strategies. The findings of this study are thus significant for educational policymakers and administrators, providing a robust framework for them to navigate the complexities of modernising educational infrastructure by applying cloud computing technologies.**

Keywords— Cloud, Adoption, HEIs, TOE, TRA, FVT.

I. INTRODUCTION

A. TECHNOLOGY IN HEIS

Globally, learning processes have changed dramatically over the past ten years, mostly as a result of technological breakthroughs. Sustainability in educational structures is now linked with the adoption of information technology, which also brings financial sustainability to organisations [1]. The educational terrain has thus undergone a significant shift due to technological progress, based on the introduction of a range of innovations such as online learning, platform-centric education, and the integration of interactive tools into the learning experience [2]. Embracing educational technology appears to hold immense promise in terms of improving the accessibility, quality, and effectiveness of education, and, as highlighted by Gonzalez [3], the imposition of physical constraints and lockdowns in recent years underscored the urgent need for improved distance education and online learning.

In an effort to establish technology-driven economies, nations all over the world have embraced technological improvements with open arms. Modern technologies are believed to improve the levels of both teaching and learning by offering access to numerous pedagogical techniques [4]. Many nations' educational systems thus now place high importance on offering technology-based instruction and learning possibilities, allowing students to access a wide range of information at any moment, from any location. According to Sailer et al. [5], the advent of technology has also brought about a paradigm shift in higher education (HE) through the use of flipped classrooms, integrated onsite and online learning, and technology-enhanced distance education. This has led to the advent of new graduate and postgraduate programs at higher education institutions, as new technologies such as virtual experiments, audio recordings, video courses, and visual more effectively ensure successful learning [6].

Technology as a term encompasses a wide range of tools and systems used in data creation, processing, storing, sharing, and security, including hardware, software, and connectivity tools. The development of contemporary IT, which has taken place over almost 60 years of steady and significant advancement has led to the growth of technological infrastructure in a manner that can be divided into five major phases, however: the centralised mainframe, personal computing, the client/server era, enterprise computing, and cloud computing [7].

B. CLOUD COMPUTING

For many educational institutions, adopting cloud computing (CC) has been seen as an inevitable course of action due to the fact that it is expected to boost both productivity and performance. This involves offering a range of accessible computing assets, including apps, accessible processing power, storage, networking, development, deployment platforms, and business procedures [8]. The US Department of Commerce's National Institute of Standards and Technology specifies CC more precisely as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [9,10]. CC can also be defined as "a modern technology that provides various resources of technology from servers, networks, storage, and various applications for large and small enterprises via the Internet or intranet" [11], while, according to Namasudra [12], it refers to "pay-as-you-go computing resources and scalable infrastructure that primarily provided cutting-edge information technology (IT) services to generate a significant amount of space and data availability".

CC virtualises resources, including software applications, so that rather than being installed on workstations, they are distributed online [13]. Sada and Saidu [14] thus noted that as a remote server, sometimes referred to as the cloud server, oversees the entire computing process, such resources are accessible, provided high-speed network connectivity is available, through any device, anywhere, at any time. Services can therefore be provided to the client on demand at relatively low cost, with charges incurred as resources become available, according to Haris and Khan [15]. There are, however, in fact three fundamental cloud computing paradigms: software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS). Each of these frameworks provides an alternate option for users, based on need and affordability [16].

CC remains a relatively novel notion in the realm of data processing; the concept has evolved over time from the idea of grid computing, which attempted to address various complex issues by using parallel computing [17]. Salesforce debuted its commercial applications in 1999, when the term "cloud computing" initially appeared in its marketing, and one year later, it launched its cloud-based storage services. This was followed in 2002 by a launch by another big internet retailer, Amazon [18], leading to "A broad acceptance of the existence as well as significance of CC for businesses evolved in the first years of the 2000s, because of the expansion of the Internet and the development of mobile computing following the dot-com bubble" [19].

CC currently allows a vast variety of operations to be performed concurrently due to the growing popularity of cloud services, expanding on earlier systems which offered restricted transaction numbers [20]. CC is thus becoming widely employed in both private and public industries due to its numerous advantages, which offer multiple levels of assistance [21]. Nevertheless, both cloud facility contributors and consumers place most emphasis on the protection offered by the packages available [21].

C. Cloud Service Model

The three services that make up the core cloud processing structure are defined as follows: [22,23]

1) ***Software as a Service (SaaS):*** The supplier of cloud computing services may make a program or software readily available to users while assuming the obligation to maintain its functionality, synchronisation with additional resources, and updates. Consumers are then permitted to utilise such programs using their own resources, allowing access via a wide array of machines, including cell phones and personal computers [24, 25].
2) ***Platform as a Service (PaaS):*** By adding extra resources (structures) to system software (the operating system), this service offers the most comprehensive and advanced option. The full infrastructure for software and hardware may thus be designed, developed, and hosted within PaaS [24, 25].
3) ***Infrastructure as a service (IaaS):*** This level of service offers access to a range of digitised computing assets, including OS, Memory, CPU, and application software, all of which are accessible via the supplier(s) of the service based on their use of various cloud servers. This service's primary objective is to convert easily accessible physical resources into corresponding rational assets that consumers and clients may use in a flexible manner via proven online providers [24, 25].

D. Cloud Deployment Model

For cloud services, four deployment methods have been proposed. The first is where the public has unrestricted access to the infrastructure of the public cloud [22]. As the consumer does not need to put up any resources beforehand, this strategy promotes economies of scale, with clients receiving resources from the public cloud as needed based on various connections to the network [38]. In the second model, a single person or organisation is granted exclusive use of a private cloud model [14]: all data is then kept on the company's own servers, thus increasing dependability, security, and privacy [38]. Community cloud deployments, used by chains including gas stations, banks, and trading organisations, are the third option: these are shared and collectively owned cloud hosting services [39] administered, owned, and overseen by one or more community groups. For these, the infrastructure may be situated on or off site [38]. Finally, two or more of the public, communal, and private cloud categories may be joined together to form a hybrid cloud.

E. Essential Cloud Characteristics

Various authors [40, 35, 14] have defined five key traits of CC:

On-demand Self Service: "Without requiring human interaction with each service provider, a consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically" [42].

Resource Pooling: "Differing physical and virtual resources are dynamically assigned and reassigned according to consumer demand, with the provider's computing resources pooled to serve multiple consumers using a multi-tenant model" [42].

Broad Network Access: "Standard mechanisms facilitate the utilization of abilities by heterogeneous thin or thick client platforms, such as workstations, tablets, laptops, and mobile phones, over the network." [42]. HEI stakeholders further "may access network resources by using various devices, including students, academic staff, and other key stakeholders" [35].

Rapid Elasticity: "capabilities that can scale rapidly outward and inward commensurate with demand, and that can be elastically supplied and let go, in some cases programmatically" [42]. As noted by Ali [35], the service thus “allows the HEIs’ stakeholders to process, utilize, and adjust the cloud resources to meet the requirements according to their demand”.

Measured Service: “cloud systems that use metering at a level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts) to automatically control and optimize resource use” [42]. The primary stakeholders in HEIs can therefore automatically regulate and optimise resource utilisation when services are upgraded, in line with HEI criteria [35].

II. Methodology

A. Theoretical Perspective for Cloud Computing Adoption

1) Technology Organisation Environment (TOE) Theory

The full adoption of innovative technology into an organisation is facilitated by various factors that may be categorised under the headings technology, organisation, and environment. Qualified gains, compatibility, complexity, and safety all come under the heading of technology. Readiness for the technology, price recovery, administration support, and comprehension are then covered under organisation, whereas internal and external pressures are discussed in terms of environment [26].

2) Theory of Reasoned Action

The reasoning behind human action depends on a person’s perceived intentions. Behavioural intentions explain the direction of human action, and, as part of this process, attitude and subjective norms play a pivotal role in the determination of behaviours [27]. The acceptability of any new technology is thus based on both deterministic aspects and consequential outlook. Explicit and implicit cost benefit comparisons can therefore pave the way to greater adoptability [28].

3) Fit Viability Theory

Accurate pairing of organisational requirements with the technological features to be adopted enhances performance. Internet initiatives were assessed by Tjan [43] to generate the fit viability model, which postulates that the dimensions of technology fit and viability must be consistent with the organisation’s needs. The extent of the compliance of tech variations with the culture, structure, and values of the organisation thus form the fit dimension, while the magnitude of the preparedness of the organisation with respect to the usability of the technology forms the viability dimension [29].

B. Related Studies and Hypothesis Development

1) Cloud Computing Adoption

The acceptability of new technologies such cloud computing has been the subject of discussion in multiple scholarly works.

In [9], Kenyan research institutions sought to develop a cloud computing adoption plan that addressed organizational, technological, and environmental variables utilising the DOI and TOE approaches. Similarly, Samyan and St Flour [30] noted that "These days, many institutions, policy makers, and administrators in the educational field want to adopt and integrate cloud-based technology to support lifelong learning". Madhumitha et al. [31] evaluated the effect of cloud computing on e-education with respect to postsecondary schooling amid the Covid-19 outbreak in Mauritius, finding that over sixty percent of graduate, doctoral, and undergraduate learners were aware of CC and anxious to incorporate it into their education. The sustainability of the academic system attained by the incorporation of the technologies was assessed in [1], while Adamu [32] evaluated the benefits of cloud computing in terms of Nigerian learning, determining that educational institutions should pay more attention to education, knowledge, and investigation with respect to such systems than the bare IT infrastructure.

During the onset of the Covid-19 pandemic, Al-Hajri et al. [33] examined the acceptability of CC systems in the realm of advanced learning, applying a partial least square approach to the data analysis for a sample size of 200 participants from top universities in Oman. The research findings indicated that perceptions regarding CC's ease of use, usefulness, reliability, and reactivity significantly influenced its utilisation in this context. These findings are important due to their applicability to other higher education institutions, offering CC providers with information regarding the features and components that should be prioritised in order to increase and enhance college students' use of their systems.

Behavioural intention (BI) to utilise CC for educational goals is beneficially impacted, according to Zondi [28], by students' expectations of effort, performance, and social factors. The expectation of performance offers the most reliable gauge of a student's behavioural intention to adopt a CC environment, however. Both behavioural intention and favourable circumstances influence the practical implementation of CC for educational purposes, however. Further, according to Jaradat et al. [34], the existence of favourable circumstances has a beneficial and statistically significant impact on real consumption. They additionally demonstrated that "communal impact, trusting elements, anticipation of performance, and effort expectancy have favorably significant impacts on intention to adopt cloud computing".

HEIs can now swiftly provide a variety of affordable services on request by implementing CC [35], yet, according to Kayali and Alaaraj [36], a variety of barriers prevent universities, particularly those in poor nations, from accessing the superior knowledge and communication technologies required to ensure the growth of research, education, learning, and alternate developmental initiatives. The significant costs that HEIs incur in terms of operating campus facilities with respect to buying hardware and software and looking after such facilities can be decreased with the adoption of CC, however.

The impact of the various sociocultural and economic factors that force corporations to adopt cloud computing was identified by Hiran [37]. The variables influencing cloud computing adoption inside enterprises remain mostly opaque, though by combining four well-known models, namely the diffusion of innovations, the technology-organisational-environmental model, the fit viability model, and the institutional theory framework, a blended flow of the impact of technological, ecological, and organisational elements was developed in their work.

2) Technology Context and Cloud Computing Fit

Fit refers to "how well a technical competency may complement or be suited to carry out duties inside a business, enhancing applications for networks and employees". The adoption of CC is thus strongly influenced by factors such as the nature of the task, safety considerations, compatibility, complexity, and expense [1]. Shakor and Surameery [46] suggested that the capacity of cloud computing to increase output, enhance communication, facilitate the availability of scientific resources, and lower expenses is among its most important features. Issues with performance, security, safety, and control remain among the most important negative drivers, however. Using the Technology Organisation Environment model, an analysis from a university perspective further suggested that "relative advantage, accuracy, integration, safety, readiness for technology, support from upper management, laws and regulations, and competitive pressure have positive significant impacts on the cloud computing adoption" [47].

Due to the relatively nascent state of the cloud industry, the adoption of CC in higher education still faces several obstacles, including security and privacy concerns, compliance issues, inadequate network infrastructure, and inconsistent internet connections [1]. Based on these fundamental ideas, Al-Ramahi et al. [48] created a technology organization environment quality of cloud computing adoption model, that showed that instructors' and students' adoption of cloud computing technology was likely to remain limited. Spoon-feeding is also a problem that hinders the usage of ICT during research. Privacy and security concerns tend to more seriously negatively impact the uptake of cloud computing technology, however, while Hussein et al. [47] demonstrated that regulations, managerial assistance, rivalry, tech harmony, competitive edge, assurance, reliability, technical preparedness, and social mindset all had major impacts on the implementation of CC.

Based on this prior work, the following testable statement were hypothesised for the current study:

H1: Cloud computing fit is significantly increased by increased relative advantage.
H2: Cloud computing fit is significantly enhanced by increased compatibility.
H3: Cloud computing fit is significantly decreased by increased complexity.
H4: Cloud computing fit is significantly decreased by increased security concerns.

3) Organisational Context and Cloud Computing Viability

When assessing a business's capacity to implement novel technologies, calculating viability includes weighing the expenses, advantages, and level of preparation for use within the business. The viability of cloud technology increases when an entity is ready to change, appreciates the savings to be made, has gathered support from executives, and has developed a knowledge intensive culture. Both human and structural aspects are thus necessary to make an entity ready for new technology, along with access to specialisation in the respective skills. The former relies on the knowledge of the human capital of the entity, especially tacit knowledge, while the latter references the knowledge embedded within the entity's infrastructure. Support from executives is also necessary due to the fact that strategic resources, including financial and non-financial resources relevant to new technology, are allocated by them [49]. CC success is thus significantly impacted by top managers' support, technological preparedness, safety, pressure from rivals, compatibility, complexity, and potential savings. Hussein et al. [47] thus attributed the acceptability of cloud computing to a range of factors, including technological preparedness, regulatory legislation, managerial backing, lifestyle and culture, and rivalry. This leads to several additional hypotheses:

H5: Cloud computing viability is significantly increased by technology readiness.
H6: Cloud computing viability is significantly increased by cost savings.
H7: Cloud computing viability is significantly increased by senior management support.
H8: Cloud computing viability is significantly increased by cloud knowledge.

4) Environmental Context and Cloud Computing Adoption

Environmental pressure provokes an organisation to adopt new technologies to remain competitive. "Official or unofficial stressors applied to organizations by other organizations they rely on" are known as coercive pressures [44]. Based on this, companies are subject to various coercive constraints inherent in their trade interactions. Such forces might originate from multiple parties, including vendors, consumers, resource-dominant firms, regulators, and mother enterprises. Some researchers have demonstrated the importance of coercive factors in the acceptance of technological developments, particularly institutionalised mutual dependence: entities within a sector or context commonly display systemic mutual dependence because they are likely to share fundamental traits, and such forces lead these entities to seek efficiency in their systems by adopting new technologies such as cloud computing [50].

The professionalisation generated by connections across organisations, shared education, and other factors can also give rise to normative constraints. The expenses and benefits of new technology can thus be investigated by an organisation that has direct or indirect connections to other firms who have embraced it, causing that organisation to potentially be convinced to act in the same way. Participants of a community form relationships that allow interorganisational education, leading to normative pressures in a consensus-building process that further strengthens such norms and their potential impact on the conduct of the organisations involved [50]. Troppe [45] thus suggested that, in terms of adopting IT innovations, a company experiences normative pressures such that the probability of it taking actions such as embracing cloud computing is increased by factors including the use of cloud tech by both its vendors and customers, any memberships in professional associations, and its involvement in business or industry groups that support acceptance of the technology.

The company may emulate its actions and habits of other companies with comparable structures that operate in the context in which it also operates. Companies may adopt imitative practices to emulate rivals to gain better status or societal fit within the larger socioeconomic framework. Irrespective of an IT innovation's technological or financial viability, an entity may thus accept it due to a perceived need for legitimacy. Uncertainty is another element that influences copying behaviours: an entity may choose to mimic competitors to achieve simple and inexpensive replication when the returns from executive effort are unclear and challenging to measure, regardless of whether such effort is in the realms of innovative technology or managerial transition. Enterprises may thus imitate other businesses' outstanding computer system implementation strategies because they remain unsure of the outcomes of adopting technologies such as cloud computing [50].

The following additional testable statements can therefore be hypothesised:

H9: Cloud computing adoption is positively influenced by coercive pressures.
H10: Cloud computing adoption is positively influenced by normative forces.
H11: Cloud computing adoption is positively influenced by mimetic forces.

5) Fit as a Mediator between Technology Context and Cloud Computing Adoption

The fit viability model combines technology fitness and feasibility, and when determining whether technology context is suitable for enabling the transmission of cloud computing in Higher Education Institutions (HEIs), the FVM framework can be helpful. The fit component evaluates how well a technical item satisfies the criteria of the relevant project, while the feasibility dimension evaluates how effectively the company's structure is set up to utilise the technology. Tapping the cutting edge of sophisticated programs that align with substantial aspects of structure, values, and traditions involves identifying a sound fit: the technology must align with the primary goal of the entity to make the adoption of novel aspects such as cloud computing valuable [54, 43, 29].

Thus, the following hypothesis is also proposed for testing:

> H12: The adoption of cloud computing is favourably impacted by fit.

6) Viability as an Intervening Factor between Organisation Context and Cloud Computing Adoption

The FVM model is a valuable tool for determining whether cloud computing is suitable for service delivery in HEIs, The feasibility of the technology can be checked with respect to organisational factors including financial support, system readiness, support from strategic senior management, and overall infrastructural knowledge. The potential monetary benefits of cloud technology makes the model more adoptable and add value, while the knowledge management system embedded in the entity, based on information being shared from one unit to another, demands a readiness for this information to be used for decision making [54, 43, 29].

Following hypothesis is thus proposed to be tested:

> H13: Cloud computing adoption is significantly positively influenced by cloud computing viability.

7) Culture as an Interactional Factor between Technological, Organisational, and Environmental Contexts and Cloud Computing Adoption

As organisations expand, they cultivate distinctive cultural identities. Such organisational cultures generate unique approaches to conducting business, exemplified by the values demonstrated by employees when performing tasks such as prioritising orders, determining which customers should receive precedence, and evaluating the appeal of product ideas. Not only does its culture define the capabilities of an organisation, but it also delineates its limitations, and in instances of significant transformation, the research indicates that organisational culture can thus generate cultural inertia, presenting a formidable obstacle to direct change. This frequently serves as a primary factor behind managers' struggles to implement timely and substantial changes, despite awareness of the need for such adjustments. Crucially, bringing about innovation such as the introduction of cloud computing must be expected to necessitate a foundational and cultural shift in how the organisation perceives its technological assets, manages operations, and strategizes for the future [51].

Culture is thus of great importance with respect to companies being adaptable, ready for change, delivering motivation, or establishing strategic plans, all of which have the power to inspire people and encourage them to seek out new and creative ways to increase productivity. Corporate culture should therefore be assessed as an element of company efficiency alongside its role as a motivator of technology [52]. Anxiety often arises in the presence of uncertainty, and individuals may feel threatened when confronted with unknown situations. Within cultures marked by high levels of uncertainty, individuals often turn to technology, legal frameworks, rules, and religion to reduce ambiguity in various situations, in an attempt to make events more easily interpretable and predictable. In organisations within such cultures, there can be a tendency to avoid unnecessary risks, with firms instead meticulously planning and executing projects to offer sufficient value based on explicit approval in the market. Where cloud computing is new phenomena for an organisation, determining how the organisational culture may play a role in bringing in the new technology is necessary to accurately measure any causal effect [53].

The following hypotheses are thus proposed to be tested:

> H14: The interaction between task and cloud computing fit is moderated by the organisational culture.
> H15: The interaction between relative advantage and cloud computing fit is moderated by organisational culture.
> H16: The interaction between compatibility and cloud computing fit is moderated by organisational culture.
> H17: The relation between complexity and cloud computing fit is moderated by organisational culture.
> H18: The relation between security concerns and cloud computing fit is moderated by organisational culture.
> H19: The interaction between technological readiness and cloud computing viability is moderated by organisational culture.
> H20: The interaction between cost saving and cloud computing viability is moderated by organisational culture.
> H21: The interaction between top management support and cloud computing viability is moderated by organisational culture.
> H22: The interaction between cloud knowledge and cloud computing viability is moderated by organisational culture.

H23: Organisational culture facilitates the interactional influence between coercive pressure and cloud computing adoption.

H24: The link between normative demands and cloud computing adoption is moderated by organisational culture.

H25: Organisational culture causes interactional effects between mimetic pressures and cloud computing adoption.

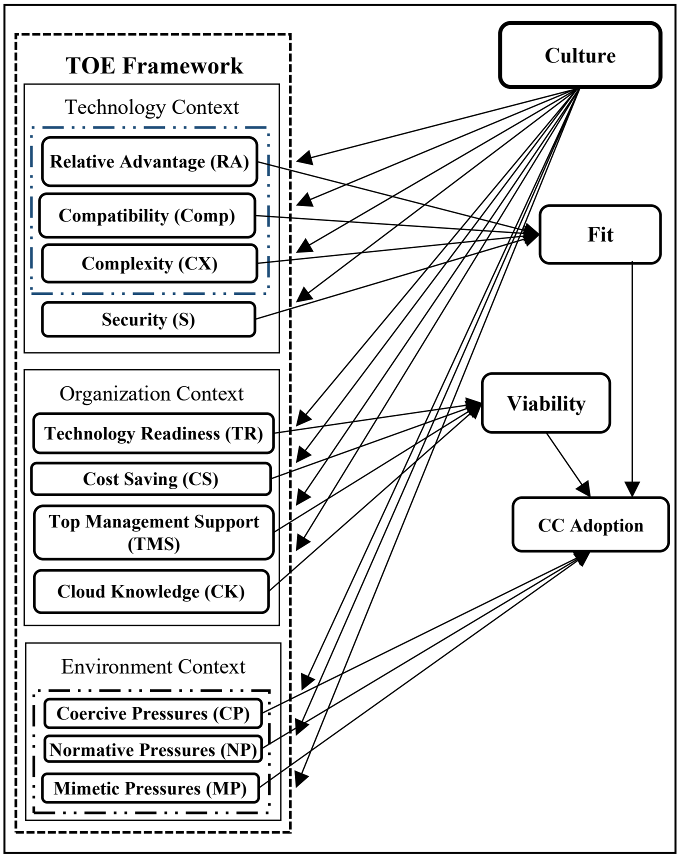

Figure 1: Research Model

III. Conclusions

In conclusion, this paper explored the potential of cloud computing in higher education through the lens of three key theories: the Technology Organization Environment (TOE) Theory, the Theory of Reasoned Action, and the Fit Viability Theory. Based on these theoretical frameworks, nine hypotheses were constructed to explore the impact of cloud computing on various aspects of higher education. Based on these theoretical frameworks, 25 hypotheses were constructed to explore the impact of cloud computing on various aspects of higher education. The theoretical framework with the constructed hypothesis offers valuable insights and reference for researchers and IT professionals in higher education institutions towards a successful implementation of cloud computing and maximizing its benefits within their respective environments. Further research is crucial to refine cloud-based models and ensure their seamless integration into the evolving needs of higher education.

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