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FACTORS AFFECTING ENGINEERING INSTITUTES OPERATIONAL EFFICIENCY: EXPLORING MEDIATING ROLE OF DIGITAL TECHNOLOGIES ADOPTION IN TEACHING/LEARNING

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Abstract: *This study aims to examine the factors contributing to adopting innovative technologies in the education sector, which can ultimately lead to operational efficiency. In order to evaluate the hypothesis, 305 respondents from Indonesian educational institutions such as schools, vocational institutions, colleges, and universities completed a self-administered questionnaire. The study's findings indicate that adopting ASES is a major factor in determining the operational efficacy of educational institutions. In addition, factors including teacher technology readiness, student personal innovation, institutional innovation, digital infrastructure, transformative leadership, and environmental pressure were found to have a positive relationship with the adoption of ASES. In addition, the mediating role of ASES adoption was evaluated. There are few studies on adopting ASES and operational efficiency in the education sector, making this study an important addition to the corpus of knowledge. This study can assist the administration of educational institutions in identifying the key factors necessary for operational efficiency.*

Keywords: *Operational efficiency, ASES, technology adoption, digital technologies in education, automated assessment.*

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1. Introduction

A company's operational efficiency is measured by its ability to produce maximum output, revenue, productivity, and excellence in providing products or services (Mantje, Rambe, & Ndofirepi, 2023). This is accomplished by minimizing the number of resources that are wasted and the number of inefficient procedures. It mainly involves utilizing human resources, material funds, machines and tools, raw materials, and technology (Hosain, Manzurul Arefin, & Hossin, 2020). As a result, firms work hard to improve their operational efficiencies consistently. Given the fluid nature of the environment in which businesses operate, increasing operational efficiency requires, among other things, considering how the environment is changing and the shifting needs of customers and/or other stakeholders as a direct result of those changes. Technological developments have recently impacted businesses functioning across many industries and fields. According to Santa et al. (2011), it has thus become critically important for businesses to modify their plans to align with the development of new technologies and to implement the most recent technology to improve their operational efficiency. According to Kehinde et al. (2022), even though operational efficiency as both a concept and a practice has been the subject of extensive research in the past, most of that research has been conducted on businesses active in manufacturing and other fields. As a result, this research aims to investigate the degree to which educational institutions, particularly in relation to their use of digital technologies, are effective in their day-to-day operations. In addition, the study explores the factors that contribute to the effective adoption of technology in the education sector (i.e., the adoption of automated short essay scoring (ASES)), which can ultimately lead to the accomplishment of operational efficiency in educational institutions. Specifically, the research focuses on adopting automated short essay scoring (ASES). In particular, the study investigates several factors, including institutional innovativeness, which refers to the capabilities and competencies of an institution to readily adopt the latest innovations (García-Morales, Llorens-Montes, & Verdú-Jover, 2006), instructors' digital readiness, which refers to the willingness and digital literacy/competence of the instructors in educational institutions to adopt and incorporate technological innovations in their teaching methods (Elliott, Hall, & Meng, 2008), and institutional In the absence of an adequate digital infrastructure, no technological innovation can be successfully implemented (Solar, Sabattin, & Parada, 2013). Lastly, environmental pressures refer to the dynamic, ever-changing environment that educational institutions operate in. This environment places continuous pressure on educational institutions to adopt innovative technologies in order for these institutions to survive in the long run and to gain a competitive advantage (Oliveira et al., 2019). Because there aren't many studies on the topic, this one represents a substantial addition to the existing body of knowledge (Ibidunni et al., 2018; Kehinde et al., 2022). The authors of this research note that the adoption of digital technologies and operational efficiency in the education sector are both understudied.

2. Literature Review

2.1 Institutional Operational Efficiency

Because the idea of operational efficiency encompasses such a broad scope, there is no definitive definition for the term. Some people think efficiency is solely a financial concept measured by calculating the input-to-maximum output ratio. Alternatively, if an organization can generate the greatest amount of revenue while incurring the fewest possible expenses, it is said to operate efficiently (Njoroge, 2013; Sharma, Vashisth, & Sharma, 2014). According to Al-Qubaisi and Ajmal (2018), some people view it as a set of guidelines or regulations driving an organization toward competence. According to Mantje et al. (2023), "operational efficiency identifies and eliminates wasteful processes and resources that threaten organizational profits and facilitates the remedial design of new work processes that improve the quality and productivity of the firm" (p. 1867). In other words, operational efficiency "identifies and eliminates wasteful processes and resources that threaten organizational profits" (p. 1867). Therefore, it is focused on establishing a balance between eliminating waste and expense and maximizing productivity, with the goal of offering quality products and services to the clients. Another way to define it is as "the efficient utilization of human and material resources," which might include the effective use of human capital, machines, tools, equipment, and material funds. According to Hosain et al. (2020), on page 31, "Better utilization of any or a combination of such resources can increase the output of goods and services while reducing costs."

In the context of production companies and other types of organizations, operational efficiency has been the subject of significant research in the past. However, only a handful of research links it to the education industry (Kehinde et al., 2022). In the same way as in other industries, the management of educational institutions must constantly contend with pressure from the environment and from their competitors to improve the efficiency of their business operations to achieve a position of advantage in the market. According to Santa et al. (2011), it is crucial for organizations to maintain a vigilant watch on newly emerging innovations and to incorporate those that can be of the greatest assistance in increasing the effectiveness of their operational procedures. According to Kehinde et al. (2022), these organizations can gain an advantage over their rivals, cut down on waste and additional costs in their business processes, and still provide quality and up-to-date services to various stakeholders. This study aims to investigate the factors that lead to adopting innovative technologies in the education sector, which can finally achieve operational efficiency. Given the limited number of studies conducted on operational efficiency in the education industry, this research represents a substantial addition to the existing body of knowledge (Ibidunni et al., 2018; Kehinde et al., 2022).

2.2 Digital Technologies Adoption in Teaching/Learning: Automated Short Essay Scoring (ASES)

According to Jöhnk, Weißert, and Wyrtki (2021), on page 7, "the decision to use an innovation, such as a product, service, process, or technology, is referred to as adoption." According to Jöhnk et al. (2021), adopting new technology may be broken down into three distinct stages: initiation, adoption, and implementation. The first step, known as "initiation," involves identifying needs, forming an attitude toward an emerging innovation, constructing a proposal for the innovation's acceptance, and developing an attitude toward that invention. In the second stage of decision-making on adopting innovation, the prepared proposal is scrutinized from every conceivable angle to conclude whether or not to accept the proposal. According to Hameed, Counsell, and Swift (2012), the third stage of implementation comes after acceptance

and includes incorporating innovation, conducting trials, and using the system. If the idea is turned down, the groups may re-consider it at some point in the not-too-distant future.

Because of shifting environmental requirements and the growing inapplicability of conventional business practices, nearly every company in the world is currently incorporating digitalization and automation into its operational procedures. In this respect, the education industry has not lagged behind other sectors. Following the outbreak of Covid-19, many educational institutions were forced to use information and communication technology (ICT) for education and learning (Ramesh & Sanampudi, 2022). During that period, many educational establishments concluded that the educational system could benefit from incorporating digitalization and automation, which resulted in a transition and revolution within the education sector. An online style of teaching and learning, the maintenance of classroom material through dashboards, and a learning management system are examples of widely adopted technology advancements. In more recent years, an automated technique of evaluating students has also evolved in addition to these developments. The idea behind it is not new; in the past, automated evaluations were used only for questions of the multiple-choice variety, which needed relatively straightforward programming like pattern matching. On the other hand, in recent years, efforts have been made to utilize advanced technologies such as machine learning and artificial intelligence to evaluate the more lengthy, essay-style responses that students provide. To accomplish this goal, it is necessary to use an advanced programming language such as natural language processing (NLP).

The benefits of automated short essay scoring (ASES) include the eradication of bias and other reliability difficulties, reduced cost for the institutions, and reduced consumption of teachers' time and efforts to manually assess the lengthy essay-type questions (Lim et al., 2021). As a result, it is plausible to assert that implementing digital technologies such as ASES contributes to enhancing the operational efficacy of educational establishments. Consequently, the following idea is put out for consideration,

H1: *The adoption of ASES is positively related to improved operational efficiency in educational institutions.*

2.3 Instructor Technology Readiness

According to Parasuraman (2000), technological readiness can be defined as an individual's "propensity to embrace and use new technologies for accomplishing goals" (p. 24). He found that an individual's level of preparedness for technological advances was influenced by their opinions in four areas of technology. The four aspects are pessimism, innovation, discomfort, and insecurity. Optimism is the most important of them. According to Elliott et al. (2008), optimism is "the degree to which individuals believe that technology can benefit their lives and give them more control over their life" (p. 13). It is focused on having a favorable attitude and sentiment toward the application of technology and its benefits. The term "innovativeness" refers to "a natural desire to experiment with new technologies, as well as to be a thought leader" (Elliott et al., 2008). An individual's natural inclination and insatiable curiosity

lead them to investigate the marvels of modern technology and search for novel and more effective approaches to completing a task. The third component is referred to as "discomfort," and it is defined as "a feeling of lacking both control over technology and the confidence in making the technology work" (Elliott et al., 2008). It acts as a barrier to adopting new technology and evaluates a person's level of preparedness for technological advancement. The more unease a person has with new technology, the more probable it is that they will fight against the widespread acceptance of it. "a need for assurance that a technology-based product, service, or process will operate reliably and accurately" is what is meant by "insecurity," which is another barrier to the acceptance of technology (Elliott et al., 2008). Insecurity impedes the acceptance of technology. It is concerned with a person's lack of trust in the ability of technology to complete a task efficiently and reliably. These four factors collectively define an individual's level of preparedness for technological advancement.

The level of technological preparedness and expertise teachers possess is of the utmost significance in educational settings. According to Lázaro-Cantabrana, Usart-Rodríguez, and Gisbert-Cervera (2019), instructors and teachers serve as the conduit for students' education. It is impossible to discount the relevance of enhancing teachers' digital competency in this day and age of rapid digitalization when technology and automation have already made their way into the educational system. It would mean developing the digital competency of educators to "equip teachers with a set of basic competencies they can transfer to their future classroom practice" (Falloon, 2020). instructors are responsible for assisting students in navigating the digital environment (Admiraal et al., 2017; Kim, Jörg, & Klassen, 2019). If instructors are successful in adopting technology, then the technological endeavor as a whole is more likely to be successful (Admiraal et al., 2017; Kim et al., 2019; Pozas, Letzel-Alt, & Schneider, 2022). The instructors and teachers who are comfortable with and confident about using advanced technologies in the education system are more likely to adopt initiatives such as online learning systems, learning management systems, maintaining dashboards, and automated assessments. In light of this, the following *possibility is put out for consideration:*

H2: *Adoption of ASES mediates the relationship between instructors' technology readiness and the operational efficiency of educational institutions.*

2.4 Student Innovativeness

A person's innovativeness is "an individual's inherent tendency to try new technologies" (Wang & Lin, 2021). There have been many technological breakthroughs in the realm of educational establishments in recent years, such as new learning management systems, online learning systems, automated assessments, classroom dashboards, and the like (Bervell, Umar, & Kamilin, 2020; Elliott et al., 2008). Some examples of these technological advancements are new learning management systems, online learning systems, and automated assessments. According to Liu, Li, and Carlsson (2010), students who exhibit innovative characteristics are more likely to be risk-takers. As a result, these students are more likely to try and readily adopt new ways of learning that involve digital technology out of their own curiosity to gain new experiences and change how they learn. Innovative students also have a positive attitude toward the implementation of new technologies in their educational institutions, such as online learning systems as well as online automated assessment technology, and they regard these most recent technological

innovations as useful and productive (Bervell et al., 2020; Huang et al., 2021; Ngafeeson & Sun, 2015). Online learning systems and online automated assessment technology are examples of such technologies. Students with personal innovativeness readily adopt new technologies at their institutes because they are keenly interested in advanced technologies. They are confident that they will be able to utilize that technology properly, learn new ways of learning, upskill themselves, and flexibly change their learning styles as per needs (Shaw & Sergueeva, 2019; Wang & Lin, 2021). An individual's technological readiness can also be defined as their openness to experimenting with and using new forms of technology. Students' digital competency is a subset of innovativeness and preparedness for technology, and it is defined "as knowledge, skills, and attitudes supporting the purposeful and effective use of technology" (Blayone et al., 2018). As a result, students' individual inventiveness, including their preparedness for the use of technology and their level of digital competency, is linked to the implementation of forward-thinking technological practices at their educational institutions, such as ASES. In light of this, the following possibility is put out for consideration:

H3: *Adoption of ASES mediates the relationship between student innovativeness and educational institutions' operational efficiency.*

2.5 Institutional Innovativeness

Organizational innovativeness is defined as "the process of proposing/ adopting/ developing/ implementing a new idea (related to a product/ process/ policy/ practice/ behavior/ program/ service) generated internally or taken from outside" (García-Morales et al., 2006). This new idea can be related to a product/ process/ policy/ practice/ behavior/ program/ service. Through innovation, businesses can discover new channels and resources for producing income and employ current resources more effectively and efficiently so that they can realize the full potential of those resources to generate money. Understanding the complexities and dynamics of the relationship between organizational practices and their outcomes, spending available resources to find alternative and more efficient ways of operations, and determining whether or not it is feasible and whether or not it has the capability to deal with environmental change are all aspects of organizational innovation practices. According to Jöhnk et al. (2021), innovativeness in companies is not a one-time event but rather an ongoing process in which organizations are always looking for better ways to create new knowledge and capabilities. In this approach, organizations can increase their skills, which in turn leads to improvements in the performance of the organizations. According to Kalmuk and Acar (2015), for an organization to prosper in the face of changing environmental demands and the pressure of competitors, it must continually produce new products or services and new processes through innovation. The organization gains a competitive advantage due to innovation's benefits compared to other businesses. According to Acar and Özşahin (2018), in the modern world, where technical progress is accelerating rapidly, the only companies with a chance of long-term survival are inventive ones.

One aspect that is incredibly necessary for organizations to have in place for them to innovate is organizational preparedness for change and innovation. "Readiness

indicates the state necessary to engage in a specific activity, such as adopting a specific innovation" (Lokuge et al., 2019). This was taken from the research done by Lokuge et al. (2019). When it comes to innovation of a digital nature, digital readiness is a more pertinent topic to consider. The formal definition of an organization's digital readiness is "the degree to which an organization is ready to transform the current organization digitally" (Nguyen et al., 2019). According to Nguyen et al. (2019), organizational readiness to change is not a one-time activity but a continual process of development in various categories, including an organization's assets, dynamic capacities, and commitment to change. A company may only be regarded as ready to innovate if it makes consistent progress and improvements across all three areas. Research conducted in the past has provided evidence of a connection between organizational readiness for innovation and the adoption of digital technologies (Jöhnk et al., 2021; Lokuge et al., 2019; Nguyen et al., 2019). Johnk, Weibert, & Wyrtki conducted these studies conducted these studies.

Therefore, given the setting of the current study, which is education, and more specifically, higher education institutions, it is possible to presume that institutions with innovativeness and readiness for change and innovation are more likely to accept new technical breakthroughs such as ASES. This is because innovativeness and readiness for change are two characteristics associated with higher education institutions. In light of this, the following possibility is put out for consideration:

H4: *Adoption of ASES mediates the relationship between organizational innovativeness and operational efficiency of educational institutions.*

2.6 Digital Infrastructure

The availability of digital infrastructure is one of the most important prerequisites that must be met before an organization or institution can successfully integrate new technologies and digitalize its operations. Without adequate digital infrastructure, there is no chance that a digital project will be successful. As a result, it is essential for businesses and other types of institutions to invest in developing their infrastructure (Hustad & Olsen, 2021; Valdés et al., 2011). This will allow the installed digital technologies to function normally and without any problems. According to Lu, Tsai, and Wu (2015), "the availability of equipment, software, Internet access, and other similar resources in the school" is what is meant by the term "digital infrastructure" in the context of education. According to Solar et al. (2013), the basic components of digital infrastructure required to apply digital technologies successfully are hardware, software, networks, and an infrastructure maintenance plan. The term "hardware" refers to the various components of a technical nature that are necessary for the operation of digital technologies. "access to the computer room; quality of technological equipment for educational use; access to equipment deployment information multimedia; computers available for education; and access equipment information capture" are the components. "operating system," "educational software," and "administrative software" are all types of software that fall under the umbrella of "software," which also refers to the process of developing applications that help enable the integration of digital technologies into existing internal and external systems. The next concept to consider is networks, which denote the underlying infrastructure of communication and the dissemination of information. The phrases "internet, wi-fi, and intranet" describe the components that make up the networks.

In conclusion, having a maintenance plan entails having a fixed strategy for regular

maintenance in order to ensure that the digital technologies that have been deployed may function and run without any problems. It necessitates the "maintenance of equipment; operational maintenance supplies; and the presence of a maintenance plan" (Solar et al., 2013). It is reasonable to assume that educational institutions, to integrate digitalization and automation into their operations, will need to place a primary emphasis on developing appropriate digital infrastructure, given the significance of a well-functioning digital infrastructure to successfully implement and incorporate any technological advancement within organizations and institutions. When a more robust digital infrastructure is readily available, it is much simpler for an organization to include digital technology best practices in the instructional process. In light of this, the following possibility is put out for consideration:

H5: *Adoption of ASES mediates the relationship between digital infrastructure and the operational efficiency of educational institutions.*

2.7 Transformational Leadership

Incorporating digital technology into the organizational system necessitates modifications and shifts, which can occasionally be significant. The organization's members will typically fight against significant reforms like these. According to Christensen and Knezek (2006), the management, specifically the leaders, plays an important position in this scenario. According to García-Morales et al. (2006), the primary factors that can drive creativity inside an organization are the features, traits, and leadership styles of the organization's leaders. According to Schiller (2015), leaders are responsible for providing direction, vision, objectives, encouragement, and support to bring about improvements. It has been observed and empirically confirmed that the transformative leadership style is the most effective when it comes to innovative and technological initiatives in the organization (Bush, 2015; Gacicio, Gakuu, & Kidombo, 2021; García-Morales et al., 2006; Weng et al., 2015). Among the many available leadership styles, it has been observed that the transformative leadership style is the most effective.

In education, just like in any other kind of company, the heads of educational institutions have also taken on the duties of professional managers who are responsible for managing a wide variety of resources and are held accountable for the results of using those resources. In this way, education has become very similar to other organizations. According to Antonopoulou et al. (2021), transformative leaders in education provide direction, support, and inspiration to the entire staff so that they may understand the benefits of bringing about creative changes that are requested by the changing environment. According to Al-Husseini, El Beltagi, and Moizer (2021), educational institutes also have to contend with intense levels of rivalry, highlighting the importance of continuously enhancing and modernizing their business practices to achieve a competitive advantage. When leaders know the benefits and advantages of implementing technology in the education system, the rest of the employees can receive the appropriate assistance and advice they need to do their jobs effectively. According to Arokiasamy, bin Abdullah, and Ismail (2015), leaders can never effectively guide and push their subordinates to incorporate new technology in the education system if they are unaware of the potential technology holds in this sector.

Because of this, it is reasonable to believe that transformational leaders are positive motivators and instigators of innovative changes and technology integration in the education system, including technology-based automated assessment methods (i.e., ASES). This conclusion is supported by the debate that was presented earlier. In light of this, the following possibility is put out for consideration:

H6: *Adoption of ASES mediates the relationship between transformational leadership and the operational efficiency of educational institutions.*

2.8 Environmental Pressure

Organizations do not work in a static context; rather, they function within a dynamic environment full of components such as competitors, changes in regulations, technological breakthroughs, and other elements. As a result, the environment in which an organization operates is the primary source of new opportunities and dangers. Because of this, businesses need to maintain vigilance regarding the shifting demands and environments in which they operate (García-Morales et al., 2006; Salahshour Rad, Nilashi, & Mohamed Dahlan, 2018). Doing so will allow them to continue to strive for a competitive advantage and ensure their continued existence (Salahshour Rad et al., 2018). Organizations must be flexible in the sense that they are willing to learn new ways of doing things, forget old methods of doing things, and occasionally relearn what they already know in order for the strategies of an organization to be aligned with the shifting conditions of their environment. Organizations can focus on developing and excelling in their existing skills by indicating methods for continuous improvement when operating in an environment that is stable.

On the other hand, when the environment is dynamic, and it continues to change unpredictably, companies must concentrate on establishing new competencies and easily embrace the needs of the changing environment. Companies may have to completely revamp their organizational structures and become familiar with new business methods. When it comes to technology advancements, new technologies are constantly being developed. As a result, businesses must be proactive and implement technological advancements to stay ahead of the competition and improve their operations (Oliveira et al., 2019).

In the context of the educational sector, the most recent technologies are continuously entering into play in the external environment. This places pressure on educational institutes to implement and integrate those technologies into their educational system to provide superior learning experiences that align with international quality standards (Kemp, Palmer, & Strelan, 2019). Integration of automation and digitalization in the processes, online learning systems, dashboards, learning management systems, and other similar technologies are among the most recent educational and technical developments. Consequently, shifts in the external environment play an important part in adopting new technology in the educational sector. In light of this, the following hypothesis is put forward:

H7: *Adoption of ASES mediates the relationship between environmental pressure and the operational efficiency of educational institutions.*

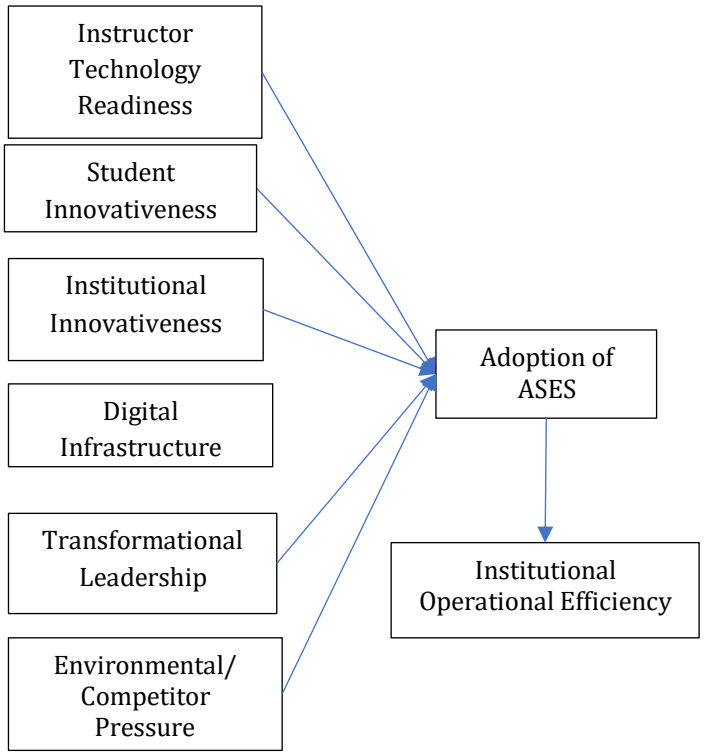

Fig.1. Conceptual model of the Study

3. Methodology

1.1. Research Instrument

The variables of the study were measured with the use of pre-existing measurement questionnaires that had already been validated. The instrument that García-Morales et al. (2006) used to measure innovativeness in institutions was modified to be applied to the institutional innovativeness variable. The tool used in the study by Parasuraman (2000) was modified so that it could be used to measure the variable of technological preparedness among instructors. The technique that Wang and Lin (2021) used to test innovativeness was modified so that it could be used to assess students' levels of personal creativity. The digital infrastructure scale was created by basing it on the recommendations made by Solar et al. (2013). The instruments developed by García-Morales et al. (2006) were modified to measure the transformative leadership and environmental pressure variables. A scale was developed to quantify the degree to which ASES was adopted, and it was based on the recommendations made by Dreher, Reiners, and Dreher (2011). The next step was the development of a scale to measure operational efficiency. This scale was built using the recommendation made by Mantje et al. (2023), as well as considering the study setting to suit the target population. A Likert scale with five points was used to

measure each of the characteristics. In the following table, Table 1, the associated measurement items or statements for each variable, together with their respective sources, are presented:

Table 1 Measurement Tools

Items	References
Institutional Innovativeness	
Indicate your degree of agreement or disagreement with the following statements (1 "totally disagree," 7 "totally agree"). In the last three years:	
The rate of introduction of new teaching/learning methods into the institution has grown rapidly.	(García-Morales et al., 2006)
The rate of introduction of new methods of learning evaluation into the institution has grown rapidly.	
In comparison with its competitors, the institution has become much more innovative.	
Instructor Technology Readiness	
Optimism	
Teaching methods that use new technologies are convenient to use.	
I prefer to use the most advanced technology available.	
I like computer programs that allow me to tailor things to fit my own needs.	
Technology makes me more efficient in my occupation.	
I find new technologies to be mentally stimulating.	
Technology gives me more freedom of mobility.	
I feel confident that machines will follow through with what I instructed them.	
Innovativeness	
Other people come to me for advice on new technologies.	
It seems my friends are learning more about the newest technologies than I am.	(Parasuraman, 2000).
I am among the first in my circle of friends to acquire new technology when it appears.	
I can usually figure out new high-tech products and services without help from others.	
I keep up with the latest technological developments in my areas of interest.	
I enjoy the challenge of figuring out high-tech gadgets.	
I have fewer problems than other people in making technology work for me.	
Discomfort	
Technical support lines are not helpful because they do not explain things in terms I understand.	
Sometimes, I think that technology systems are not designed for ordinary people.	
There is no such thing as a manual for a high-tech product or service that's written in plain language.	
When I get technical support from a high-tech product or service provider, I sometimes feel as if I am taken advantage of by someone who knows more than I do.	
If I buy a high-tech product or service, I prefer a basic model over one with many extra features.	
It is embarrassing to have trouble with a high-tech gadget while people watch.	
There should be caution in replacing important people's tasks with technology because new technology can break down or get disconnected.	
Many new technologies have health or safety risks not discovered until people use them.	
New technology makes it too easy for governments and companies to spy on people.	
Technology always seems to fail at the worst possible time.	
Student Innovativeness	
If I heard about a new technology, I would look for a way to gain experience.	(Wang & Lin, 2021)
Among my peers, I am usually the first to try out a new/latest technology.	
I like to experiment with new technology/high-tech gadgets.	
Digital Infrastructure	
Our institute has the operating systems installed to meet the educational objectives.	
Our institute has the necessary educational and administrative software.	
I can store digital information and data securely.	
Our institute has a proper high-speed internet connection/wi-fi.	(Solar et al., 2013)
Our institute has an intranet system for administrative communication.	
All staff members and students have access to computer rooms/labs.	
The quality of technological equipment for educational use is up to the mark.	
Our institute regularly maintains the ICT equipment.	
The operational maintenance supplies are readily available.	
A proper maintenance plan for equipment is present.	
Transformative Leadership	(García-Morales et al.,

My Institute management always looks for new opportunities for the unit/department/institute.	2006)
My Institute management has a clear common view of its final aims.	
My Institute management succeeds in motivating the rest of the faculty and staff.	
My Institute management always acts as the institute's leading force.	
The institute has leaders who can motivate and guide their colleagues on the job.	
Environmental Pressure	
Few changes in the sector could affect my institute.	(García-Morales et al., 2006)
The changes in the sector have been easily predictable.	
The sector's evolution depended on multiple factors.	
The factors that affect the sector's evolution differ greatly from each other.	
Adoption of ASES	
My institution encourages me to use ASES techniques to evaluate students' learning.	
My institution explains the benefits of ASES for students and instructors.	
I think the ASES evaluation technique facilitates me in my job/improves my efficiency.	(Dreher et al., 2011)
ASES provides me time to focus on other aspects of my job, such as individual student guidance.	
ASES technique for assessment is more accurate and reliable	
Operational Efficiency	
Our institute can leverage technology.	
Our institute is continuously involved in enhancing employee skills.	
Our institute promotes the efficient delivery of educational services.	
After using technology in teaching/learning, such as ASES, the operational cost of our institute has been reduced.	(Mantje et al., 2023)
After the adoption of digital methods of learning/teaching, such as ASES, the quality of institutional operations has been improved.	
After the adoption of digital methods of learning/teaching, such as ASES, the teaching staff has more time to focus on student learning and guidance.	

3.2 Target Population and Sampling Technique

The information required for this study came from various educational institutions in Indonesia. These establishments include primary and secondary schools, colleges, and universities. In order to collect data, we employed the convenience sampling technique because it was impossible to create a list of the population (i.e., the population frame was unknown).

3.3 Data Collection Method

A survey of employees, staff, and management of various educational institutes in Indonesia, such as schools, vocational institutes, colleges, and universities, were allowed to self-administer was used to collect the data. The respondents' informed consent was obtained before any data collection. Were 500 questionnaires handed out, with 310 being returned after being filled out. 5 surveys were thrown out before the analysis began. Therefore a total of 305 questionnaires were used.

3.4 Data Analysis Method

The data obtained for the present study's aim was analyzed using structural equation modeling with AMOS Software, which enables the testing of complicated models, including mediation. The measurement model was first put through a confirmatory factor analysis test during the SEM analysis. This was done to evaluate the quality of the measurement items—that is, to determine their reliability and establish the convergent and discriminant validity of the measurement scale—to quantify the quality of the measurements. After that, structural models were analyzed for path analysis using regression models so that direct and indirect effect hypotheses

could be tested.

4. Analysis

4.1. Measurement Model Assessment

Table 2 Measurement model assessment

Variable	Cronbach's α	CR	AVE
Institutional Innovativeness	0.814	0.783	0.764
Instructor Technology Readiness	0.788	0.814	0.710
Student Innovativeness	0.799	0.737	0.710
Digital Infrastructure	0.899	0.874	0.749
Transformative Leadership	0.792	0.873	0.737
Environmental Pressure	0.710	0.730	0.734
Adoption of ASES	0.901	0.799	0.709
Operational Efficiency	0.911	0.729	0.766

Confirmatory factor analysis using the SPSS AMOS software was carried out to determine the appropriate measurement mode. In Table 2, you can find the results of the reliability tests that were conducted on the various research variables. All variables have reliability statistics higher than the generally acknowledged threshold of 0.70. In addition, the values of AVE are higher than the cutoff value of 0.5, indicating that each variable's components have internal consistency and may be relied upon.

Table 3

Discriminant Validity								
Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Institutional Innovativeness	1							
Instructor Technology Readiness	0.678	1						
Student Innovativeness	0.647	0.647	1					
Digital Infrastructure	0.710	0.600	0.716	1				
Transformative Leadership	0.791	0.709	0.766	0.611	1			
Environmental Pressure	0.731	0.701	0.699	0.674	0.600	1		
Adoption of ASES	0.641	0.767	0.671	0.647	0.701	0.780	1	
Operational Efficiency	0.796	0.647	0.611	0.599	0.649	0.610	0.766	1

Note: The bold values in diagonal are square roots of AVEs of the variables. The off-diagonal values are correlations among the variables.

The statistical evidence supporting the discriminant validity of the study's variables is presented in Table 3. The approach developed by Fornell and Larcker is used to determine whether or not a discriminant is legitimate. In this method, the values on the diagonal represent the AVEs of the variables, while the values that fall under the diagonal represent the correlations between the variables. In order to ensure that the discriminant validity of the model is preserved, the value of AVE for each variable should be greater than the correlation of that variable with all of the other variables. Table 3 demonstrates that the AVE for each variable is significantly higher than the correlations for those variables. As a result, the discriminant validity of every variable has been established.

Table 4

Measurement Model Fit Indices			
Fit Indices	**Overall Model Score**	**Acceptable Model Fit**	**Acceptable Baseline**
CFI	0.90	Accept	≥0.90
AGFI	0.81	Accept	≥0.80
RMSEA	0.05	Accept	<0.10
CMIN/df	1.57	Accept	<3
TLI	0.90	Accept	≥0.89
IFI	0.94	Accept	≥0.90

Examining the measurement model's fit indices is another approach that may be taken to evaluate the model's overall quality. The fit indices and their respective acceptable standard values are presented in Table 4. All the fit indices are consistent with the commonly accepted values, demonstrating that the measurement model used in confirmatory factor analysis has a good fit. This can be observed clearly.

4.2. Structural Model Assessment

Table 5

Structural Model Fit Indices			
Fit Indices	**Overall Model Score**	**Acceptable Model Fit**	**Acceptable Baseline**
CFI	0.94	Accept	≥0.90
AGFI	0.85	Accept	≥0.80
RMSEA	0.034	Accept	<0.10
CMIN/df	2.67	Accept	<3
TLI	0.91	Accept	≥0.89
IFI	0.93	Accept	≥0.90

Following the evaluation of the measurement model, the structural model is tested to see whether the data support the study hypotheses. Before moving on to the testing of the hypotheses, the model fit of the structural model was evaluated using fit indices. This was done before moving on to the testing of the hypotheses. The fit indices for the structural model of the study are presented in Table 5, together with the standard acceptable values for each of those indices. As far as can be seen, all of the fit indices fall within the parameters of acceptable ranges. As a result, the structural model is an appropriate representation.

Table 6: Direct and Indirect Effects

Relationship	**Direct Effects**	**Indirect Effects**	**Total Effects**
Adoption of ASES → Operational Efficiency	0.547	-----	0.547
Instructor's Technology Readiness → Adoption of ASES	0.416	-----	0.416
Student's Innovativeness → Adoption of ASES	0.304	-----	0.304
Organizational innovativeness → Adoption of ASES	0.497	-----	0.497
Digital Infrastructure → Adoption of ASES	0.570	-----	0.570
Transformational Leadership → Adoption of ASES	0.334	-----	0.334
Environmental Pressure → Adoption of ASES	0.257	-----	0.257
Instructor's Technology Readiness → Operational Efficiency	-----	0.289	0.289
Student's Personal Innovativeness → Operational Efficiency	-----	0.149	0.149
Organizational innovativeness → Operational Efficiency	-----	0.211	0.211
Digital Infrastructure → Operational Efficiency	-----	0.101	0.101
Transformational Leadership → Operational Efficiency	-----	0.470	0.470
Environmental Pressure → Operational Efficiency	-----	0.272	0.272

The fidings of the investigation's investigation into the direct and indirect effects of the study's variables are presented in Table 6. It has been demonstrated that the

implementation of ASES has a significant and favorable association with the educational institutions' operational efficiency that supported Hypothesis 1 of the study. In addition, it has been discovered that there is a positive relationship between the adoption of ASES in educational institutions and the technological readiness of instructors, the personal innovation of students, the organizational innovation of institutions, the digital infrastructure, the transformational leadership, and the environmental pressure. In addition to that, proof of indirect links is provided in the table as well. The hypothesis that H2 of the study is supported suggests that operational efficiency is indirectly related to the technological readiness of instructors through the mediation of the adoption of ASES in educational institutions. The hypothesis that H3 of the study is supported is that adopting ASES in educational institutions mediates the relationship between a student's innovativeness and an institution's operational efficiency. Adopting ASES in educational institutions as a mediator between institutional innovation and operational efficiency supports hypothesis 4 of the study. Institutional innovation is indirectly related to operational efficiency. It has been found that adopting ASES in educational institutions is a mediating factor in the relationship between digital infrastructure and operational efficiency, which supports hypothesis 5 of the study.

On the other hand, transformational leadership does not have a substantial indirect link with operational efficiency through the mediation of the adoption of ASES. As a result, Hypothesis 6 of the study is not supported. In the same vein, environmental pressure does not have a substantial indirect link with operational efficiency through the mediation of the adoption of ASES, which means that the study's hypothesis H7 is not supported. In the next table, Table 7, you will see a summary of the testing of the hypothesis and the decisions that corresponded to it.

Table 7: Results of Hypothesis Testing

Hypothesis	t-value	p-value	Accept/Reject
The adoption of ASES is positively related to improved operational efficiency in educational institutions.	3.01	0.02	Accept
The adoption of ASES mediates the relationship between instructors' technology readiness and the operational efficiency of educational institutions.	2.68	0.01	Accept
The adoption of ASES mediates the relationship between students' innovativeness and the operational efficiency of educational institutions.	3.47	0.03	Accept
The adoption of ASES mediates the relationship between organizational innovativeness and the operational efficiency of educational institutions.	2.99	0.01	Accept
The adoption of ASES mediates the relationship between digital infrastructure and the operational efficiency of educational institutions.	2.56	0.02	Accept
The adoption of ASES mediates the relationship between transformational leadership and the operational efficiency of educational institutions.	1.01	0.24	Reject
The adoption of ASES mediates the relationship between environmental pressure and the operational efficiency of educational institutions.	1.12	0.34	Reject

p-value <0.05; t-value > 1.96 (Hair et al., 2007)

5. Discussion

This study aimed to investigate the elements that contribute to educational institutions' high levels of operational efficiency. In manufacturing and other

organizations, the idea of operational efficiency and the actual practice of achieving it has been the subject of much research. The education industry, on the other hand, is not as focused as other sectors on maximizing its operational efficiency. Within the scope of this research, we evaluate how implementing digital technologies like ASES can help businesses improve their operational efficiencies. Quantitative data were collected from various educational institutions across Indonesia and evaluated with the AMOS program. This was done so that the study's hypotheses could be tested.

According to the study's findings, the implementation of ASES has a substantial impact on and a favorable correlation with the operational efficiency of educational institutions. Previous research (Njoroge, 2013; Santa et al., 2011). has shown that there is a positive correlation between the incorporation of digital technology and the achievement of higher levels of operational efficiency. This finding is in line with those findings. Incorporating digital technology into business operations enables companies to cut back on inefficient parts of their workflows while simultaneously improving the quality of the goods and services they offer, contributing to overall operational efficiency. In a similar vein, the deployment of digital technologies such as ASES in the education sector can assist in improving the operations involved in providing educational services. Adoption of ASES in educational institutions helps to eliminate bias and other reliability issues, cuts down costs for the institutions, and reduces the consumption of teachers' time and efforts to assess the long essay-type questions manually; all of these benefits can be considered to fall under the category of operational efficiency (Lim et al., 2021).

In addition, the findings demonstrated a favorable and direct effect that teachers' level of technological preparedness had on the adoption rate of ASES. This finding is in line with what has been found in previous research (Admiraal et al., 2017; Falloon, 2020; Kim et al., 2019; Pozas et al., 2022). Instructors that are open to new technologies and willing to use them in their classrooms can be a huge asset to the successful implementation of digital technologies in their respective institutions. In this manner, they can direct and facilitate the acceptance of new technologies, such as ASES, among their colleagues and students. The findings also point to the adoption of ASES playing a beneficially mediating effect in the relationship between the instructors' technological readiness and the business's operational efficiency. It is the preparedness of an instructor to adopt digital technology such as ASES that leads to the integration of such technologies in educational institutions, which can ultimately contribute to the accomplishment of operational efficiency. The findings also show a positive association between a student's innovativeness and the adoption of ASES, consistent with previous research (Liu et al., 2010). Similarly, the results provide evidence of a positive relationship between personal innovativeness and the adoption of ASES. For educational institutions to successfully adapt and integrate digital technologies such as ASES, one of the most important factors is the students' willingness to experiment with the most recent technological advancements. Students with a positive attitude and approach toward digital technologies are more likely to accept any innovative advancements their institutions introduced readily. Furthermore, these students consider these changes productive and are more confident in their ability to easily navigate the system (Bervell et al., 2020; Huang et al., 2021; Wang & Lin, 2021). The findings also indicate that the implementation of

ASES has a beneficial mediating effect on the relationship between a student's innovativeness and the effectiveness of their operations. As a result, students' individual creativity can pave the way for the successful implementation of ASES in educational institutions, which can ultimately result in increased operational efficiency. In addition, it has been discovered that the innovativeness of institutions has a good link with the implementation of ASES. This finding is in line with findings from previous studies that give evidence of a connection between organizational readiness for innovation and the adoption of digital technologies (Jöhnk et al., 2021; Lokuge et al., 2019; Nguyen et al., 2019). This finding is comparable with findings from previous studies. Spending the resources necessary to discover new methods of doing things can only be done by an inventive organization. As a result, forward-thinking educational establishments will eagerly and actively search for new chances and technology improvements to better their operations. The successful application of digital technologies such as ASES is contingent on the organization's readiness to embrace change and maintain flexibility regarding adapting its existing strategy. The findings also prove a positive mediating effect of adopting ASES in the link between institutional innovativeness and operational efficiency. This effect was found to have a beneficial impact. This indicates that a forward-thinking organization will implement ASES, which will ultimately lead to increased operational efficiency. In addition, the findings indicate a favorable correlation between the availability of digital infrastructure and the implementation of ASES in educational institutions. According to Solar et al. (2013), the successful implementation of any digital technology is contingent upon the pre-existing presence of digital infrastructure. According to Lu et al. (2015), educational institutions that already have an established supportive digital infrastructure are in a position to easily and quickly embrace digital technologies such as ASES. In addition, the findings indicate that implementing ASES acts as a positive mediator in the relationship between digital infrastructure and operational efficiency. This indicates that if the necessary digital infrastructure is present, the institution will have an easier time adopting digital technologies such as ASES, ultimately resulting in those institutions achieving greater operational efficiency. In addition, the study's findings indicate a good connection between transformational leadership and the utilization of ASES in educational establishments. This finding is consistent with the findings of previous research, which found that a transformational leadership style is the most effective when it comes to the deployment of digital technologies (Gacicio et al., 2021; Weng et al., 2015). This finding is consistent with previous research findings since it shows that the transformational leadership style is the most effective. In educational institutions, transformative leaders provide guidance, support, and motivation to the entire staff. This helps the staff see the benefits of bringing about innovative changes demanded by the changing environment, facilitating the implementation of digital technologies such as ASES (Antonopoulou et al., 2021). The study's results indicate that utilizing ASES does not substantially mediate the connection between transformative leadership and operational efficiency. This indicates that transformative leadership can only facilitate the adoption of ASES; nevertheless, this does not necessarily equate to increased operational efficiency. This conclusion is inconsistent, which means it requires additional investigation by researchers in the future. In a similar vein, the study's findings indicate a favorable connection between environmental pressure and the implementation of ASES in educational institutions. According to Oliveira et al. (2019), organizations and institutions face increased pressure to innovate in response to the development of new technologies and to adapt to the shifting requirements of their

environments. The field of education is always being updated with cutting-edge technological advancements. ASES is another example of an inventive innovation that has resulted in increased pressure on many institutions to improve how they assess students. According to Kemp et al. (2019), for establishments to maintain their position in the market, they need to satisfy the growing environmental demand. However, the study's findings indicate that the implementation of ASES does not substantially mediate the connection between environmental pressure and operational efficiency. This indicates that environmental pressure can result in educational institutions adopting ASES, but this does not necessarily equate to increased operational efficiency. This discovery is also inconsistent, which is something that needs to be investigated more by academics in the future.

Implications

This study makes substantial contributions to the existing body of knowledge because ASES's field and subject area are new, and not much research has been done. In the context of the implementation of ASES in the educational sector, this study offers empirical data through the testing of a complicated conceptual framework, which has not been investigated in previous research. In addition, not much research focuses on the operational efficiency of the education sector, which is another reason why this study is such an important addition to the existing body of knowledge (Ibidunni et al., 2018; Kehinde et al., 2022).

The conclusions of this study can provide educational institutions with various actionable recommendations, which can be taken from the findings. To begin, the research has uncovered several different elements that have the potential to contribute to the successful adoption of digital technologies such as ASES in educational institutions. In addition, the research presents empirical evidence of the good outcomes that might result from deploying digital technologies such as ASES in educational institutions, particularly regarding the efficiency with which operations are carried out. This study highlights the importance of focusing on the operational efficiency of the educational sector, just as one would any other sector. According to the study's findings, a crucial factor contributing to the successful implementation of ASES is the technological preparedness and innovative capacities of both students and teachers and the institution as a whole. In addition, the significance of the presence of digital infrastructure has been brought to light, which teaches organizations that they need to concentrate their efforts first and foremost on the growth of their digital infrastructure if they wish for any attempt at digital integration to be successful. Additionally, educational institutions need to work on improving students' and teachers' digital skills and capabilities. In addition, the importance of transformative leadership is brought to light, demonstrating that educational institutions require good inspiring leadership to facilitate any innovative development in the educational sector.

5.1. Limitations and Recommendations

The following are some of the constraints that this study has. This study chose a quantitative approach, and data collection was accomplished through survey

questionnaires. In subsequent research, a qualitative method may be utilized for an in-depth investigation of the topic. Future studies may look into factors besides instructor technological readiness, students' innovativeness, institutional innovativeness, digital infrastructure, transformative leadership, and environmental pressure. The inconsistent role that the adoption of ASES plays as a mediator in the relationship between transformative leadership and operational efficiency, as well as the relationship between environmental pressure and operational efficiency, is something that future scholars will need to look back on and investigate further. The data for this study came from several educational institutions located in Indonesia. In subsequent research, a comparison between nations can be made by testing the same model in each nation's respective contexts.

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