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Article

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MANAGEMENT | RESEARCH ARTICLE

Green Techno-Entrepreneurship model on student business performance: The mediating role of competitive advantage

Astri Ayu Purwati^{1*}, Zulfadli Hamzah² and Muhammad Luthfi Hamzah³

Abstract: This study aimed to examine the influence of green techno-entrepreneurship on student business performance, with competitive advantage acting as a mediator. The research focused on university students in Riau Province, Indonesia, who are engaged in entrepreneurial activities. A purposive sampling technique was employed to select a sample of 288 participants. The findings indicate that the Use/Adoption of Environmental Friendly Operations significantly boosts competitive advantage. However, it does not directly exert a significant positive impact on student business performance. In this context, competitive advantage has been validated as an effective mediator between the Use/Adoption of Environmental Friendly Operations and student business performance. Contrarily, Use/Adoption of Technologies in Operations did not significantly affect either competitive advantage or students' business performance. As such, no mediating role for competitive advantage was identified in the relationship between Use/Adoption of Technologies in Operations and business performance. Entrepreneurial competency positively and significantly influenced both student competitive advantage and business performance. Furthermore, this study found that having a robust competitive edge also significantly enhances student business performance. Therefore, entrepreneurial competency affects business performance through its impact on competitive advantage. Students possessing high levels of entrepreneurial competence are likely to achieve substantial competitive advantages which subsequently yield positive effects on their businesses' performances.

Subjects: Information & Communication Technology (ICT); Environmental Economics; Business, Management and Accounting

Keywords: Use/adoption of environmental friendly operations; Use/adoption of technologies in operations; entrepreneurial competency; competitive advantage; student business performance

1. Introduction

Rapid and significant changes in technology, telecommunications, and digitalization in the era of Industry 4.0 have become a necessity, including in higher education. These changes compel every participant in the field of education to adapt to global economic developments that demand university graduates who can create new jobs based on intellectual values (Apriana et al., 2019).

Universities play a crucial role in producing graduates who can effectively compete, particularly in contributing to the nation's economy.

Furthermore, college graduates are expected to apply their knowledge in generating new employment opportunities. According to data from the Central Statistics Agency, Indonesia for year 2023, the Open Unemployment Rate (TPT) decreased by 0.38 percentage points compared to February 2022, standing at 5.45 percent. The COVID-19 pandemic has affected approximately 3.60 million individuals (1.70 percent) within the working-age population. With an increasing number of university graduates each year, job seekers will continue to rise; therefore, students must embrace a mindset shift from being job seekers after graduation to becoming job creators.

The Indonesian government strongly encourages students' entrepreneurship through Presidential Regulation (Perpres) Number 2 of 2022 concerning National Entrepreneurship. The government aims to raise Indonesia's entrepreneurship ratio from its current rate of 3.47 percent to 3.95 percent by 2024. Student entrepreneurship is prioritized by the Ministry of Education and Culture and Research and Technology as a national agenda. Consequently, implementing Indonesian Student Entrepreneurship is expected to support students' growth and development as entrepreneurs while aligning with national priorities.

Student Business is a term used to describe business activities or projects undertaken by students while they are in school (Secundo et al., 2023). This encompasses various endeavors, such as starting new businesses and running business projects within a school setting. It is crucial for students to assess the performance of their businesses during operation. Business performance refers to the measurement and evaluation of how well a business has achieved its goals and objectives (Franco-Santos et al., 2007; Taouab & Issor, 2019). This involves assessing different aspects of the business, including its finances, operations, marketing, and human resources. Various metrics and indicators are available to measure business performance in each of these areas. Students can evaluate their business's financial performance by analyzing revenue generation and expected profits. Financial performance serves as an indicator of success and growth potential for the future. Additionally, students can gauge their business's growth through indicators such as increased sales, expanded market reach, or growing customer base. Successful business growth signifies expansion opportunities and an ability to attract more customers.

Previous research has explored factors influencing student success in entrepreneurship. For instance, Buil et al. (2019) found that students who possess clear goals or a strong interest in entrepreneurship tend to perform better in related courses. Menzies and Paradi (2003) conducted research highlighting how students' knowledge about business concepts and skills impacts their entrepreneurial performance positively. Proficiency in areas such as data analysis, management, and other essential skills required in the business world enhances student outcomes (Wallace & Clariana, 2005). Furthermore, utilizing information systems can improve efficiency and effectiveness when running a business (Wallace & Clariana, 2005).

Green techno-entrepreneurship refers to entrepreneurial activities focused on developing and utilizing green technology for environmentally friendly products or solutions (Bulsara et al., 2012). Incorporating green technology into businesses provides a competitive advantage in today's highly competitive market (Leonidou et al., 2013). Student-run businesses that embrace green technology stand out from competitors while attracting environmentally conscious customers.

According to Ramayah et al. (2019) and Bischoff et al. (2020), under the notion of green techno-entrepreneurship, firms that emphasize green solutions have an edge over their rivals. This study focuses on the potential of student enterprises that use green technology entrepreneurship strategies. Customers increasingly choose ecologically friendly products/services, according to Shaukat and Ming's (2022) study in green entrepreneurship. Another research discovered empirical evidence that the financial advantages of environmental investments are positive and

considerable in family businesses, but not in non-family businesses (Garcés-Ayerbe et al., 2022). While various studies have identified the Use/Adoption of Environmental Friendly Operations to be important in supporting company success, past research has tended to concentrate on the broad benefit of green practices on business performance without taking into account contextual aspects that may alter this connection.

Benitez-Amado and Walczuch (2012) and Fernando et al. (2019) discovered the role of technology in affecting company success in the present age. Businesses must be fast to accept technology in this day and age, both in terms of building their own technology and using current technology. Other study results on the relevance of entrepreneurship in enabling company success have also been extensively published (Frank et al., 2010; Rauch et al., 2009). Other studies have looked at the notion of green entrepreneurship, which may help firms improve their financial performance (Brochado et al., 2017; Ramayah et al., 2019, 2022; Yoganandan & Chander, 2018). However, no study has been conducted that explicitly investigates the green-technoentrepreneurship paradigm (Use/Adoption of Environmental Friendly Operations, Technology, and Entrepreneurship) in promoting company success, particularly student firms.

As a result, this study gives a chance for student firms to use entrepreneurial concepts as well as technological adoption in an environmental context (green techno-entrepreneurship). Furthermore, further research is needed to uncover and analyze potential mediating or linking processes between the Use/Adoption of Environmental Friendly Operations, technology, and entrepreneurship in impacting company success. The competitive advantage mediation technique is employed in this research to bridge the gap between the studies of ecology, technology, and entrepreneurship and company success. Previous study could not adequately explain how market rivalry or competitive advantage may operate as a mediator in this connection. The distinctiveness of innovation created by student enterprises gives a competitive edge. Green techno-entrepreneurship allows students to create and sell new goods or services that are valuable in terms of green technology or sustainability (Gast et al., 2017). This may provide student enterprises a competitive edge and attract clients who value environmentally friendly goods. Students may take use of this competitive edge to boost their business success (Lestari et al., 2020). When developing new goods or services, green technology entrepreneurs often use new and creative technologies. If students can build better, more efficient, or unique technologies in the field of green technology entrepreneurship, they will have a technical edge that will distinguish their firm. This technical edge may have a substantial influence on students' economic performance by improving the value of their goods or services (Farzin et al., 2014; Khorsheed et al., 2014).

The primary objective of this study is to comprehensively analyze the influence of green techno-entrepreneurship on student business performance while considering the mediating role of competitive advantage. The remainder of this manuscript is structured as follows: Section 2 provides an in-depth literature review elucidating key theories and empirical studies that underpin this research, hypothesis development and research frameworks. Section 2.2.3 explains the research methodology encompassing research design, data collection methods, and statistical techniques for analysis. Section 4 outlines the research results and discussion of the research findings along with practical and theoretical implications. Finally, Section 6 concludes the study by summarising the research results, limitations and recommendations for future researchers.

2. Literature review and hypothesis development

2.1. Student business performance

Business performance is a person's or a group's accomplishment or evaluation of their work over a period of time, based on the size of the business institution or company (Morgan, 2012). In this age of globalization, keeping a business going depends on how well it does business. The business world has become very fast-paced, unpredictable, and competitive on a global scale. Entrepreneurship within already-established businesses gives them life and a competitive edge,

which leads to better business performance. Student business performance refers to how well students who run their own businesses do or what they accomplish. Student business performance can be measured in many ways, such as revenue, sales growth, profits, market share, customer satisfaction, product innovation, or the achievement of other business goals (Marr & Schiuma, 2003). The future of the company will depend a lot on how well the business does. The company's goals, such as staying in business (which is called "sustainability"), making money (which is called "profits"), and growing and developing, will be met if the institution/company does well (Page, 2015).

2.2. Green techno-entrepreneurship

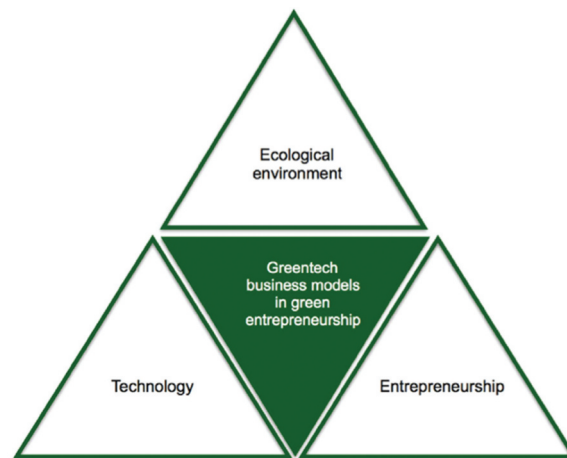
The Green Techno Entrepreneurship model refers to an approach or framework that involves the application of sustainable and environmentally friendly business principles and practices in entrepreneurial activities and technological innovation. This model encourages the use of environmentally friendly technologies, efficient resource management, and the development of products or services that contribute to environmental sustainability. The *Theory of Innovation Diffusion* was formulated to examine the notion of green-technoentrepreneurship. Everett Rogers created this theory to shed light on how novel ideas, products, technologies or practices proliferate within a social system over time (Fernando et al., 2019). It offers valuable perspectives on how different sections of a population adopt innovations and pinpoints elements that sway the speed of adoption (Melay & Kraus, 2012).

This theory encompasses several central concepts: 1) *Innovation*: In relation to green techno-entrepreneurship, innovation pertains to the inception and incorporation of eco-friendly technology and practices into business strategies. This could mean creating new products, services or solutions that are in line with sustainability objectives. 2) *Diffusion*: This refers to the method by which an innovation is disseminated among various groups or individuals. With respect to green techno-entrepreneurship, this theory elucidates how businesses adopt and incorporate eco-friendly technologies and practices. 3) *Adopter Categories*: The theory sorts individuals into diverse groups based on their inclination towards adopting innovations. These categories encompass innovators, early adopters, early majority, late majority and laggards. Innovators and early adopters play a key role in spearheading the initial acceptance and spread of green techno-entrepreneurship initiatives. 4) *Factors Influencing Adoption*: The theory highlights multiple factors that affect adoption rates such as relative advantage (perceived benefits compared with existing alternatives), compatibility (congruence with current values and needs), complexity (simplicity of understanding and implementation), trialability (feasibility for experimentation), and observability (noticeability of results).

In relation to green techno-entrepreneurship, we can apply the Theory of Innovation Diffusion to comprehend how student entrepreneurs accept environmentally friendly technologies and practices into their business projects. The theory provides understanding into elements that promote or obstruct the adoption of green technologies like perceived sustainability benefits, alignment with a student entrepreneur's values, simplicity in implementing green practices along with visibility of positive results. For example, innovators among student entrepreneurs could have an instrumental role in demonstrating the advantages associated with green techno-entrepreneurship. Such individuals could act as mentors inspiring their colleagues to integrate eco-friendly innovations into their business projects. Additionally, the theory can help understand how wider business environment factors such as policy structures, market trends, and societal norms influence diffusion of green innovations.

Green Techno-entrepreneurship is a series of activities that solve environmental or social problems through innovative creative ideas that have a positive impact on the environment and social life of the community while providing benefits to corporate organizations (Bulsara et al., 2012). Businesses that apply the Green Entrepreneurship Concept are expected to have an impact on 5 things, including People, Planet, Practice, Prudence, and Profit. In this case, Green techno-

Figure 1. Greentech business model triangle.



entrepreneurship for students aims to develop students' interest in becoming technology-based entrepreneurs by paying attention to the “green business” aspect (Lindgren, 2020). Some of the elements that can be included in the Green Techno Entrepreneurship model are illustrated through the following Greentech business model triangle (Lindgren, 2020) in the figure 1:

2.2.1. Use/Adoption of environmentally friendly operations

The Use/Adoption of Environmental Friendly Operations is a system made up of interactions between living things (like people), nonliving things like soil, air, and water, and other nonliving things like weather, climate, and topography (Rehman Khan & Yu, 2021). The Use/Adoption of Environmental Friendly Operations is made up of many different ecosystems, both natural and man-made. Natural ecosystems include forests, rivers, and lakes, while man-made ecosystems include cities, farms, and factories. The adoption of environmentally friendly operations refers to the practices and strategies implemented by an organization to reduce its negative impact on the environment. Businesses may be more aware of environmental issues if the environment is healthy and stable. A competitive edge can be gained by giving businesses an environment that encourages constant innovation (Kuo et al., 2022).

2.2.2. Use/Adoption of technologies in operations

Technology lets businesses come up with new products and services that are more innovative, more efficient, and better meet customer needs. Technological innovation can give a company a competitive edge by making a product that is unique, has better features, is of higher quality, or gives customers a better experience (Deyanova et al., 2022; Haseeb et al., 2019). Technologies make it possible to automate, process data quickly, analyze and improve operational processes. By using the right technology, businesses can improve their operational efficiency, cut down on production costs, boost productivity, and make their supply chains more efficient (Ramadhan et al., 2022; Xie et al., 2019). This gives them a cost, time, and quality edge over their competitors. Also, technology has a big, positive effect on how well a business does. Businesses can serve their customers better and faster with the help of technology. Businesses can help customers faster and better if they use digital communication tools like email, instant messaging, and chatbots (Chege & Wang, 2020).

2.2.3. Entrepreneurial competency

Entrepreneurship is what leads to the creation of new goods and services. Business owners who are creative often come up with new products or services or find solutions to problems that haven't been solved yet (Frank et al., 2010). With this new idea, businesses can stand out from the crowd by giving customers something they can't get anywhere else and meeting their needs in a better way. Entrepreneurship is a big way that a business can stand out from its competitors.

2.3. Competitive advantage

Competitive advantage refers to a company's ability, derived from its characteristics and resources, to outperform other companies in the same industry or market. The concept of competitive advantage gained significant popularity following Porter's development of the idea. Competitive advantage arises from a company's capacity to leverage its internal strengths in response to external opportunities while mitigating external threats and internal weaknesses (Lestari et al., 2020). It is important to note that competitive advantage is not a static outcome but rather a dynamic process. This is because it stems from various activities undertaken by companies in areas such as product design, production, marketing, delivery, and support. Based on the aforementioned definitions, it can be concluded that competitive advantage represents a condition wherein a company surpasses its competitors.

In today's fiercely competitive environment, organizations strive to outperform their rivals and attract new customers. Individuals possessing knowledge play a crucial role in generating innovations for companies. Their personal creativity, knowledge, skills, and abilities enable them to generate fresh ideas that contribute to achieving competitive advantage for their organizations. Annarelli et al. (2020) suggest that other factors supporting internal competitiveness within a company include motivational factors, financial resources, and leadership support. These elements play an integral role in fostering the internal competitiveness of an organization. Furthermore, Kuo et al. (2022) highlight the significance of innovation for companies as it enables them to create cutting-edge products and services that are highly sought after in the market. This implies that an organization's competitiveness is rooted in its ability to continuously develop internal resources encompassing leadership support, fiscal strength, motivation for enhancing strengths, and ongoing creation of innovative solutions with market competitiveness.

2.4. Use/Adoption of environmental friendly operations effect on competitive advantage and student business performance

Companies that can create environmentally friendly technology or business models, such as using renewable energy, reducing waste, or developing sustainable goods, may gain a competitive edge in terms of product originality, operational efficiency, and a reputation for innovation (Melay & Kraus, 2012). Technological improvements may also have an influence on company operations in the ecological setting. Students that exhibit skill in embracing new technologies with more efficiency and inventiveness may benefit in terms of production, product quality, and customer service. The natural environment may inspire student enterprises to create services that set them apart from competition, particularly if they take a sustainable or environmentally sensitive approach (Mishra & Yadav, 2021). This distinction may be critical in building a competitive edge in the marketplace. According to Kuo et al. (2022) research on the idea of green marketing, the Use/Adoption of Environmental Friendly Operations has an influence on green competitive advantage. Based on these considerations, the following hypothesis is proposed:

H1. Use/Adoption of Environmental Friendly Operations has a significant positive effect on Competitive Advantage

Companies often consider the environment while making business choices. This may lead to more ecologically friendly and sustainable company practices in the long term. Furthermore, as people grow more aware of environmental concerns and sustainability, they tend to select ecologically friendly goods and services (Jiang et al., 2019; Kumar et al., 2023). The degree of social and environmental consciousness is always growing (Yang & Liu, 2021). Businesses that stress social and environmental responsibility in their operations likely to get more customer and societal support (Fernandes & Ferreira, 2022). This has the potential to improve brand reputation and overall company success. It is critical for student entrepreneurs to constantly evaluate and grasp the environmental context in which they operate. They may improve company performance and assure long-term success by reacting quickly to changes and changing their business strategy to

environmental circumstances (Scott et al., 2022). This viewpoint is consistent with the findings of Shaukat and Ming's (2022) and Garcés-Ayerbe et al. (2022) study, which discovered that environmental investments are beneficial and substantial in corporate financial success (Garcés-Ayerbe et al., 2022). The following research idea is based on this explanation:

H2. Use/Adoption of Environmental Friendly Operations has a significant positive effect on student business performance

2.5. Use/Adoption of technologies in operations effect on competitive advantage and student business performance

By automating repetitive processes, technology may improve operational effectiveness (Lindgren, 2020). Students who run their own enterprises may use software to manage inventory, track stock, and handle transactions. This allows firms to save time and money, enabling them to focus on more important initiatives. Through social media, e-commerce platforms, and websites, technology enables student-run enterprises to access a larger audience of prospective consumers. Additionally, online-based customer services like as chatbots or email may improve client connection. Student entrepreneurs may gain a significant competitive advantage by wisely using technology, regardless of the size or type of their firm. According to the findings, students' technology preparedness may help their businesses gain a competitive edge (Purwati & Hamzah, 2022). On the basis of this reasoning, the following hypothesis is proposed:

H3. Use/Adoption of Technologies in Operations has a significant positive effect on Competitive Advantage

Students may track their company success in real time using technology. They may measure sales, profitability, and other key performance metrics using proper analytics and reporting technologies to find opportunities for improvement. Technology allows student firms to more readily respond to market changes or trends (Purwati & Hamzah, 2022). They can quickly and responsively change their strategy if they have quick access to up-to-date information. The careful and deliberate use of technology may dramatically improve the performance of student-run enterprises, allowing them to function with increased efficiency, inventiveness, and competitiveness in an ever-changing digital business world (Benitez-Amado & Walczuch, 2012). Based on this reasoning, the following hypothesis is proposed:

H4. Use/Adoption of Technologies in Operations has a significant positive effect on student business performance

2.6. Entrepreneurial competency effect on competitive advantage and student business performance

Entrepreneurial competencies are a collection of skills, knowledge, attitudes, and personal traits required for success as an entrepreneur. These abilities have a significant impact on competitive advantage in company operations. Entrepreneurs with these skills may successfully detect, analyze, and manage risks. They are capable of taking measured risks and making judgments based on sound judgment. The capacity to accept suitable risks might reveal new opportunities and provide a competitive advantage in product creation or market expansion (Khanin et al., 2022). Using these entrepreneurial qualities enables an entrepreneur to run a firm in an efficient, inventive, and flexible manner in response to market swings. Entrepreneurs may build a strong brand identity, identify themselves in the marketplace, and achieve a distinct market position by developing an innovative company plan (Marthing & Firdausy, 2023; Rauch et al., 2009). This allows

the company to stand out and attract loyal consumers while earning a competitive advantage. Following this explanation is the hypothesis' formulation:

H5. Entrepreneurial Competency has a significant positive effect on Competitive Advantage

Students with entrepreneurial talents are frequently more creative and inventive when developing goods, services, or company concepts (Bulsara et al., 2012). They may create new and unique solutions to existing problems, producing in more attractive goods and services that meet customer wants more effectively. Students involved in company operations may see improvements in their business results. They are more likely to achieve greater achievements, adapt to changes, and face challenges with confidence (Gast et al., 2017). Following this explanation is the hypothesis' formulation:

H6. Entrepreneurial Competency has a significant positive effect on student business performance

2.7. The role of competitive advantage in between green techno-entrepreneurship dimensions on student business performance

Competitive advantage is an important factor that can affect student business performance. Competitive advantage is a unique ability or certain advantage possessed by a company or business that distinguishes it from its competitors and makes it more attractive to customers (Annarelli et al., 2020). If a student is able to create a product or service that is unique and different from what is offered by competitors, this can be a significant competitive advantage. The product or service can be more attractive to consumers, thus increasing sales and revenue (Haseeb et al., 2019). Based on this opinion then:

H7. Competitive Advantage has a significant positive effect on Student Business Performance

A company's competitive advantage is a distinct feature that separates it from competitors and accelerates the attainment of its business goals. Firms may outperform their competition by offering unique, innovative, or better goods or services (Annarelli et al., 2020). Aspects such as a product's quality, features, performance, or dependability may provide a company an advantage over its rivals. Competitive advantage mediates the impact of Green-Technoentrepreneurship on an Use/Adoption of Environmental Friendly Operations factor. The Use/Adoption of Environmental Friendly Operations fosters green technologies and other sustainable behaviors. Student-run enterprises with a competitive advantage are often better equipped to incorporate these innovations into their product development or operational operations. These technologies have the potential to improve operating efficiency, reduce negative environmental consequences, and provide extra value to customers. As a result of these advances, competitive advantage acts as a bridge between Use/Adoption of Environmental Friendly Operational elements and student business success. While no earlier research has examined the function of competitive advantage in mediating environmental impacts on business development in fishery companies, Hatani's (2023) indicated that competitive advantage mediates environmental influences on business growth in fisheries firms. Based on these data, the following hypothesis are proposed:

H8. Competitive Advantage mediates the effect of Use/Adoption of Environmental Friendly Operations on Student Business Performance

The use of technology has a vital role in outperforming competition. Proper technology application enables organizations to improve their operations, develop new products, save money, and adapt

quickly to market trends (Haseeb et al., 2019). Technology allows student-run enterprises to create new goods or services that are more efficient, inventive, or different. With a competitive advantage, these student businesses may use technology to improve the quality of their services, increase operational efficiency, and nurture greater client experiences. Such inventions may provide significant competitive advantages and lead to improved corporate success. However, research on the function of competitive advantage in moderating the impact of technology on corporate performance is limited. According to a research conducted by Novitasari and Agustia (2023) on Green Innovation with a focus on one technical dimension, competitive advantage is capable of mitigating the influence of technological innovation on a company's financial performance. Based on this information, the following is proposed:

H9. Competitive Advantage mediates the influence of Use/Adoption of Technologies in Operations on Student Business Performance

The function of competitive advantage as a moderator in the link between entrepreneurial competence and company success, specifically the capacity to innovate, is one of the most essential components of entrepreneurial competence. Students that have this skill may be more likely to develop distinctive goods or services that give value to their clients, resulting in competitive advantages that may improve their company success. Entrepreneurial competence also includes risk management, which includes the capacity to detect and react to prospective business issues or barriers. Students that possess this ability may be more likely to create effective risk management methods, allowing them to retain a competitive edge in the market and increase corporate performance. Based on this information, the following is proposed:

H10. Competitive Advantage mediates the effect of Entrepreneurial Competency on Student Business Performance

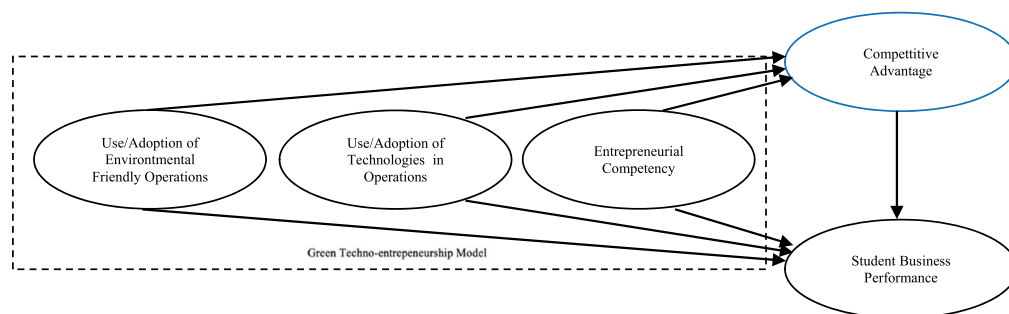
2.8. Conceptual framework

The following is the conceptual framework of this research (see figure 2):

3. Methodology

This study uses a quantitative approach by conducting statistical analysis of primary data obtained from respondents' responses. The population in this study are all students in Riau Province, Indonesia who have businesses. However, researchers are constrained in finding the exact number of students who already have these businesses, for this research sample is calculated using the (Hair et al., 2012) approach which states that the best number of samples for research with the Structural Equation Model (SEM) approach is 200–400 samples. The reason of choosing university students as sample respondents in this research is to investigate the viewpoints of prospective entrepreneurs who are presently involved in business operations, either via personal initiatives or

Figure 2. Research Framework.



family firms. This study focuses on student-run firms and their potential for entrepreneurship in the realm of green technology. We want to look at how these young entrepreneurs incorporate green practices and technology into their businesses. For this reason, this study took a sample of 288 samples carried out with a purposive sampling technique, namely a sampling technique using certain criteria, where the criteria set are as follows:

- (1) Is a personal or family business (but participates in the management of the business).
- (2) Business has been running for more than 2 years.
- (3) have total assets of at least Rp. 50000,000,-
- (4) Have a minimum turnover of Rp. 120,000,000,- per year.
- (5) Focus on green techno-entrepreneurship: The sample consists of students who specifically apply green techno-entrepreneurship principles in their business operations. They should integrate green practices and green technologies in their business models such as e-commerce trading, manufacturing green products, or providing green technology solutions, among others.

The research was conducted using a survey method using a questionnaire distributed via electronic survey to all students in Riau who have businesses. The questionnaire was designed using a Likert scale of 1–5. The research instrument was developed through the following indicators: 1. **Student Business Performance** measurement indicators include: Sales Growth, Profit Margins, Market Share, Customer Satisfaction, Operational Efficiency, Cash flow (Page, 2015), 2. **Use/Adoption of Environmental Friendly Operations**, the measurement indicators are: Waste management, Utilization of Natural Resources, Compliance with environmental regulations (Jiang et al., 2019; Yang & Liu, 2021), 3. Indicator of **Use/Adoption of Technologies in Operations** included Level of technology adoption, technology investment, product and service innovation (Xie et al., 2019). 4. **Entrepreneurial competency**, consisting of: Creativity and innovation (Kumar & Shukla, 2023), Risk taking, Social entrepreneurship, Communication skills, Financial skills, Business management skills (Rauch et al., 2009). 5. Competitive advantage, the indicators consist of: Product uniqueness, Product quality, Competitive Price, Brand advantage (Kuo et al., 2022).

To ensure the validity of the research instrument used, in this study a pilot test was conducted on 30 respondents. Pilot test testing using validity and reliability tests through SPSS and the results of the validity test were obtained with an R count < 0.3 and a reliability test with a Cronbach alpha value > 0.6, so that all indicator variables in this study could be declared valid and reliable.

In this study, the Structural Equation Model (SEM) with PLS was used to look at the data. SEM is a type of statistical study that can be used to solve research problems where both the independent variable and the response variable cannot be measured. SEM can test a number of relationships that are hard to measure at the same time. The relationship in question is made up of at least one independent variable and at least one dependent variable. These variables can be latent, which means they can't be measured directly, or they can be made up of several explanatory, or manifest, variables, which can be measured directly. SEM is made up of two models: measurement models and structural models. The structural model shows the structure of causality between latent variables, while the measurement model is used to support the latent variables that are confirmed by the dimensions of the explanatory variables. PLS-SEM is also used to predict endogenous latent variables or find the main variables if the research is exploratory or an extension of an existing structural theory. In PLS, the path analysis model for all latent variables is made up of three sets of relationships: (1) the inner model, which shows the relationship between latent variables, (2) the outer model, which shows the relationship between latent variables and their indicators or manifest variables, and (3) the weight relations, which show how to estimate the values of latent variables.

4. Results and discussion

4.1. Respondent characteristics

Table 1 shows that the majority of students who run businesses are 64% male, the remaining 35.2% are female. The majority of students are aged 21–30 years as much as 45.8%, less than 21 years as much as 22.2% and the rest over 30 years as much as 31.9%. Students who run businesses on average are dominated by students taking undergraduate programs as much as 69.8%, and the remaining 30.2% are postgraduate students, and these students mostly take the type of lecture program for social majors as much as 83.3% while the rest are from science by 16.7%. The business fields run by students are dominated by trade business as much as 41%, followed by businesses in services, technology and manufacturing. For business types, the majority of students form partnership businesses as much as 53.8%, followed by sole proprietorship and corporation, respectively 30.6% and 15.6%. For the length of business, the average number of students who have just run their business within a span of 1–2 years is 64.6%, the rest have run businesses for 3–5 years by 35.4% and the rest >5 years by 22.2%.

4.2. Convergent validity

Concerning the assessment of the measurement model, correct steps were taken to show the validity and reliability of the measurement model. Table 2 shows that each indicator for a research variable already has an outer loading value of more than 0.7. The validity of the statement or questionnaire is also shown by the Average Variance Extracted (AVE) value, which is greater than 0.50 overall (AVE >0.50) (Fornell & Larcker, 1981). In this study, reliability is shown by a Cronbach Alpha value of more than 0.70 (CA >0.70). Then, if the Composite Reliability value is greater than 0.70 (CR >0.70) (Fornell & Larcker, 1981), this shows that the reliability is good. Table 2 shows that the Cronbach Alpha and CR values for all variables are higher than 0.70. In other words, all of the variables in this study are valid.

Table 1. Respondent Characteristics			
Category	Classification	Total	Percentage
Gender	Male	186	64.6%
	Female	102	35.4%
Age	<21 years	64	22.2%
	21–30 years	132	45.8%
	>30 years	92	31.9%
University Program	Undergraduate	201	69.8%
	Post-graduate	87	30.2%
Study Program	Sciences	48	16.7%
	Social	240	83.3%
Business fields	Manufacture	28	9.7%
	Service	75	26.0%
	Technology	67	23.3%
	Trade	118	41.0%
Business type	sole proprietorship	88	30.6%
	partnership	155	53.8%
	corporation	45	15.6%
Length of Business	1–2 years	186	64.6%
	3–5 years	102	35.4%
	>5 years	64	22.2%

Source: Data Processed SEM PLS (2023)

4.3. Discriminant validity

Table 3 shows the results of the Fornell-Larcker Criteria for discriminant validity. The values for each construct (in bold) are higher than the other items in the same row and column (Fornell & Larcker, 1981). So, this study can be used to tell people apart.

Table 4 shows the results of Heterotrait-Monotrait Ratio (HTMT) achieved values smaller than the proposed threshold values of 0.9 and below for all constructs which means the measurement model used in this study is valid and reliable (Hanseler et al., 2015).

4.4. Hypothesis test

After confirming the validity and reliability of the measurement model, the next step was to test the hypothesized relationships between the constructs by looking at the standardized path coefficients. Figure 3 shows how the PLS Algorithm worked out the path coefficients.

The direct effect demonstrates the direct relationship between variables. The model results, as shown in Table 5, indicate a significant correlation that supports H1. The correlation value between the Use/Adoption of Environmental Friendly Operations and competitive advantage is $\beta = 0.391 (p < 0.05)$, indicating a significant positive effect of the Use/Adoption of Environmental Friendly Operations on competitive advantage. Hypothesis 2 ($\beta = 0.072, p > 0.05$) suggests that the Use/Adoption of Environmental Friendly Operations does not have a significant positive effect on Student Business Performance. In hypothesis 3, the correlation value between Use/Adoption of Technologies in Operations and competitive advantage is $\beta = -0.132 (p > 0.05)$, indicating no significant effect of Use/Adoption of Technologies in Operations on Competitive

Table 2. Result for convergent validity

Variable	Indicator	Outer Loading	Cronbach's Alpha	Composite Reliability	AVE
Io	EFO1	0.961	0.903	0.941	0.841
	EFO2	0.832			
	EFO3	0.953			
Use/Adoption of Technologies in Operations	TS1	0.972	0.943	0.964	0.898
	TS2	0.894			
	TS3	0.975			
Entrepreneurial Competency	EC1	0.781	0.893	0.918	0.612
	EC2	0.809			
	EC3	0.803			
	EC4	0.825			
	EC5	0.860			
	EC6	0.763			
Competitive Advantage	CA1	0.804	0.831	0.888	0.664
	CA2	0.841			
	CA3	0.804			
	CA4	0.811			
Student Business Performance	SBP1	0.791	0.818	0.867	0.623
	SBP2	0.676			
	SBP3	0.730			
	SBP4	0.701			
	SBP5	0.738			
	SBP6	0.790			

Source: Data Processed SEM PLS (2023)

Table 3. Result for discriminant validity using Fornell-Larcker criteria

	Competitive Advantage	Use/Adoption of Environmental Friendly Operations	Entrepreneurial Competency	Student Business Performance	Use/Adoption of Technologies in Operations
Competitive Advantage	0.815				
Use/Adoption of Environmental Friendly Operations	0.508	0.917			
Entrepreneurial Competency	0.613	0.519	0.807		
Student Business Performance	0.519	0.471	0.586	0.723	
Use/Adoption of Technologies in Operations	0.457	0.844	0.474	0.446	0.948

Source: Data Processed SEM PLS (2023)

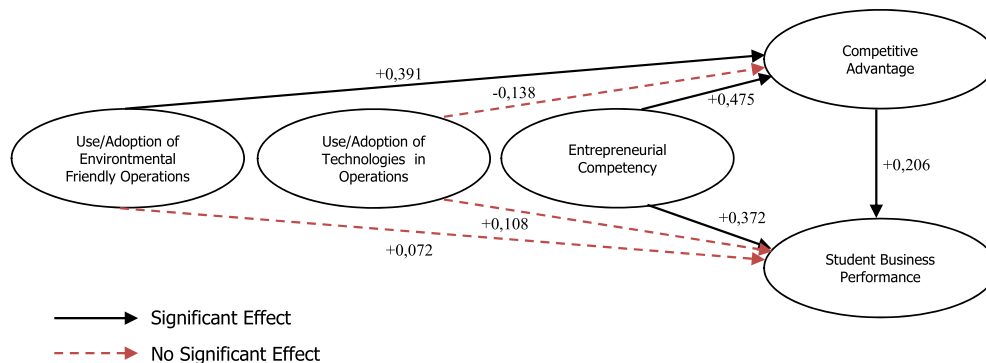
Table 4. Result for discriminant validity using heterotrait-monotrait ratio (HTMT)

	Competitive Advantage	Use/Adoption of Environmental Friendly Operations	Entrepreneurial Competency	Student Business Performance	Use/Adoption of Technologies in Operations
Competitive Advantage					
Use/Adoption of Environmental Friendly Operations	0.585				
Entrepreneurial Competency	0.707	0.579			
Student Business Performance	0.619	0.544	0.674		
Use/Adoption of Technologies in Operations	0.517	8.921	0.517	0.505	

Source: Data Processed SEM PLS (2023)

Figure 3. Results for hypothesis test model.

Notes: Significant Effect
 No Significant Effect



Advantage. Hypothesis 4 ($\beta = 0.108, p > 0.05$) suggests that Use/Adoption of Technologies in Operations has no significant effect on Student Business Performance either. Hypothesis 5 ($\beta = 0.475, p < 0.05$) supports that entrepreneurial competency has a significant positive effect on Competitive Advantage. In hypothesis 6, the correlation value between entrepreneurial competency and competitive advantage is $\beta = 0.372 (p < 0.05)$. The positive coefficient β indicates that entrepreneurial competency has a significant positive effect on Student Business Performance. Hypothesis 7: The correlation coefficient (β) value between competitive advantage and student business performance is found to be $\beta = 0.206 (p < 0.05)$. It indicates that competitive advantage has a significant positive effect on Student Business Performance.

Regarding indirect effects: For hypothesis 8, with a regression coefficient of $\beta = 0.080 (p < 0.05)$, it can be concluded that competitive advantage mediates the influence of the Use/Adoption of Environmental Friendly Operations on Student Business performance. In hypothesis 9, with a regression coefficient of $\beta = -0.028 (p > 0.05)$, it can be concluded that competitive advantage does not mediate the effect of Use/Adoption of Technologies in Operations on Student Business performance. Hypothesis 10 shows support with a regression coefficient of $\beta = 0.098 (p < 0.05)$, indicating that competitive advantage mediates the influence of the entrepreneurial competency on Student Business performance.

4.5. Discussion

The results of this study's hypothesis 1 demonstrate a strong positive effect of the Use/Adoption of Environmental Friendly Operations on competitive advantage. This implies that a higher level of competitive advantage corresponds to a better Use/Adoption of Environmental Friendly Operations within the student business setting. One way businesses fulfill their social and environmental responsibilities is by prioritizing environmental care. Sustainable and eco-friendly business practices often emphasize cost-effective and efficient resource utilization (Fernando et al., 2019). By reducing waste, improving energy efficiency, and making optimal use of natural resources, businesses can gain a competitive edge by offering lower prices or increasing profitability (Kuo et al., 2022). Students who adopt environmentally friendly products can also explore innovative approaches to enhance their products and services. Businesses can achieve a competitive advantage by developing solutions that are environmentally beneficial or add value through green methods (Yang & Liu, 2021). For instance, currently, up to 95% of the MSME sector in Indonesia has embraced environmentally conscious business practices. Furthermore, individuals who prioritize environmental concerns are more likely to choose products that contribute positively to the environment in various ways.

However, Hypothesis 2 suggests that the environment does not have a significant impact on students' business performance. This study reveals that while the Use/Adoption of Environmental Friendly Operations plays a role in sustainability and overall environmental considerations, it does not significantly affect students' business performance. Although it is important for students and

Table 5. Result for hypothesis

Hypothesis	Original Sample	Standard Deviation	T Statistics	P Values	Conclusion
H1 Use/Adoption of Environmental Friendly Operations -> Competitive Advantage	0.391	0.153	2.551	0.011	Accepted
H2 Use/Adoption of Environmental Friendly Operations -> Student Business Performance	0.072	0.154	0.468	0.640	Rejected
H3 Use/Adoption of Technologies in Operations -> Competitive Advantage	-0.138	0.127	1.080	0.280	Rejected
H4 Use/Adoption of Technologies in Operations -> Student Business Performance	0.108	0.144	0.747	0.456	Rejected
H5 Entrepreneurial Competency -> Competitive Advantage	0.475	0.066	7.165	0.000	Accepted
H6 Entrepreneurial Competency -> Student Business Performance	0.372	0.061	6.102	0.000	Accepted
H7 Competitive Advantage -> Student Business Performance	0.206	0.061	3.368	0.001	Accepted
H8 Use/Adoption of Environmental Friendly Operations -> Competitive Advantage -> Student Business Performance	0.080	0.041	1.968	0.049	Accepted

(Continued)

Table 5. (Continued)

Hypothesis	Original Sample	Standard Deviation	T Statistics	P Values	Conclusion
H9 Use/Adoption of Technologies in Operations -> Competitive Advantage -> Student Business Performance	-0.028	0.028	1.017	0.310	Rejected
H10 Entrepreneurial Competency -> Competitive Advantage -> Student Business Performance	0.098	0.032	3.081	0.002	Accepted

Source: Data Processed SEM PLS (2023)

communities to be aware of environmental issues, the Use/Adoption of Environmental Friendly Operations itself does not exert substantial influence on students' business performance. Nevertheless, understanding and being aware of environmental issues can shape students' perspectives on social responsibility and future engagement with the business world (Ramayah et al., 2019). Students who possess knowledge about environmental protection are more likely to consider these factors when starting businesses and make decisions aligned with better environmental outcomes. Although direct effects between the environment and students' business performance may not be observed directly, understanding environmental issues can alter their perceptions regarding social responsibility in relation to future entrepreneurial endeavors.

Hypotheses 3 and 4 suggest that Use/Adoption of Technologies in Operations does not significantly affect students' performance in business or their competitiveness. While technology can be used by students to access information, resources, communication, and support from their teachers and peers, its use alone does not provide a significant advantage when it comes to achieving success in business. Software and business apps that aid in technology management can be beneficial for student businesses, but their success is not directly dependent on the technology they use (Purwati & Hamzah, 2022). Rather, students' performance in business is influenced by their ability to effectively utilize their knowledge and skills, generate new ideas and ventures, work collaboratively, and solve complex problems. Factors such as creativity, leadership, communication skills, and perseverance also play crucial roles in students' business success.

Technology can certainly assist students in both academic and business settings, but the competitiveness of student businesses primarily relies on elements such as the quality of their work, their understanding of the market (Montororing & Widyantoro, 2022), their capacity for innovation, and their adaptability to change (Purwati et al., 2022). The competitive advantage of student businesses heavily depends on their entrepreneurial skills (hypothesis 5). A successful entrepreneur possesses the ability to generate new ideas. Students who are knowledgeable about entrepreneurship often exhibit innovative and creative thinking. They can identify business opportunities that others may overlook and develop new, original concepts. By offering unique products or services that differentiate them from existing offerings, they gain a clear advantage over competitors. This aligns with research conducted by Hwang et al. (2020) and Wirda and Rivai (2019), which demonstrate that strong entrepreneurial skills enhance a business owner's competitiveness.

In hypothesis 6, it is also found that entrepreneurial competency has a significant positive effect on student business performance in addition to its impact on competitive advantage. Students who excel as entrepreneurs typically possess expertise in developing effective business plans. They possess analytical skills to assess market dynamics, create marketing strategies, make financial projections, and plan business operations effectively. A well-crafted business plan enables them to focus their efforts while identifying risks and opportunities, thereby establishing a solid foundation for business growth. This finding is consistent with research conducted by Frank et al. (2010), which highlights entrepreneurial competency as one of the key factors influencing entrepreneurs' success and overall business performance.

This study also found that competitive advantage plays a role in students' business performance (Hypothesis 7). By having a competitive advantage, student businesses can distinguish themselves from their competitors. Offering unique products or services with enhanced features or better customer experiences allows student businesses to attract more customers and gain a larger market share. This provides them with a significant edge over their rivals and contributes to improved business performance. These findings align with previous research conducted by Annarelli et al. (2020) and Wirda and Rivai (2019), which highlight that a business's competitive advantage stems from its ability to efficiently control production or operational costs, enabling them to offer lower prices compared to similar competitors. This competitive pricing strategy attracts price-conscious customers and enhances business performance by increasing sales.

Furthermore, this study demonstrates that the environment influences students' business performance (Hypothesis 8). Competitive advantage serves as a link between the environment and the success of student businesses. The Use/Adoption of Environmental Friendly Operations impacts a business's competitive advantage by presenting opportunities or threats that must be addressed. Student businesses equipped with a competitive edge can leverage environmental challenges and opportunities to their advantage, thereby enhancing their overall performance. Competitive advantage enables student businesses to adapt to market changes, capitalize on emerging trends, and meet new government requirements (Mishra & Yadav, 2021).

Additionally, this study reveals that competitive advantage acts as an intermediary between entrepreneurial competency and business performance among students (Hypothesis 10). The role played by competitive advantage in the relationship between entrepreneurial competency and student business performance highlights how entrepreneurial skills influence business outcomes through their impact on gaining a competitive edge. Students who possess strong entrepreneurial abilities tend to enjoy a robust competitive advantage, which positively affects their overall business performance. However, this study did not find evidence supporting the role of competitive advantage in influencing students' business success when they have access to technology (Hypothesis 9).

4.6. Implication

This study's theoretical implications include reinforcing the link between Green Techno-Entrepreneurship and Student Business Performance. The study underlines the need of applying green business practices and employing technology (techno) to affect students' business performance in this setting. The consequence is that students who use the green techno-entrepreneurship paradigm have a better chance of succeeding in business. The outcomes of the study show that competitive advantage mediates the relationship between green techno-entrepreneurship and student business success. This suggests that competitive advantage is important in connecting green techno-entrepreneurship techniques to greater levels of company performance.

The following are the practical consequences of this research findings: it is critical for students to include eco-friendly environmental considerations into their company growth plans in order to get a competitive edge. Additionally, students should concentrate on building differentiation tactics in order to compete successfully with other competitors. This may be accomplished through providing distinctive goods or services, improving the customer experience, and increasing operational efficiency. Furthermore, educational institutions should promote entrepreneurship education and provide students a variety of chances to enhance their entrepreneurial abilities via specialized courses, seminars, mentorship programs, and hands-on learning activities. Overall, these implications emphasize the need of incorporating green practices and technology into student enterprises, as well as stressing entrepreneurship education for improved performance results.

5. Results and discussion

One of the concerns of a business towards the Use/Adoption of Environmental Friendly Operations is a form of social and environmental responsibility carried out by a business. In this study, the Use/Adoption of Environmental Friendly Operations has a significant positive influence on competitive advantage, but the Use/Adoption of Environmental Friendly Operations does not directly have a significant positive effect on student business performance. In this case, the mediating role of competitive advantage is proven to be able to mediate the influence of the Use/Adoption of Environmental Friendly Operations on student business performance. Use/Adoption of Technologies in Operations in its effect on competitive advantage and business performance of students did not have a significant effect, and no mediating role was found for competitive advantage in the effect of Use/Adoption of Technologies in Operations on business performance. Technology can be a useful tool for students to support academic and business activities, the competitive advantage of student businesses depends more on the quality of their work, market

understanding, innovation, and ability to adapt to change. Entrepreneurial competency has a significant influence on student business performance and competitive advantage. In addition, the competitive advantage in this study also has a significant positive influence on student business performance. For this reason, the role of mediating competitive advantage in the influence of entrepreneurial competency on student business performance explains that entrepreneurial competency influences business performance through its influence on competitive advantage. Students who have high entrepreneurial competence tend to achieve a strong competitive advantage, which in turn has a positive impact on their business performance. However, this study did not find a mediating role for competitive advantage in the effect of Use/Adoption of Technologies in Operations on student business performance.

6. Limitation and future research

This study, while insightful, has certain limitations that need to be addressed in future research. Firstly, despite identifying mediating effects in certain relationships (for example, the use/adoption of environmentally friendly operations mediated by competitive advantage), this study did not discover a mediating role for competitive advantage in the impact of technology support on students' business performance. The study was limited to university students who own businesses in Riau Province, Indonesia. This specific sample may not fully represent the broader student population or be applicable to other regions or countries, limiting the generalizability of the findings beyond the specific context of Riau Province. Moreover, considering that university students only work part-time in their businesses, the context of green-technopreneurship may be more applicable to a study of full-time entrepreneurs. Future research should address these limitations by considering larger, more diverse samples from multiple regions, employing rigorous sampling techniques. Longitudinal studies could also be beneficial, providing insights into causal relationships over time and controlling for external factors that might impact student business performance. Additionally, it would be valuable for future research to investigate how servant leadership can foster the variables used in this model, particularly the use of environmentally friendly operations and technology. Servant leaders focus on addressing the needs of society and are oriented towards serving society, which is increasingly focused on becoming more technologically advanced and environmentally friendly (Ruiz-Palomino et al., 2021, 2023). Furthermore, future research could explore how servant leadership at managerial levels could foster the social capital of entrepreneurs (students), which could be key in adopting new technologies and greener practices (Zoghbi-Manrique de Lara & Ruiz-Palomino, 2019).

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