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Determinants of Dietary Supplement Consumption Among International Students in the University of Debrecen: Integrating Social Media Usage and Health Consciousness into the Theory of Planned Behavior

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SUMMARY

Dietary supplements are popular globally and may be more susceptible due to specific challenges encountered abroad. This study looks at the factors affecting their consumption at the University of Debrecen using the Theory of Planned Behavior (TPB).

An online cross-sectional survey design measuring attitude, subjective norms, perceived behavioral control, health consciousness, social media usage, and intention to purchase dietary supplements was used. 320 international students provided data online for convenience sampling.

Due to social media use, health consciousness, and subjective norms, international students typically had positive attitudes regarding dietary supplements. A sense of behavioral control suggested self-assurance in acquiring and ingesting supplements.

The findings emphasized the significance of social media usage, attitude, subjective norms, perceived behavioral control, and health consciousness in influencing purchase intentions. The results offer guidance for creating focused interventions that support responsible and well-informed supplement use.

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1. INTRODUCTION

A dietary supplement is one that is used orally with an intention to supplement the ingredients of the diet; it may include vitamins, minerals, herbs, amino acids, and other ingredients (Temple, 2012; Mishra et al., 2020). The definition set up by the U.S. Food and Drug Administration (FDA) is a product that is orally consumed that contains "dietary ingredients," especially to supplement the diet (Mishra et al., 2020). Dietary supplements are available in different forms such as tablets, capsules, powders, and liquid, and they are not considered as food and medicine (Temple, 2012; Mishra et al., 2020; Buchman, 2002). Unlike drugs and food additives, they are exempted largely from regulation by that category in which they fall- dietary supplements (Buchman, 2002). Due to a shift in health perception and an emphasis on preventive health, the majority of people globally currently utilise dietary supplements, resulting in a market value of over $100 billion annually (Binns et al., 2018). Additionally, it was noted that most consumers were using dietary supplements more frequently in an effort to boost their immune systems and protect themselves from the COVID-19 virus (Djaoudene et al., 2023; Ghaith et al., 2023). Since the consumption of dietary supplements has gained significant popularity among

individuals seeking to enhance their health and well-being. International students, a rapidly growing population, are no exception to this trend. International students face unique challenges and stressors while studying abroad and thus may be particularly inclined to use dietary supplements (Huang et al., 2023). Understanding the determinants of dietary supplement consumption among this population is crucial for developing targeted interventions and promoting healthy behaviors. However, the specific factors influencing their dietary supplement use in a new academic environment have not been extensively explored. Using the Theory of Planned Behavior (TPB) as a theoretical framework, this study examines the factors influencing international students at The University of Debrecen-Hungary intention to purchase dietary supplements. While purchase intention is the dependent variable, the independent factors under investigation are attitude, subjective norms, perceived behavioral control, health consciousness, and social media usage. This research will contribute to a better understanding of factors influencing dietary supplement use among international students. It can inform targeted interventions to promote healthy dietary practices and responsible supplement use within this population

2. Literature Review

2.1. Dietary Supplement Popularity and International Students

Cultural dissimilarities have been reported to affect dietary supplements, such that people from different cultures tend to consume supplements either more or less than the local population, choose different types of supplements, and have different reasons for doing so (Huang et al., 2023; McArthur et al., 1990). Huang et al. (2023) showed differences in preference and frequency of supplement use between the Chinese international and Korean college students in South Korea, with cultural backgrounds influencing both consumption behavior and product choice. Such a cultural dimension to supplement acceptability has been confirmed by earlier works such as McArthur et al. (1990), where different beliefs and practices with regard to supplementation emerged amongst international and U.S. students. Other factors reviewed in the literature include age, self-reported health status, interest in health, and, in the case of international students, length of residence in the host country (Huang et al., 2023). Within this context, health motivation—meaning the internal drive of an individual to undertake health-enhancing activities—has been found to modify the relationship between social cognition (e.g., subjective norms, perceived behavioral control) and intentions to consume supplements (Noor et al., 2019).

This study focuses further on expanding the findings by investigating the application of the TPB framework to understanding the dietary consumption of international students in The University of Debrecen.

2.2. Stress and Health Concerns among International Students

International students face significant challenges when studying abroad, including academic stress, cultural adaptation, and social isolation (Wu et al., 2015; Zhai, 2002). These adjustment issues can negatively impact their physical and mental health (Sharif, 1994). Academic demands often present the greatest difficulty, with students struggling to communicate with professors and classmates (Wu et al., 2015). Cultural differences and language barriers further compound these challenges (Zhai, 2004). Temperature comfort in educational environments is a strong influencer on students' well-being and academic performance. Investigations covering a wide spectrum of climates and educational stages indicate that the factors determining students' perception of thermal comfort and their adaptability of it vary with age and exposure to climate (Torriani et al., 2023; Romero et al., 2023). International students often face much more discomfort than their local counterparts, especially in sub-cold climates (Mmereki & Akpaca, 2021). Interestingly, students generally perceive the coldest months to be the most uncomfortable, regardless of geography (Golshan et al., 2021). The adaptive approach to assessing comfort needs across age groups has been found more appropriate from a practical point of view, sometimes in combination with Fanger's method (Romero et al., 2023). The recently introduced COVID-19 requirements for ventilation affected thermal comfort within classrooms (Romero et al., 2023). Such findings require model thermal comfort guidelines for educational buildings to be stratified according to age, climate, and cultural adaptation that allow for the best learning conditions (Torriani et al., 2023; Romero et al., 2023).

The process of dietary acculturation can lead to health consequences, with many students reporting weight gain due to larger portions, unstructured mealtimes, and frequent snacking (Alakaam & Willyard, 2020). Notably, a majority of international students reported taking unprescribed dietary supplements after moving to the United States (Alakaam & Willyard, 2020). To address these issues, universities should provide academic and cultural orientation programs (Zhai, 2004) and develop policies aimed at reducing the impact of acculturation on international students' health and well-being (Alakaam & Willyard, 2020).

2.3. The Theory of Planned Behavior (TPB) as a Framework

The Theory of Planned Behavior (TPB) by Ajzen (1991) offers a well-established framework to understand factors influencing health-related behaviors (Norman & Conner, 2005; Conner & Sparks, 2005), including dietary supplement consumption (Ghaith et al., 2023). The TPB posits that three key factors influence behavioral intention: attitude, subjective norms, and perceived behavioral control (Ajzen, 1991). This study validates the theory of planned behavior in understanding the factors influencing dietary supplement purchasing intentions among international students at the University of Debrecen. According to the Theory of Planned Behavior (TPB) model, studies consistently identify attitude, subjective norms, and perceived behavioral control (PBC) as significant predictors of students' intention to use supplements (Alami et al., 2019; El Khoury et al., 2021). This finding extends to young adults more broadly, with Lee et al. (2016) demonstrating that subjective norms, perceived behavioral control, and attitude significantly predict their purchase intention of dietary supplements.

Research shows that attitudes toward dietary supplements are conditioned by a number of factors. For example, Individuals with higher health consciousness tend to exhibit more positive those attitudes towards supplements: they are more likely to see their benefits, less likely to see risks (Royne et al., 2014).

Health motivation also moderates the relationship between social cognition and intention to consume supplements (Noor et al., 2019). Willis and Stafford (2016) found that health consciousness, rather than familiarity with supplement advertising, significantly affects attitudes toward different supplement types and price perceptions. Among adolescent athletes, attitudes are better predictors of intentions to use supplements than subjective norms, with athletic trainers having more influence on attitudes and intentions than parents and coaches (Dunn et al., 2001). These findings suggest that health consciousness and perceptions of improved health play a crucial role in shaping attitudes toward dietary supplements, while the influence of subjective norms and advertising familiarity may vary depending on the context and population studied.

2.3.1. Theory of Planned Behavior constructs

The Theory of Planned Behavior is built on three constructs. The first, attitude, refers to an individual's beliefs about the positive and negative consequences of a behavior (Ajzen, 1991). Attitude towards supplements consistently emerges as a significant predictor of consumption intention and behavior, most studies show that a positive attitude toward dietary supplements is associated with the intention and behavior of consuming them. This means that human beings who perceive supplements to be beneficial will tend to take them. (Jeżewska-Zychowicz & Pilska, 2006; Noor et al., 2019).

The second construct is subjective norms, which are the perceived social pressures to engage or not engage in a behavior (Ajzen, 1991). Social influences, particularly from family and friends, play a role in shaping attitudes and consumption patterns (Huang et al., 2023; Noor et al., 2019).

The third construct is perceived behavioral control. This refers to an individual's confidence in their ability to perform the behavior (Ajzen, 1991). Perceived behavioral control also impacts supplement use. Specifically; perceived behavioral control has a generally positive influence on supplement use. Those who feel confident in their ability to acquire and properly use a supplement are more likely to have an intention to use one and, in fact, actually use the supplement. (Noor et al., 2019).

2.3.2. Additional Factors Influencing Supplement Use

Beyond the core TPB constructs, other factors might influence international students' dietary supplement consumption, particularly health consciousness and social media usage. Research indicates that health consciousness is positively associated with attitudes toward dietary supplements and their perceived benefits (Royne et al., 2014; Willis and Stafford, 2016). Supplement users tend to be more health-conscious, better educated, and more likely to adopt healthier lifestyle habits compared to non-users (Dickinson & Mackay, 2014). While traditionally associated with older adults, younger populations, including university students, are increasingly using supplements (Choi, 2019). Health involvement (the level of individual importance or interest assigned to health and health-related decisions) depicts the degree of engagement of the individual in managing one's health, which may affect behaviors regarding supplement use., rather than knowledge or expectations about efficacy, appears to be a significant predictor of supplement use and future purchase intentions among young adults (Choi, 2019). However, familiarity with supplement advertising does not significantly influence attitudes or price perceptions (Willis & Stafford, 2016).

Social media plays a significant role in shaping health behaviors and disseminating health information among young adults. Studies have shown that dietary supplement use is prevalent among college students, with the internet and social media platforms serving as important sources of information (Salmean & Alhuwail, 2018). An integrated health campaign model on social media revealed that communicative behaviors, such as information acquisition and transmission, mediate the relationship between perceptions and behavioral intentions (Yoo et al., 2018). Young adults report that social media is highly persuasive in influencing dietary behaviors through social support, access to health information, and exposure to

fast-food advertisements (Friedman et al., 2022). However, exposure to health-focused content can also induce feelings of guilt, particularly among women. These findings suggest that social norms on social media platforms are crucial in shaping young adults' health behaviors, highlighting the potential for targeted interventions.

2.4. Knowledge Gap and Research Aims

The previous literature has presented several insights regarding the use of dietary supplements and the challenges international students face. The gap in understanding pertains to the specific factors impacting the consumption of dietary supplements by international students when in a new environment such as Hungary. This study will accommodate this gap by examining the factors influencing the intention to purchase dietary supplements among international students at the University of Hungary within the framework of the TPB.

2.5. The Research Model

The initial structural model includes one dependent variable (the purchasing intention of dietary supplements) and five independent variables (attitude, subjective norms, perceived behavioral control, health consciousness, and social media usage).

Attitude as an independent variable: This refers to a student's positive or negative evaluation of consuming dietary supplements.

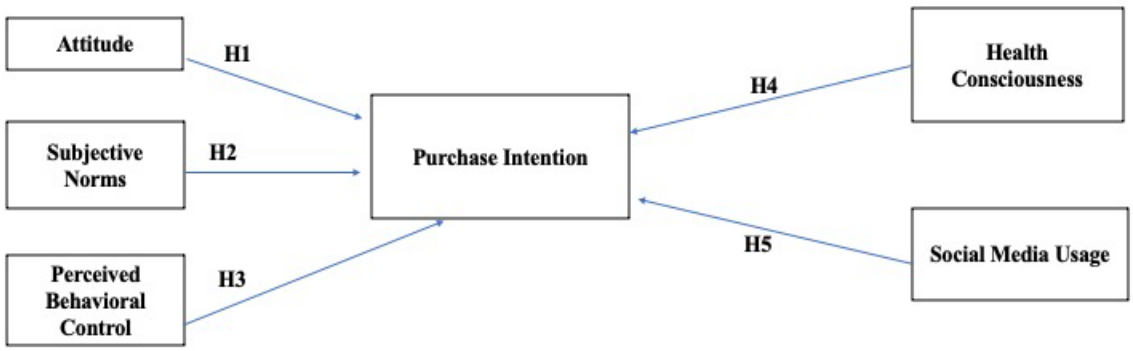
Subjective Norms as an independent variable: This reflects the perceived pressure from family, friends, and the broader community regarding supplement use.

Perceived Behavioral Control as an independent variable: This captures a student's belief in their ability to overcome obstacles and successfully consume supplements.

Health Consciousness as an independent variable: The intention to purchase is significantly influenced by health consciousness, which is believed to be determined primarily by attitudes and subjective norms. As such, the TPB framework attempts to clarify how health consciousness relates to these predictors to form consumption behaviors.

Social media usage as an independent variable: This study proposes social media usage as an independent variable. Students who use social media as a source of information might be more receptive to positive attitudes towards supplements and the influence of social norms.

Purchase Intention as dependent variable: This study proposes purchase intention as dependent variable that is affected by attitudes, subjective norms, perceived behavioral control, health consciousness, and social media usage.



Source: Author's own assembling based on Ajzen (1991)

Figure 1: Proposed research model

2.6. Methodology

2.6.1. Study Design and Participants

Data were collected over a four-month period, from June 14 to October 22, 2023; this study focused on cross-sectional questionnaire design which examined factors influencing the international student's intention to purchase dietary supplements at the University of Debrecen, Hungary.

2.6.2. Sampling Strategy

A non-probabilistic method convenience sampling was used to recruit participants. Using Google Forms, online links to the survey were shared via Facebook groups, WhatsApp, Telegram, and other social media platforms that international students at The University of Debrecen frequently use. Prior to completing the anonymous online survey, each eligible participant was required to fill out an informed consent form.

2.6.3. Data Collection and Response Rate

A total of 325 participants completed the self-administered questionnaire. Following data validation, 320 questionnaires were deemed usable for further analysis.

2.6.4. Questionnaire Development

The structured questionnaire was designed after comprehensive reviewing the relevant literature. Key constructs were included from the proposed theoretical framework, including health consciousness, social media usage, attitude toward dietary supplements, and purchase intention. In accordance with Ajzen's (1991) guidelines, each construct was measured by means of multi-item scales to make them more valid and reliable. The respondents were asked to give their level of agreement with a number of statements on a five-point Likert scale. The scale ranged from 1 (strongly disagree) to 5 (strongly agree). The final instrument included items on attitude (4 items), subjective norms (4 items), perceived behavioral control (4 items), health consciousness (5 items), social media usage (6 items), and purchase intention (3 items). The questions on the independent variables can be found in Appendix 1.

2.6.4.1. Measures

- Attitude, Subjective Norms, and Perceived Behavioral Control: TPB-based scales assessed students' beliefs and perceptions regarding dietary supplements.

- Attitudes: (Ajzen, 1991; Ghaith et al., 2023; Pop et al., 2020)
- Subjective norms: (Ghaith et al., 2023)
- Perceived behavioral control: (Ghaith et al., 2023)
- Health Consciousness: A validated scale measured students' focus on maintaining good health (Ghaith et al., 2023; Gould, 1988; Michaelidou & Hassan, 2008)
- Social media usage: A validated scale measured students' social media usage and trustworthiness (Chi, 2021; Pop et al., 2020).
- Purchase Intention: A scale measured students' likelihood to purchase dietary supplements in the future (Ajzen, 1991; Ghaith et al., 2023)

3. Data Analysis

Descriptive statistics summarized participants' characteristics and supplement consumption patterns. Regression analysis examined the relationships between the independent variables (attitude, subjective norms, perceived behavioral control, social media, and health consciousness) and the dependent variable (purchase intention).

3.1. Data Quality

The number of participants in this study is 325. To ensure data quality, two techniques have been employed. First, in measuring the variance of participants' responses, five cases were found to be straight liners with zero variance. These cases have been removed, reducing the total number of participants to 320. Second, the Cronbach Alfa test was used to measure reliability. According to Hair et al. (2010), Cronbach's alpha coefficients ranging from 0.70 to 0.80 are indicative

of high reliability. Values falling between 0.60 and 0.70 suggest adequate reliability, while those below 0.60 indicate poor yet acceptable reliability. Table 1 shows the reliability values of the variables, the values ranging from 0.704 for perceived behavioral control to 0.911 for purchasing intention that means the questionnaire has high reliability.

Table 1

Reliability test results

Constructs	Cronbach Alpha
Attitudes	0.811
Subjective Norms	0.788
Perceived Behavioral Control	0.704
Health Consciousness	0.829
Social Media Usage	0.874
Purchasing Intention	0.911

Source: Author's own calculations using SPSS v.29

3.2. Demographic Data

This part describes the demographic data of the respondents, it includes gender, age, educational level, student status, study field, and self-reported level of knowledge about dietary supplements. To maintain anonymity among participants considering the relatively small and diverse nature of the international student population at the University of Debrecen, country or region of origin was not asked. This was to minimize the chances of an indirect identification in combination with any other demographic variable. Further, the study focused mainly on investigating general behavioral predictors rather than cross-cultural comparisons.

Table 2

Demographic data

Demographic profile	Frequency	Percentage%
Gender		
Male	120	37.5
Female	200	62.5
Total	320	100.0
Age		
18–22 years	69	21.6
23–27 years	87	27.2
28–32 years	84	26.3
33 years & above	80	25.0
Total	320	100.0
Educational Level		
Bachelor	121	37.8
Master	115	35.9
One-tier program	9	2.8
PhD	75	23.4
Total	320	100.0
Student Status		
Scholarship Student	196	61.3
Self-financed Student	124	38.8
Total	320	100.0
Study Field		
Medical & Health	87	27.2

Engineering, Manufacturing, & Construction	80	25.0
Science, Mathematics, & Computer	48	15.0
Humanities, Social Science, & Education	34	10.6
Economics & Business	55	17.2
Agriculture, Environment, & Veterinary	16	5.0
Total	320	100.0
Knowledge Level		
Low	53	16.6
Moderate	199	62.2
High	66	20.6
Missing	2	0.6
Total	320	100.0

Source: Author's own calculations using SPSS v29

3.3. Descriptive Statistics

Table 3 illustrates the descriptive statistics of the study variables. The first column represents the independent and dependent variable, the second column indicates the mean value, and the third column deals with the values of standard deviation, and *N* value is the number of respondents.

Table 3

Mean, standard deviation, and variance of the variables

Variable	Mean	Std. Deviation	Variance	N
Attitude	3.5711	.70588	.498	320
Subjective Norms	3.2898	.80784	.653	320
Perceived Behavioral Control	3.7510	.80370	.646	320
Health Consciousness	3.9806	.67522	.456	320
Social Media Usage	2.9656	.89244	.796	320
Purchasing Intention	3.5417	.89951	.809	320

Source: Author's own calculations using SPSS v29

The results provide a comprehensive overview of the central tendencies and variability of the variables in the study. The mean scores suggest the average levels of each construct, while the standard deviations and variances provide insights into the dispersion of scores around the means.

Based on the results, the Pearson's correlation of the variables is positive, all *p* values are below 0.05. The correlation coefficient between purchase intention, health consciousness, and social media usage is positive but relatively modest, indicating that these variables have a less prominent but still significant impact on purchasing decisions. Table 4 gives more insights about the correlation coefficient values.

Table 4

Correlation Coefficient Matrix

Variables		Purchasing Intention	Attitude	Subjective Norms	Perceived Behavioral Control	Health Consciousness	Social Media Usage
Attitude	Pearson Correlation	.608	1.000	.421	.460	.230	.155
	Sig. (2-tailed)	.000		.000	.000	.003	.000
	N	320	320	320	320	320	320
Subjective Norms	Pearson Correlation	.429	.421	1.000	.210	-.009	.260
	Sig. (2-tailed)	.000	.000		.000	.435	
	N	320	320	320	320	320	320
Perceived Behavioral Control	Pearson Correlation	.462	.460	.210	1.000	.413	.034
	Sig. (2-tailed)	.000	.000	.000		.000	.274
	N	320	320	320	320	320	320
Health Consciousness	Pearson Correlation	.251	.230	-.009	.413	1.000	.099
	Sig. (2-tailed)	.000	.000	.435	.000		.038
	N	320	320	320	320	320	320
Social Media Usage	Pearson Correlation	.269	.155	.260	.034	.099	1.000
	Sig. (2-tailed)	.000	.003	.000	.274	.038	
	N	320	320	320	320	320	320
Purchasing Intention	Pearson Correlation	1.000	.608	.429	.462	.251	.269
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001
	N	320	320	320	320	320	320

Source: Author's own calculations using SPSS v29

To analyze the study's hypotheses, the researchers used IBM SPSS version 29 to conduct multiple linear regression in order to measure the influence of the independent variables on the dependent variable.

Table 5

Results of multiple linear regression

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	-.367	.243		-1.511	.132		
Attitude	.515	.064	.404	8.091	<.001	.675	1.481
Perceived Behavioral Control	.263	.052	.235	5.077	<.001	.787	1.271
Subjective Norms	.188	.052	.169	3.641	<.001	.783	1.277
Social Media Usage	.155	.043	.154	3.617	<.001	.928	1.078

a. Dependent Variable: Purchasing Intention

Source: Author's own calculations using SPSS v.29

Using the stepwise method for multiple linear regression, it was found that attitude, perceived behavioral control, subjective norms, and social media usage all have a significant impact on purchasing intention, with *p* values below 0.05 (Sig. <.001). Also, the variance inflation factor VIF values do not exceed 1.481, which is below the threshold of 3, indicating that there is no issue with multicollinearity, ensuring the reliability of the results. On the other hand, the results revealed that the health consciousness of students has no significant influence on their intention to buy over-the-counter dietary supplements.

3.4. Differences in Demographic Variables

Gender, age, education level, student status, study field, and knowledge level are demographic variables that have been employed in the study to explore differences among groups. Some of them have just two groups (gender and student status) and other variables have more than two groups, therefore, independent sample t-test, one-way ANOVA, and post-hoc test were employed to analyze the data.

In terms of **gender**, the results indicated a significant difference between male and female students regarding their intention to purchase dietary supplements in winter in the city of Debrecen as a response to the shortage of the vitamins that people suffer in that period. Female students are more likely to intend to buy dietary supplements than male students. Regarding **age**, the findings indicate that the age group ranging from 23 to 27 years exhibits a noticeable contrast in their preference to purchase supplements in comparison to the younger demographic of 18 to 22 years. With regards to the **knowledge level** of dietary supplements, the analysis reveals significant disparities in attitudes, perceived behavioral control, health consciousness, and purchasing intentions among participants with varying self-rated knowledge about dietary supplements. Specifically, individuals with higher self-assessed knowledge display more positive attitudes towards dietary supplements, a greater sense of control in their dietary choices, and heightened health awareness, which also translates to a stronger intention to purchase dietary supplements. These findings suggest that educational interventions could potentially enhance the uptake of dietary supplements by boosting knowledge and thereby altering attitudes and perceived behavioral control, particularly among those with an initially lower self-evaluation of their dietary supplement knowledge.

4. DISCUSSION

This study validates the theory of planned behavior in understanding the factors influencing dietary supplement purchasing intentions among international students at the University of Debrecen. According to the Theory of Planned Behavior (TPB) model, studies consistently identify attitude, subjective norms, and perceived behavioral control (PBC) as significant predictors of students' intention to use supplements (Alami et al., 2019; El Khoury et al., 2021). This finding extends to young adults more broadly, with Lee et al. (2016) demonstrating that subjective norms, perceived behavioral control, and attitude significantly predict their purchase intention of dietary supplements.

The outcomes demonstrate the significant impacts of attitudes, perceived behavioral control, subjective norms, and social media usage on these intentions. Particularly, attitude stands out as a strong predictor, suggesting that positive perceptions towards dietary supplements are closely tied to higher purchasing intentions. This aligns with Ajzen's (1991) theory, which posits that a favorable attitude towards a behavior enhances the likelihood of its execution. Perceived behavioral control also significantly influenced purchasing intentions, indicating that students who feel more capable of managing their dietary choices are more inclined to buy supplements. This could be leveraged in interventions aiming to boost consumer confidence and perceived ease of supplement procurement. Subjective norms had a notable but lesser impact, reflecting the role of social influence and external expectations in shaping consumer behavior.

4.1. Attitudes Towards Dietary Supplements

The study results reveal that the participants generally held positive attitude towards dietary supplements. This aligns with previous research suggesting a favorable perception of potential health benefits associated with supplement consumption (Royne et al., 2014; Willis & Stafford, 2016). The high mean score for health consciousness in this study further emphasizes the prioritization of well-being among these students. This focus on health likely contributes to positive attitudes towards supplements as a potential means of enhancing health.

4.2. Subjective Norms and Perceived Behavioral Control

Though not as much as attitude, subjective norms and perceived behavioral control also had significant impacts on students' intentions to purchase dietary supplements. Research on young adults and student populations highlights the significant role of subjective norms, reflecting perceived social pressure, in dietary supplement purchase intentions (Lee et al., 2016). While some studies found subjective norms to be the strongest predictor of purchase intention (Lee et al.,2016), others reported a weaker influence (Jeżewska-Zychowicz & Pilska, 2006). Attitudes consistently emerge as a key factor influencing purchase intention (Lee et al., 2016; Jeżewska-Zychowicz & Pilska, 2006; Azila Mohd Noor et al., 2014). Interestingly, adolescent athletes demonstrated stronger prediction of intentions through attitudes compared to subjective norms (Dunn et al., 2001). The influence of significant others such as athletic trainers was noted to impact attitudes, subjective norms, and intentions regarding supplement use among adolescents (Dunn et al., 2001). These findings highlight the interplay of social and personal factors in dietary supplement consumption decisions.

PBC and knowledge were earlier found to be particularly associated with intentions to take nutritional supplements among adolescent girls (Alami et al., 2019). Similarly, self-efficacy, closely related to PBC, predicts health-promoting behaviors across diverse countries (Luszczynska et al., 2004). These findings suggest that students' perceived control over obtaining and using supplements – potentially influenced by accessibility, affordability, and personal knowledge – is an important factor in their consumption. The TPB model demonstrates utility in explaining supplement use behavior among students in various contexts.

4.3. Health Consciousness and Dietary Supplement Use among International Students

The descriptive data indicated that participants' overall levels of health consciousness were high, despite the fact that our study showed that health consciousness was not a significant predictor of purchase intention. Research on university students reveals a strong link between health consciousness and dietary supplement consumption (Royne et al., 2014; Willis & Stafford, 2016). Health-conscious individuals tend to have positive attitudes towards supplements, perceiving them as beneficial and reducing perceived risks (Royne et al., 2014). However, familiarity with direct-to-consumer advertising can moderate this relationship, potentially inflating perceived benefits (Royne et al., 2014). The Theory of Planned Behavior (TPB) further supports this link, suggesting that health consciousness shapes attitudes, subjective norms, and perceived behavioral control regarding supplement use, with health motivation further influencing these relationships (Noor et al., 2019). While health consciousness is important, navigating accurate nutrition information online can be challenging for students (Szűcs et al., 2015).

Research identifies three distinct consumer groups: "ambitious", "health conscious", and "indifferent" (Szűcs et al., 2015). Given the unique challenges they face, international students can be seen as a vulnerable group in terms of dietary supplement utilization. Factors such as limited access to culturally competent health care, language barriers, different levels of health literacy, and lack of knowledge about local regulations may somehow determine their ability to weigh the merits and demerits of consuming supplements. These scenarios render them even more susceptible to misinformation or product misuse when functioning mainly through social media or so-called informal peer networks. Hence, reaching this group with reliable evidence-based messages becomes so imperative, as emphasized by Szűcs and his colleagues (2015) underlining the need for a tailored communication strategy for various consumer segments. Research on international student health paints a complex picture. While some studies report increased risks of negative health outcomes and lower help-seeking behavior for mental health compared to domestic students (Skromanis et al., 2018), others suggest international students may have better overall wellness profiles (McDaniel et al., 2021).

Additionally, studies in Turkey (Citak Tunc et al., 2021) and Australia (Harris et al., 2020) highlight the potential influence of cultural background on health perceptions and behaviors. These contrasting findings emphasize the need for targeted and culturally-sensitive health promotion programs for international students.

4.4. Social Media Usage and Dietary Supplement Use among International Students

Additionally, the data show a moderate but statistically significant positive correlation between social media usage and the desire to purchase dietary supplements. Social media usage influences consumer purchasing intentions in social commerce, with cultural intelligence mediating the effect (Hu & Zhu, 2022). However, social media was found to be a less influential factor in dietary supplement purchases among female military cadets (Jaffe et al., 2021). Nonetheless, social media platforms serve as a significant source of information about dietary supplements for college students (Salmean & Alhuwail, 2018). The impact of social media on supplement knowledge and purchasing behavior may vary across demographics. While product quality, absence of banned substances, and ingredients were the top factors influencing purchases among female cadets (Jaffe et al., 2021), college students in general showed high supplement use and relied on various information sources, including the internet and social media.

5. Conclusions

This study explored the applicability of the Theory of Planned Behavior in the context of dietary supplementation among international students of the University of Debrecen in Hungary. The findings reveal that attitudes, subjective norms, perceived behavioral control, health consciousness, and social media usage are all important determinants of students' intentions to purchase these dietary supplements, with attitude and perceived behavioral control being two of the principal predictors.

With the empirical evidence for supplement consumption on the backdrop of international student life, this study successfully adds to the body of knowledge regarding health behavior trends among internationally mobile student populations. The implications from the results would provide some substantial input for national health policymakers, university administrators, and health and wellness service providers in their endeavors to promote student welfare. In particular, there is room to develop culturally sensitive health promotion interventions, like nutrition education programs and wellness workshops that can effectively be employed to prevent extreme reliance on dietary supplements.

In addition, the apparent impact of social media on health-related choices points to an immediate need for the establishment of regulations to ensure the authenticity of evidence-based information to students. This would aid any future intervention in strategically using digital platforms to ensure dissemination of trustworthy content, deterring misinformation, and promoting informed dietary behavior among international students.

6. Limitations

It would be suggested that though this study gives much insight into some of the aspects affecting dietary-supplement consumption among international students at The University of Debrecen in Hungary, it is being drained by some limitations. First, the research investigates the consumption pattern only within the international student population in a Hungarian university, thus restricting the extension of its findings to any other student populations. Hence, a more heterogeneous sampling of dietary-supplement consumption patterns would broaden the insight from around the world and other educational institutions.

In addition, the cross-sectional design applied in this study assessed students' attitudes and behaviors at a single point in time and therefore failed to capture changes in consumption patterns across time spans. A longitudinal study would be insightful in monitoring the impacts of acculturation, academic stress, and changing health awareness on dietary supplement use by international students.

Another limitation was self-reports, which could be readily influenced by socially desirability bias. For example, participants might tend to over-report their healthy behaviors or intention to buy. Future studies could include an objective measure, such as buying records or even some bio-assessment on health to authenticate these findings.

Lastly, this study covered the major psychological and social factors affecting dietary supplement consumption, but it did not cover such factors as government regulations or healthcare policies, or the impact of university health services, which are crucial to the developmental phase of the students' perception and behavior regarding dietary supplements.

7. Future Research

Current findings of this study should be broadened with more diversity, for instance by including international students from different academic institutions and cultural backgrounds. The significance of results would be increased, and a much more comprehensive picture of student supplement use trends globally would emerge.

Also, longitudinal studies would be useful to assess how students' purchasing behaviors and perceptions of health change over time. The research could incorporate the long-term influence of acculturation, diet, and academic pressure on the use of supplements.

And in-depth interviews or a focus group may also reveal insights into the driving factors, beliefs, and challenges that affect the decision-making process of international students with regard to dietary supplements. This would complement the quantitative findings with depth and nuance regarding the psychological and cultural driving forces.

Future research could also investigate how various digital platforms influence supplement purchasing decisions through online health information, digital marketing, and mobile health applications; insight into this would help to create more appropriately targeted interventions for informed decision-making and to shield against misinformation.

Finally, Policy measures such as nutrition education programs within universities or stricter controls on dietary supplements advertising may ultimately be pursued to potentially enhance students' health and well-being. Future work may provide a basis for assessing such interventions in relation to their informing of health promotion strategies.

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Author's contribution

Abrar Ghaith: Created ideas and hypotheses for study 50%, conceived and designed the study 50%, collected the data 60%, performed the analysis 70%, wrote the paper 50%, logical explanation and presentation of findings 50%, overall: 55 %.

Omar Salem: Created ideas and hypotheses for study 50%, conceived and designed the study 50%, collected the data 40%, performed the analysis 30%, wrote the paper 50%, logical explanation and presentation of findings 50%, overall: 45 %.

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Data available on request due to privacy, from the corresponding author: Abrar Ghaith, a.ghaith@outlook.com

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APPENDIX

Appendix 1: The study questions

Dear Student, we are a research team, Omar Salem and Abrar Ghaith, PhD students in the field of Business and Management at the University of Debrecen. Currently, we are conducting a study related to identifying factors that can increase the purchase intention of dietary supplements. Note: Dietary supplements include vitamins such as vitamin C, D and B12; minerals like calcium and iron; herbs such as cinnamon and garlic; and products like probiotics and fish oils. Please help our research work by filling out the following questionnaire. Thank you in advance for your participation.

Measurement	Statement	Source
Attitude toward dietary supplements		(Ajzen, 1991; Ghaith et al., 2023; Pop et al., 2020)
	I think consuming dietary supplements is healthy	
	I think consuming dietary supplements is beneficial	
	I believe that consuming dietary supplements improves my physical appearance	
	I believe that dietary supplements are safe	
Subjective norms		(Ghaith et al., 2023)
	People who are important to me would think I should consume dietary supplements periodically	
	My family thinks I should consume dietary supplements to improve my performance, physical appearance, or general health	
	My peers/friends think I should consume dietary supplements to improve my performance, physical appearance, or general health	
	My health care professional (e.g. physician or dietitian) think I should consume dietary supplements to improve my performance, physical appearance or general health	
Perceived Behavioral Control		(Ghaith et al., 2023)
	Whether I consume or do not consume dietary supplements from now on is entirely up to me	
	It is easy for me to consume dietary supplements from now on	
	I have complete control over whether to consume or not to consume dietary supplements from now on	
Health consciousness		(Ghaith et al., 2023; Gould, 1988; Michaelidou & Hassan, 2008)
	I think about my health a lot	
	I am very self-conscious about my health	
	I am alerted to changes in my health	

	I take responsibility for the state of my health	
	I am aware of the state of my health as I go through the day	
Social Media Usage		(Chi, 2021; Pop et al., 2020).
	I use social media to find and spread information	
	I seek information from other consumers online	
	My engagement in social media influences my dietary supplements purchase	
	I use social media to search for information about dietary supplements	
	Contents about dietary supplements on social media are trustworthy	
	Contents about dietary supplements on social media are believable	
Purchase Intention		(Ajzen, 1991; Ghaith et al., 2023)
	I intend to take or keep taking dietary supplements to improve my performance and/or general health	
	I plan to take or keep taking dietary supplements to improve my performance and/or general health	
	It is very likely that I will take or keep taking dietary supplements to improve my performance and/or general health	

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An Analysis of the Financial Sustainability of Public Universities in South Africa

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SUMMARY

Purpose of the study: The purpose of this study is to analyse the financial sustainability of South African public universities from 2017 to 2021. The paper, therefore, seeks to analyse how these universities manage their resources amidst increasing student enrolment, increased costs, and limited state support.

Design/methodology/approach: The study follows a qualitative methodology. The research paper uses calculated and analysed financial ratios to analyse various aspects of financial sustainability, together with a methodical assessment of existing literature and a content analysis of the annual audited financial statements of 23 different public universities.

Findings: The research indicates that while several public universities have improved their financial stability over time, the extent of this improvement varies among universities. While some universities exhibit a high level of financial management, at the same time, others are exposed to financial risks. The improvement in reserve ratios also points towards better financial planning; however, the increasing operational costs, specifically those of personnel, are a cause for concern. The complex relationship between state support, own funding, and operational efficiency has been highlighted, besides pointing to an orientation towards innovative funding solutions for enhancing financial sustainability and education quality.

Recommendations/value: To secure financial sustainability, universities must adopt robust risk management strategies, improve liquidity by managing debt more effectively, and shift towards more diversified funding sources. Additionally, aligning financial strategies with operational efficiency will be crucial in maintaining educational quality amid growing fiscal pressures.

Managerial implications: The findings of this study have significant managerial implications for the contemporary field of higher education management. The findings underscore the urgent need for national policy reforms to ensure predictable and equitable funding allocations. Government should reassess the sustainability of current NSFAS funding models. Furthermore, policies promoting third-stream income generation such as research commercialisation and public-private partnerships should be prioritised to reduce reliance on government grants. Strategic policy alignment is essential to ensure that higher education institutions remain financially viable while fulfilling their social mandate of access and quality education

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1. Introduction

In the rapidly-changing landscape of Higher Education (HE) in South Africa, rising enrolment pressures and fiscal stringency create the most challenging environment for the financial sustainability of public universities. Section 29 of South Africa's 1996 Constitution guarantees the right to HE and mandates governmental action to facilitate access for all. In accordance with this constitutional mandate, the government established the National Student Financial Aid Scheme (NSFAS) to offer financial assistance to students from impoverished and working-class families. The primary objective of NSFAS, as outlined in the 1999 NSFAS framework, is to operate as an efficient and well-managed distributor of financial aid, thereby enhancing entrance to and success in higher and further education and training. This is a critical initiative for grasping the financial sustainability of public universities in South Africa, which impacts the enrolment and retention rates of students through the mitigation of financial barriers to HE. Public HE comprises 26 universities with 1,068,046 students in 2021 (DHET, 2021). This is a ground-breaking increase of 230,270 (27.5%) more students over the 13 years from 2009 to 2021, reflecting a net annual increase in student enrolment throughout the public HE sector. The demonstrated need for such growth necessitates a comprehensive approach to managing HE's financial mechanisms, including funding and expenditure. According to Arumugam (2019), these financial streams must be effectively coordinated to maintain the growth of enrolment and the sustainability of public universities in South Africa.

In South African economic development, public universities emerge as some of the most pivotal institutions, fostering educational progress and significantly contributing to the national economy. Researchers have identified these universities as significant economic contributors, contributing approximately R513 billion annually (Bawa & Pouris, 2023). This contribution is equivalent to major industries such as gold mining, beverages, and tobacco, making HE an essential sector of the economy. In addition to general academic literature, education and openness to trade largely propel economic growth (Akinwale & Grobler, 2019). As a result, South Africa's public universities serve educational purposes. They are instrumental in the region's economic integration and development, promoting knowledge economies that underpin immediate financial benefits and long-term developmental strategies.

Overall, the funding models of public universities in South Africa are closely tied to the country's broader economic conditions; therefore, it is crucial to address concerns about maintaining financial sustainability while ensuring quality education. Economic constraints over time have pushed most public universities to diversify their funding sources beyond reducing state subsidies. Often, this results in increasing tuition fees, which may deny poor students an opportunity for education and increase further educational inequalities (Ayuk & Koma, 2019). Furthermore, Ayuk and Koma (2019) state that the financial sustainability of these institutions is continuously challenged by economic stagnation, which strains both public resources and household incomes, impacting the affordability of HE. At the same time, research such as that done by Naidoo and McKay (2018) suggests that the financial constraints and effectiveness of existing funding models, like NSFAS, do not correlate straightforwardly with improved academic outcomes, underscoring the complexity of the impact that financial aid mechanisms can have on student success. This, therefore, is a call for innovative funding solutions that, in addition to stabilising the financial environment of HEIs, will also increase access and improve quality in line with national development goals and global standards of competitiveness. It is, therefore, a time when comprehensive rethinking of funding models should be on the horizon to develop mechanisms that are sustainable at high levels of educational standards, both economically and socially.

Despite increases in HE spending from 0.7 per cent in 2012 to 1.3 per cent in 2021, as reported by Khuluvhe and Netshifhefhe (2021), this increase is still modest compared to more successful HE systems around the globe. Ironically, the #FeesMustFall campaign, which has been lauded for achieving huge concessions for students over the course of 2015/16, placed enormous financial pressure on a severely under-resourced university sector (USAf, 2016). Further complicating matters, in 2017, former President Zuma announced fee-free HE; this was contrary to the recommendations made by the Zuma Commission report, which declared the move fiscally unviable. This statement added another layer to the debate over funding (Moolman & Jacobs, 2019). According to Cloete (2015), "free higher education", as a powerful slogan, is fiscally impractical for a developing nation like South Africa. Jacobs et al. (2019) placed this on a scale of impracticality, estimating that fee-free education would have required approximately R54.4 billion in 2016, a figure exclusive of other necessities, such as infrastructure and accommodations for students. This would need to be financed by GDP growth equal to R2.88 trillion if this policy were to be sustained, something impossible given the current economic climate (Langa et al., 2017; Jacobs et al., 2019).

Recently, the financial sustainability of HEIs has been flagged as one of the top concerns for policymakers and academic administrators. Since the operational costs are rising faster than the funding offered by government grants in this growing sector, it puts significant pressure on the budget (Ahmad et al., 2019). This eventually compelled public universities worldwide to seek additional income and explore mechanisms to reduce costs to diminish any probability of falling short of money. In addition, fuzzy subsidies complicate matters since universities have no choice but to seek alternative sources of funding that will keep them in business (Ngcobo, 2021). Although the "Fees Must Fall" protest in 2015–2016 was a call for free education, this caused NSFAS to give more financial support, but the funding is still inadequate. In addition, the economic challenges of high unemployment and slow economic growth will not likely allow students to pay school fees.

Meanwhile, costs have increased, while services' revenues, such as student housing, have fallen due to the COVID-19 pandemic.

2. LITERATURE REVIEW

The history of the financial operations of public South African universities has arguably been significantly influenced by legislation and policies aimed at redressing past disparities and fostering an equitable allocation of resources. Notable legislative reforms include enacting the Higher Education Act of 1997 and the National Plan for Higher Education of 2001 However, universities are under fiscal stress due to increased student enrolment and a decrease in state support in real terms (Ntshoe & De Villiers, 2013). To cope with these constraints, universities have increasingly begun to rely on student fees and third-stream income, but these are inadequate to cover the funding shortfall (Bunting & Cloete, 2010). Additionally, economic challenges such as high unemployment, slow economic growth, and the COVID-19 pandemic have further strained financial resources and increased costs (Langa et al., 2017).

Financial sustainability in HE aims to ensure that the institutions function and remain viable in future operations while delivering quality education. Sazonov et al. (2015) further define financial sustainability as being concerned with how effectively Higher Education Institutions (HEIs) can manage their resources so that they remain financially stable. Financial sustainability is also focused on ensuring that a university can achieve its goals by generating sufficient income to invest in its academic programmes and future research activities (Sazonov et al., 2015). As enumerated by Afriyie (2015), key factors impact financial sustainability; they include funding sources, cost management, and income diversification. Thus, economic, political, and social factors determine the financial stability of public universities in South Africa. Economic conditions, such as recessions and governmental funding shifts, have much to say about university budget operations. According to Johnstone and Marcucci (2007), universities worldwide have become even more dependent on tuition fees and other private support. In South Africa, which is not an exception, Zusman (2005) notes that the pressure from increasing student enrolment tends to stretch resources and infrastructure.

State support, specifically through the NSFAS, significantly impacts South African university finances. NSFAS's disbursement of financial aid to financially disadvantaged students considerably impacts the number of students who may access university education, hence determining the financial stability of the universities (DHET, 2020). By easing students' financial constraints, NSFAS attracts large numbers of enrolments and contributions to the universities' revenue streams. However, reliance on state support also creates risks, as government budgets and policies can change, directly affecting the universities' financial sustainability (De Jager & Bitzer, 2018). An increase in operational costs such as personnel, maintenance, and technology upgrades contributes to the university budget's constraints. Badat (2004) states the importance of generating new income sources while operational costs increase to maintain financial sustainability. To ensure financial sustainability, universities should investigate ways to diversify their income, such as raising tuition fees, obtaining private funding, or even opening to commercial operations, such as research commercialisation, as is happening today, and offering courses online (Webb, 2014).

The term "financial sustainability" is used to describe an organisation's capacity to produce income and keep its productive operations going at a constant or growing rate to fulfil its mission and achieve its goals and objectives. In other words, the fundamental goal is the outcome that the organisation hopes to attain (Leon, 2001). McLaren and Struwig (2019) assert that the institution manages itself in a financially sustainable manner to achieve its goals and objectives through four key elements: strategy, investments, operating sustainability, and risk management. Sazonov et al. (2015) further emphasise that financial sustainability enables a university to meet its objectives by generating sufficient income to invest in future academic and research activities. The financial sustainability of HEIs has become a growing concern as the sector expands and state support becomes constrained (McLaren & Struwig, 2019). Ahmad et al. (2019) note that HE spending has been exponential, surpassing government grants. This has forced public universities globally to have alternative sources of income and adopt strategies to curb financial shortages (Deloitte, 2015). Ngcobo (2021) accentuates that, with limited resources and inconsistent government subsidies, universities must realise sustainability goals, thereby forcing the institution to use other means to get finances.

Financial sustainability is a core element of assessing an institution's financial soundness and will be one of the most pertinent concerns for universities over the next decade. Sazonov et al. (2015) assert that only institutions with robust financial structures and reliable income streams can effectively meet their broad responsibilities and adapt to increasingly complex and global challenges. Ahmed Bawa, the head of Universities South Africa (USAf), highlights the long-term sustainability of NSFAS as a significant challenge for the university sector (van der Merwe, 2021). Furthermore, Higher Education and Training Minister Blade Nzimande has expressed concerns over growing student debt, which compromises the future sustainability of HE and delays infrastructure development, with the debt reaching R16.5 billion (Bhengu, 2023).

3. RESEARCH METHODOLOGY

This research explores the financial sustainability of public universities in South Africa, a subject that, to date, has attracted limited empirical research. In adopting a qualitative methodology, this research utilises a comprehensive literature review and a detailed content analysis of audited annual financial statements for the five years from 2017 to 2021. Such an approach enables a nuanced exploration of complex financial issues within the HE sector, focusing on interpreting the narratives derived from these documents rather than quantifying data through numerical analysis. The study by Dai (2016) used a qualitative approach involving informal interviews and content analysis to find out about financial performance in small-medium enterprises, focusing on the use of profitability ratios to interpret financial health. Similarly, Al Qtaish and Makhloufi (2024) used financial ratios in qualitative analysis in order to enhance the quality of financial reports, giving insight into the assessment of financial performance. These studies reveal much support for using qualitative methodologies in analysing the financial sustainability of HEIs.

According to the USAf website (USAf, 2016), South Africa has 26 public universities. For this study, secondary data comprising audited financial statements from these universities was employed, specifically selecting those that are publicly available. Out of the 26, only 23 universities had consistently published audited statements over the five-year period and were thus included in the analysis. The reliability and credibility of the data analysed are taken care of by the assurance provided using audited financial statements. The audited financial statements of the public universities for the five-year period were carefully analysed through financial ratios as detailed in Table 1 Statistical analysis was conducted, which facilitated the computation of means, standard deviations, minimums, maximums, and variances of all financial ratios. This not only enhances our understanding of financial sustainability but also complements the qualitative insights from the content analysis of the audited financial statements.

The audited annual financial statements from HEIs were used to analyse the financial sustainability of public universities in South Africa. This analysis was conducted using a theoretical framework that was developed by McLaren and Struwig (2019). We have adopted this framework, which identifies specific financial ratios crucial for assessing financial sustainability within HEIs. According to this framework, the financial ratios listed in Table 1 are essential indicators of financial sustainability.

Table 1

Theoretical framework

Financial ratio category	Financial ratio measured	Financial ratio formula	Elements of financial sustainability	Definition of the financial ratio	Recommended
1. Financial performance	Income stream	State support income as a percentage of total recurrent income (council-controlled)	Strategy	Represent the percentage of funding provided by the government in the total revenue of universities.	A lower percentage indicates less reliance on the state support.
		Own funding (total income less state support income) as a percentage of total recurrent income (council-controlled)	Strategy	Represent the proportion of the universities' overall revenue that is derived from their own funding.	A higher percentage indicates a greater proportion of funding by the university.
	Personnel costs	Staff cost as a percentage of total recurrent income (council-controlled)	Operating sustainability	Display the staff expenditures as a proportion of the overall recurring revenue.	58% - 62% Government Gazette (2009:8).
	Total operation surplus	Council-controlled operating surplus ratio (excluding interest income)	Strategy, operating sustainability, and investment	The university historical record of surpluses and deficits, excluding any income from interest.	Surplus = positive and recommended.

Financial ratio category	Financial ratio measured	Financial ratio formula	Elements of financial sustainability	Definition of the financial ratio	Recommended
		Council-controlled operating surplus ratio (including interest income)	Strategy, operating sustainability, and investment	The university historical record of surpluses and deficits, including any income from interest.	Surplus = positive and recommended.
2. Liquidity	Current ratio	Current assets: Current liabilities	Risk management	Measures the university's ability to cover its short-term obligations with its current assets.	> 1 is recommended.
	Quick ratio	Current assets (excluding stock and student debtors): Current liabilities		Measures the university's ability to cover its short-term obligations with its current assets excluding stock and student debtors.	0.3 to 1 is recommended (Cernostana, 2017).
3. Debt management	Solvency ratio	Total assets (excluding PPE): Total liabilities	Risk management	Indicates the university's ability to cover liabilities by utilising its assets. In most cases, the PPE of universities consists mainly of buildings. PPE is not included in the assets as PPEs are not liquid.	Higher than 1 is recommended.
4. Asset management	Student debt	Student debtors before provision for doubtful debt as a percentage of total tuition and other fees	Risk management	Reflects the ability of the university to manage student debts.	Lower percentage is recommended.
5. Reserves	Council-controlled reserves	Unrestricted use funds (council-controlled reserves): Annual recurrent expenditure (council-controlled)	Investment	Assess the ability of the university to sustain its primary operations without new funding in the year to come.	Higher is recommended.
	Total reserves	Total reserves: Total recurrent expenditure			

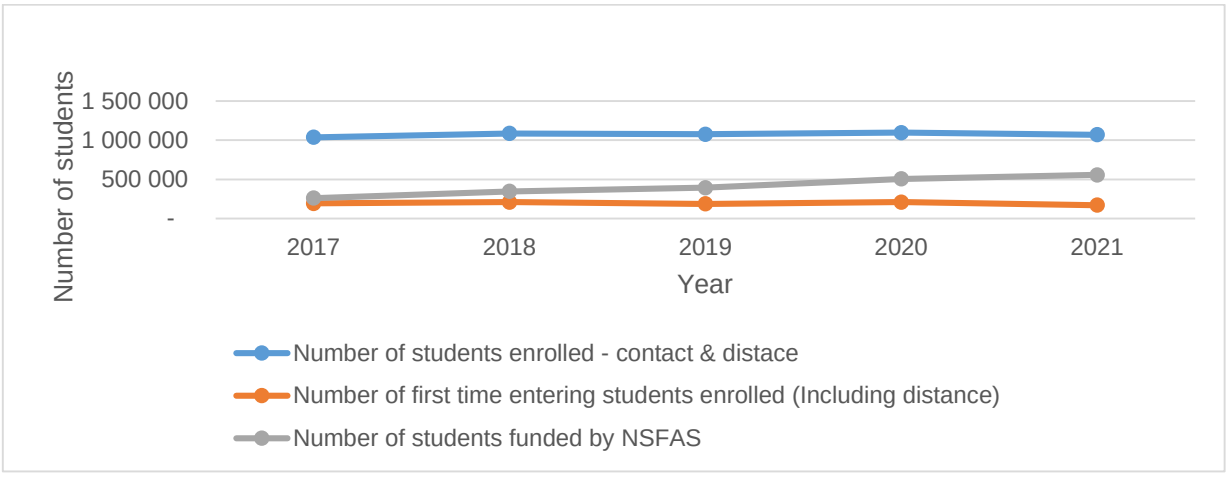
Source: McLaren and Struwig (2019) and original synthesis

4. FINDINGS AND DISCUSSION

This study analyses the financial sustainability of South African public universities, presenting its findings and discussions across three sections. The first section reviews demographic data from public universities between 2017 and 2021. The second section discusses the results of a financial ratio analysis to assess financial sustainability. Finally, the third section explores the findings in relation to risk management, investment strategy, and operational sustainability, incorporating the financial ratios discussed in the second section.

4.1. Demographics of public universities in South Africa

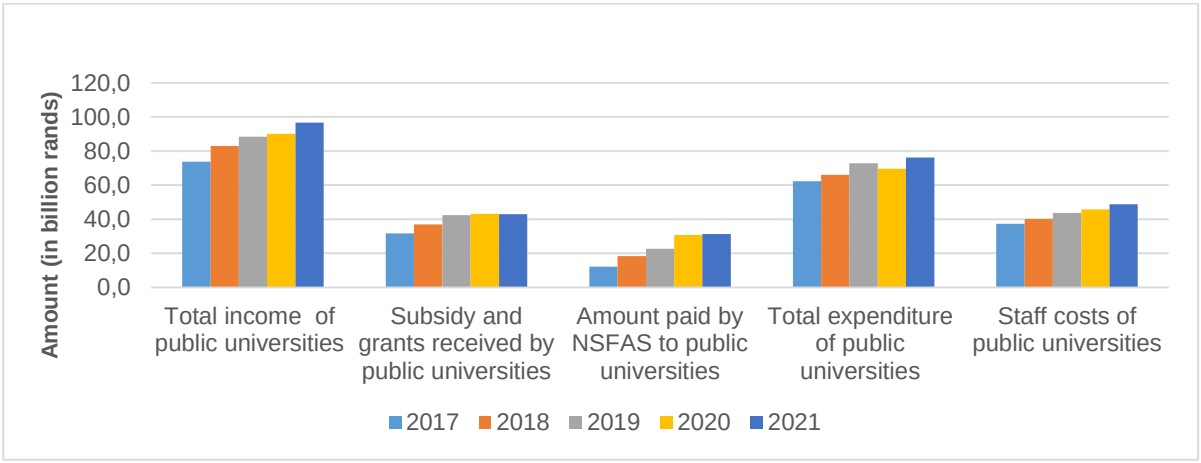
According to DHET (2021), there are 26 public universities in South Africa. As indicated in Figure 1 below, the combined total number of students enrolled in these institutions in 2017 was 1 036 984, showed a gradual increase to 1 094 808 in 2020, and then slightly decreased in 2021 to 1 068 046. Similarly, the number of first-time entering students depicts a positive trend, starting at 193 282 in 2017, increasing to 209 522 in 2020, and then decreasing to 169 675 in 2021. On the other hand, the number of students with funding through the NSFAS depicts a positive increasing trend in that it has risen from 260,002 in 2017 to 555 950 by 2021. This rising trend has been an indication of more commitment in terms of the provision of financial aid to students within the reviewed period.



Source: Department of Higher Education and Training and National Student Financial Aid Scheme

Figure 1: Student enrolled and funded by NSFAS

Figure 2 shows a consistent increase in total income from 2017 to 2021, which indicates that one part of the revenue streams is increasing for public universities in South Africa. Also, the subsidies and grants received by public universities have increased consistently over the years. On the other hand, the amount received by public universities in South Africa from NSFAS increased; a significant increase was noted from 2019 to 2020. The trend in total expenditure mirrors that of total income, with an overall increase throughout the period; however, there is a slight decrease from 2019 to 2020 before it rises again in 2021. The decrease in total expenditure might be due to the COVID-19 pandemic in 2020. The personnel costs have been increasing steadily every year, as depicted in Figure 2. It is also observed that subsidies and grants received from 2019 to 2021 marginally increased, whereas total expenditure, including personnel costs, increased significantly.



Source: Statistics South Africa and National Student Financial Aid Scheme

Figure 2: Financial overview of public universities

4.2. Financial ratio analysis for assessing financial sustainability

This study analyses the financial sustainability of public universities in South Africa from 2017 to 2021. Such a period allows for identifying and analysing trends in the realisation of a comprehensive understanding of financial sustainability, which would otherwise have aberrations for a shorter period, leading to adequate conclusions. The financial ratios analysed are derived from a theoretical framework detailed in Section 3, which groups these ratios into five distinct groups. The data relating to these financial ratios for the selected universities are systematically analysed and presented in Tables 2–6, each table corresponding to a specific category.

4.2.1. Financial performance ratios

Table 2 delineates the outcome of the financial ratios employed to evaluate the financial performance of universities. An examination of Table 2 reveals temporal fluctuations in state support income as a percentage of total recurrent income, manifesting an initial augmentation followed by a modest diminution. This fluctuation attests to a difference in dependency on state support income between the universities over the period delineated. The standard deviation values show the presence of variability in these ratios across the institutions but relative consistency through the years, suggesting a stable dispersion around the mean. The other is the range, or the difference between maximum and minimum values, which underlines the variety in the extent to which different universities depend on state support. An extensive range of these values infers that while certain universities strongly rely on state support, others demonstrate minimal dependence.

The analysis further reveals that other than a marginal decline in the mean across universities from 2017 to 2020, the trend in own funding as a proportion of total recurrent income is towards a decrease before a marginal rise in 2021. This trend may reflect an escalating reliance on state support or alterations in the total income composition over the scrutinised years. The standard deviation remains relatively uniform, suggesting that the dispersion of the ratio values around the mean is stable over time. Such stability implies that although the absolute level of own funding varies, the relative variability among universities does not undergo significant changes. The incremental increase in minimum values and a decrement in maximum values, particularly noticeable from 2019 to 2020, denote a narrowing range. The mean personnel cost ratio shows minor variations throughout the observation period, with a noticeable decrease from 2017 to 2019, a rise in 2020, and a slight decrease again in 2021. The indicated pattern allows one to observe changes over time in the proportion of staffing costs to total recurrent income. Standard deviation values are relatively stable over the years; therefore, the dispersion of staff cost ratios is also close for universities. This consistency suggests that, despite fluctuations in the mean, the relative variability among universities remains unchanged. However, these calculations reveal yearly variations in the maximum and minimum values of staff cost ratios across universities.

The net operating surplus or deficit ratio, exclusive of interest, shows a trend of average enhancement in operational surpluses among the universities, which indicates augmented financial stability and operational efficiency. Most universities transitioned from a deficit in 2017 to a surplus in 2021, showing substantial improvement. In contrast, one university faced continuous deficits, from-3.26 per cent in 2017 to-2.37 per cent in 2021. Nonetheless, the increase in both standard deviation and variance suggests that this improvement is not uniformly distributed among the universities. The expanding range between the minimum and maximum values, particularly the significant elevation of the maximum value in 2021, underscores considerable disparities in financial performance and operational efficiency among the universities. This discrepancy in the results suggests that some universities had implemented successful financial policies or operated in a conducive environment, but this did not apply to others. The high percentage of the negative minimum values realised across the span clearly indicates that universities within the sectors still operate in deficits, revealing areas of potential concern and calling for specific improvements in financial management and operational efficiency.

Bringing interest income into the operating surplus ratio would better reflect the financial health of universities, showing a positive direction towards performance improvement. For instance, there were six universities with a significant improvement from a deficit in 2017 to a surplus in 2021. However, on the downside, three universities had deficits from 2018 to 2020. All other universities showed a consistent surplus from 2017 to 2021. The standard deviation variability of the data shows relative stability during the latter two years. This indicates that the variation in performance among universities is considerable but similar in range over time. The discrepancy between the minimum and maximum values emphasises that the universities perform differently. Notably, the shift of the minimum value from negative to positive between 2017 and 2021 shows that the number of universities that operated with a deficit decreased when accounting for interest income.

Table 2

Financial performance ratios

Financial ratio measured	Formula	Year	Mean	Standard deviation	Variance	Min.	Max.
Income stream (State support income) ratio	State support income / Total recurrent income (council-controlled)	2017	52.09%	8.47%	0.72%	38.90%	76.45%
		2018	54.74%	9.31%	0.87%	39.96%	75.51%
		2019	56.36%	9.02%	0.81%	39.29%	79.24%
		2020	58.29%	9.54%	0.91%	41.28%	79.07%
		2021	55.42%	9.38%	0.88%	40.04%	76.13%
Income stream (Own funding) ratio	Own funding (total income less state support income) / Total recurrent income (council-controlled)	2017	47.91%	8.47%	0.72%	23.55%	61.10%
		2018	45.26%	9.31%	0.87%	24.49%	60.04%
		2019	43.64%	9.02%	0.81%	20.76%	60.71%
		2020	41.71%	9.54%	0.91%	20.93%	58.72%
		2021	44.58%	9.38%	0.88%	23.87%	59.96%
Personnel cost ratio	Staff costs / Total recurrent income (council-controlled)	2017	59.17%	8.08%	0.65%	45.25%	77.20%
		2018	57.46%	7.01%	0.49%	47.37%	70.23%
		2019	56.93%	7.33%	0.54%	41.91%	68.99%
		2020	59.26%	7.39%	0.55%	43.69%	74.59%
		2021	57.34%	7.28%	0.53%	47.09%	72.07%
Total operation surplus (Excluding interest income)	Total net surplus (Deficit) less Interest income / Total recurrent income	2017	-1.56%	12.56%	1.58%	-42.77%	16.09%
		2018	4.81%	8.33%	0.69%	-12.95%	23.05%
		2019	5.68%	9.86%	0.97%	-13.04%	27.15%
		2020	6.34%	10.23%	1.05%	-10.69%	25.74%
		2021	13.06%	12.35%	1.52%	-2.37%	56.80%
Total operation surplus (Including interest income)	Total net surplus (Deficit) / Total recurrent income	2017	3.90%	13.20%	1.74%	-38.82%	22.70%
		2018	9.80%	8.39%	0.70%	-4.38%	28.69%
		2019	10.97%	10.50%	1.10%	-12.22%	34.51%
		2020	10.89%	10.54%	1.11%	-5.58%	31.38%
		2021	17.29%	13.25%	1.76%	3.55%	64.31%

Source: original synthesis

4.2.2. Liquidity management ratios

Table 3 presents the results of the ratios used to gauge the university's liquidity position. This ratio reflects a company's ability to cover its short-term obligations utilising current assets (Bordeianu & Radu, 2020). Cernostana (2017) said that liquidity ratios assess the business's ability to fulfil financial commitments and sustain operations. Table 3 illustrates a variation in the current ratio of public universities from one to the other between 2017 and 2021, whereby some remain stable in terms of their liquidity and others fluctuate. This indicates different financial strategies or operational conditions among universities. The mean current ratio fluctuated over the years, suggesting different levels of management or consistency in maintaining liquidity. Differences in standard deviation and variance across universities also explain financial stability and strategy differences. Similar variation is demonstrated in quick ratios, a more stringent liquidity measure. The quick ratio comprises current assets, excluding stock and student debtors, as a percentage of current liabilities. It can also be said that the quick ratio testifies to how well universities can pay off their obligations at any time. The mean quick ratio also fluctuated, with changes in the standard deviation and variance highlighting the diversity in how universities manage their most liquid assets.

The range between the minimum and maximum values for both ratios across the years underscores the diversity in liquidity management among universities. Universities with ratios close to or below 1, especially in the quick ratio, might be at risk of liquidity stress but could also be leveraging their assets more aggressively to pursue growth or operational expansion.

Table 3

Liquidity management ratios

Financial ratio measured	Formula	Year	Mean	Standard deviation	Variance	Min.	Max.
Current ratio	Current assets: Current liabilities	2017	2.71	2.12	4.48	0.72	8.28
		2018	3.14	2.31	5.33	0.71	10.23
		2019	3.09	2.63	6.93	0.75	11.59
		2020	2.89	2.01	4.04	0.65	8.94
		2021	3.01	2.23	4.96	0.62	10.21
Quick ratio	Current assets (excluding stock and student debtors): Current liabilities	2017	2.08	2.13	4.55	-0.36	7.80
		2018	2.48	2.27	5.14	0.52	9.58
		2019	2.44	2.45	6.01	-0.24	9.60
		2020	2.28	1.86	3.46	-0.28	7.12
		2021	2.40	2.11	4.44	0.06	8.77

Source: Original synthesis

4.2.3. Debt management ratio

Table 4 analyses solvency ratios at public universities. The average solvency ratio across all universities has been increasing from 2017 to 2021, suggesting a general trend of improving financial stability among public universities. Specifically, the mean ratio increased from 1.97 in 2017 to 2.21 in 2021. There is a standard deviation and variance fluctuation across the years, with a notable increase in 2021. This suggests that while the average solvency ratio has increased, the dispersion or spread of ratios among the universities has also widened, indicating differing financial stability statuses among public universities. Each year, the range between the minimum and maximum ratios indicates a significant disparity among the universities. For instance, the gap between the least solvent and the most solvent university has varied, with the minimum

ratio being 0.31 in 2017 and slightly improving to 0.34 in 2021, whereas the maximum ratio saw an increase from 5.30 in 2017 to 5.12 in 2021.

The continued upward movement in the mean ratio suggests sector-wide financial reinforcement, yet the increasing variance indicates growing disparity in financial resilience among institutions. his divergence is concerning, as highlighted in McLaren and Struwig (2019), who emphasise that solvency is critical for long-term financial sustainability, especially under fiscal constraint. The widening spread, evidenced by standard deviation and the consistent difference between minimum and maximum values, signals that while some institutions have made gains in financial stability, others remain at risk. The relatively stagnant improvement of the minimum values implies persistent solvency pressures on less financially robust universities.

Universities with weaker solvency may need to prioritise asset reallocation, debt restructuring, or improved operating efficiency to avoid risk exposure. At the same time, more solvent universities may need to plan how best to reinvest surplus capacity into strategic growth or infrastructure.

Table 4

Debt management ratio

Financial ratio measured	Formula	Year	Mean	Standard deviation	Variance	Min.	Max.
Solvency ratio	Total asset (excluding PPE): Total liabilities	2017	1.97	1.47	2.17	0.31	5.30
		2018	1.85	1.26	1.58	0.37	4.63
		2019	1.96	1.30	1.70	0.39	4.47
		2020	2.04	1.28	1.65	0.40	4.58
		2021	2.21	1.54	2.38	0.34	5.12

Source: Original synthesis

4.2.4. Asset management ratio

Table 5 presents an analysis of student debt before provision for doubtful debt as a percentage of total tuition and other fees across 23 public universities from 2017 to 2021. It is observed that, as of 2020, there has been a significant increase in the mean due to the substantial rise in the average per cent share of student debtors in total tuition and other fees. The 2020 increase and the standard deviation reflecting a similar mean increase show variability in the proportion of student debtors found across the universities analysed, which points to a diversified impact of financial strains on these universities. Further variance within the data follows suit in 2020: the gap in student debt ratios to total tuition and fees widens for public universities. On the other hand, the minimum ratio does not fluctuate markedly through the years, suggesting that the universities with the lowest percentages of student debt to total tuition and fees have not experienced significant annual changes. The maximum ratio increases significantly in 2020, reaching its peak, which implies that at least one university has a growing proportion of student debtors. This confirms the complex and diversified effects of financial challenges across the studied public universities during the examined period.

High student debt ratios are indicative of potential cash flow constraints for universities that rely heavily on tuition revenue. These ratios reflect delayed or defaulted student payments, which can significantly disrupt financial planning and operational sustainability. for institutions heavily reliant on tuition income. As noted by McLaren and Struwig (2019), poor debt management can undermine financial sustainability by constraining operational flexibility. The increase in 2020 coincides with the COVID-19 pandemic, which likely disrupted students' ability to pay fees and contributed to the sudden divergence in debt burdens across universities.

The consistently low minimum values suggest that certain universities have adopted effective debt recovery mechanisms or serve student populations less prone to financial default. Conversely, the substantial rise in maximum values particularly in 2020 points to increasing financial vulnerability among institutions serving more economically constrained students or with weaker debt collection practices.

Table 5

Asset management ratio

Financial ratio measured	Formula	Year	Mean	Standard deviation	Variance	Min.	Max.
Student debt ratio	Student Debt before provision for doubtful debt / Total tuition and other fees	2017	48.70%	37.49%	14.05%	10.40%	146.38%
		2018	48.41%	38.60%	14.90%	13.15%	155.35%
		2019	50.20%	40.32%	16.26%	11.04%	175.25%
		2020	66.20%	59.22%	35.07%	14.21%	279.77%
		2021	53.45%	38.38%	14.73%	14.29%	170.78%

Source: Original synthesis

4.2.5. Reserve ratios

Table 6 elaborates on the council-controlled reserves and total reserve ratios. In both cases, the mean has continuously increased over the years, reflecting an overall growth in the council-controlled reserves ratio. In addition to these reserves, the ratio of total reserves is also growing. These indexes of variability and dispersion are relatively constant, meaning that although the mean ratio is on an increasing trend, the spread of the data around the mean remains relatively constant for both ratios. The total reserves show a higher mean ratio and variability than the council-controlled reserves. The continuous increase in both types of reserves may indicate a general trend towards improved financial stability in reserve funds across universities. The minimum and maximum values make it clear that an extensive range is covered in the data and show significant differences in reserve ratio from one university to another.

The upward trajectory of reserve ratios between 2017 and 2021 further signals enhanced financial resilience. The council-controlled reserves increased from a mean of 0.57 in 2017 to 0.99 in 2021, while total reserves rose from 1.19 to 1.66. Despite this progress, the standard deviation for council-controlled reserves also increased from 0.56 to 0.67, suggesting growing divergence in reserve accumulation across institutions. This variance implies that some universities are significantly improving their reserve base while others lag behind.

Negative minimum values, such as-0.35 in 2017 and-0.57 in 2021, reveal that certain institutions are operating with reserve deficits, which is a potential signal of financial distress. In contrast, maximum values above 2.0 suggest that other universities are in a much stronger position to withstand financial shocks or make long-term investments.

Table 6

Reserve ratios

Financial ratio measured	Formula	Year	Mean	Standard deviation	Variance	Min.	Max.
Council-controlled reserves	Unrestricted use funds (council-controlled reserves): Annual recurrent expenditure (council-controlled)	2017	0.57	0.56	0.31	-0.35	2.08
		2018	0.68	0.55	0.30	-0.42	1.99
		2019	0.75	0.53	0.28	-0.34	1.80
		2020	0.86	0.57	0.32	-0.39	1.96
		2021	0.99	0.67	0.44	-0.57	2.51
Total reserves	Total reserves: Total recurrent expenditure	2017	1.19	0.69	0.48	-0.05	2.68
		2018	1.26	0.69	0.48	0.02	2.69
		2019	1.30	0.71	0.51	0.13	3.09
		2020	1.44	0.75	0.56	0.19	2.98
		2021	1.66	0.90	0.81	0.23	3.42

Source: Original synthesis

4.3. Financial sustainability analysis

4.3.1. Risk-management-related ratios

Tables 3, 4, and 5 analyse financial ratios that are important for risk management in public universities because they provide insights into the financial health, efficiency, and sustainability of these universities. These ratios provide a complete picture of the universities' liquidity, solvency, and asset management and attempt to rationalise the validity of risk management policies adopted for securing financial sustainability by identifying the two given ratios. The liquidity ratios assist in ascertaining the extent to which a university is prepared to settle its short-term obligations. The current and quick ratios are the two significant measures used. The above data clearly shows that the current ratio does not remain steady year after year. It means that the degree of liquidity management varies over time. Universities with current ratios close to or below one will struggle to meet their short-term obligations, putting them in a liquidity risk zone. The quick ratio is much tighter because it only considers cash as an asset to cover short-term liabilities. Similar to the current ratio, the variability will be high in a liquidity crisis scenario, with negative values.

Solvency ratios assess the long-term stability and capacity to cover all obligations with total assets, excluding property, plant, and equipment. The mean increasing trend from 1.97 in 2017 to 2.21 in 2021 suggests an overall improvement in financial stability. However, the growing dispersion variance and standard deviation indicate a widening gap in financial stability between the most and least solvent universities, which points to differing financial management strategies and potential risks for less solvent institutions. To evaluate asset management, we look at the ratio of student debt to tuition and other fees. This measures the proportion of student debt to total tuition fees, providing insight into how much of the university's revenue might be at risk due to unpaid student fees. The noticeable increase in this ratio, particularly in 2020, along with increased variability, suggests a significant financial strain during that period. This ratio increased dramatically, especially in 2020, and showed variability, indicating extremely high financial stress during that period. This increase means that at least one university experienced a rise in student debt in 2020, compromising its financial sustainability.

The differences in risk-management-related ratios between different universities indicate that, on the one hand, some institutions maintain very stable and healthy ratios. On the other hand, some face huge risks that might eventually impact long-term sustainability. In this regard, proper risk management would require universities to follow such ratios closely and take measures that could mitigate those associated with liquidity, solvency, and student debt growth. Some specific strategies include increasing cash reserves, diversifying revenue, and improving mechanisms for debt collection.

4.3.2. Investment-related ratios

Tables 2 and 5 above deal with investment-related ratios: the total operating surplus and reserve ratios. The ability of universities to generate a net operating surplus, both without and with interest income, and trends in these ratios are critical for their ability to reinvest surpluses in maintaining or expanding productive capacity. The rising trend in these ratios, specifically the increase in 2021, indicates that universities are improving their ability to generate operational surpluses. This is crucial for financing capital investments without relying on external funding. However, the variability and differences between universities suggest that even though some universities appear well-positioned to finance their investments, others may not do so without other financial management strategies. Council-controlled reserves and total reserve ratios measure the funds available that are not earmarked for specific purposes but can be used for new investments. These have shown an upward trend, further supporting greater financial resilience and the accumulation of reserves as a base to plan future strategic capital investment. This suggests different potentials for financing investments from internal resources.

4.3.3. Strategy-related ratios

An analysis based on financial ratios reveals significant information in the university's strategic plan. For example, looking at the trends in funding clearly shows that approximately seven universities had a decreased trend in their own funding as a percentage of total recurrent income up to 2020 and then an increase in 2021. Such a change would indicate the need to adjust the universities' financing mechanisms to provide them with more predictable and stable financial support. Furthermore, the differences among universities' net operating surplus ratios suggest differences in financial and operational efficiencies. Such differences imply that universities should carefully analyse their own financial and operational contexts before embarking on planning strategies. Some crucial ratios include government support income, own funding, and net operating surplus, all explained in Table 2 above. Universities should assess their financial scenarios and formulate ways to improve their operating surpluses. Those with higher net operating surplus ratios should still optimise their operations for better results. Those with lower or fluctuating surpluses may have to adopt stricter financial discipline to stabilise and improve surplus generation.

4.3.4. Operational sustainability-related ratios

Table 2 above shows the operational sustainability financial ratios, total operating surplus with and without interest, and personnel cost ratios. Note that a rising trend in net operating surpluses after removing interest reflects increased operational efficiency and better financial management. The range and standard deviation scores remain high, implying that some universities could be operationalising on deficits and indicating wide disparities in operational performances. A net operating surplus plus interest income better reflects financial sustainability. The fewer universities in the sample now showing deficits indicate better economic stability overall and a positive harbinger of financial health and longevity. This modest decline in the personnel cost ratio in 2021 may indicate some degree of optimisation of staff costs compared with incomes. Building on these sector-level insights, future research could benefit from institution-specific analyses. Financial ratios such as income per full-time equivalent (FTE) student and cost per academic or research staff member can help assess income and cost structures at the individual university level.

5. CONCLUSION

This paper examines the financial sustainability of South African public universities over the period 2017–2021 and brings out the challenges and improvements in the sector. State support, own funding, and rising operational costs significantly impact HEIs. Historically, there has been a heavy reliance on state funding, but it hasn't kept up with the growing needs and enrolment pressures of universities. To bridge this gap, other universities have relied minimal on their own funding sources, such as tuition fees and third-stream income. However, these sources have not been sufficient to cover rising operating costs. Between 2017 and 2021, the financial landscape of South African public universities varied across institutions. Financial ratio analysis showed notable differences in performance, with some universities demonstrating stronger reserve accumulation, higher operating surpluses, and better liquidity positions. Others continued to show signs of financial strain, including persistent deficits and high student debt exposure. These results derived not only from mean values but also from standard deviation, variance, and range highlighted significant institutional differences and revealed that improvements in financial stability have not been uniform. This variability in financial outcomes reflects broader institutional challenges, including operational cost pressures and varying levels of strategic and risk management maturity.

Some financial ratio analyses show the extent to which some universities have greater dependency on state support in comparison to others, which diversify their revenue sources more effectively. The personnel cost ratio represents a very significant portion of the total recurrent income. Although some universities have optimised personnel costs relative to income, others are burdened by inflexible expenditure patterns. The study also demonstrates how universities are progressing towards financial stability, as measured by an increase in reserve ratios and operating surpluses. However, financial stability has not been uniform across all universities; some have demonstrated better financial management and operational efficiency. This really speaks to a broader issue of financial inequality within universities, which could impact their ability to deliver on their education and the state of their infrastructure.

The liquidity and solvency ratios indicate that, although some universities are doing very well in terms of meeting short-term obligations and managing against debt, others are less financially stable and pose a potential long-term risk. An increasing trend in the proportion of student debt relative to fees also raises concerns about increased financial pressure on students and possible effects on university income. It is acknowledged that this study focused on sector-wide trends based on publicly available audited financial statements and did not assess detailed liquidation treatment, individual funding discrepancies, or internal income activities of universities. Future research could incorporate institution-level financial records to explore these dimensions.

The overall financial sustainability of South African public universities remains a complex and multifaceted issue. While progress is evident in several financial dimensions, such as surplus generation and reserve strengthening, challenges remain in aligning financial strategies with institutional capacity and funding adequacy. As the results across financial indicators are mixed, a one-size-fits-all solution would be inappropriate. Instead, universities should adopt context-responsive approaches to planning, guided by continuous financial monitoring and adaptive strategies.

Importantly, this study recommends the following policy considerations: (i) reassess the long-term sustainability of NSFAS and its implications for institutional stability, (ii) support third-stream income growth through enabling frameworks, (iii) incentivise financial efficiency through strategic budget allocation and performance-linked funding, and (iv) establish early warning systems using ratio trends to identify emerging financial stress. These measures may support more balanced and resilient funding models in the future.

Significantly, the study offers a foundation for financing innovations that challenge traditional state support and tuition fees. This includes exploring alternative revenue streams and enhancing operational efficiencies to enable universities to maintain quality despite financial constraints. The findings contribute to the broader discourse on HE funding in South Africa, which is crucial for policymakers, academic leaders, and other stakeholders advocating for a sustainable HE system. Progress in this regard will require collaborative effort, innovative thinking, and adaptive policy implementation. In doing

so, South African public universities can better confront the challenges of financial sustainability and continue contributing to excellence in education and national development.

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Author's contribution

Lungelo Mjabulisi Khumalo's contribution to the paper is 70%. He designed the study and wrote the paper.

Daniel Schutte's contribution to the paper is 30%. He reviewed the paper and provided guidance.

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Data availability statement

The data that support the findings of this study are available from the corresponding author Daniel Schutte, (e-mail: danie.schutte@nwu.ac.za) upon reasonable request.

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Social Acceptance of Nuclear Energy Among Y and Z-Generation Hungarian Residents

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SUMMARY

Governments all over the world are trying to find the balance between the constantly increasing electricity demand of their countries' economy, while mitigating the negative effects of energy generation on the atmosphere (especially CO2 emission). Nuclear energy generation seems like a solid solution for both problems; however, the technology itself is considered as a two-edged sword by many people because of the negative effects of a possible accident. To understand people's attitude, scholars and researchers developed several behavioral and technology acceptance models such as TPB, TAM, and Risk-Benefit Concept, which they used successfully in many countries to investigate energy-related topics. This study aims to scrutinize the social acceptance of nuclear energy generation among Y and Z generation Hungarian residents to gain a deeper understanding of the factors that could support the acceptance and promotion of the technology. For this purpose, a unique theoretical framework has been developed (by mixing the above-mentioned behavioral and technology acceptance models) and tested via survey method, where the gathered data has confirmed the importance of the influencing factors of the model.

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1. INTRODUCTION

1.1. The Potential of Nuclear Energy

In order to decarbonize the world's economy, people tend to focus on the utilization of renewable energy sources and not give enough credit to the possibilities that lie in nuclear energy. This is so even though- based on a study by Sarkodie and Adams (2018) renewable energy investment has a competitive disadvantage compared to fossil fuel and nuclear energy systems, because for them to be attractive, fiscal incentives from governments are required to achieve development in three key areas: technology (research and development), industry (higher performance and quality) and commerce (available and accessible markets).

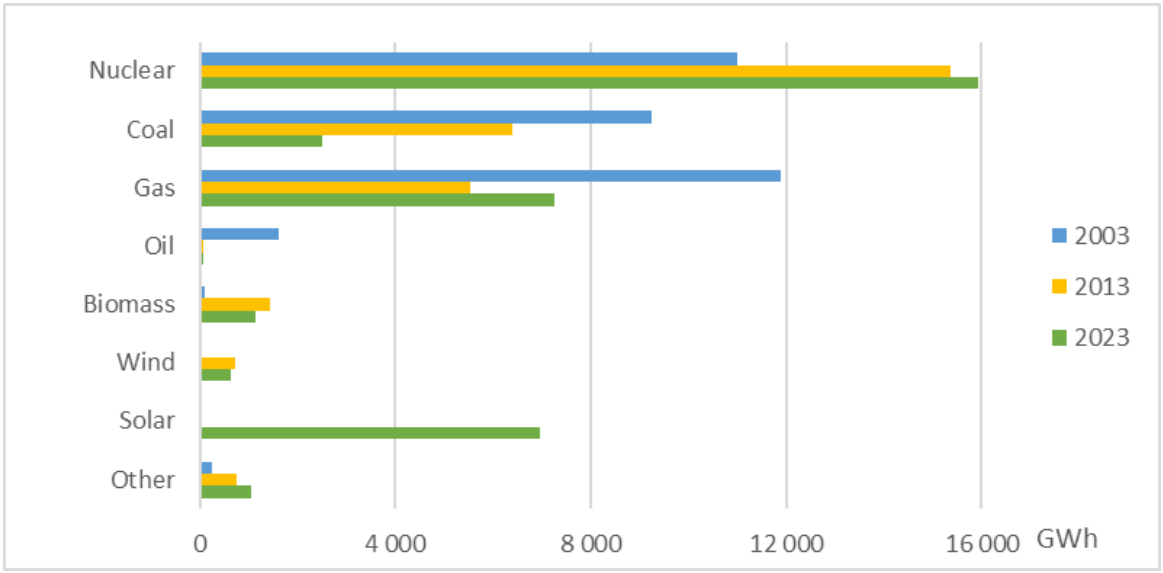
Nuclear power plants (NPP) could be the solution to maintain the balance between the constantly growing energy needs of the economies while offering a less harmful way of producing energy than burning fossil fuels. Throughout its lifecycle, nuclear fuel emits roughly the same amount of carbon dioxide as wind turbines, when measured per unit of energy production, and this ratio is even better (only one-third) when compared to solar panels. (Arias & Lozano, 2001; Knief, 1981; Rust, 1979) At the same time, it is also important to highlight that CO_2 emission is mostly related to the front-

end processes of the nuclear fuel cycle and less to the building, operation, or back-end processes (Rashad & Hammad, 2000). From a financial point of view, building NPPs could also be a reasonable solution for meeting the constantly growing energy demand, since these facilities produce base-load electricity less expensively than many other energy sources (thanks to their low operating costs), while from an operation aspect, availability cannot be a negligible element either, since NPPs are able to generate electricity 24 hours a day. (Lau et al., 2019; Rosen & Dincer, 2007)

1.2. Hungary's electricity mix

Based on the data of the International Atomic Energy Agency and the World Nuclear Association, nuclear reactors generated a total of 2545 TWh of electricity in 2022, in 38 countries. From the total of 437 operable reactors, 413 were operating throughout the year, while only 25 were suspended (21 in Japan, mostly due to the Fukushima accident in 2011, and 4 in India) (IAEA, 2024; World Nuclear Association, 2023; Yamagata, 2024).

Hungary is one of the above-mentioned 38 countries with nuclear energy capacity. A nuclear power plant has been in operation since 1982, contributing significantly to the electricity mix of the country. (MVM, 2024)



Source: Own editing based on KSH (2024a) data

Figure 1: Gross electricity production of Hungary by source in 2003, 2013 and 2023

As can be seen in Figure 1, Hungary's electricity mix has substantially changed in the last 20 years. The usage of coal decreased by 73% compared to the data from 2003, while oil consumption had been nearly eradicated in these decades. On a positive note, solar energy became an essential component (6,960 GWh) due to the EU and government incentives (FIT, METÁR systems and other tenders such as Napenergia Plusz Program) but biomass and wind turbines are also taking their fair share from the electricity production with 1,126 GWh and 645 GWh in 2022 (Atsu et al., 2021; Szolnoki, 2022; Szőke, 2023). While the share of renewable energy sources increased substantially, nuclear energy remained the number-one contributor with 15,918 GWh, making for 45% of the overall mix in 2023 (KSH, 2024a). Since Hungary has a long-term relationship with nuclear energy, it is no wonder that the government had already started to explore the theoretical options for expanding the currently working nuclear power plant back in 2009. The project officially began in 2023, when the Hungarian government signed the construction contract for building two new units with a combined capacity of 2,000 MW, in addition to the current plant. That means that if everything goes according to the construction plan, for a couple of years nuclear energy will become even more significant in Hungary's energy and electricity mix because the old units will be operating simultaneously with the new ones (Paks 2 is expected to be ready in 2032, while the old units will be phased out from 2037) (Ablonczy, 2023; Paks 2 Zrt., 2024).

To maintain or temporarily increase the contribution of nuclear energy in the country's electricity mix seems like a reasonable idea, based on the fact that the demand has shown a slow but continuous tendency to grow in the past decade (KSH, 2024a). Studies suggest that by 2040 the yearly electricity usage could be around 66,000 GWh, which is 85% more than in 2023 (ITM, 2020).

Today's policymakers must take into consideration not just the previous trends but also prepare the electricity system for the upcoming structural changes in Hungary's economy. A series of articles published in recent years indicate that the

government's idea is to make the country into a battery-producing superpower, which is a highly electricity-intensive sector (HIPA, 2022; McCormack, 2023; Simon, 2023). To fulfill that role, a steady energy supply is essential for the country, and nuclear energy meets this objective.

1.3. Nuclear energy as a divisive issue: social dilemmas

Although many scholars (Naser, 2015; Uche et al., 2023; Wang et al., 2023; Yue et al., 2022) have argued that countries should promote the development of nuclear energy, the downside of this technology should not be forgotten. The greatest public concern about using nuclear power is that a major incident can happen, which could have severe consequences for the environment or for the local population (McCombie & Jefferson, 2016). These events (for example the Three Mile Island accident in the USA, the Chernobyl accident in Ukraine, or the Fukushima accident in Japan) are usually accompanied by dread and fear of the unknown or also called "radiation phobia" which can influence how different generations perceive benefits and risks by operating an NPP (Ayoub & Sornette, 2023). Another concern of laypeople regarding the usage of nuclear energy is the disposal of the wastes produced by the process. A survey carried out by Flynn et al. (1990) in the USA revealed that citizens would like to have a median distance of 320 kilometers from a nuclear waste facility. This mentality can be described as the NIMBY phenomenon (which refers to "Not in My Back Yard") and it indicates that people are willing to support a cause as long as they are not directly affected by it, otherwise they (actively) oppose it (Bell et al., 2005; Bonev et al., 2024; Hu & Han, 2023).

For these reasons, nuclear energy can be considered a two-edged sword, and many scholars, such as Goodfellow et al. (2011), argue that policymakers must acknowledge the fact that public perception is an important factor, and without winning the public's opinion, such developments cannot be successfully carried out. When governments are thinking about promoting nuclear energy, it is necessary to persuade the citizens that the perceived benefits outweigh the perceived risks, thus gaining a social license to operate (Hall et al., 2015; Moffat & Zhang, 2014). In this study I focus on the social acceptance of nuclear energy among Y and Z generation citizens of hungarians because they represent 37.4% (KSH, 2024b) of the population, they have not been affected by any serious nuclear accident in their lifetimes, and due to technological advancement they have wide access to information and data about anything that they care about, including energy generation, energy dependency, and even the operational risks and benefits of a nuclear reactor.

2. Literature review

Forecasting citizens' perceptions associated with new technologies is a popular topic in both academic and business environments; thus, several theories have come to light in the last four decades.

To understand the motives behind people's decisions, the Theory of Planned Behavior (TPB) model (which is an extension of the theory of reasoned action model) was introduced by Icek Ajzen in 1991. It was designed to predict and explain human behavior in specific contexts. The model describes that people's behavior in a given situation depends on their intention (aggregated motivational factors), which indicates how much effort they are planning to exert in order to engage in a behavior (Ajzen, 1991).

This intention can be described as the aggregation of the following factors:

- Attitude towards the behavior, which means that people constantly evaluate the outcome of a particular behavior based on the assumption, that it will carry out positive or negative personal value for them (Ajzen, 1991).
- Subjective norms are in a broader sense the equivalent of the expected behavior set by the society or relevant others (family, friends, or just important people in our environment such as colleagues, doctors, personal trainers, and so on) (Fishbein & Ajzen, 1975; Nickerson, 2023).
- Perceived Behavioral Control based on Bandura (1982) determines an individual's beliefs about whether they can carry out a given task or not. When people encounter difficulties, those who have serious doubts regarding their capabilities tend to slacken their efforts or completely give up on overcoming the challenges, while those who believe in their own strong self-efficacy tend to exert greater effort in order to complete the task at hand (Bandura & Schunk, 1981; Schunk, 1984; Schunk, 1991).

In order to better explain human behavior in technology-related topics, the Technology Acceptance Model, which was introduced by Davis in 1985, is often used in an extended form with the TPB model (Chang, 2023; Chen, 2016; Ong et al., 2022; Tang & Jiang, 2024; Wong et al., 2024).

According to the model, technology acceptance is a three-stage process, where different External Factors (design features) can trigger Cognitive Responses (perceived ease of use and perceived usefulness) in the potential user, which form an Emotional Response (attitude toward using technology) influencing the Behavioral Response, thus determining

whether someone is willing to use the given technology or not (Davis, 1985). In the model, Perceived Usefulness is defined as the potential user's belief that the use of a certain technology will improve his/her performance and Perceived Ease of Use refers to the effort that the potential user has to make (whether is it mental or physical) in order to use the technology (Davis, 1989; Innovation Acceptance Lab, 2024). While the above-mentioned factors are permanent in the model, the number of external factors can vary. In previous studies, many factors have been identified, that had a significant impact on public acceptance, but the most often used and confirmed one was Knowledge (Alzahrani et al., 2023; Jang & Park, 2020; Ong et al., 2022; Zhu et al., 2016).

Another popular approach especially in nuclear energy topics for analyzing the acceptance of the population is the risk-benefit concept (Guo & Ren, 2017; Ho et al., 2019; Mah et al., 2014; Wang et al., 2019). As Heider (1958) highlights, seeking benefits is part of our daily life, and even in our relations, we tend to like those people who benefit us. Wang et al. (2022 p. 5) defined perceived benefit as "the perceived likelihood that taking a recommended course of action will lead to a positive outcome" even if it is shown only in psychological terms such as reduced risk or reduced worry. In this research, perceived benefit is defined as the individual's belief that either he or the whole society will benefit from developing and or utilizing nuclear energy technologies.

According to Jacobs and Worthley (1999 p. 231), "risk can be defined by the probability of an event and magnitude of its consequences". Nuclear energy production is widely perceived as a dangerous technology compared to the usage of other renewable sources because in case of an accident (malfunctioning, leakage, improper waste management) the consequences can be severe for the economy, for the environment, and even for the individual's health (Cha, 2000; Keller et al., 2012; Parkhill et al., 2010). For this reason, based on Wang et al. (2019), perceived risk will be defined in this study as the extent to which the public believes that they may be exposed to certain risks or hazards arising from the usage of nuclear energy production.

In this research I combine the above-mentioned behavioral models- as other researchers did in other countries- in order to identify the social acceptance of the Hungarian Y and Z generation related to nuclear energy generation, while trying to keep my model as simple as possible so that even a limited number of survey respondents could support my hypotheses.

3. Theoretical framework

Many scholars in different countries have confirmed that knowledge is an important psychological factor that can influence risk and benefit perception in both ways. Insufficient knowledge can hinder not just the development of nuclear energy but even the development of the less controversial renewable energy sources; therefore, it is crucial to pay attention to this factor in case governments want to promote nuclear power plants on a wider scale (Frederiks et al., 2015; Kardooni et al., 2016). Wang et al. (2019) in their survey of Chinese residents also found a significant positive effect between knowledge and perceived benefit, while Huang et al. (2013) examined how the Fukushima accident affected the risk perception of residents living near a nuclear power plant in China. Alzahrani et al. (2023) also argue that as people gain more information about the principles of nuclear energy generation, they will worry less as the advantages start to outweigh the disadvantages; at the same time, faith is replaced in their mindset by facts (Wallquist et al., 2010). As a result, I propose the following hypotheses:

H1: Knowledge about nuclear energy has a significant effect on Risk Perception
H2: Knowledge about nuclear energy has a significant effect on Benefit Perception

Creating knowledge and influencing public opinion is not a subject of this research but based on Elmustapha et al. (2018) and Kiss (2023) mass media and gamification methods can be useful intermediary tools for this purpose, while Yamagata (2024) emphasizes that young people obtain more information from the internet and they trust it more than they trust information from older generations; thus, providing sufficient data on this channel could be a useful way to increase their awareness.

Attitude in the TPB model pertains to the mindset when people decide about their point of view or about their future behavior related to an important topic, based on the assumption that it will carry out positive or negative value for them (Ajzen, 1991). Previous studies, such as Ryu et al. (2018), have confirmed that there is a negative relationship between perceived risk and public attitudes in the case of nuclear energy technologies; thus, if the perceived risks outweigh the perceived benefits, people will not support this type of energy source. When people do not take any action for or against a technology, that means that they simply tolerate it (Huijts et al., 2012). While not supporting a case is an easy decision, taking action against it is quite another. Sadly, in the case of nuclear energy generation, there is no middle ground, which means that if there is no public support, then usually there is active public resistance (Huang et al., 2018). Huhtala and Remes (2017) concluded that if the risk perception of the residents is high, then it directly results in lower public acceptance and larger social expenses. Siegrist et al. (2014) found that attitudes toward nuclear energy can change over the course of time, and in case of a serious accident this can happen abruptly, especially if it is close to the individual's

living environment (change of the attitude of Japanese people towards nuclear energy after Fukushima), therefore permanent attention is required to maintain public support. Interestingly, there is a gender difference between the influencing factors of attitude, according to Choi et al. (1998), benefit perception is more dominant in male participants' attitudes toward nuclear energy, while female participants give more importance to perceived risks. As a result, I propose the following hypotheses for the theoretical framework:

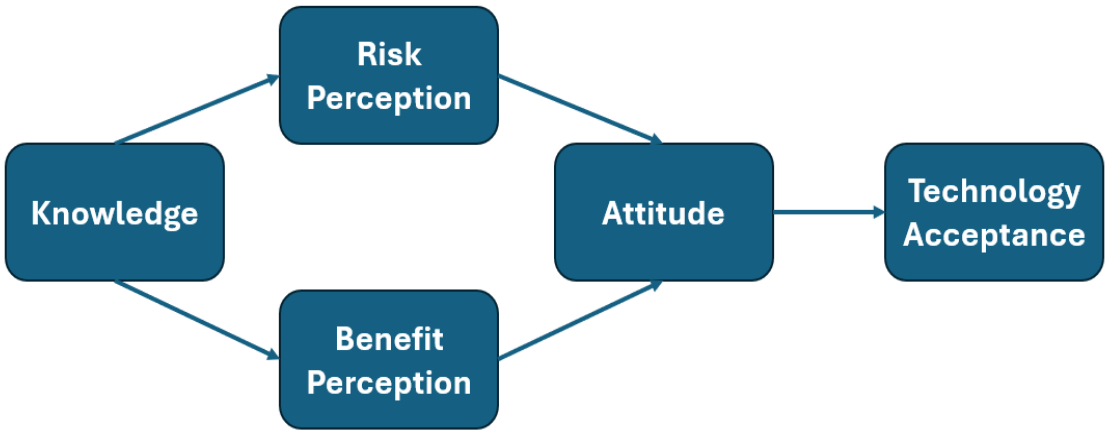
H3: Risk Perception has a significant effect on Attitude
H4: Benefit Perception has a significant effect on Attitude

Technology acceptance refers to the state where people accept the presence of a new technology in their daily lives, which is usually later manifested in actual system usage. Technology acceptance derives from different and complex motivational factors, such as public perception, or from social, cultural, and historical factors (Liu et al., 2008), but many scholars have proved that one of the key elements of this factor is attitude (which can also be an accumulated factor) (Jang & Park, 2020).

As Savari and Gharechaee (2020) implied, aggregated motivational factors can determine technology acceptance in both ways. Conducting research amongst Iranian farmers, they confirmed that attitude has a significant effect on technology acceptance and influencing the antecedent factors can lead even to technology rejection if it is desired. Lim et al. (2017) found that residents close to a future nuclear-related facility may strongly oppose its construction, even if it would be beneficial for the majority of the population. This statement was supported by Xiao et al. (2017), who also confirmed that without gaining the trust of local communities, there is no way to successfully expand the use of nuclear energy. For this reason, governments have to make more efforts to persuade local residents than those who farther away from the construction site. At the same time, it is also important to note that the influencing factors of technology acceptance may vary over the course of time. Park and Ohm (2014) found that after the Fukushima earthquake and accident, the main factor that determines technology acceptance shifted from perceived costs to public attitudes. As a result, I propose the following hypothesis:

H5: Attitude has a significant impact on Technology Acceptance

In alignment with the above-presented models and studies, Figure 2 depicts the theoretical framework of the study. This illustrates the various factors that were considered for the extended Technology Acceptance Model, which focuses on the acceptance of nuclear energy among Y and Z generation people in Hungary.



Source: Own editing based on TAM, TPB and Risk-Benefit concept models

Figure 2: Conceptual framework of the study

4. METHODOLOGY

4.1. Sample selection

The aim of this study is to scrutinize the nuclear energy acceptance of Y and Z generation people in Hungary. The time periods of the different generations are identified variously in the literature (Gen Y from 1980-1982 to 1994-2000) and there is no one common classification accepted by everyone (BBC, 2024; Laor & Galily, 2022; Seaman et al., 2018; Vafaei-Zadah et al., 2022). Due to this reason, the separation between Gen Y and Gen Z was made by the presumed economic status at the time of the study:

- Gen Y: 1980-1998, who is probably economically active and already has a family therefore cares more about the future.
- Gen Z: 1999-2010, those who are probably still studying and are not yet supporting themselves.

This classification was also considered when setting the ranges for the age question in the questionnaire.

At the beginning of the questionnaire, the respondents were asked to accept the data policy, confirming that the survey information they submitted would be used for research purposes only and anonymously. A consent statement was provided in the preface section of the questionnaire, and respondents were asked to confirm their agreement with a checkbox before proceeding with the questionnaire items (if they did not accept the terms, the questionnaire jumped to the last page without recording any information).

The Hungarian-language survey was sent out to 1,200 students of the University of Miskolc who were studying economics at that time or in the previous three years at the university. At the same time, it was also shared in a Hungarian Facebook group specialized in research questionnaires where young researchers can mutually fill out each other's forms. For this reason, the survey cannot be considered representative of the Y and Z generation of Hungarian residents; however, the high number of the respondents lays the foundations of the research. The survey was available online from the beginning of May 2024 till the end of May 2024. In that period, 232 people answered the questions: about 90% of the answers came from university students and about 10% from the Facebook group. From this data pool, 3 potential participants were excluded because they did not accept the data policy, and another 13 people were excluded at the end because based on their age, they were not part of Generation Y or Z. As a result, the final table contained the data from 216 participants.

4.2. Sample

At the beginning of the survey, four demographic questions were asked: Gender, Age, Residence, Education.

From the 216 respondents who are within the age range, the majority are considered Generation Z, which seems reasonable because the survey was sent out mostly to undergraduate students who are usually starting their college education after high school at age 18 or 19. Consequently, the remaining 72 respondents were from Gen Y (49 respondents were in the 25-34 age group, while 23 respondents were in the category of 35-44 years old).

As can be seen from Table 1, almost two-thirds of the respondents were women, which is probably due to the fact that women usually tend to fill out surveys on a higher scale than men (Smith, 2008), and additionally, the survey was sent out mostly to economics students, where the balance also shifts in favor of women.

The University of Miskolc is a prestigious school located away from the capital; therefore, 85% of the respondents are currently living in villages, cities, or in cities that are county seats. Since Miskolc is located close to the country's borders, Hungarians who are living abroad but studying at the university also filled out the survey (since the language of the survey was Hungarian it is unlikely that any of the respondents were international student).

The distribution of the educational attainment also reflects the characteristics of the sample. The majority of the respondents had only a high school degree or post-secondary educational degree, probably due to their young age, with only one-fourth of them holding a degree.

Table 1

Descriptive statistics of the sample

Sample characteristics	*Frequency*	*Percent*
Gender		
Men	84	38.9
Women	132	61.1
Age		
18-24	144	66.7
25-34	49	22.7
35-44	23	10.6
Residence		
Abroad	4	1.9
Village	56	25.9
City	69	31.9
County seat	60	27.8
Capital city	27	12.5
Education		
Secondary School	140	64.8
Post-secondary vocational education	23	10.7
College or University Degree	53	24.5

N = 216

Source: Own editing based on the survey data

4.3. Measurement

In this investigation the questions for the questionnaire of the study were carefully selected, with the purpose of gathering important data about the perception of the Hungarian residents related to the usage of nuclear energy as an alternative energy source to fossil fuels.

Based on the conceptual framework, presented theories, and the received feedback, the questionnaire is divided into five sections (in addition to the demographic section). Survey questions in the same topic by other researchers were considered (see Appendix 1) when developing my own structure. The questions were divided into the following categories:

- Knowledge (4 items)
- Risk Perception (3 items)
- Benefit Perception (3 items)
- Attitude (3 items)
- Technology Acceptance (3 items)

To assess the validity and reliability of the survey instruments and questionnaire contents, two researchers from the University of Miskolc were contacted through e-mail and invited to evaluate the questionnaire and look for double-barreled, perplexing, or leading queries, which they are examples of errors. The researchers were selected based on their expertise in nuclear science, energy transition, and survey methodology, which is a requirement for content validation (Taherdoost, 2016).

The survey utilized a 5-point Likert scale to evaluate the perception of participants related to the latent variables, and the questionnaire was provided in Hungarian as it is the official language of the country. (Appendix 2)

For analyzing the technical variables, first Cronbach's α was calculated in order to check the reliability of the data; results can be seen in Table 2.

Table 2

Unidimensional reliability of the analyzed variables

Variable	Cronbach's α	CI = 95%
Knowledge	.78	[.72; .82]
Risk Perception	.66	[.57; .73]
Benefit Perception	.75	[.69; .81]
Attitude	.77	[.71; .82]
Technology Acceptance	.89	[.86; .91]

Source: Own editing based on the survey data

Based on the data in Table 2, the reliability is considered acceptable for all factors as the lowest Cronbach's α in the table is still above α = .65 (for Risk Perception), while most of the factors are above α = .75 (Zeller, 2005).

Due to the decent reliability results, the scale scores were created by averaging; thus, the values range from 1 to 5.

5. Statistical Analysis

5.1. Descriptive statistic

I started by reviewing the descriptive statistics of the variables included in the study. As can be seen from Table 3, the skewness value is close to 0 regarding all variables, which indicates that the dataset is symmetrically distributed.

Further analyzing the dataset, it can be seen that the kurtosis values are negative, which indicates that the distribution has slightly lighter tails and a flatter peak than the normal distribution (platykurtic kurtosis), and responses also occur towards the edges of the mean, therefore covering the whole range relatively well (see Appendix 3). Based on the skewness and kurtosis values, which are both relatively close to 0, the dataset is considered to be normally distributed.

After that, I used a t-test to examine the difference between the Risk and Benefit Perception measures and how they are affected by the different demographic factors. Since the data gathered by the questionnaire for the demographic factors were ordinal, this analysis was performed with the Spearman correlation, while the correlations between the factors of the theoretical framework were analyzed with the Pearson correlation. Unfortunately, the number of respondents did not allow the investigation of the model as a whole, so to tackle that issue, a decision was made to separate the framework into two different models. For the first part, parallel mediation analysis was performed in order to test the mediating role of Risk and Benefit Perception between Knowledge and Attitude, while for the second part, linear regression was used in order to test how well the different factors can predict Technology Acceptance.

To perform the above-mentioned analyses, the software JASP was utilized, which is an open-source statistical tool developed by the University of Amsterdam.

5.2. Results

In order to get a deeper understanding of the data, descriptive statistics were performed and the results are presented in Table 3.

In the questionnaire, two variables were used to obtain the respondents' perceptions about the effects of nuclear energy generation. Positive perception about nuclear energy generation was identified with Benefit Perception, while negative perception was identified with Risk Perception factor. Using a paired samples t-test, a significant difference was found between the magnitude of Risk and Benefit Perception, $t(215) = -4.86$ $p < .001$ Cohen's $d = -0.33$, which means that respondents of the survey perceived the benefits larger.

Table 3

Skewness and kurtosis of the analyzed variables

Variable	Mean	Std. Deviation	Skewness	Kurtosis
Knowledge	2.98	0.88	0.06	-0.50
Risk Perception	3.09	0.91	-0.11	-0.54
Benefit Perception	3.57	0.87	-0.20	-0.30
Attitude	3.19	0.89	0.00	-0.22
Technological Acceptance	2.66	1.07	0.21	-0.57

Source: Own editing based on the survey data

After that, I examined whether nuclear energy scales show a correlation with demographic indicators. The four demographic factors considered in the questionnaire were gender, age, education, and place of residence. In order to test the possibility of any gender difference, an independent samples t-test was used on the dataset.

In Table 4 it can be seen that for the factors Knowledge, Benefit Perception, Attitude, and Technological Acceptance there is a positive significant difference, which means that men give higher ratings to these variables than women do, while for Risk Perception the significant difference remains, but with a negative direction, which means that in this case women perceive the risks associated with nuclear energy generation as being higher than men do.

Table 4

Independent samples t-test

	Mean		Std. Deviation		t	p	Cohen's d
	Men	Women	Men	Women			
Knowledge	3.35	2.75	0.83	0.83	5.24	< .001	0.73
Risk Perception	2.71	3.33	0.92	0.81	-5.15	< .001	-0.72
Benefit Perception	4.01	3.30	0.78	0.82	6.36	< .001	0.89
Attitude	3.64	2.91	0.86	0.80	6.29	< .001	0.88
Technological Acceptance	3.10	2.38	1.07	0.97	5.11	< .001	0.71

Men: N = 84; Women: N = 132

Source: Own editing based on the survey data

Based on the conceptual framework of the study, correlations of the demographic variables is investigated, which can be seen in Table 5.

The results show that the Age factor is related to the Education factor with a positive strong correlation, so as people become older, they usually become more qualified, as they have more time to educate themselves. I think this is especially true of this database, as many participants, at 18-24 years old, literally did not have time to gain a higher qualification than finishing their high school studies. Related to that, there is a positive weak correlation between Age and Knowledge also.

Education also has a link with Knowledge; presumably those who are more educated have more knowledge about nuclear energy generation, while based on the data there is a negative and weak connection between Education and Risk Perception, therefore more educated people usually evaluate Risk Perception, at a lower level than those who have a lower educational background.

Table 5

Spearman's Correlation between the different variables

Variable	Age	Residence	Education
Age	—		
Residence	.077	—	
Education	.51***	.10	—
Knowledge	.17*	.02	.22**
Risk Perception	-.11	-.13	-.15*
Benefit Perception	-.06	.09	.03
Attitude	-.02	.11	.06
Technological Acceptance	-.08	-.02	.04

* p < .05, ** p < .01, *** p < .001

Source: Own editing based on the survey data

Table 6

Pearson's Correlation between the different variables

Variable	Knowledge	Risk Perception	Benefit Perception	Attitude	Technological Acceptance
Knowledge	—				
Risk Perception	-.37***	—			
Benefit Perception	.56***	-.37***	—		
Attitude	.51***	-.43***	.66***	—	
Technological Acceptance	.43***	-.47***	.59***	.73***	—

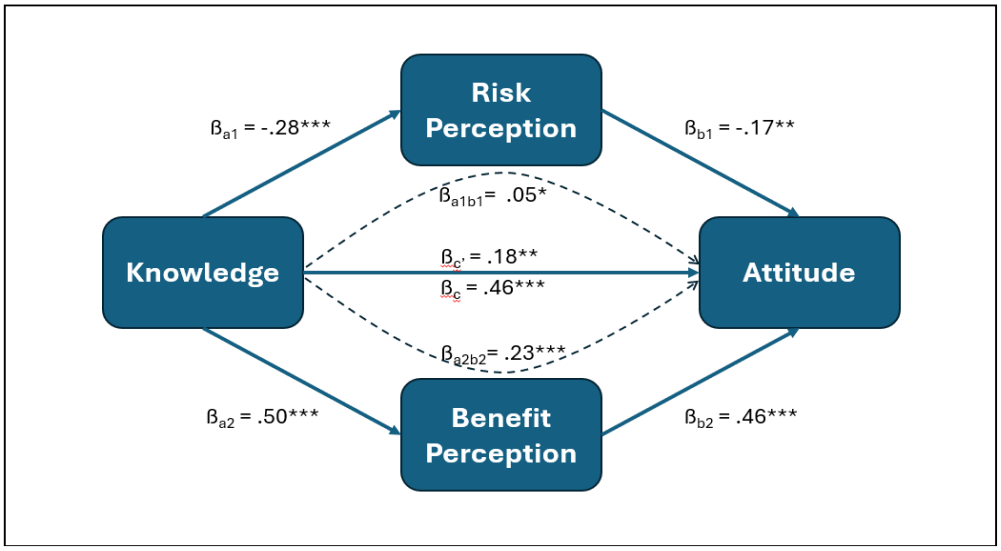
Source: Own editing based on the survey data

As can be seen from Table 6, there is a positive strong connection between Knowledge and Benefit Perception, which means that people who dig deeper into the literature on nuclear power generation tend to rate the benefits coming from the usage of the technology higher than others, while at the same time, they devalue the risks (negative medium link between the two factors).

The same dichotomy can be discovered when the correlation is measured between Attitude and Risk and Benefit Perception variables. Simply put, if Benefit Perception increases, it has a positive strong correlation with Attitude while evaluating the risks highly, usually resulting in lower Attitude towards the technology (negative medium correlation).

Interestingly, the strongest relation is between Attitude and Technology Acceptance (0.730), which means that if people have a strong positive attitude towards the technology, then they are open to supporting the spread of it.

To analyze the direct and indirect effects of the factors of the model, mediation analysis was performed on the data of the survey; however, because of the limited data availability (N = 216) the conceptual framework was divided into two different analyses. Throughout the analysis, background confounders were used (Gender, Education, Residence, Age) and the values represented in Table 7 are modified by these factors, therefore, the effects of the direct and indirect paths are independent from the demographical aspects of the survey.



Note: * p < .05, ** p < .01, *** p < .001
The model has been controlled for demographic indicators and the ß values are unstandardized
Source: Own editing based on the survey data

Figure 3: Parallel mediation analyzing the relationship between knowledge and attitude mediated by RP and BP

As can be seen in Figure 3, Risk Perception and Benefit Perception are both considered mediating factors between Knowledge and Attitude. The total explanatory effect is $ß_c$ = .457, while the direct effect is $ß_{c'}$ = .181, which means that Knowledge by itself is significantly responsible for shaping people's Attitude toward nuclear energy generation. At the same time, the total indirect effect ($ß_{ab}$ = $ß_{a1b1}$ + $ß_{a2b2}$) is also significant ($ß_{ab}$ = .276), but it is divided between the two perception factors. Risk Perception accounts for $ß_{ab1}$ = .046 and $ß_{ab2}$ = .230. It is also important to note that there is a negative relationship between the Knowledge → Risk Perception → Attitude path, which also proves that acquiring more information about nuclear energy technology, will result in a decreasing risk perception, and this lower perception value will have an opposing effect on the Attitude (with decreasing Risk Perception, Attitude will increase). Based on the analysis results in Table 7, all effects presented in Figure 3 are considered significant.

Table 7

Mediation analysis of Knowledge, Perception, and Attitude factors

				Estimate	Std. Error	p
Path coefficients						
$ß_{b1}$ - Risk Perception	→		Attitude	-.17	.06	0.005
$ß_{b2}$ - Benefit Perception	→		Attitude	.46	.07	< .001
$ß_{c'}$ - Knowledge	→		Attitude	.18	.06	.003
$ß_{a1}$ - Knowledge	→		Risk Perception	-.28	.07	< .001
$ß_{a2}$ - Knowledge	→		Benefit Perception	.50	.06	< .001
Total effects						
$ß_c$ - Knowledge	→		Attitude	.46	.06	< .001
Direct Effects						
$ß_{c'}$ - Knowledge	→		Attitude	.18	.06	.003
Indirect Effects						
$ß_{a1b1}$ - Knowledge	→	Risk Perception	→ Attitude	.05	.02	.033
$ß_{a2b2}$ - Knowledge	→	Benefit Perception	→ Attitude	.23	.05	< .001

Note: The model has been controlled for demographic indicators and the ß values are unstandardized
Source: Own editing based on the survey data

Now that the mediation model is considered for the first part of the model, I will analyze the factors influencing Technology Acceptance by building a hierarchical regression model.

Table 8

Hierarchical regression model of Technology Acceptance

Model	R^2	F	p
M_0	.13	7.74	< .001
M_1	.25	13.68	< .001
M_2	.44	23.67	< .001
M_3	.59	37.70	< .001

Note: M_0 includes Gender, Age, Residence, Education
M_1 includes Gender, Age, Residence, Education, Knowledge
M_2 includes Gender, Age, Residence, Education, Knowledge, Risk Perception, Benefit Perception
M_3 includes Gender, Age, Residence, Education, Knowledge, Risk Perception, Benefit Perception, Attitude
Source: Own editing based on the survey data

As can be seen in Table 8, the demographical factors explain Technology Acceptance only in 13%, while the M_3 regression model extended with the professional factors is responsible for 59%. This is a good result, because based on the literature review, basic behavioral models (mixed or extended TPB and TAM models) tend to have 40-50% explanatory power (Aziz et al., 2020).

Table 9

Detailed hierarchical regression model of Technology Acceptance

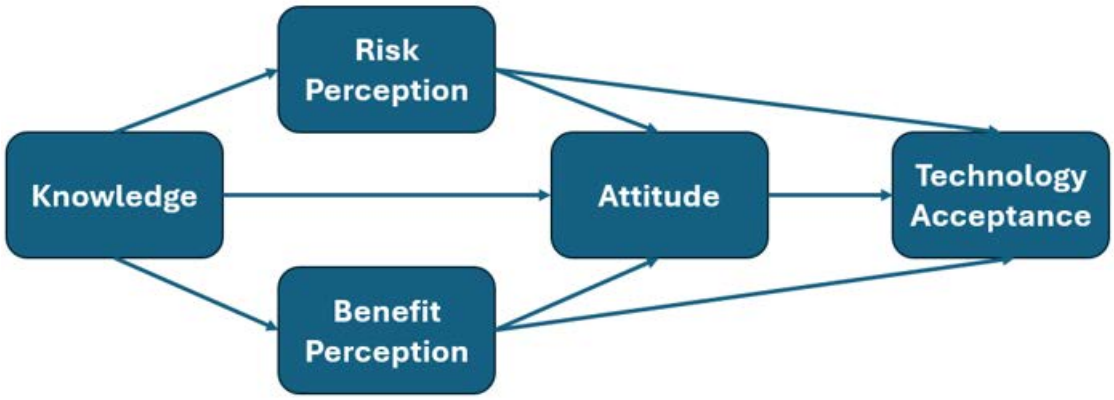
Model	Standardized	p
M_0		
Gender	- .33	< .001
Age	- .14	.061
Residence	- .04	.587
Education	.13	.087
M_1		
Gender	- .21	.001
Age	- .17	.016
Residence	- .03	.612
Education	.06	.393
Knowledge	.38	< .001
M_2		
Gender	- .05	.432
Age	- .10	.101
Residence	- .09	.107
Education	.03	.556
Knowledge	.09	.187
Risk Perception	- .28	< .001
Benefit Perception	.42	< .001
M_3		
Gender	.01	.840
Age	- .06	.274
Residence	- .11	.018

Education	.04	.487
Knowledge	- .01	.858
Risk Perception	- .19	< .001
Benefit Perception	.17	.008
Attitude	.55	< .001

Source: Own editing based on the survey data

When thoroughly analyzing the M_3 model (Table 9), it can be seen that most of the demographic factors and Knowledge only affect Technology Acceptance through the antecedents (Figure 3), while Risk Perception and Benefit Perception have an impact on TA through Attitude, but also exert their effect directly to Technology Acceptance. Interestingly, the Residence factor is the only demographic parameter that has a significant negative effect on Technology acceptance; those who live in bigger towns accept nuclear energy less than those who live in smaller settlements.

Based on the statistical studies carried out above, the hypotheses of the study can be approved, while the final conceptual framework of the research is presented in Figure 4.



Source: Own editing based on the survey data

Figure 4: Final theoretical framework of the research, based on the statistical analyses

The hypotheses of the base model had been confirmed, while other significant effects were also identified between the factors, such as Knowledge on Attitude, Risk Perception on Technology Acceptance, and Benefit Perception on Technology Acceptance.

6. Discussion

In this research, social acceptance of nuclear energy generation was analyzed using a mixed framework of behavioral models (TPB, TAM, Risk-benefit concept) among generation Y and Z citizens of Hungary. Through an online survey 232 responses were gathered, and from them, 216 were considered in the study (others were excluded because respondents either did not accept the data policy or they were not Generation Y or Z). The considered factors of the theoretical framework were Knowledge, Risk Perception (RP), Benefit Perception (BP), Attitude, and Technology Acceptance, while throughout the analysis, I extended my model with demographic attributes such as Gender, Age, Residence, and Education. With the paired samples t-test, I found that Y and Z generation people rate the Perceived Benefits more highly, than they rate the Perceived Risks. This finding is interesting, given the fact that two-thirds of the respondents were women, and women usually tend to focus on the negative effects of nuclear power plants (Choi et al. 1998). Based on the results of the survey, surprisingly, women evaluated the RP and BP factors at almost the same level (RP=3.33; BP=3.30), while men showed a huge difference in their ratings (RP=2.71; BP=4.01), which can be considered a normal deviation based on the literature (Hitchcock, 2001; Islam et al., 2023; Rasmussen et al., 2020). The close values of RP and BP for women may come from their age, as they have not experienced any nuclear crisis in their lives, or also from the fact that the country has a working nuclear reactor; thus, they may have become used to the idea that such a facility can safely produce energy without any malfunction.

Correlation in the demographical data obviously indicated the links between Age to Education and Age to Knowledge, while Education had a significant effect on both Knowledge and Risk Perception. It is interesting that the Residence factor had no significant effect on other demographic factors, nor on the factors of the theoretical framework. I think this is the result of globalization, because with the rapid development of convenient services (such as internet connections), distances have shrunk (especially for the Y and Z-generation residents), and a vast amount of data is available to everyone on every topic they are interested for (in 2023, 92.7% of Hungarian households had internet access, and 96.6% of the population used the internet daily), regardless of where they live (Statista, 2025; KSH, 2025). Analyzing the correlation between the professional factors of the model, it can be seen that the selected features indeed have an impact on each other; therefore, the validity of the theoretical framework is proved.

In the base model, Risk and Benefit Perception were considered as an intermediary factor, but the mediation analysis showed that there is also a direct effect between Knowledge and Attitude ($ß_{c'}$ = .181). This means that people who gather more expertise about nuclear energy generation generally have a more positive attitude towards the technology because they feel more familiar with the principles of its operation. In other fields, this concept was proved by Wei et al. (2016), however, in nuclear energy research, this idea is not often analyzed. From the open-access studies available for this research (Appendix 1) only Zhu et al. (2016) examined the effect of Knowledge on Behavioral Intention, and this hypothesis was also accepted in his paper.

The same effect can be observed in the hierarchical regression model, where Attitude cannot fully capture the explanatory power of Risk and Benefit Perception to Technology Acceptance; therefore, there is a significant direct effect between these factors. This concept is often hypothesized in the literature (Alzahrani et al., 2023; Contu et al., 2016; Islam et al., 2023; Roh & Geong, 2021), and the reason why fellow researchers leave out the intermediary factor is probably that nuclear energy generation and an operating NPP can affect people life on such a wide scale (especially in case of malfunctioning), that these perceptions (if already arisen) are strong enough on their own to have an effect on the acceptance or on the rejection of the technology. Although based on my statistical analyses, leaving out the intermediary factor (Attitude) does not seem like a reasonable idea because the explanatory power is presented on the Perception-Attitude-Technology Acceptance path too.

While the hypothesized effects were identified for the dataset, it is important to note that the survey data was not representative of Hungarian Y and Z-generation residents; therefore, it would be useful to extend the data-gathering process in a later study to support the current findings.

7. Conclusion

Hungary is one of the 38 countries that have an operational nuclear power plant in its territory, and policymakers are actively working on increasing its capacities, but building new sites has also not been ruled out yet.

The perception of nuclear energy production as well as the optimal transition to alternative energy sources are hot topics in today's societies; therefore, gaining citizen support is a must-have for this type of endeavor. The aim of this research was to analyze the social acceptance of nuclear energy generation among Generation Y and Z citizens of Hungary in order to get an insight about their ideas for the future electricity mix of the country.

For this purpose, a theoretical framework was built from the social acceptance models available in the literature, such as TPB, TAM, or the Risk-Benefit concept, while trying to minimize the number of factors in order to keep the survey as short as possible. For this purpose, the factors Knowledge, Risk Perception, and Benefit Perception were selected, which theoretically exert their effect through Attitude to Technology Acceptance. After performing a hierarchical regression, it was clear that these factors (with the additional demographic parameters) can predict Technology Acceptance with 59% accuracy, which is a decent value considering the low number of External Factors used in the theoretical framework. At the same time, there is still room to improve the model, perhaps by adding other factors, because a wide range of external factors have been tested for similar studies in other countries. This investigation may serve as a basis for future research in Hungary utilizing a wider scale of psychological factors.

Through the analyses, it was proved that there is a significant effect between the factors of the model, therefore, the basic hypotheses of the theoretical framework were approved, while other significant effects arose, such as the direct effect of Knowledge on Attitude and the direct effect of Perceptions to Technology Acceptance. Based on this information, it is clear that policymakers have to tackle Knowledge, Risk Perception, and Benefit Perception factors if they want to increase the share of nuclear energy in the country's electricity mix. For this purpose, educational materials or campaigns should be more widely available, not just for the younger generations but also for the whole society, especially if increasing the share of nuclear energy generation in Hungary's electricity mix is under discussion.

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Data availability statement

Data available on request due to privacy, from the author: **Péter Bihari** bpeti7@gmail.com

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APPENDIX

Appendix 1: Nuclear energy acceptance researches used as a baseline for the questionnaire

Title	Author	Year	Journal
The acceptance of nuclear energy as an alternative source of energy among Generation Z in the Philippines: An extended theory of planned behavior approach	Belmonte et al.	2023	Nuclear Engineering and Technology
Who is willing to participate? Examining public participation intention concerning decommissioning of nuclear power plants in Belgium	Hoti et al.	2021	Energy Policy
Social acceptance of nuclear power plants in Korea: The role of public perceptions following the Fukushima accident	Jang and Park	2020	Renewable and Sustainable Energy Reviews
A framework of examining the factors affecting public acceptance of nuclear power plant: Case study in Saudi Arabia	Alzahrani et al.	2023	Nuclear Engineering and Technology
Public perceptions and acceptance of nuclear energy in China: The role of public knowledge, perceived benefit, perceived risk and public engagement	Wang et al.	2019	Energy Policy
Modeling individual preferences for energy sources: The case of IV generation nuclear energy in Italy	Contu et al.	2016	Ecological Economics
An empirical study of the risk-benefit perceptions between the nuclear and non-nuclear groups towards the nuclear power plant in Bangladesh	Islam et al.	2023	Nuclear Engineering and Technology
Public Perception of the Nuclear Research Reactor in Thailand	Tantitaechochart et al.	2018	2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)
Predicting unsafe behaviors at nuclear power plants: An integration of Theory of Planned Behavior and Technology Acceptance Model	Zhang et al.	2020	International Journal of Industrial Ergonomics
Effects of information strategies on public acceptance of nuclear energy	Hu et al.	2021	Energy
When it is unfamiliar to me: Local acceptance of planned nuclear power plants in China in the post-fukushima era	Guo and Tao	2017	Energy Policy
Anti-nuclear behavioral intentions: The role of perceived knowledge, information processing, and risk perception	Zhu et al.	2016	Energy Policy
How and when does information publicity affect public acceptance of nuclear energy?	Wang et al.	2020	Energy
Investigating the acceptance of the reopening Bataan nuclear power plant: Integrating protection motivation theory and extended theory of planned behavior	Ong et al.	2022	Nuclear Engineering and Technology
Residents' acceptance of using desalinated water in China based on the theory of planned behaviour (TPB)	Lili et al.	2021	Marine Policy
A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies	Venkatesh and Davis	2000	Management Science

Predicting intention to improve household energy efficiency: The role of value-belief-norm theory, normative and informational influence, and specific attitude	Fornara et al.	2016	Journal of Environmental Psychology
What affects college students' acceptance of nuclear energy? Evidence from China	Hao et al.	2019	Journal of Cleaner Production

Appendix 2: Survey form English translation

Dear Participant,
My name is Péter Bihari, I am a final-year PhD student at the Faculty of Economics, University of Miskolc. My research topic is the social acceptance of different energy sources.
In this questionnaire, I aim to assess public attitudes toward nuclear energy. Please support my professional work by completing the following survey.

The questionnaire contains no open-ended questions, only items rated on a 1-to-5 Likert scale, and takes only 4–6 minutes to complete.
Your data will be handled strictly confidentially and anonymously. Submitted responses will become part of a larger database and will not be traceable to individuals.
Thank you for contributing to my scientific work by completing the survey!

*** Required question**
By completing this questionnaire, I consent to the use of my data for research purposes as described in the information notice. *
1. Gender
- Male
- Female

2. Age
- Under 24
- 25–34
- 35–44
- 45–60
- Over 61

3. Place of residence
- Village/Small town
- Town
- County seat
- Budapest
- Abroad
- Other:

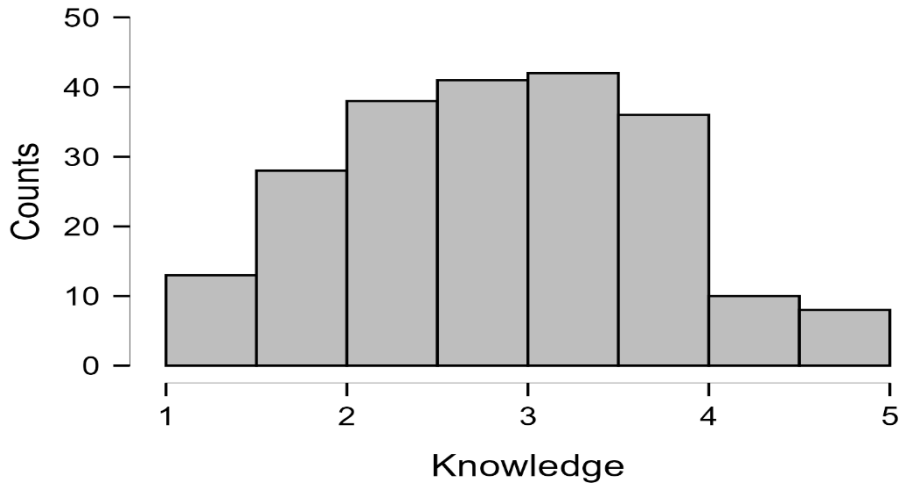
4. What is your highest level of education?
- Secondary school diploma
- Higher education vocational training
- College or university degree
- Ph.D.
- Other:

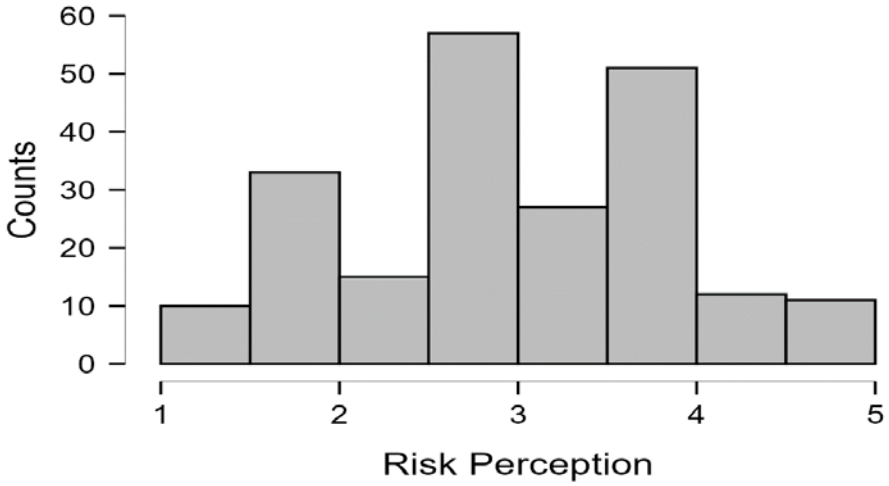
Questions related to nuclear energy
(Please rate the extent to which you agree with the following statements, 1 = Strongly disagree, 5 = Strongly agree):

5. I understand the scientific principles behind nuclear energy and know how a nuclear power plant operates.
6. I am aware of the effects of nuclear radiation on the environment and human health.
7. I am familiar with news and major events related to nuclear energy, as well as their background.
8. The risks associated with building and operating nuclear power plants are decreasing thanks to technological advancements.
9. The construction or operation of a nuclear power plant causes serious environmental damage to its immediate surroundings.
10. Operating nuclear power plants negatively affects human health.
11. Today's nuclear power plants are not capable of withstanding extreme natural events (e.g. earthquakes, droughts) or other unforeseen incidents (e.g. terrorist attacks), which could lead to unforeseeable consequences.
12. Nuclear power plants help mitigate climate change by emitting significantly less carbon dioxide than other fossil fuels (coal, oil, natural gas).
13. Operating nuclear power plants significantly contributes to energy security and cheaper electricity production in a given country.
14. Operating a nuclear power plant can be beneficial for a country due to job creation and technological development.
15. Overall, the advantages of using nuclear energy outweigh the disadvantages.
16. Due to Hungary's geographical and geopolitical position, the operation of a nuclear power plant does not involve any extra risk.
17. Electricity produced in nuclear power plants is a suitable alternative to fossil fuels.
18. I support the construction of more nuclear power plants in the EU.
19. I support the maintenance/expansion of nuclear energy use in electricity generation in Hungary.
20. I support nuclear energy projects even near my place of residence (research, development, plant construction, or fuel repository).

Thank you for supporting my work with your feedback!

Appendix 3: Distribution plots for technical variables

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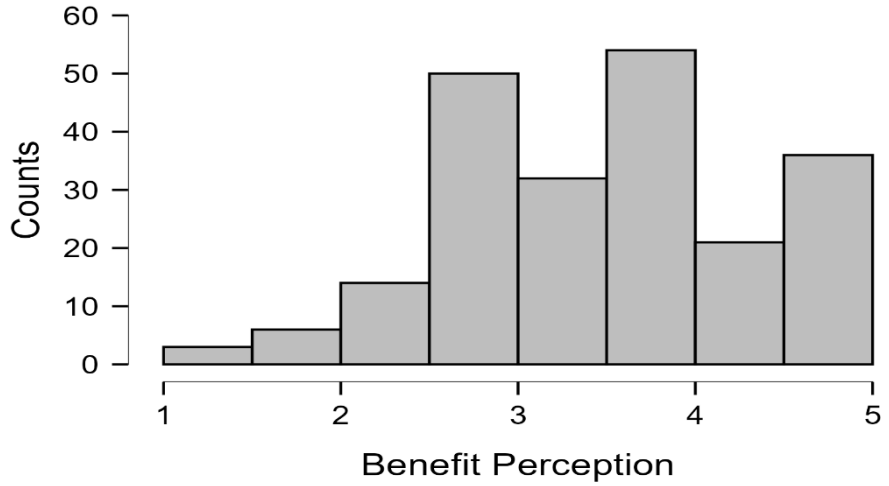
2
3
4
5
Risk Perception


Counts
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40
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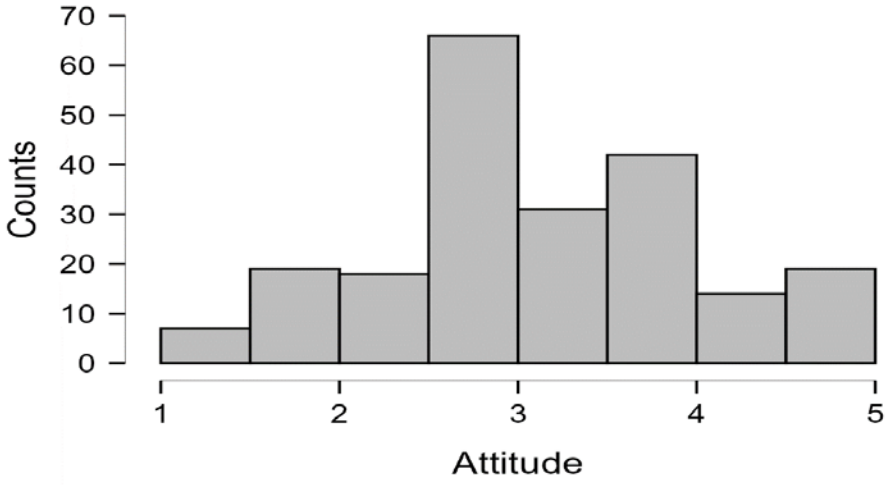
20
10
0
1
2
3
4
5
Benefit Perception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1
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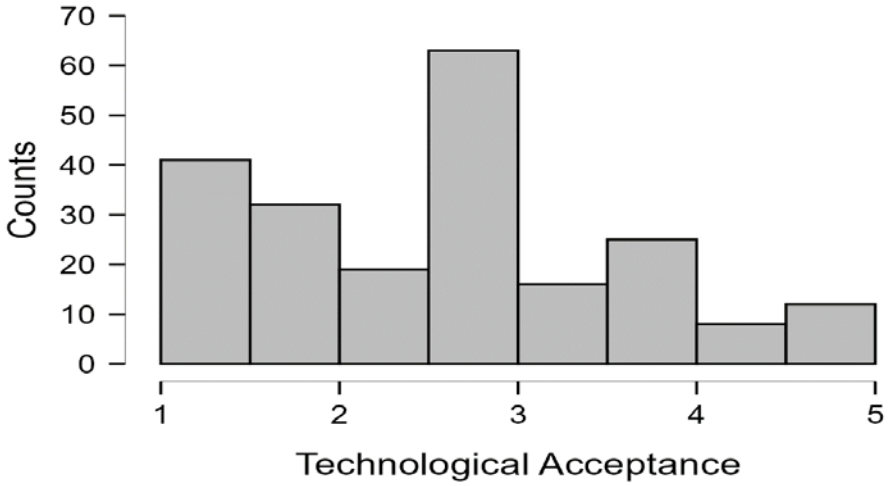
3
4
5
Attitude



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Business Control System on Performance of Small and Medium Scale Enterprises (SMEs) in Ilorin Metropolis, Kwara State Nigeria

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SUMMARY

Nigeria's unfledged physical as well as social infrastructure has hampered SMEs growth of the country. Many small and medium-sized businesses supply their own basic infrastructure; those that cannot do so are forced out of business or rely on inefficiently provided public infrastructure. As a result, this study investigates the influence of a business control system on SMEs performance in the Ilorin metropolitan area. The study specifically; (i) investigate the influence of cultural control on SMEs sustainability in Kwara State; and (ii) investigate the impact of administrative control on SMEs growth in Kwara. Descriptive design was used. A straightforward random sample strategy was used to get the study's data. 278 of the 313 questionnaires that were given to the chosen SME owners or managers were completely filled out, recovered, and utilized in this investigation. The data gathered was experimentally and statistically assessed using descriptive as well as inferential statistics, and the hypotheses were tested using Statistical Products and Services Solutions (SPSS) version 23. Findings revealed administrative control variables have a substantial influence on SMEs' development (Belief [β=.360, p=.000], Values [β=.214, p=.000], and Norms [β=.494, p=.000]; with overall R^2 of 86.5%,) and cultural control has a considerable impact on SMEs' sustainability (Organizational structure control [β=.189, p=.000], Vision/Mission Control [β=.218, p=.000], and Governance System Control [β=.491, p=.000]; with overall R^2 of 82.6%). The study indicated that business control systems had a beneficial impact on the performance of SMEs. It was suggested, among other things, that SME owners use cultural control in their enterprises to guarantee that their employees share the same perspective and focus, norms, and values as the organization's aims, since this contributes to the sustainability of SMEs.

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M10

1. INTRODUCTION

To sustain or change patterns in organizational activity, managers often employ formal information-based routines and processes. These processes comprise, but are not restricted to, any management tasks that provide managers the ability to create and carry out organizational strategies. These activities cover every tool managers use to make sure their

subordinates' actions and choices align with the goals and strategies of the company, including transfer pricing, budgeting, resource distribution at the unit level, performance assessment, evaluation, and incentive programs (Vinberg, 2024).

Business control systems (BCS) have become more important in businesses. It started off as a formal feedback and control system that supported the learning and innovation of the company. BCS has long been recognized by academics as a significant instrument for organizational management. However, it is worth noting that the application of BCS among businesses is limited (Tim et al., 2025), with most organizations relying on traditional strategies such as budgetary control systems instead. In poor nations, enterprises commonly use BCS as a conventional accounting instrument. Sri Lankan companies mostly adopt the strategy (Vinberg, 2024).

The Small and Medium Industry Equity Investment Scheme (SMIEIS) in Nigeria defines a small and medium-sized firm (SME) as any business with fewer than 10 or more than 300 employees and a maximum fixed base of N500 million, excluding land and working capital (Tim et al., 2025). In the United States, the United Kingdom, and Canada, SMEs are classified based on annual revenue and the number of paid workers, whereas in Japan, SMEs are defined as an industry with paid-up capital and a workforce.

Kwara State is one of Nigeria's 36 states, located in the North Central geopolitical zone, with 2.7 million people. It was founded in 1967 and comprises of 16 local government units with lush land, a good climate, and a peaceful environment. According to the Survey Report on MSMEs in Nigeria (2012), Kwara State has 428,111 MSMEs, which include 427,668 micro companies, 415 small businesses, and 28 medium enterprises. MSMEs in Kwara State are classified into three development paths: low, moderate, and high.

Some of the challenges that MSMEs in Kwara State, Nigeria, face are similar to those identified by Kalluri (2023) as the five major barriers that SMEs must overcome: insufficient capital, human resource constraints, impractical or limited adoption of technology, ignorance of potential customers and markets, and global competition. Aside from the concerns mentioned above, the control system employed by SMEs in Nigeria is a key issue affecting their performance. Such business areas as business culture, business administration, and business processes require adequate and accurate business control systems that can help to enhance the performance of SMEs. However, most SMEs fail to realize this major part of their business function, so it becomes a major feat affecting SMEs operation in Nigeria. This study will therefore, will therefore looking at the effect of business control system on SMEs performance in Kwara State.

1.1. Research Objectives

The main objective examined how business control system affect SMEs performance in Kwara State. The study shall focus attention on the following specific objectives- to;

1. examine the impact the cultural control on SMEs sustainability in Kwara State; and
2. examine the impact of administrative control on SMEs growth in Kwara State.

2. Literature Review

2.1. Concept of Business Control System

The term "business control system" (BCS) has many different meanings as it is a concept that is part of the management accounting field. According to Wang et al. (2024), BCS is a system that gives top managers and business owners the data they need to make choices about new investments, leasing, buying, advertising and promotion costs, and other matters. The procedures known as BCS enable managers to get resources and then allocate them in a way that best serves aim of the firm. Adopting information-based schedule enables firms to adopt management processes to preserve or modify designs in firm’s operations, managers may successfully implement strategies through the use of BCS.

However, the most essential aspect is not identifying the sorts of controls that organizations employ, way of utility, according based on control paradigm. The methods in which managers use BCS is the major drivers driving differences in organizational success between organizations that develop and execute BCS.

2.2. Components of Business Control System

2.2.1. Cultural Controls

Within any given culture, cultural backgrounds and standards serve as the primary cause that shapes social interactions. The thought patterns and collective programming that members of certain communities share and pass down through the generations are known as cultural traditions and norms. Similar to this, culture reveals the interpretations that individuals give to different facets of their own reality. In terms of control and management, "a society's cultural context

greatly limits management within it, as it is impossible to coordinate people's actions without a thorough understanding of their values, beliefs, and expressions."

Cultural philosophies, customs, and values are highly significant elements which determine the kind of society in order to comprehend the function that cultural values play in organizing and controlling the various civilizations. Organizations must construct a subculture based on the social culture in order to bring various members of the organization's goals into alignment. As a result, Feng and Ali (2024) contends that an organization's BCS cannot be comprehended in a vacuum, divorced from the social context in which it functions.

2.2.2. Administrative Controls

This duty concerns the administrative pattern and power system. The duties include administrative concerns such as designing organizational structures, assigning roles, and establishing governance procedures. Administrative control in these suggested new dimensions includes vision/mission, administrative pattern, power structure, and panels, as well as BCS change stages.

The organization's "overriding purpose in line with the values or expectations of stakeholders" is expressed in the vision and mission statement, which comes first (Kokala, 2024). Kokala (2024) assert that having a clear vision and mission statement helps people align their goals and directs their behavior toward the goals of the business (Mahabub et al., 2024). While a vision or purpose statement does not ensure the success of BCS practices, it does offer management and staff members a way to communicate more effectively.

2.3. Performance of SMEs

There is no universal understanding of the idea of 'performance' in the literature, particularly among businesses or SMEs. This notion can be described in a variety of ways, including abstract or generic, less or well defined. firm or SMEs' performance is defined as the extent to which the firm's target job was completed in contrast to the final output at the conclusion of a business cycle (Vinberg, 2024). Performance is assessed based on how well organizational goals have been met during the course of its evolution, including the efficiency of its human resources, supplier performance, the caliber of its goods and services, the demand from customers and markets, and other financial considerations.

2.3.1. Determinant of Performance of SMEs

2.3.1.1. Sustainability of SMEs

Sustainability in small and medium-sized enterprises (SMEs) refers to the ability of these businesses to operate in a manner that is environmentally responsible, socially equitable, and economically viable over the long term. According to Malesios et al. (2020), sustainability in SMEs encompasses various dimensions, including resource efficiency, social responsibility, and economic performance. This holistic approach not only contributes to environmental preservation but also enhances the competitive advantage of SMEs by fostering innovation and improving stakeholder relationships. Furthermore, the integration of sustainable practices is often influenced by external pressures such as regulatory frameworks, market demands, and societal expectations, which can motivate SMEs to adopt more sustainable business models (Martins et al., 2022). The commitment to sustainability can lead to improved operational efficiencies and brand loyalty, thereby creating a positive feedback loop that benefits both the enterprise and the wider community.

2.3.1.2. Competitiveness of SMEs

Since understanding what it means to be competitive is necessary before defining it, competitiveness is frequently described as a company's capacity to contend with more powerful companies in its field. What is accomplished, how it is accomplished, and what task is completed are all factors in competitiveness. Competitiveness is the accomplishment, execution, carrying out, working out of anything ordered or undertaken and includes the term "carrying out" in its definition. In their study, Kuzminski et al. (2020) linked competitiveness to several factors such as output amount, quality, timeliness, presence/attendance, efficiency, and effectiveness of finished work when compared to other companies in the same industry. A firm's ability to produce goods or provide services more effectively than other businesses in the same industry is a key component of its competitiveness, according to (Senthil et al., 2024).

2.4. BCS and Performance

Wang et al. (2024) defined BCS as a larger term that includes management accounting systems used to achieve goals, as well as a tool that delivers external and internal information to help managers make decisions. All of these statements indicate that BCS is a tool for making decisions and taking managerial actions. For many academics and scholars, BCS is a

component of the performance management process (Feng & Ali, 2024), which lends itself to real-world management applications. This applied control approach uses performance management techniques to explain and anticipate outcomes based on managerial experience.

It was thus established that performance management has an impact on the effectiveness of organizations (Kokala, 2024). Mahabub et al. (2024) asserted that, in order to successfully develop the BCS through the processes of goal-setting, strategy selection, resource allocation, performance measurement, and reward, the organization must appropriately set up its performance management system.

3. Theoretical Review

3.1. Contingency Theory

Contingency Theory posits that there is no one-size-fits-all approach to management and organizational structure; rather, the effectiveness of a particular strategy or structure depends on the specific context and environment in which an organization operates. As noted by (Aliu, 2025), this theory emphasizes the importance of aligning organizational practices with external and internal factors, such as market conditions, technology, and organizational size. In the context of SMEs, applying Contingency Theory can help leaders make informed decisions that enhance adaptability and resilience in a rapidly changing business landscape. For instance, SMEs may need to adopt different strategies in response to varying levels of competition or regulatory environments, demonstrating that flexibility and situational awareness are crucial for sustainable success (Zapata, 2017). This adaptability not only supports the sustainability goals of SMEs but also enables them to thrive amidst uncertainty and change.

The contingency theory is applied in this work. This theory was chosen because all branches of contingency theory share the tenet that an organization's performance depends (or is contingent) on how well it fits with a number of elements, including people, technology, structure, strategy, and organizational culture (Ganescu, 2012).

4. Empirical Review

Valeiras, Sanchez, and Conde (2015) explored the impact of interactive business control systems (IBCS) on both process and organizational innovation. Their research utilized a survey of 230 companies to empirically test their model. The findings, derived from a structural model analyzed through Partial Least Squares regression while considering factors such as company size, family ownership, research and development, and product innovation, indicated that IBCS significantly fosters both process and organizational innovation. Additionally, the study revealed that IBCS may serve as a moderating factor in the relationship between process innovation and financial performance.

In their study, "The Effects of Business Control System on Performance Measurement System at Small Medium Hotel in Malaysia", Jamil and Mohammed (2013) examined the role of BCS in the design of performance measurement systems (PMS) within Malaysian SMEs in the hotel sector. Utilizing contingency theory and Simon's four levers of control as intervening variables, they gathered data through a survey targeting small and medium-sized hotels in Northern Peninsular Malaysia. The results indicated that PMS is linked to each of the four selected business control systems, suggesting that the development of PMS can positively influence the overall performance of the small and medium hotel industry by interacting with BCS.

Ganescu, (2012) authored a paper titled "Business Control Systems, Business Strategy, and Performance: A Comparative Examination of Family and Non-Family Enterprises in a Transition Economy in Sub-Saharan Africa." The study found that the influence of business control systems (BCS) on business strategy differs based on whether a company is family-owned (FB) or non-family-owned (NFB). Specifically, NFBs are more affected by direct control systems (DCS) in terms of cost leadership strategies, while FBs are more influenced by interactive control systems (ICS) concerning differentiation strategies. Furthermore, the research indicated that business strategy mediates the relationship between BCS and performance, with FBs experiencing stronger direct and overall effects of BCS on their performance compared to NFBs.

5. Methodology

The research employed a descriptive approach to gather insights from selected small and medium-sized enterprises (SMEs) in Ilorin metropolis regarding the influence of business control systems on their performance. This design is particularly appropriate for this study over other designs since it helps to describe phenomenon, concepts or variables under study the way it is how it affects other concepts or variables. The study's population comprised all types of SMEs, totaling 1,448 businesses within Ilorin metropolis, Kwara State, Nigeria which was obtained from Kwara State Ministry of

Commerce and Industry as at 2024. However, this study collect data specifically by surveying SME owners or managers as the case may be depending on availability. A simple random sampling method was utilized to ensure that the selected respondents were appropriate for the research objectives, focusing specifically on SMEs in the region. The sample size was determined to be 313 SMEs, calculated using the Yamane (1967) formula for sample size determination.

For data collection, the study relied on primary sources, employing a structured questionnaire developed based on the study's concepts. The questionnaire consisted of two sections: Section A gathered general information about the respondents, while Section B included questions addressing the impact of business control systems on SME performance in Kwara State. Responses were measured using a five-point Likert scale. To ensure the validity of the questionnaire, construct validity was applied, confirming that it accurately assessed the effects of business control systems on the performance of service-oriented SMEs in the state. The reliability of the instrument was evaluated using Cronbach's alpha method. For data analysis, inferential statistical techniques, specifically, regression analysis was employed to draw conclusions and assess the significance of the hypotheses using the standard beta value, p-value and coefficient of determination (R^2). All data processing was conducted using Statistical Product and Service Solutions (SPSS) version 23.

5.1. Model Specification

5.1.1. Model 1

HO_1: Cultural control has no significant influence on the sustainability of small and medium scale enterprise in Kwara State.

The multiple regression model below was used for analysis of hypothesis 1
Y=f(X)
$Y= \beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+\mu$
Where
Y= Sustainability of SMEs (dependent variable)
X_1, X_2, X_3 = independent variables
X_1= Belief
X_2= Values
X_3= Norms
β_0 =constant
$\beta_1, \beta_2, \beta_3$ = regression coefficients
μ = error term

5.1.2. Model 2

HO_2: Administrative control does not significantly affect the growth of small and medium scale enterprise in Kwara State.

The multiple regression model below was used for analysis of hypothesis 2
Y=f(X)
$Y= \beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+\mu$
Y= Growth of SMEs (dependent variable)
X_1, X_2, X_3 = independent variables
X_1= Organizational structure control
X_2= Vision/Mission Control
X_3= Governance System Control
β_0 =constant
$\beta_1, \beta_2, \beta_3$ = regression coefficients
μ = error term

6. Data Analysis Result

This section focuses on the study's objectives by testing the formulated hypotheses through regression analysis.

Hypotheses one: Cultural control support have no significant impact on the sustainability of small and medium scale enterprise in Kwara State.

Table 1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.863[a]	.826	.825	.26302

a. Predictors: (Constant), Belief, Values, Norms

Source: SPSS Output, 2024

The regression analysis examining the link between cultural control and the sustainability of small and medium-sized enterprises (SMEs) is presented in Table 1. The R-squared value of 0.826 signifies that cultural control accounts for 82.6% of the variance in SME sustainability, leaving 17.4% attributed to other factors not included in the analysis. This indicates that the model is robust. Consequently, the null hypothesis, which posits that cultural control does not significantly influence SME sustainability, was dismissed in favor of the alternative hypothesis.

Table 2

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	409.600	4	102.400	1480.157	.000[b]
	Residual	23.453	339	.069		
	Total	433.052	343			

a. Dependent Variable: Sustainability of SMEs

b. Predictors: (Constant), Belief, Values, Norms

Source: SPSS Output, 2024

The F-statistic results shows that the ANOVA result in Table 2 are noteworthy, with an ANOVA significance of .000, which is below the alpha threshold of 0.05, confirming the validity of the results. Additionally, the regression sum of squares at 409.600 exceeds the residual sum of squares of 23.453, underscoring the model's overall significance and fit.

Table 3

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.035	.083		-.417	.677
	Belief	.360	.060	.319	5.985	.000
	Values	.214	.047	.232	4.566	.000
	Norms	.494	.040	.531	12.275	.000

a. Dependent Variable: Sustainability of SMEs

Source: SPSS Output, 2024

Table 3 demonstrates a notable correlation between shifts in Belief and the Sustainability of SMEs, evidenced by a Beta (B) value of 0.319 and a P-value of 0.000, which is less than 0.05. Similarly, Values and Norms also significantly impact SME sustainability, with Beta (B) values of 0.232 and 0.531, both accompanied by P-values of 0.000, indicating their relevance. Overall, the findings suggest that cultural control exerted by the government plays a crucial role in enhancing the sustainability of SMEs.

Hypotheses two: Administrative control has no significant impact on the growth of SMEs in Kwara State.

Table 4

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.887[a]	.865	.865	.12929

a. Predictors: (Constant), Organizational structure control, Vision/Mission Control, Governance System Control

Source: SPSS Output, 2024

Table 4 presents a regression analysis examining the impact of administrative control on the growth of small and medium-sized enterprises (SMEs). The R-squared value of 0.865 indicates that administrative control accounts for 86.5% of the variance in the development of SMEs, while the remaining 13.5% is attributed to other factors not captured in the model. This finding suggests that the model is well-fitted. Consequently, the null hypothesis, which asserts that administrative control does not significantly affect SME growth, was rejected in favor of the alternative hypothesis.

Table 5

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	381.638	4	95.410	5707.941	.000[b]
	Residual	5.666	339	.017		
	Total	387.305	343			

a. Dependent Variable: Growth of SMEs

b. Predictors: (Constant), Organizational structure control, Vision/Mission Control, Governance System Control

Source: SPSS Output, 2024

The results are significant, as evidenced by an ANOVA significance of 0.000 in Table 5, which is below the alpha level of 0.05, confirming the robustness of the findings. Furthermore, the regression sum of squares, at 381.638, exceeds the residual sum of squares of 5.666, reinforcing the model's overall significance.

Table 6

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.091	.040		-2.277	.023
	Organizational structure control	.189	.020	.176	9.327	.000
	Vision/Mission Control	.218	.024	.244	8.930	.000
	Governance System Control	.491	.026	.474	19.208	.000

a. Dependent Variable: Growth of SMEs

Source: SPSS Output, 2024

Table 6 indicates that variations in organizational structure control significantly influence the growth of SMEs, with a Beta (B) value of 0.176 and a P-value of 0.000, which is less than 0.05. Similarly, Vision/Mission Control also has a significant

impact, reflected by a Beta (B) value of 0.244 and a P-value of 0.000. Lastly, Governance System Control shows a strong effect on SME growth, with a Beta (B) value of 0.474 and a P-value of 0.000. Overall, the research highlights that administrative control plays a crucial role in the growth of SMEs in Kwara State.

7. Discussion of Research Findings

The first objective's study showed that cultural controls like beliefs, values, and norms have an effect on the sustainability of small and medium-sized enterprises. Belief, values, and norms were found to be proxies for cultural influence on the sustainability of SMEs. According to the overall data, cultural control has a big impact on SMEs' capacity to stay sustainable. Cultural control has an impact on SMEs' capacity to survive. As a result, the alternative hypothesis was supported and the null hypothesis — which claims that cultural control has no discernible impact on the sustainability of SMEs — was rejected. Vinberg (2024), who discovered that an organization's BCS cannot be comprehended in isolation from the social context in which it functions, lends credence to this.

The examination of the second aim also revealed that administrative control is impacted by the expansion of SMEs in Kwara. The findings revealed that organizational structure control, vision/mission control, and governance system control, which are proxies for administrative control, impact the growth of SMEs in Kwara State. The entire research indicates that administrative control of SMEs has a substantial impact on the growth of SMEs in Kwara State. SMEs' productivity and growth are affected by the administrative oversight they receive from microfinance banks during COVID-19. As a result, the null hypothesis, which claims that administrative control has no substantial influence on the expansion of SMEs in Kwara State, was rejected, and the alternative hypothesis was supported. Feng and Ali (2024) provide support for this, finding that mission and vision statements that are clear help people align their goals and direct their actions toward the goals of the organization.

8. Conclusion and Recommendation

Cultural control is a crucial consideration when analyzing the variables impacting the sustainability of small and medium-sized enterprises (SMEs). This is especially true given the variety of information obtained from the use of questionnaires on business control systems and enterprise performance. Belief, values and norms are significant in order to maximize sustainability of SMEs. When SME owners engage in cultural control, they vet the values, belief and norms of the workers to enhance the sustainability of their enterprise. Hence this study concludes that cultural control significantly affects the sustainability of SMEs in Kwara State. Also, Administrative control had a significant influence on growth of SMEs in Kwara State. Administrative control such as Organizational structure control, Vision/Mission Control, and Governance System Control are an important factor affecting growth of SMEs in Kwara State. When SME owners ensure administrative control, they ensure that the governance system is effective and also make clear the vision and mission statement of the enterprise. Hence this study concludes that administration control significantly affects the growth of SMEs in Kwara State.

In view of the findings given above, the following recommendations were suggested;

i. SME owner should adopt cultural control in its enterprise to ensure that its workers have the same view and focus, norms and values with the goals of the organization as this helps to achieve sustainability of the SMEs.
ii. SME owners should ensure it harness administrative controls like building an effective organization structure, ensuring that the management of the organization is functioning as efficient as possible as this helps to enhance the growth of enterprises.

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Author's contribution

Yinusa Olawale: Created ideas and hypotheses for study 50%, conceived and designed the study 50%, collected the data 50%, performed the analysis 50%, wrote the paper 50%, logical explanation and presentation of findings 50%, overall: 50 %.

Ebenezer Oluwadamilare Balogun Created ideas and hypotheses for study 50%, conceived and designed the study 50%, collected the data 50%, performed the analysis 50%, wrote the paper 50%, logical explanation and presentation of findings 50%, overall: 50 %

Disclosure statement

No potential competing interest to declare by the authors.

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Data availability statement

The data that support the findings of this study are available from the corresponding author Yinusa Olawale ,(e-mail: olawale.ya@unilorin.edu.ng) upon reasonable request.

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