

Article

# ROSE (Recycling Organization through Sustainability Education): Examining the mediating effects of waste minimization behaviour in the relationship between environmental education and environmental performance at the Saudi Arabian Universities

Abu Elnasr E. Sobaih<sup>1,2,\*</sup>, Hassane Gharbi<sup>3</sup>, Imed Zaiem<sup>3</sup>, Nadir Aliane<sup>1</sup><sup>1</sup> Management Department, College of Business Administration, King Faisal University, Al-Ahsaa 31982, Saudi Arabia<sup>2</sup> Hotel Management Department, Faculty of Tourism and Hotel Management, Helwan University, Cairo 12612, Egypt<sup>3</sup> Management Department, Faculté des Sciences Économiques et de Gestion de Nabeul, Nabeul 8000, Tunisia\* **Corresponding author:** Abu Elnasr E. Sobaih, [asobaih@kfu.edu.sa](mailto:asobaih@kfu.edu.sa)

## CITATION

Sobaih AEE, Gharbi H, Zaiem I, Aliane N. (2024). ROSE (Recycling Organization through Sustainability Education): Examining the mediating effects of waste minimization behaviour in the relationship between environmental education and environmental performance at the Saudi Arabian Universities. *Journal of Infrastructure, Policy and Development*. 8(6): 6462. <https://doi.org/10.24294/jipd.v8i6.6462>

## ARTICLE INFO

Received: 16 May 2024

Accepted: 19 June 2024

Available online: 27 June 2024

## COPYRIGHT



Copyright © 2024 by author(s).

*Journal of Infrastructure, Policy and Development* is published by EnPress Publisher, LLC. This work is licensed under the Creative Commons Attribution (CC BY) license.

<https://creativecommons.org/licenses/by/4.0/>

**Abstract:** The world has never been more developed, yet humanity is on the brink of irreversible environmental loss. Despite the urgency of the situation, there is a limited body of studies addressing environmental concerns in higher education institution, particularly in developing countries, i.e., Saudi Arabia. Sustainable development is the only viable solution, albeit it requires the courage to initiate and sustain efforts dedicated to preserving the environment for the well-being of future generation. The article delves into this issue and examines the impact of environmental education program (EEP) on environmental performance (EP) via waste minimization behaviour (WMB). The research involved meticulous data collection from a sample of 597 students, representing diverse genders and academic specialties at the esteemed public university—King Faisal University (KFU) in Saudi Arabia. The study used statistical software (including SPSS and AMOS, v 25) for rigorous analysis and revealed significant findings. Firstly, the study showed a significant and positive relationship between EEP and EP. Secondly, it revealed a significant and positive association between EEP and WMB. Thirdly, the study ascertained a significant and positive association between WMB and EP. Finally, the study found that the relationship between EEP and EP remains significant even after presenting WMB as a mediator, proposing that WMB has a partial mediation role between EEP and EP. The results highlighted the significance role of EEP in stimulating WMB and achieving EP in the Saudi universities, which contributes to national initiative of green Saudia.

**Keywords:** environmental education; environmental performance; public universities; Saudi Arabia; KFU; waste minimization behaviour

## 1. Introduction

“We aim at contributing to food security and environmental sustainability for the kingdom”. This statement is the organisational identity of King Faisal University (KFU), a well-established public institution that has been operating for fifty years, i.e. since 1975. The university is located in Al-Hufuf, which is the capital of the Al-Ahsa oasis in the Eastern Province of Ach-Charqiya, Saudi Arabia. It was founded in 1975 by royal decree and was inaugurated by the late King Faisal ben Abdelaziz Al Saoud (KFU, 2024). The university is bordered to the north by the Province of Abqaiq, to the east by the Arabian Gulf, to the west by the Al-Dahna’ desert, and to the south by the Rub’ al-Khali desert. It is situated on the world’s largest oasis, which is home to over

2.5 million palm trees (KFU, 2024).

The KFU organisational identity is the strategic direction of the university. This allows the leadership of the university to allocate resources and develop programmes for achieving this purpose. The identity serves as a catalyst of change in directing the university's components and resources. Therefore, KFU was able to brand itself as an expert house and a key player in environmental innovation across multiple domains, including infrastructure development, cutting-edge technologies, enhancement of groundwater resources, and exploration of the water reserves available in the Kingdom, and the investigation of seawater desalination technology. This unique approach distinguishes the university from its competitors and underscores its commitment to environmental sustainability. The university's institutional identity plays a pivotal role in its ongoing transformation, enabling it to strike a balance between modernity and the preservation of the natural environment. Nevertheless, this does not prevent the university from embracing a promising future while remaining mindful of its cultural and natural heritage and taking measures to preserve it.

Nevertheless, after conducting almost spontaneous participant observation over several years, inefficiencies in the daily management of waste generated by administrative, teaching, and research activities were identified. The majority of the waste generated on the campus is paper, which fills almost all the garbage cans. A simple calculation based on the average consumption of three reams of paper per day for a campus with fifteen academic colleges, five deanships, twenty-nine administrations, and nine research centres, shows that KFU produces a large amount of waste on daily basis. Although the university has paper collection bins, the practice of recycling program of paper waste is almost not fully implemented. There is an important question that arise regarding waste management at KFU: What is the role of waste minimization behaviour (WMB) in the link between environmental education programme (EEP) and environmental performance (EP)?

What is more, in 1978, UNESCO's Intergovernmental Conference on Environmental Education declared that environmental education aims to cultivate people who care about the environment and its related issues. As we move forward, we hope that future generations can prioritize sustainable development and work towards rehabilitating nature. This reform should be accompanied by behaviours from students, administrators, and educators that minimize waste and ensure positive management. Universities in particular have a responsibility to adopt eco-friendly practices like waste minimization and recycling activities, as suggested by Alam et al. (2019). These practices are outcomes of the environmental education program by the university. It is expected that such eco-friendly practices impact significantly on EP of the university (Elshaer et al., 2022; Sobaih, Hassnein et al., 2022). Despite the importance of these issues, they were not sufficiently addressed in previous published studies. Expanding on this argument and building on the resource-based view (RBV) theory (Barney 1991), universities could achieve better EP, when they strategically manage the resources, capabilities, and competencies. The core competencies of a university include its educational programmes, scientific research, and community partnership. This study focuses on the educational programmes, particularly those that devoted for environmental conservation.

The purpose of this study is to explore the role of EEP in driving the WMB and

achieving EP in the Saudi universities, using KFU as a case study. The study investigates the mediating role of WMB in the link between EEP and EP in public Saudi universities, through the case of KFU, which strategically use its EEP to achieve EP as a competitive advantage with other universities.

## **2. Theoretical analysis and hypothesis development**

### **2.1. Environmental education and waste minimization behaviour**

The world is currently facing many challenges, e.g., climate change, population growth, expanding industrial development, pollution, and biodiversity loss (Hecht and Fiksel, 2015; Ramadhan et al., 2019; Wulandari et al., 2023), which are more obvious in Saudi Arabian context (Sobaih, 2023, Sobaih and Abu Elnasr, 2024). While technical progress has undoubtedly fueled these challenges, it is difficult, if not impossible, to turn our backs on technological advancements. According to environmental education primarily aims to transmit and acquire the skills, attitudes, and behaviour necessary to address environmental problems (Ambe et al., 2024). As such, environmental education can help improve human behaviour (Brendel et al., 2024) and preserve ecosystems (Hong et al., 2022) for sustainable living. Universities play a significant role in transmitting and receiving social values. Therefore, the value that students place on their university's corporate culture can influence their future behaviour. In other words, the knowledge gained on university campuses forms a crucial cognitive foundation for students to improve their behaviour towards the environment and take wiser action. A recent study on the impact of university education support in Saudi Arabia context (Aliedan et al., 2022) showed that it significantly affects students' entrepreneurial intention and behaviour. Thus, the first hypothesis will take the following form:

- H1: Environmental education positively influences waste minimization behaviours.

### **2.2. Environmental education and environment performance**

In recent years, undertaking behaviour that care of environment has become more than just a pressing need (Gharbi et al., 2022; Sobaih, Gharbi et al., 2022), which could be enhanced by environmental education. Erhabor and Don (2016) defined environmental education as a concept that integrates environmental-related subjects into the course to raise students' responsiveness to environment. It involves direct interactions among actors, stimulating their knowledge, and transforming them into actors in their learning. Environmental education program makes students more environmentally aware and encourages them to mobilize resources wisely while reducing waste. This, in turn, leads to the adoption of pro-environmental behaviour in their environments, which has a positive influence EP (Ojo et al., 2022). Moreover, recent research suggests that actors who perceive environmental support tend to respond by engaging in activities that contribute to environmental performance (Temminck et al., 2015). Environmental education also provides students with practical external activities that encourage them to react positively to the environment (Matsekoleng et al., 2024). This increases their level of eco-skills, as suggested by

Roy and Therin (2008). Hence, the second hypothesis is:

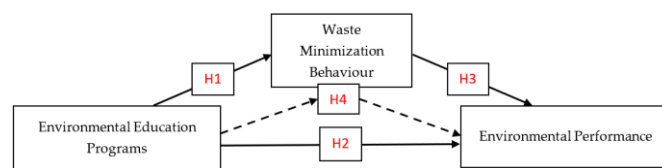
- H2: Environmental education positively influences the environmental performance.

### 2.3. Waste minimization behaviour and environment performance

According to Judge and Douglas (1998), a company's environmental performance is evaluated based on its ability to meet society's expectations of collusion concerning the natural environment, pollution prevention, waste minimization, and recycling activity. On the other hand, Sobaih, hasanein et al. (2022) consider green performance as an importance factor in preserving the environment from destructive concerns, e.g., pollution. Additionally, Dezdar (2017) highlights the importance of stakeholder attitudes and behaviour in proper execution of environmental initiatives. Thus, pro-environmental behaviour is an important element in determining the EP of any enterprise, as noted by Ojo et al. (2022). Ramus (2001) also affirms that ecological behaviour aimed at reducing waste and environmental pollution is crucial in achieving environmental performance. Similarly, Lober (1996) emphasizes the significance of ecological behaviours, such as waste minimization and recycling in EP. It is worth noting that various research revealed a significant influence of pro-environmental behaviour, particularly waste minimization behaviour, on EP (Boiral et al., 2015; Daily et al., 2009; Ojo et al., 2020; Ojo and Fauzi, 2020; Paillé et al., 2014; Shore et al., 2006). Thus, the following hypotheses are suggested:

- H3: Waste minimization behaviour positively influences environment performance.
- H4: Waste minimization behaviour mediates the relationship between environmental education and environmental performance.

After the presentation of the different constructs and the operationalization of the hypotheses, we can draw the model showing the research hypotheses (**Figure 1**).



**Figure 1.** The research hypotheses.

### 3. Methods

This research adopted a quantitative approach using a pre-examined survey. The primary role of survey is to offer with the most accurate measurements for this phenomenon (Igalens and Roussel, 1998). The first part of the survey addresses respondents' demographics, e.g., gender, age and academic year. The second part includes the measurement scale. Certainly, the more valid and reliable the measurement scales, the more relevant the information will be. For the waste minimization behaviour scale, Chung and Leung's (2007) five-item scale seem to meet our needs, as it has good psychometric properties (for the final-scale items adopted in this study please see Appendix. For the concept of environmental education, we chose the four-items scale of Brandl et al. (2019). For the environmental performance

variable, we chose the seven-items scale of Yong et al. (2020). We also apply the five-point Likert format. All the measurement scales have been adapted to this format. Participants will be asked to indicate their preferences by placing a cross next to each point. They are asked to choose the best answer that fit with their perception from 1 to 5, as 1 means “strongly disagree” and 5 means “strongly agree”. The third part was an open-end question for any further comment.

Our study was undertaken at KFU, a public Saudi university. We had planned a sample of 700 participants. However, we received only 597 usable questionnaires from fairly young students of different ages (between 18 and 25 years old) and genders (9% males and 4% females), enrolled in the first (11%), second (18%), third (50%) and fourth (21%) years of their bachelor’s degrees. Our sample was remarkably homogeneous.

#### 4. Data analysis

After collecting data through the research questionnaires, an exploratory analysis was undertaken to evaluate the quality of the measurement scales, with the aim of validating their reliability. This was done using Principal Component Analysis (PCA). We then made a confirmatory analysis to verify the conclusions drawn from the exploratory data analysis. In addition, Structural Equation Model (SEM) using AMOS v 25 was adopted to examine correlations and paths between the three constructs.

##### 4.1. First order analysis

The answers to the questions had a minimum and maximum value of 1 to 5 (Table 1). Additionally, the averages of answers vary between 3.76 and 4.21, and their standard deviations varies between 0.995 and 1.229, meaning that the answers are dispersed and less condensed around the mean (Bryman and Cramer, 2012). We also note that the Skewness and kurtosis coefficients do not contradict the assumptions (Kline, 2015) and reveal acceptable values. Therefore, it could be concluded that all items were equally distributed (Table 1). Based on Table 1 and Figure 2, we see that the  $\chi^2/dof$  ratio is equal to 4.171, and well below 5. The results show the data has good fitness for the model. This includes SRMR value of 0.0574, and the RMSEA value of 0.073. The CFI, TLI, IFI and NFI show values of 0.936, 0.900, 0.936, 0.927 respectively, which are close to 1.

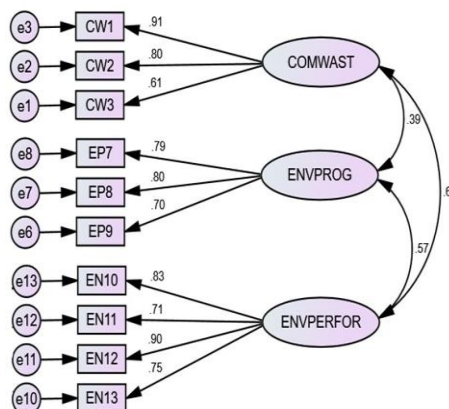


Figure 2. The first order model.

**Table 1.** Descriptive results.

<b>Abr.</b>	<b>Min</b>	<b>Max</b>	<b>M</b>	<b>SD</b>	<b>Skewness</b>	<b>Kurtosis</b>
Waste minimization behaviour						
CW1	1.0	5.0	4.19	0.995	-1.332	1.504
CW2	1.0	5.0	4.21	1.008	-1.310	1.245
CW3	1.0	5.0	4.12	1.071	-1.336	1.299
Environmental education programming						
EP7	1.0	5.0	3.76	1.214	-0.853	-0.094
EP8	1.0	5.0	3.84	1.229	-0.952	-0.015
EP9	1.0	5.0	3.82	1.177	-0.937	0.172
Environmental performance						
EN10	1.0	5.0	4.04	1.107	-1.276	1.086
EN11	1.0	5.0	4.10	1.027	-1.231	1.202
EN12	1.0	5.0	4.13	1.024	-1.229	1.097
EN13	1.0	5.0	3.97	1.081	-1.024	0.494

Note: “Min = Minimum, Max = Maximum, M = Mean, SD = Standard Deviation, Skewness = Symmetry Coefficient, kurtosis = kurtosis coefficient”. Model fit: ( $\chi^2$  (29,  $N$  = 597) = 120.951  $p$  < 0.001, normed  $\chi^2$  = 4.171, RMSEA = 0.073, SRMR = 0.0574, CFI = 0.936, TLI = 0.900, IFI = 0.936, NFI = 0.927, \*\*\*  $p$  < 0.001.

#### 4.2. Convergent and discriminant validity

To determine whether the items are associated with each other, we checked convergent validity, using composite reliability, that should be above 0.7, and the Average Variance Extracted (AVE), that should be above 0.5. The results in **Table 2** show that convergent validity was confirmed for all items (Joreskog, 1988). We also checked whether the square root of the AVE of each item is indeed higher than the association it shares with the other variables or not. The values presented in **Table 2** below show that discriminant validity has been respected for all items.

**Table 2.** Scale validity.

<b>Variables</b>	<b>S.L</b>	<b>CR</b>	<b>AVE</b>	<b>MSV</b>	<b>ASV</b>	<b>1</b>	<b>2</b>	<b>3</b>
1 Waste minimization behaviour ( $\alpha$ = 0.809)	-	0.823	0.613	0.288	0.202	0.783	-	-
CW1	0.91	-	-	-	-	-	-	-
CW2	0.80	-	-	-	-	-	-	-
CW3	0.61	-	-	-	-	-	-	-
2 Environnemental education ( $\alpha$ = 0.802)	-	0.808	0.585	0.242	0.179	0.342**	0.765	-
EP7	0.79	-	-	-	-	-	-	-
EP8	0.80	-	-	-	-	-	-	-
EP9	0.70	-	-	-	-	-	-	-
3 Environnemental performance ( $\alpha$ = 0.851)	-	0.876	0.641	0.288	0.265	0.537**	0.492**	0.801
EN10	0.83	-	-	-	-	-	-	-
EN11	0.71	-	-	-	-	-	-	-
EN12	0.90	-	-	-	-	-	-	-
EN13	0.75	-	-	-	-	-	-	-

Using **Table 2**, we can perform a test of discriminant validity based on a correlation coefficient, the square roots of the AVEs and the Cronbach’s  $\alpha$  coefficient for constructs. The square roots of the AVEs must be higher than the off-diagonal values, which show the relationship between the variables. This supports the discriminant validity of the factors, as determined by Fornell and Larcker (1981). In addition, AVE scores for waste minimization behaviour (0.613), environmental education (0.585) and environmental performance (0.641) are significantly higher than the maximum shared variances (MSV), showing the next values respectively: 0.288, 0.242, 0.288. In this respect, Hair et al. (2014) assert that this ensures the discriminant validity of our constructs. Furthermore, it is important to emphasize that the inter-correlation scores for each variable must be less than the values on the diagonal (see bold results in **Table 2**).

### 5. Results and structural findings

Structural analysis was adopted to prove the influence of environmental education (ENVPROG) on environmental performance (ENVPERFOR) through waste minimization behaviour (COMWAST). The results of the study are more than satisfactory (**Table 3**). Indeed, they show a Chi-square related to its degree of freedom  $\chi^2/dof$  (3.349). This share is considered reasonable, as it is below 5. What’s more, the RMSEA value is equivalent to 0.063, close to zero and showing it is acceptable. Other values, such as “NFI = 0.996, TLI = 0.970, IFI = 0.969, RFI = 0.958 and CFI = 0.987” were acceptable. Furthermore, “SRMR = 0.0698, is tolerable for being near zero. The results of structural models enabled us to the research paths (**Table 3, Figure 3**).

**Table 3.** Testing hypotheses.

Hypotheses	( $\beta$ )	P	(t-Value)	R <sup>2</sup>	Hypothesis test
H1 ENVPROG has a positive impact on COMWAST	0.387	***	7.142	-	Supported
H2 ENVPROG has a positive impact on ENVPERFOR	0.345	***	7.370	-	Supported
H3 COMWAST has a positive impact on ENVPERFOR	0.513	***	9.746	-	Supported
ENVPERFOR (regression)	-	-	-	0.396	-

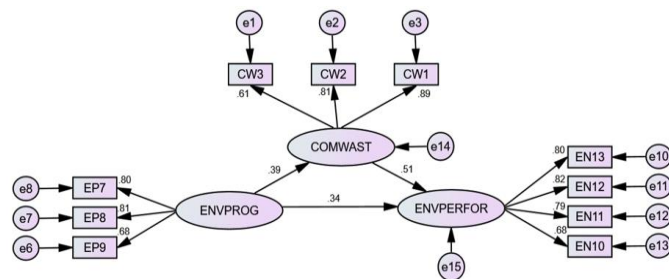
Model fit: “( $\chi^2$  (30, N = 597) = 100.484  $p < 0.001$ , normed  $\chi^2 = 3.349$ , RMSEA = 0.063, SRMR = 0.0698, CFI = 0.987, TLI = 0.970, IFI = 0.969, NFI = 0.966, \*\*\*  $p < 0.001$ ”.

The results indicate that ENVPROG significantly and positively affect COMWAST ( $\beta = 0.387$ ,  $p < 0.001$ \*\*\*). Additionally, it significantly and positively affects ENVPERFOR ( $\beta = +0.345$ ,  $p < 0.001$ \*\*\*). Furthermore, COMWAST was found to significantly and positively influence ENVPERFOR ( $\beta = +0.513$ ,  $p < 0.001$ \*\*\*). We also tested the robustness of the structural model using R square. R<sup>2</sup> displays a significant value of 0.396 (**Table 3**), in this study the ratio of ENVPERFOR explained by ENVPROG and COMWAST. Subsequently, by combining ENVPROG and COMWEST, we can explain around 39.6% of the variance of ENVPERFOR in the regression model.

To find out what kind of mediation COMWEST performs in the relationship between ENVPROG and ENVPERFOR, we have opted for the methodology of Baron and Kenny (1986). This includes some steps, which we will test within the framework of our model. The first verification by examining the relationship between ENVPROG

and ENVPERFOR that has to be significant for ensuring the presence of potential mediation. The structural model shows that ENVPROG significantly influence ENVPERFOR ( $\beta = 0.345, p < 0.001$ ). The second verification consists of demonstrating that ENVPROG significantly effect on the mediating variable. The results show that ENVPROG significantly affect COMWAST, ( $\beta = +0.387, p < 0.001$ ). The third test consists of confirming the significance of the link uniting the mediator to ENVPERFOR. Indeed, COMWAST has a significantly on ENVPERFOR ( $\beta = +0.513, p < 0.001$ ). In a linear regression of ENVPERFOR on COMWAST, the relationship between these two variables must remain significant (student’s test equal to  $15.531 \geq 1.96; p = 0.001$ ).

In the end, we examined type of “COMWAST” mediation. Here we notice that the link is still significant even when the mediator variable is taken into account, as shown in **Table 4** on how ENVPROG affects ENVPERFOR through COMWAST (= 0.216, with  $p = 0.004 < 0.05$ ). Additionally, the Sobel test shows a Z value of  $2.487 > 1.96$  with a P value of  $0.0128 < 0.05$ . In light of this, we can see that COMWAST has partial mediation (**Figure 3** and **Table 4**).



**Figure 3.** The structural model.

**Table 4.** Mediation type (developed by authors).

Parameter		( $\beta$ )	Lower	Upper	P	Mediation
After introduction of the mediating variable	ENVPROG → COMWAST → ENVPERFOR	0.216	0.128	0.308	0.004	0.004 < 0.05 partial mediation
Before introduction of the mediating variable	ENVPROG → ENVPERFOR	0.345	-	-	***	-

## 6. Discussion

This paper explored the relationship between EEP, WMB, and EP. The study was conducted on 597 students of all genders and specialties at KFU, a renowned Saudi university. The data were analysed through SPSS and AMOS version 25 statistical software, and all hypotheses were confirmed.

The study revealed a significantly positive correlation between EEP and EP. This support the findings of Ojo et al. (2022) who claimed that environmentally literate individuals are concerned about environmental problems and are more likely to adopt pro-environmental behaviour, ultimately leading to improved EP. The study also revealed a significantly positive relationship between EEP and WMB. This finding supports previous studies (Fu et al., 2020; Meadows, 2020), which also found that environmental education is an important tool in raising individuals’ awareness regarding their environmental practices. It also enhances their behaviour to sort out



any environmental problems (Ambe et al., 2024; Brendel et al., 2024). Furthermore, our results showed a significant positive correlation between WMB and EP. Our results are in agreement with earlier studies, which also found a positive impact of pro-environmental behaviour on EP (Boiral et al., 2015; Elshaer et al., 2022; Ojo et al., 2020; Ojo and Fauzi, 2020; Paillé et al., 2014). Lastly, the study found that WMB partially mediates the link between EEP and EP. The link between EEP and EP remained significant, even after presenting WMB as a mediator.

This article makes substantial theoretical contributions to the current body of studies. Indeed, the present work set out to conduct exploratory research in order to provide an outline likely to give interested researchers a deeper understanding of three new causal relationships, both theoretically and empirically, between variables, in this case EEP (independent variable), EP (dependent variable) and WMB (mediating variable), which have been treated alternatively but not simultaneously. This article succeeded in bringing them together in a single model, for which we tested its robustness by applying the  $R^2$ , thus displaying a significant value of 0.396, giving an  $\chi^2/dof$  equal to 3.349, a satisfactory value because it is below 5. In addition, the RMSEA value is equivalent to 0.063, approaching zero and showing that the fit is acceptable. Its indices are as follows: NFI = 0.996, TLI = 0.970, IFI = 0.969, RFI = 0.958 and CFI = 0.987 certifying a very good fit. Its standardized RMR is equal to 0.0698, which is tolerable since this value is near to zero. To conclude, the research confirmed all hypotheses. This has both theoretical and methodological implications.

This research proposes two critically important managerial implications to support KFU decision-makers and other universities. The first is to implement a strategy aimed at creating a new culture in line with environmental expectations. The second is to provide the faculty with a guide to action for a profitable project that will enable KFU to occupy a leading position among its immediate competitors. Our research has demonstrated that KFU's EP is heavily reliant on EEP and WMB. Therefore, we suggest that:

a) Investing in EEP is crucial to reinforce KFU's (and other universities of similar context) symbolic value and establish its leadership position locally, regionally, and internationally. Interdisciplinary collaboration is necessary to ensure that teaching staff are provided with the necessary assistance. To incorporate sustainable development into the curriculum, it is essential to rethink the field's future professional practice. As sustainable development is a new way of explaining and conceiving the world, it requires a radical change in culture rather than a mere procedural technique. In addition to changing the content to meet international standards, the pedagogical approaches must also be revamped. The new environmental education programming aims to establish a new organizational culture at KFU, where administrative, teaching, and research activities are mutually supportive, with a community-focused approach. While sustainable development is a costly challenge, it is also a daring one that KFU must embrace.

b) Policy makers are strongly encouraged to consider establishing a close collaboration between universities and Monsha'at, a government body established in 2016 to stimulating EP via EEP and WMB. Handling waste and achieving positive requires a collaboration between all stakeholders within campus. It is important that policy makers develop a policy that encourage such collaboration and contribute to

zero waste within campus. This would contribute to national priorities of green Saudi Arabia as part of the Saudi Vision 2030.

The idea is to collect waste paper at a sorting center, sort it according to type, and package it into large bundles for further processing. KFU, in collaboration with Monsha'at, can resell these reels to specialized companies that will transform them into books, newspapers, magazines, food paper, handkerchiefs, gift paper, draft paper, and napkins. This project may be costly but highly beneficial and profitable in the long term for KFU, particularly in terms of environmental sustainability. KFU can position itself both upstream and downstream in this process, creating a significant impact on the environment while generating revenue. By implementing this project, KFU can see life in ROSE.

## **7. Conclusion, limitations and future research**

The investigation confirmed a significant positive correlation between EEP and EP. Additionally, a significant and positive relationship was found between EEP and WMB and between WMB and EP. Regarding the mediation of waste minimization behaviours, the research demonstrated that even after introducing WMB as a mediating variable, the link between EEP and EP remained, indicating a partial mediation effect. These findings are of importance for a university that makes EP as its key priority making a competitive advantage over its rivalry.

The RBV emphasized the significance of an organization's internal resources in achieving a competitive advantage. For resources to sustain their potential as sources of competitive advantage, they should be valuable, rare, imperfectly imitable, and non-substitutable. However, in the context of sustainable development, resources must be perfectly imitable. Although we do not intend to discredit Barney's (1990) theory, sustainable development requires a tried-and-tested model that prioritizes the environment over the immediate profitability of companies. If all organizations implement such a model, the ultimate beneficiary will be Mother Nature. In essence, this is the essence of sustainability. It is pertinent to address this issue in future studies to shed more light on Barney's RBV theory (1991), and examine how its shortcomings can be remedied in the context of environmental sustainability.

Admittedly, although the research work has successfully addressed the problem and the research question, and accomplished the desired objective, it still has some limitations. As with any research project, the results cannot be generalized since we have only focused on the KFU case. This is a significant challenge of our research, which needs to be addressed in future studies. This study relied solely on self-reported data from a survey. Hence, future studies could undertake longitudinal studies or incorporating more diverse data sources may be insightful.

**Author contributions:** Conceptualization, AEES, HG, IZ and NA; methodology, AEES and HG; software, HG; validation, AEES and HG; formal analysis, HG; investigation, AEES and NA; resources, AEES; data curation, HG; writing—original draft preparation, AEES, HG, IZ and NA; writing—review and editing, AEES and HG; visualization, AEES and HG; supervision, AEES; project administration, AEES and HG; funding acquisition, AEES. All authors have read and agreed to the published

version of the manuscript.

**Funding:** This research was funded by the Deanship of Scientific Research, Vice Presidency for Graduate Studies and Scientific Research, King Faisal University, grant number GrantA234.

**Conflict of interest:** The authors declare no conflict of interest.

## References

- Alam, Md. S., Atif, M., Chien-Chi, C., et al. (2019). Does corporate R&D investment affect firm environmental performance? Evidence from G-6 countries. *Energy Economics*, 78, 401–411. <https://doi.org/10.1016/j.eneco.2018.11.031>
- Aliedan, M. M., Elshaer, I. A., Alyahya, M. A., et al. (2022). Influences of University Education Support on Entrepreneurship Orientation and Entrepreneurship Intention: Application of Theory of Planned Behavior. *Sustainability*, 14(20), 13097. <https://doi.org/10.3390/su142013097>
- Ambe, B. A., Agbor, C. E., Amalu, M. N., et al. (2024). Electronic media learning technologies and environmental education pedagogy in tertiary institutions in Nigeria. *Social Sciences & Humanities Open*, 9, 100760. <https://doi.org/10.1016/j.ssaho.2023.100760>
- Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173–1182. <https://doi.org/10.1037/0022-3514.51.6.1173>
- Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), 99–120. <https://doi.org/10.1177/014920639101700108>
- Boiral, O., Talbot, D., & Paillé, P. (2013). Leading by Example: A Model of Organizational Citizenship Behavior for the Environment. *Business Strategy and the Environment*, 24(6), 532–550. <https://doi.org/10.1002/bse.1835>
- Brandl, R., Alvarado, A., & Peltomaa, A. (2019). Evaluating efficacy of environmental education programming. *School Science and Mathematics*, 119(2), 83–93. <https://doi.org/10.1111/ssm.12319>
- Brendel, U. M., Eberhardt, R. and Wiesmann, K. (2024). Conservation of the Golden Eagle (aquila Chrysaetos) in the European Aplasia Combination of Education, Cooperation, and Modern Techniques. *Journal of Raptor Research*, 36(5).
- Bryman, A., & Cramer, D. (2012). *Quantitative data analysis with IBM SPSS (21): A guide for social scientists*. Rutledge.
- Chung, S. S., & Leung, M. M. Y. (2007). The Value-Action Gap in Waste Recycling: The Case of Undergraduates in Hong Kong. *Environmental Management*, 40(4), 603–612. <https://doi.org/10.1007/s00267-006-0363-y>
- Christen, M., & Schmidt, S. (2011). A Formal Framework for Conceptions of Sustainability – a Theoretical Contribution to the Discourse in Sustainable Development. *Sustainable Development*, 20(6), 400–410. <https://doi.org/10.1002/sd.518>
- Daily, B. F., Bishop, J. W., & Govindarajulu, N. (2009). A Conceptual Model for Organizational Citizenship Behavior Directed Toward the Environment. *Business & Society*, 48(2), 243–256. <https://doi.org/10.1177/0007650308315439>
- Dezdar, S. (2017). Green information technology adoption: influencing factors and extension of theory of planned behavior. *Social Responsibility Journal*, 13(2), 292–306. <https://doi.org/10.1108/srj-05-2016-0064>
- Elshaer, I. A., Sobaih, A. E. E., Aliedan, M., et al. (2021). The Effect of Green Human Resource Management on Environmental Performance in Small Tourism Enterprises: Mediating Role of Pro-Environmental Behaviors. *Sustainability*, 13(4), 1956. <https://doi.org/10.3390/su13041956>
- Erhabor, N. I., & Don, J. U. (2016). Impact of environmental education on the knowledge and of students towards the environment. *International Journal of Environmental & Science Education*, 11(12), 5367–5375. <https://doi.org/10.25073/0866-773X/68>
- Fornell, C., & Larcker, D. F. (1981). Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. *Journal of Marketing Research*, 18(3), 382–388. <https://doi.org/10.1177/002224378101800313>
- Fu, L., Sun, Z., Zha, L., et al. (2020). Environmental awareness and pro-environmental behavior within China’s road freight transportation industry: Moderating role of perceived policy effectiveness. *Journal of Cleaner Production*, 252, 119796. <https://doi.org/10.1016/j.jclepro.2019.119796>
- Gharbi, H., Sobaih, A. E. E., Aliane, N., Almubarak, A. (2022). The Role of Innovation Capacities in the Relationship between Green Human Resource Management and Competitive Advantage in the Saudi Food Industry: Does Gender of Entrepreneurs

- Really Matter? *Agriculture*, 12(6), 857. <https://doi.org/10.3390/agriculture12060857>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage.
- Hecht, A. D., & Fiksel, J. (2015). Solving the problems, we face: The United States Environmental Protection Agency, sustainability, and the challenges of the twenty-first century. *Sustainability: Science, Practice, & Policy*, 11(1), 75–89. <https://doi.org/10.1080/15487733.2015.119081>
- Hong, P., Schmid, B., De Laender, F., et al. (2022). Biodiversity promotes ecosystem functioning despite environmental change. *Ecology Letters*, 25(2), 555–569. <https://doi.org/10.1111/ele.13936>
- Igalens, J., & Roussel, P. (1998). *Research methods in human resources management (French)*. Economica.
- Nesselroade, J. R., & Cattell, R. B. (1988). *Handbook of Multivariate Experimental Psychology*. Springer.
- Jöreskog K, Sorbom D. (1994). *LISREL, A Guide of the Program and Applications*. SPSS Inc.
- Jorgenson, S. N., Stephens, J. C., & White, B. (2019). Environmental education in transition: A critical review of recent research on climate change and energy education. *The Journal of Environmental Education*, 50(3), 160–171. <https://doi.org/10.1080/00958964.2019.1604478>
- Judge, W. Q., & Douglas, T. J. (1998). Performance Implications of Incorporating Natural Environmental Issues into the Strategic Planning Process: An Empirical Assessment. *Journal of Management Studies*, 35(2), 241–262. <https://doi.org/10.1111/1467-6486.00092>
- KFU. (2024). About the University. Available online: <https://www.kfu.edu.sa/en/Pages/AboutKKFU.aspx> (accessed 01 May 2024).
- Kline, P. (2015). *A handbook of test construction (psychology revivals): Introduction to psychometric design*. Routledge.
- Lober, D. J. (1996). Evaluating the environmental performance of corporations. *Journal of Managerial Issues*, 8(2), 184–205
- Matsekoleng, T. K., Mapotse, T. A., & Gumbo, M. T. (2024). The role of indigenous games in education: a technology and environmental education perspective. *Diaspora, Indigenous, and Minority Education*, 18(1), 68–82. <https://doi.org/10.1080/15595692.2022.2160436>
- Meadows, M. E. (2020). Geography Education for Sustainable Development. *Geography and Sustainability*, 1(1), 88–92. <https://doi.org/10.1016/j.geosus.2020.02.001>
- Ojo, A. O., & Fauzi, M. A. (2020). Environmental awareness and leadership commitment as determinants of IT professionals engagement in Green IT practices for environmental performance. *Sustainable Production and Consumption*, 24, 298–307. <https://doi.org/10.1016/j.spc.2020.07.017>
- Ojo, A. O., Tan, C. N. L., & Alias, M. (2022). Linking green HRM practices to environmental performance through pro-environment behaviour in the information technology sector. *Social Responsibility Journal*, 18(1), 1–18. <https://doi.org/10.1108/srj-12-2019-0403>
- Paillé, P., Chen, Y., Boiral, O., et al. (2014). The Impact of Human Resource Management on Environmental Performance: An Employee-Level Study. *Journal of Business Ethics*, 121(3), 451–466. <https://doi.org/10.1007/s10551-013-1732-0>
- Potter, G. (2010). Environmental Education for the 21st Century: Where Do We Go Now? *The Journal of Environmental Education*, 41(1), 22–33. <https://doi.org/10.1080/00958960903209975>
- Ramadhan, S., Sukma, E., & Indriyani, V. (2019). Environmental education and disaster mitigation through language learning. *IOP Conference Series: Earth and Environmental Science*, 314(1), 012054. <https://doi.org/10.1088/1755-1315/314/1/012054>
- Ramus, C. A. (2001). Organizational Support for Employees: Encouraging Creative Ideas for Environmental Sustainability. *California Management Review*, 43(3), 85–105. <https://doi.org/10.2307/41166090>
- Roy, M., & Thérin, F. (2008). Knowledge acquisition and environmental commitment in SMEs. *Corporate Social Responsibility and Environmental Management*, 15(5), 249–259. <https://doi.org/10.1002/csr.145>
- Sobaih, A. E. E., Gharbi, H., Hasanein, A. M., Elnasr, A. E. A. (2022). The Mediating Effects of Green Innovation and Corporate Social Responsibility on the Link between Transformational Leadership and Performance: An Examination Using SEM Analysis. *Mathematics*, 10, 2685. <https://doi.org/10.3390/math10152685> <https://doi.org/10.3390/math10152685>
- Sobaih, A. E. E., Hasanein, A., Gharbi, H., & Elnasr, A. E. A. (2022). Going Green Together: Effects of Green Transformational Leadership on Employee Green Behaviour and Environmental Performance in the Saudi Food Industry. *Agriculture*, 12(8), 1100. <https://doi.org/10.3390/agriculture12081100>
- Sobaih, A. E. E. (2023). Saudi Zero Food Waste Certification: A Novel Approach for Food Waste Management in Saudi Arabia. *Agronomy*, 13(6), 1654. <https://doi.org/10.3390/agronomy13061654>

- Sobaih, A. E. E., & Abu Elnasr, A. E. (2023). Exploring the 5Rs Holistic Model for Zero Food Waste in Saudi Arabian Food Service Outlets. *Recycling*, 8(6), 91. <https://doi.org/10.3390/recycling8060091>
- Shore, L. M., Tetrick, L. E., Lynch, P., et al. (2006). Social and Economic Exchange: Construct Development and Validation. *Journal of Applied Social Psychology*, 36(4), 837–867. <https://doi.org/10.1111/j.0021-9029.2006.00046.x>
- Temminck, E., Mearns, K., & Fruhen, L. (2015). Motivating Employees towards Sustainable Behaviour. *Business Strategy and the Environment*, 24(6), 402–412. <https://doi.org/10.1002/bse.1827>
- UNESCO. (1978). Rapport Final. In: Proceedings of the 1997 Intergovernmental Conference on Environmental Education.
- Wulandari, A. A., Pertuak, A. C., & Rakuasa, H. (2023). Climate Change and its Impact on Human Health: A Medical Geography Perspective. *Journal of Health Science and Medical Therapy*, 1(02), 80–90. <https://doi.org/10.59653/jhsmt.v1i02.279>
- Yong, J. Y., Yusliza, M.-Y., & Fawehinmi, O. O. (2020). Green human resource management. *Benchmarking: An International Journal*, 27(7), 2005–2027. <https://doi.org/10.1108/bij-12-2018-0438>

## Appendix

### The research instrument adopted in this study \*

**Table A1.** Environmental education program.

---

EP6: I want to know more about the Sahara and/or the people who live there
EP7: I enjoy learning from and working with scientists in the classroom and in the field
EP8: I enjoy learning to use and working with different scientific tools and equipment
EP9: I find it interesting to go over field data and to figure out what the data mean

---

\* Lines with gray background were excluded during analysis because they had low factor loading.

**Table A2.** Waste minimization behavior.

---

CW1 Protecting the environment is the responsibility of every Saudi citizen
CW2 When making purchases, I take into account the environmental impact of the items I wish to buy
CW3 I generally prefer double-sided photocopying to single-sided photocopying
CW4 Waste should be sorted at source and recycled to save landfill space
CW5 I will personally support waste sorting at source

---

\* Lines with gray background were excluded during analysis because they had low factor loading.

**Table A3.** Environmental performance.

---

EN10 Environmental management at our university has helped reduce waste.
EN11 Environmental management at our university has reduced water consumption.
EN12 Environmental management at our university has reduced energy consumption.
EN13 Environmental management has reduced the purchase of non-renewable materials and components.
EN14 Environmental management has reduced overall costs.
EN15 Environmental management has reduced waste and improved the university's competitive position.
EN16 Environmental management has helped improve our university's reputation.

---

\* Lines with gray background were excluded during analysis because they had low factor loading.