“Designing a model to measure and manage the implementation of green initiatives at South African universities”

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DESIGNING A MODEL TO MEASURE AND MANAGE THE IMPLEMENTATION OF GREEN INITIATIVES AT SOUTH AFRICAN UNIVERSITIES

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Abstract

South African universities experience increased pressure to comply with and implement environmentally friendly practices. Specifically, state-funded universities need to enhance environmental management efficiency and environmental awareness. However, measuring the implementation of green initiatives in higher education takes time and effort. South African models for state-funded universities are absent, and international models are inapplicable. Therefore, this study aims to develop and empirically test the model by investigating existing theories and models and identifying potential factors for higher education. The paper determined ten initial factors from 31 environmental studies, limiting their number to five. The finally selected factors are cost of green products, awareness, training and education, top management attitude and commitment, committee for sustainable accountability, and digital transformation. This qualitative study uses a five-point Likert-scale questionnaire sampling 149 university managers. Structural equation modeling retained three of the original five factors in the model: cost of green products, top management attitude and commitment, and digital transformation. However, knowledge of the environment (SRW = 0.76) is also crucial. Ten theoretical measuring criteria are retained as valid measures of implementing green initiatives. The model has good fit indices (CMin/Df = 4.07, CFI = 0.944, GFI = 0.909), despite RMSEA exceeding 0.10. The developed conceptual model can be used to measure the implementation of green initiatives by South African state-funded universities.

Keywords green initiatives, implementation, factors, model, measure, universities, environment, education, management

JEL Classification Q56, R11, I23

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INTRODUCTION

South Africa's National Development Plan 2030 (South African Government, 2022) identified the need for environmental awareness at South African universities. South African universities are increasingly concerned with green initiatives and how to develop ways to reach these goals. As communicated in the National Plan, to redress the need for environmental awareness, South African universities require a re-examination of the factors that determine the implementation of green initiatives and the failure thereof. Furthermore, South African universities' lack of environmental awareness concerns the communities and government. This was already a concern ten years ago. There is a high financial and social cost of going green. Therefore, universities must understand the factors that influence green initiatives. Currently, educational research into students' environmental awareness is focused on cognition and motivation of green initiatives because knowledge, cognitive and metacognitive strategies influence environmental awareness. Research on motivation focused on the reasons why students behave and how these reasons affect environmental awareness.

The South African Department of Forestry, Fisheries and Environment (2022) isolated several vital criteria to improve students' environmental awareness. All these criteria focused on the universities' personnel and students to support and facilitate environmental success, access, and awareness. In support, the Department of Higher Education and Training (2022) expressed its concerns about the environmental awareness of students and universities. South African universities find it increasingly necessary to articulate environmental management in their missions and adopt green strategies. Therefore, there is a growing interest in managing, understanding, and even predicting the implementation of green initiatives at universities. However, there are no local models South African universities can use to measure and manage their performance. The value of international university models is also limited because of South Africa's unique educational environment constraints.

1. LITERATURE REVIEW

Globally, limited research exists on green initiatives at universities, even more so in South Africa. Moreover, environmental management initiatives regarding public universities in South Africa are non-existing. As a result, new applicable and adaptable models are needed. Current private sector models could serve as a source where business activities could be scrutinized to identify some relevant factors that dovetail university operations. The theoretical study, firstly, focused on identifying the relevant factors bearing these constraints in mind.

The broader literature basis identified ten potential factors (Table 1) from selected studies across various industries that might be applicable to assess and analyze the implementation of green initiatives at a public university. Table 1 also shows the respective industries and researchers who assessed the implementation of green initiatives.

Although these factors originate from myriad industries where implementation may differ from a university, they showed promise to be included for further scrutiny and to identify the key factors critical to universities in South Africa per sé. Next, the relevance of each of the ten factors was identified. As per the methodology to scientifically eliminate factors from a list (Moolla & Bisschoff, 2012), the factors were scrutinized to determine their "relevance to universities," and the "frequency of use" determined the factors most relevant to public universities. Confirmatory literature support for retained factors is also required to retain factors. The confirmatory literature study supports the five selected factors and their

Table 1. Green initiatives implementation models and factors examined

No.	Factor	Industry	Literature source
1	Marketing strategy	Construction	Wirtz and Zeithaml (2018), Chang et al. (2019), Bukhari et al. (2020)
2	Pressure from customers	Hospitality	Deraman et al. (2017), Shashi et al. (2020), Han (2021)
3	Awareness, training, and education	Supply chain	Burki et al. (2019), Jadhav et al. (2019), Bhutta et al. (2021)
4	Mutual participation and acceptance	Information technology	Goetsch and Davis (2016), Kotler and Keller (2016), Ighalo and Adeniyi (2020)
5	Digital transformation	Food	Martzopoulou and Komninos (2019), Acar et al. (2019), Berggren et al. (2019)
6	Cost of green products	Logistics	Ghadimi et al. (2021), Shurrab et al. (2019), Lambrechts et al. (2019)
7	Environmental regulations and laws	Supply chain	Taghikhah et al. (2019), Ghebrehiwet (2019), Dai et al. (2021)
8	Top management attitude and commitment	Manufacturing	Piyathanavong et al. (2019), Mao and Wang (2019), Mabrouk and Ibrahim (2021)
9	Improved communication strategies	Supply chain	Kazancoglu et al. (2021), Dahlmann and Roehrich (2019), Makhitha and Ngobeni (2021)
10	Committee for sustainability accountability	Human resources	Bribena (2019), Macke and Genari (2019), Chams and García-Blandón (2019)

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criteria to assess their progress in implementing green initiatives at public South African universities. These factors are:

1) cost of green products;
2) awareness, training, and education;
3) top management attitude and commitment;
4) digital transformation; and
5) committee for sustainability accountability.

Regarding the cost of green products, it is a common perception that efforts to save the Earth are expensive and that accessing eco-friendly products is difficult. However, although eco-friendly products may be more expensive than traditional products initially, the total cost over the product's lifetime is usually lower. Installing green products may save money in the long run (Kasliwal & Agarwal, 2016). An energy-saving Light-Emitting Diodes (LED) light bulb, for example, is a well-known example. LEDs can use up to 90% less energy and last 25 times longer than traditional incandescent bulbs. Although a traditional incandescent light bulb's price is lower, the energy saving of LEDs more than adequately makes up for the additional purchase cost over the lifetime of the light (Adhvaryu et al., 2020). However, the cost of change or additional start-up capital to install the green products remains an obstacle. As a result, the demand for these products is lower than that for traditional products (Sana, 2020).

The cost is also a major obstacle regarding alterations and facility upgrades. For example, a traditional (non-green) science laboratory at a university may be too costly to go green as this would mean replacing the traditional equipment with green substitutes at a high cost; such costs are different from the budget structure of a public university. Likewise, rebuilding eco-unfriendly buildings is not cost-effective as universities need more subsidies and resultant budgets (Green Building Council in South Africa, 2021). Even an activity such as switching energy suppliers and purchasing wind-grated electricity rather than conventional coal-generated electricity could result in paying a premium price for the green energy source (Hyun et al., 2020). However, if such upgrades and alterations are made, this additional investment should yield satisfactory results (Venhoeven et al., 2020). Likewise, the switch to solar-generated energy requires the installation of solar panels. Although there are definitive energy cost savings by going green, this is often vague to offset the initial upfront conversion costs (Gürtürk, 2019). At present, costs at universities are measured on the bottom line; this means the direct costs and return on investment are regarded as the primary financial performance indicators. Unless a system is developed where the costs of environmental damage are quantified and fully incorporated in the calculations of profit, costs, and return on investment, sustainable products could lose their cost disadvantage (Hirunyawipada & Pan, 2020). Just earning "green points" or "green tokens" is not enough to encourage green management practices.

Environmental awareness, training, and education processes empower individuals to investigate environmental issues, seek answers to environmental problems, and act to improve the environment. It encompasses developing a thorough understanding of the environment and attaining the skills to make informed and responsible decisions (Marpa, 2020). Environmental awareness, training, and education not only educate the world population about the natural environment and its problems but also aims to develop the knowledge, attitude, and necessary skills to protect natural resources. It generates widespread awareness of environmental problems and teaches about natural and developed environments. Awareness identifies aspects that affect the environment and possible actions to prevent, improve, and sustain the environment (Destek & Sinha, 2020). Environmental awareness, training, and education benefit the youth, scholars, educators, and the whole community. These benefits are more impactful if they are formally integrated into the curriculums.

Interestingly, a positive correlation exists between knowledgeable students, enthusiasm, and learning if awareness and environmental learning are included in the academic curriculum. The knowledge enables students to apply their knowledge and rectify environmental issues they encounter in the real world because knowledgeable individuals can see the interconnectedness between ecological, social, cultural, economic, and political issues (Danielraja, 2019). Environmental awareness, training, and education encourage students to research complex ecological issues and help foster an informed new generation of workers and consumers who look differently upon current policies and decision-makers. The key to incorporating green education initiatives into the curriculum is integrating the different study fields and combining mathematics, science, languages, history, and arts. Practical sessions outside the classroom (or to bring nature into the classroom) provide an excellent opportunity to facilitate interdisciplinary learning (Torrejos & Israel, 2022). Practical exposure to nature allows for increased sensitivity and environmental respect. Practical applications also improve students' understanding of the repercussions of their decisions and subsequent actions on the environment. They also obtain practical knowledge and the necessary skills to address environmental issues. Resultantly, educated individuals make better decisions to maintain and sustain a healthy future environment (Marpa, 2020).

Top management is responsible for formulating and executing strategies. This requires sustainable leadership and commitment embedded in strong ethical values and healthy corporate culture in all business activities (Graves et al., 2019). Organizational sustainability is a core competency, and management must maintain the organization's competitive position consistently. Sustainability is an organizational priority that requires exceptional commitment. New positions, such as the Corporate Sustainability Officer, can be developed to oversee this aspect of the business operations (Henry et al., 2019). The top management team will likely influence the organization to develop capabilities in implementing green initiatives like green product design and manufacturing. In addition, green initiatives can significantly improve its strategic and environmental performance (Burki et al., 2019). When undertaking the empirical investigation, top management commitment needs to specify those factors that help increase an organization's green performance. Top management commitment can significantly improve an organization's environmental and strategic performance through green product development and manufacturing initiatives (Haessler, 2020). Top management capabilities can also promote green initiatives to take advantage of the benefits of environmental uncertainties and consequently improve their strategic and environmental performance (Woo & Kang, 2020).

Digital transformation or digitalizing refers to when a business adopts digital technologies to alter its business model or to move away from traditional business processes. It aims to get value from new and advanced technologies by utilizing digital network dynamics and the extensive digital flow of information (Nadkarni & Prügl, 2021). However, digitalizing can be affected by reliance on paper (Prasetyo et al., 2020), costs and time (Venhoeven et al., 2020), organizational impacts and obstacles (Venhoeven et al., 2020), fear of losing control (Doneva et al., 2020), breaches on online data (Confente et al., 2019), lack of understanding of legal processes (Stoykova, 2021), and the skills gap between younger and older personnel (Nadkarni & Prügl, 2021).

The organization's team responsible for green initiatives also requires sustainability. The team needs to know that the organization will maintain and support the solutions they implement. Only then can they collaborate to identify and implement solutions to environmental issues (for example, reducing waste or establishing a recycling initiative) (Gryshova et al., 2019). Vitale et al. (2020) asserted that there are simple ways of assembling a green initiatives projects team. Start small by getting a small group that agrees on achievable goals, holds regular meetings, and breaks down borders by working on issues across departments, divisions, and campuses (Sinclair, 2019).

The measuring criteria to assess the five factors discussed above were identified from the literature. Table 2 illustrates these measuring criteria of the respective factors and their literature support.

Figure 1 summarizes the study's literature basis and shows the hypotheses. It also illustrates that a five-factor theoretical model is plausible to apply to analyze the implementation of green initiatives at South African public universities.

The formulated hypotheses are based on the theoretical model:

H_0: *There are no significant positive relationships between the factors and green initiatives at South African universities.*

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Table 2. Measuring criteria and theoretical support

Retained factors	Supporting studies
Factor 1: Cost of green products	
Demand and supply are low because it is expensive to access eco-friendly products	Sana (2020), Hyun et al. (2020)
Start-up capital to install green products remains a stumbling block	Kasliwal and Agarwal (2016), Adhvaryu et al. (2020), Gürtürk (2019)
The green certification process is not simple	Hirunyawipada and Pan (2020)
Rebuilding eco-unfriendly buildings is time-consuming	Venhoeven et al. (2020), Green Building Council in South Africa (2021)
Factor 2: Awareness, training, and education	
Develops the knowledge, attitude, and problem-solving skills	Destek and Sinha (2020)
Promotes student engagement in both the natural and built environments	Marpa (2020)
Encourages interdisciplinary learning	Torrejos and Israel (2022), Danielraja (2019)
Creates an understanding of how actions affect the future environment	Marpa (2020), Destek and Sinha (2020)
Factor 3: Top management attitude and commitment	
Requires values and ethical commitment by the management	Graves et al. (2019), Woo and Kang (2020)
Management commitment can improve an organization's corporate culture	Woo and Kang (2020)
Management commitment identifies environment key performance areas	Burki et al. (2019), Haessler (2020), Woo and Kang (2020)
Management commitment creates empirical investigation	Graves et al. (2019)
Management commitment ensures consistent monitoring	Henry et al. (2019)
Factor 4: Digital transformation	
Using a paper trail seems easier	Prasetyo et al. (2020), Stoykova (2021)
Investing in digitalization tools and services is costly and time-consuming	Nadkarni and Prügl (2021)
Automation of business operations brings fear of loss of control	Confente et al. (2019)
There is fear that data stored online or in a cloud could be breached	Venhoeven et al. (2020), Doneva et al. (2020), Confente et al. (2019)
Older professionals struggle to adapt to digitalization processes	Doneva et al. (2020), Nadkarni and Prügl (2021)
Factor 5: Committee for sustainable accountability	
This team collaborates to implement the organization's sustainability goals	Gryshova et al. (2019), Burki et al. (2019),
This team implements change management processes	Vitale et al. (2020), Nadkarni and Prügl (2021)
The team creates a platform for skills transfer processes	Vitale et al. (2020)
The team manages budget allocation for sustainability goals	Burki et al. (2019)
The team is responsible for leading the implementation goals	Gryshova et al. (2019), Henry et al. (2019)

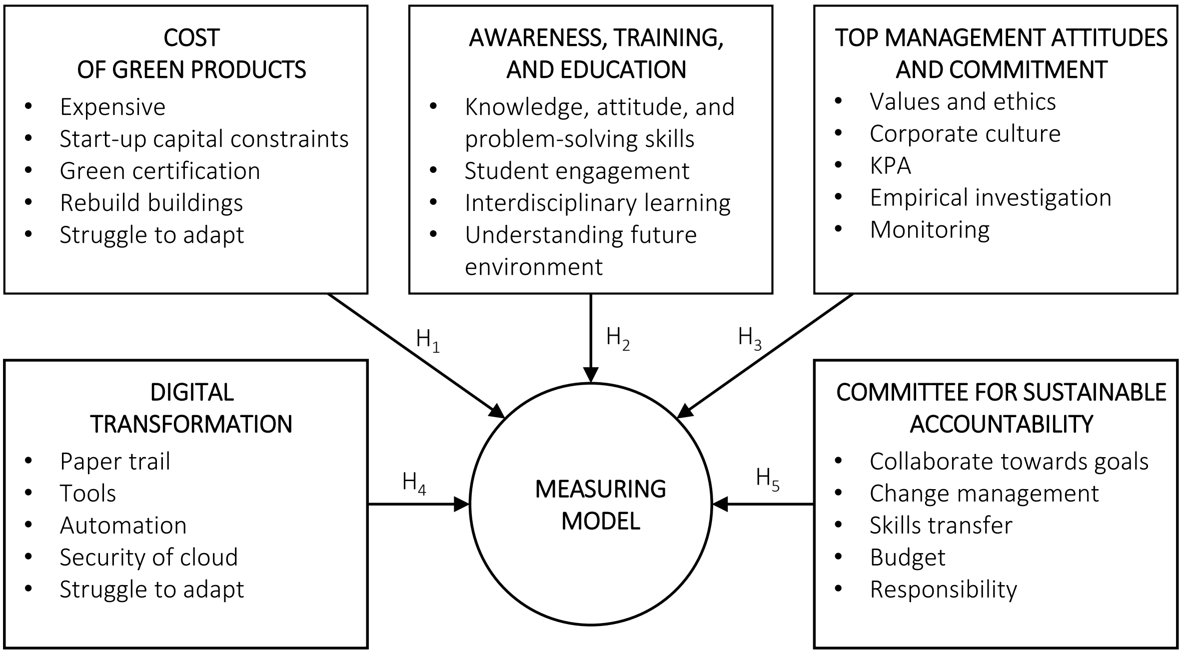

Figure 1. Conceptual model

H_1: *There is a significant positive relationship between cost of green initiatives and green initiatives at South African universities.*

H_2: *There is a significant positive relationship between awareness, training, and education and green initiatives at South African universities.*

H_3: *There is a significant positive relationship between management's attitudes and commitment and green initiatives at South African universities.*

H_4: *There is a significant positive relationship between digital transformation and green initiatives at South African universities.*

H_5: *There is a significant positive relationship between committee for sustainable accountability and green initiatives at South African universities.*

2. METHODOLOGY

The study employs a quantitative research design and collects data using a structured questionnaire. An ordinal scale was used based on semantic differential scaled-response questions that required respondents to record their views on a five-point Likert-type scale (ranging from 1 = Strongly Disagree to 5 = Strongly Agree).

The study population includes all executive directors, assistant directors, senior managers, senior lecturers, and faculty deans at all 23 South African public universities. Not all universities were targeted. Instead, a purposeful sample was drawn, and only eight universities were selected for this study based on their interest in green practices (as publicly outlined on their websites). All the individuals adhering to the defined population at these eight universities were targeted with online questionnaires. All participants consented in writing that their data could be used for research purposes and that the results may be published.

Permission to conduct the research was obtained from each university's human resource department. These human resource departments also acted as gatekeepers and distributed the invitational letter and link to their personnel complying with the population definition. The data were collected online via Google Forms and automatically captured on the database. As such, the study is limited to access to the database only and cannot identify individual respondents. The study was ethically approved and issued an official ethics number (NWU-00588-22-A4). Data from 149 completed questionnaires were captured and analyzed.

3. RESULTS

The data collected are adequate for analysis. The Kaiser, Meyer and Olkin tests of sample adequacy exceed 0.50, signifying sufficient data for analysis (Field, 2017) (Table 3). It also shows that Bartlett's sphericity test is significant at the 90% confidence interval ($p \leq 0.10$). This means the data are suitable for multivariate analysis (such as structural equation modeling used in this study) (Pallant, 2016).

Table 3. Sample adequacy and sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.502
Bartlett's Test of Sphericity	
Approx. Chi-Square	285.717
df	253
Sig.	.077

Figure 2 shows the structural equation model. As per My Easy Statistics (2015), all the retained measuring criteria have regression weights equal or exceeding 0.70. Criteria with regression weights smaller than 0.70 were discarded from the model after scrutinizing the model fit statistics.

A structural model should have construct validity (thus both convergent and discriminant validity) before it can be used (My Easy Statistics, 2015). This means that the AVE value of each factor must exceed 0.50. Fornell and Larcker (1981, p. 45) suggest that the Joreskog rho calculation be used to indicate construct validity. Likewise, the factor should be reliable, and composite reliability should be 0.7 or higher (Hair et al., 2017). Table 4 shows the model's validity and reliability.

All three factors have convergent validity, and the Jorekog rho value indicates that they also have construct validity. The factors are also reliable be-

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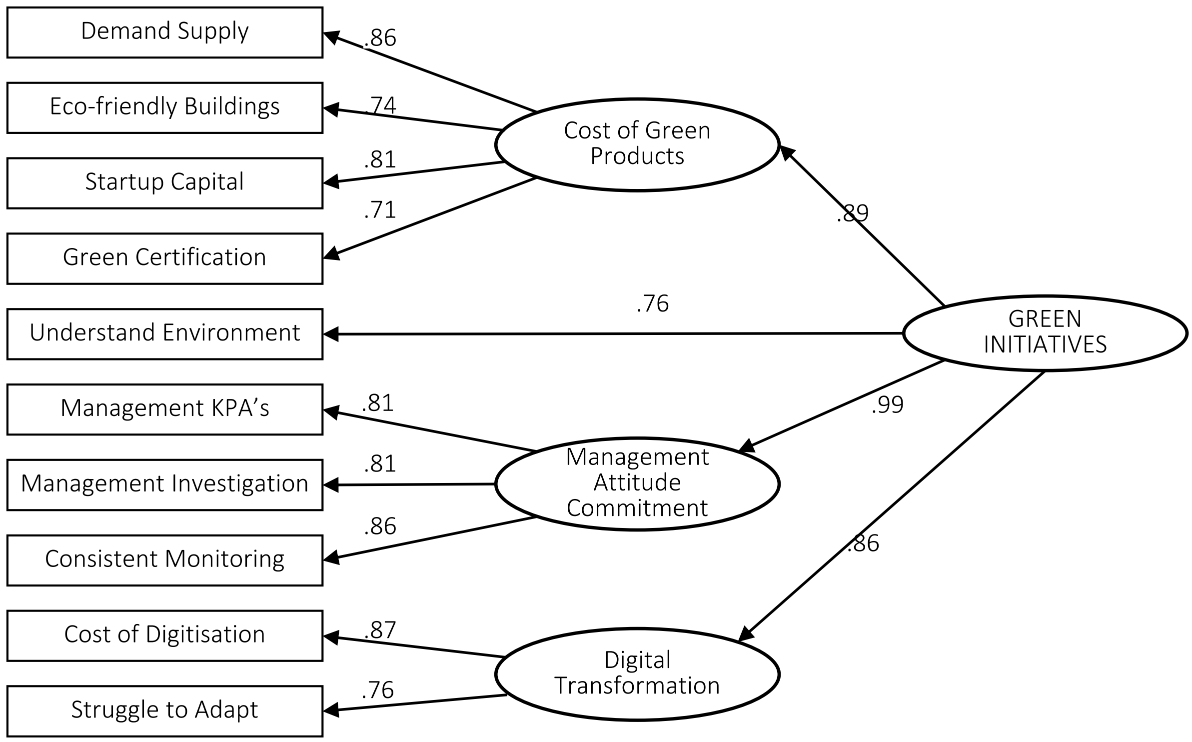

Figure 2. A model to measure and manage green initiatives at public universities

Table 4. Validity and composite reliability

Factor	AVE (≥ 0.50) Convergent	Joreskog rho (Construct)	Composite Reliability (≥ 0.70)
Cost of green products	0.612	0.862	0.862
Management attitude and commitment	0.684	0.866	0.866
Digital transformation	0.667	0.800	0.784

cause the composite reliability exceeds 0.70 with ease. The model is thus valid and reliable.

All indices, except RMSEA, are satisfactory. These model fit indices all exceed the required values, as summarized by the decision rules indicated in the table. The RMSEA does not have a good model fit. The index indicates that the model can deviate up to 17.4% from an ideal model (exceeding the acceptable 10% deviation) (Xia & Yang, 2019). However, this is an exploratory model. Exploratory models rarely have an excellent fit on all the indices. The model can be fully operationalized based on the other fit indices (Bisschoff, 2021).

4. DISCUSSION

After scrutinizing 31 similar studies, albeit none directly applicable to public higher education in South Africa, the study developed a theoretical model. Ten factors showed promise, but after fur-

Table 5. Goodness of fit indices

Index	Decision rule (preferred; minimum)	Model score	Outcome	Literature support
CMin/df	≤ 5	4.068	Good fit	My Easy Statistics (2015)
CFI	≥ 0.95; ≥ 0.85	0.944	Good fit	Bentler (1990)
GFI	≥ 0.90; ≥ 0.80	0.909	Good fit	My Easy Statistics (2015)
TLI	≥ 0.95; ≥ 0.85	0.900	Good fit	Xia and Yang (2019), Tucker and Lewis (1973)
RMSEA	≤ 0.08; ≤ 0.10	0.144	Poor fit	DiStefano and Morgan (2014), Brown and Cudeck (1992)

ther analysis, five key factors (including each factor's measuring criteria) were retained in the theoretical model to measure South African universities' green initiatives. Finally, these factors were empirically evaluated to develop an empirical model.

First, the results determined the data's suitability for model development, and the sample adequacy and sphericity of the data were measured. This analysis revealed that the data's sphericity are acceptable at the 90% confidence interval. Furthermore, as per the Kaiser, Meyer and Olkin measure of sampling adequacy, there are also adequate data points to analyze (this means that the number of responses was suitable and that "enough" data was collected to warrant multivariate statistical analysis). Thus, the data are suitable for multivariate analysis and model development.

Secondly, the results show that the model is valid, reliable, and has a good fit. However, structural modeling demonstrates that only three of the five theoretical factors are suitable for measuring green initiatives at a South African public university. These factors are cost of green products, top management's attitudes and commitment, and digital transformation. The other two factors dealing with awareness and sustainable accountability failed as measures of implementing green initiatives.

Regarding the model's validity and reliability, the model has excellent reliability. All three factors have composite reliability higher than the required 0.70. Likewise, these three factors also have convergent and construct validity. This means that two significant milestones in model development were achieved, namely that the factors are valid and reliable.

Finally, model fit is also a critical determinant to determine the model's applicability for operational use. This structural model has good model fit indices. This shows that the model is suitable for use in practice. However, one index (RMSEA) shows that the model may deviate as much as 17% from the ideal model. This implies that model users should test the RMSEA index when they measure their green initiatives to determine how much their application deviates from the ideal.

Furthermore, the study rejects H_0 because the model shows three significant positive relationships between the factors and green initiatives. Based on the structural model, the following hypotheses are accepted:

H_1: *There is a significant positive relationship ($r = 0.86$; $p \leq 0.05$) between cost of green initiatives and green initiatives at South African universities.*

H_3: *There is a significant positive relationship between management's attitudes and commitment ($r = 0.99$; $p \leq 0.05$) and green initiatives at South African universities.*

H_4: *There is a significant positive relationship between digital transformation ($r = 0.89$; $p \leq 0.05$) and green initiatives at South African universities.*

The structural analysis, however, clearly indicated no relationships between the green initiatives and the following two factors. Therefore, these hypotheses are rejected:

H_2: *There is a significant positive relationship between awareness, training, and education and green initiatives at South African universities.*

H_5: *There is a significant positive relationship between committee for sustainable accountability and green initiatives at South African universities.*

CONCLUSION

This study aimed to develop a model based on theoretical models from other industries. The five selected factors emanating from the literature were structured in a conceptual model and empirically validated. Eventually, three of the five factors are triumphant; the other two factors have limited bearing on the measurement model and are discarded.

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The study has two limitations. First, it is noteworthy that the study is geographically limited to South Africa and its specific macro-, economic and regulatory environment. Secondly, this study covers only state-funded universities in South Africa. Private universities have different macroeconomic realities, hence different constraints. Consequently, the model would be partially applicable at best. As such, private universities were excluded from the study.

In summary, this study initially identified ten factors from the literature review and then scrutinized and eventually reduced the number of factors to five using focused and supportive literature. These five factors were developed further by identifying measuring criteria from the literature. They were empirically evaluated and measured for reliability. The model was also tested for goodness of fit. As a result, three valid and reliable factors were retained that provide a good model fit. Therefore, the model can be used to measure green initiative implementation at universities in South Africa.

AUTHOR CONTRIBUTIONS

Conceptualization: Lelo Tshivhase, Christo Alfonzo Bisschoff.
Formal analysis: Christo Alfonzo Bisschoff.
Methodology: Christo Alfonzo Bisschoff.
Project administration: Lelo Tshivhase.
Validation: Lelo Tshivhase, Christo Alfonzo Bisschoff.
Writing – original draft: Lelo Tshivhase.
Writing – review & editing: Christo Alfonzo Bisschoff.

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