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Four Pillars of the Green University Soft Infrastructure:
Towards a Non-Linear Model of Innovation

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ABSTRACT

Universities are isomorphic not because of the effectiveness of their processes but because of the legitimacy assigned by institutional logic. However, sustainable development discourses invoke a novel mission for producing knowledge and innovation for sustainable development. Accordingly, this research collected data from five types of internal stakeholders' intellections of the four pillars of green university infrastructure. The analysis of data collected from 89 university stakeholders sufficient for a 90% confidence level with 5% relative tolerable error was organized as five groups in a contingency table for the chi-square test. The statistical analysis, that is, the chi-square value, indicates that all five stakeholders perceive in the same direction – that the four pillars of the green university soft infrastructure need to be reconfigured to produce green knowledge and innovation. Hence, the findings inspire the conventional universities and policymakers to transform their universities into sustainable institutions with four pillars of soft green infrastructure.

KEYWORDS

Contingency Tables, Green Knowledge and Innovation, Green University, Green University Infrastructure, Non-Linear Innovation Model, Non-Parametric Tests, Quintuple Helix Model, Sustainable Development

INTRODUCTION

Knowledge is what a knower knows with experiences, values, information in the context, and insights (Davenport & Prusak, 1998). It can be classified into two types: tacit knowledge and explicit knowledge. Tacit knowledge means the knowledge that is in the mind of the knower. In this study, the tacit knowledge of the universities' internal stakeholders, viz., professors, senior lecturers, academic managers, non-academic managers, and students (hereafter referred to as internal stakeholders). Tacit knowledge is made of two components, cognitive knowledge and technically associated knowledge.

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Cognitive knowledge relates to what is in the mind of the knower. It exists as a mental model of the knower. Because of the unstructured nature of cognitive knowledge, it cannot be used directly in an organized manner. On the other hand, explicit knowledge is structured and can be readily used.

The explicit and tacit knowledge of the university and the internal stakeholders are critical to organizational knowledge creation (Jennex, 2006). There are two views of organizational knowledge creation, the organizational learning view and the knowledge creation view

According to the organizational learning view, members and the organization learn dynamics in the environment for acquisition, distribution, and sharing the knowledge. The organization's future success depends on new knowledge created to meet new dynamics in the environment (Campanella et al., 2019). Organizational learning decodes the tacit knowledge of members of the organization (internal stakeholders) into organizational knowledge (Nonaka & von Krogh, 2009). In this process, universities and their internal stakeholders, as members of the organization, are active and purposive learners of new dynamics in the environment (Argyris & Schon, 1978). Nonaka et al. (2001) point out that active and purposive learning is confined to solving and improving existing problems.

The contemporary problem is why universities do not explicitly produce the knowledge needed for sustainable development in their mainstream knowledge production process. Sustainable development means knowledge that can address complex social problems codified as the 17 Sustainable Development Goals. A few of them are poverty, hunger, clean water, and global warming (hereafter referred to as green knowledge).

The underlying reason is that universities are isomorphic not because of the effectiveness of their processes but because their legitimacy is assigned by institutional logic. Namely, the conventional role of universities is to produce disciplinary knowledge in their discrete disciplines. As a result, the explicit knowledge produced at universities is increasingly inadequate for sustainable development.

However, the United Nations 2030 Agenda for 17 SDGs, the Paris Climate Agreement, and King IV: Code of Corporate Governance have conferred a new mandate. Accordingly, universities are supposed to produce green knowledge. It is interdisciplinary and multidisciplinary.

Despite the fact that the universities do not explicitly produce green knowledge in their mainstream knowledge production process, the internal stakeholders create green knowledge not in the mainstream but by sub-streams such as sustainability research, conference papers, guest lecturers, and renewable energy projects. It indicates that internal stakeholders' tacit knowledge is green, but universities' explicit knowledge is not green.

The gap mentioned above is inconsistent with the evolving higher education knowledge. The evolution can be noticed in two remarkable respects. One of them is the advocacy of Gibbons et al. (1994). They argue that the conventional production of knowledge with basic research labeled the Mode 1 innovation model is not adequate to resolve complex social problems in society. They propose producing interdisciplinary and transdisciplinary knowledge called the Mode 2 innovation model (Etzkowitz & Leydesdorff, 2000). One of the fundamental differences between the Mode 1 innovation model and the Mode 2 innovation model is the delay in applying the knowledge produced with the basic research.

On the other hand, basic research is conducted within discrete disciplines. Mode 2 research is interdisciplinary and transdisciplinary. It is critical to resolving complex social problems. Furthermore, the Mode 3 innovation model (Carayannis & Campbell, 2009) advocates pluralism and diversity of knowledge and innovation by coexistence and coevolution with different modes of knowledge and innovation.

Carayannis and Campbell (2010) introduced the other development, the Quintuple Helix innovation model. They argue that the university system needs to produce interdisciplinary and transdisciplinary knowledge with the government, industry, civil society, and the natural environment of society. Since knowledge is made with the natural environment, the corresponding knowledge is called green knowledge.

Nonetheless, the aforesaid evolution of knowledge cannot be used explicitly because of the traditional knowledge management system. For example, traditional university governance (leadership, structure, and strategy) cannot connect, communicate and transfer green knowledge effectively to knowledge users.

Nonaka (1994) articulates that knowledge is context-specific. Consequently, traditional universities produce linear knowledge and innovation with basic research because of conventional processes. In other words, universities' traditional knowledge management processes, namely, governance, culture, and reporting processes, cannot create non-linear green knowledge (Liyanage, 2022). Jennex and Olfman (2006), in their KM success model, bridged the gap between the inadequate current knowledge management system of an organization and the prospective improved knowledge management system. In this regard, they devoted one of three constructs of their model to emphasize the importance of governance (leadership, strategy, and structure).

Accordingly, traditional governance, culture, and reporting processes are the underlying variables that inhibit the production of green knowledge. The gap reflects that the existing knowledge management system needs improvements to discover, capture, share, and apply (green) knowledge (Cacioppe, 2017). Hence, governance as a process can align knowledge management with organizational goals to achieve the benefits of knowledge management (Jennex, 2020). Organizational culture and knowledge management have a positive, strong relationship (Jennex, 2006). Furthermore, leadership rather than technology enables an organization to develop a culture of knowledge management (Jacks et al., 2012). The reporting process reflects the control structure to monitor knowledge and knowledge management use (Jennex, 2008) for organizational goals.

Hence, an inquisitiveness emerges as to how internal stakeholders' mental models conceive the reconfiguration of processes, green corporate governance, green corporate culture, the three pillars of sustainability, and green reporting. These four knowledge management processes create a strong platform on which green knowledge can be created. Nissen and Jennex (2007) justify the separation of multiple dimensions of knowledge management to prevent the risk of stagnation of the knowledge management system.

Accordingly, the study's objective is to ascertain how the internal stakeholders of universities conceive the necessity for reconfiguring four knowledge management processes. The findings are significant for uncovering the tacit knowledge of internal stakeholders. The tacit knowledge of members of the organization is the basis for creating organizational knowledge (Nonaka & Takeuchi, 1995). Furthermore, the insights from their mental models can be used to improve the current knowledge management system to produce green knowledge in the mainstream. Consequently, the following hypotheses are framed.

The null hypothesis (H_0) is that:

H_0: There is no significant difference in mental models among university stakeholders regarding the reconfiguration of knowledge management processes, green corporate governance, green corporate culture, the three pillars of sustainability, and green reporting.

In other words, different university stakeholders perceive in the same direction that the *knowledge management processes, Green corporate governance, Green corporate culture, Three pillars of sustainability, and Green reporting* need reconfiguration to be a green university.

Consequently, the alternative hypothesis (H_a) is that:

H_a: There is a significant difference in mental models among university stakeholders regarding the reconfiguration of knowledge management processes, green corporate governance, green corporate culture, three pillars of sustainability, and green reporting.

In other words, different stakeholders of universities do not perceive in the same direction that the *knowledge management processes, Green corporate governance, Green corporate culture, Three pillars of sustainability, and Green reporting* need reconfiguration to be a green university.

A green university is meant in this study as a university that produces green knowledge in its mainstream knowledge production process. This paper is structured, beyond this introduction, to include a literature review, methodology, data analysis & findings, discussion, and conclusion sections.

LITERATURE REVIEW

Triple Helix innovation model (Etzkowitz & Leydesdorff, 1995), Quadruple Helix innovation model (Carayannis & Campbell, 2009), and Quintuple Helix innovation model (Carayannis & Campbell, 2010) are called Helix Innovation Models. They are non-linear innovation models. Gibbons et al. (1994) demonstrate that the non-linear innovation model enables universities to produce i. problem-focused knowledge in the context of application, ii. Transdisciplinary knowledge, iii. Heterogeneous knowledge with organizational diversity, iv. Socially accountable knowledge with reflexivity, and v. Quality knowledge beyond peer review.

As a non-linear innovation model, the Quintuple Helix model recommends reconstructing national knowledge structures with five helices: university, industry, government, society, and nature. These five knowledge sub-systems blend with each other, focusing on the natural environment as a central sub-system. It is an alternative to Schumpeter's innovation model (1912, 1934, 1939) because Schumpeter's creative destruction created negative impacts on living standards and economic development over time. For example, overconsumption of nonrenewable resources, global warming, imminent encroachment of ecological boundaries (Daniels et al., 2015), and unequal income distribution have caused an unsustainable world. Carayannis et al. (2019) explain that several critical factors have weakened Schumpeter's creative destruction innovation model based on free and open international trade. They substantiate their argument by giving critical factors, such as espousing rising populist social movements, mercantilism, protectionism, and economic nationalism.

Consequently, the Quintuple Helix innovation model enables universities to produce green knowledge. It is superior to the triple helix innovation model and quadruple helix innovation model because of the natural environment of society and coopetition (Ferasso & Grenier, 2019; Liyanage, 2022). It shelters different knowledge systems such as the Mode 1 innovation model, Mode 2 innovation model, Mode 3 innovation model, Triple Helix innovation model, and Quadruple Helix innovation model.

However, the dynamics for a win-win situation depend on each sub-system's internal knowledge structure (Ode & Ayavoo, 2020), in this study, the university system. Van Lancker et al. (2015) point out that an organizational innovation system, i.e., a microlevel innovation system, improves innovation performance not only at the organizational level but also at higher system levels, such as the sectoral, regional, and national levels (Walshok et al., 2014).

Structural changes (Senge, 1990) with four infrastructural knowledge management processes are critical for universities to create deep knowledge and higher-level learning. Sparrow (1998) demonstrates that the constituent parts of a phenomenon (green knowledge) can be integrated to configure a coherent system. These learning processes build an infrastructural environment needed to create knowledge under the views of organizational learning and knowledge creation.

The structure of the knowledge management system is not necessarily restricted to a document management system (Jennex, 2009). It can be in any form if the knowledge management system can accomplish its goals (Churchman, 1979). For example, the green governance directs and controls by vision, mission, goals, and objectives provide for green information processing system. Green culture recognizes green values and beliefs. The information system espouses with the necessary reconciliation of three pillars of sustainability. The green reporting process ensures the measuring and control system for the information processing system. The overall objective of reconfiguration

is to align four processes as an information processing system. The system's role is to encode, store, retrieve, and use green knowledge. Consequently, it develops (green) cognitive knowledge of internal stakeholders and the university in their mainstream knowledge creation process.

System thinking (Senge, 1990) enables a knowledge management system to develop higher-level learning against lower-level learning. There are fundamental differences between these two levels. Higher-level learning creates deep knowledge, whereas lower-level learning creates learning adequate for survival or short-term learning (Senge, 1990). Argyris and Schon (1978) developed another distinction called single- and double-loop learning models. Accordingly, lower-level learning creates a single-loop learning model. It engages with a single feedback loop. It detects the errors and fixes them, but there is no focus on the theories of action. Learning organizations with higher levels detect errors and strategies, but the learning process goes beyond fixing the errors. It relates the errors with the theories of action. In other words, the norms that contribute to the organization's functioning are also fixed.

Since the creation of green knowledge is a new phenomenon, higher-level learning is warranted for deep knowledge. Deep/broad knowledge focuses not on how things can be fixed for errors but on why it happens or the cause-and-effect relationship (Kim, 1993). For example, the green reporting system detects errors and fixes them with necessary changes in the theory of action, the master program for green knowledge. Accordingly, the infrastructural processes system enables organizational learning to create deep knowledge with a double-loop learning model. Since green knowledge is a new phenomenon, double-loop learning is critically important. It involves substantial and transformative environmental dynamics. As a result, the theory of action can be recreated to create knowledge (DiBella et al., 1996).

In brief, these reconfigured four-processes system improve existing knowledge and develop internal stakeholders' (green) cognition. Ultimately, internal stakeholders apply their tacit knowledge to explicit knowledge by externalization (Jennex, 2005; Nonaka et al., 2000). In other words, they apply their tacit knowledge while teaching, research, internal operations, and community outreach.

METHODOLOGY

Quantitative research aims to uncover the tacit knowledge of internal stakeholders if their mental models advocate transforming universities' conventional knowledge management systems to produce green knowledge and innovation. Internal stakeholders' mental models are unstructured. They are difficult to explain in numeric terms, but they can be ranked. Consequently, the Likert scale instrument collected ordinal data for four constructs: Green corporate governance, Green corporate culture, Three pillars of sustainability, and Green reporting. Each construct represented three Likert items totaling 12 Likert items for four constructs (Appendix 1). These four processes reflect organizational knowledge creation from the organizational learning view.

However, the same Likert scale instrument collected ordinal data for four more processes: green education, green research, green internal operations, and green community outreach. These four processes reflect organizational knowledge creation from a knowledge creation view. They are not within the scope of this research.

After a pilot run, some modifications were made to improve the readability and answerability of the questionnaire. Some demographic questions were dropped, and the ten-point Likert scale was reduced to five. The five points are Strongly disagree, Disagree, Undecided, Agree, and Strongly agree. They were assigned numerical values of 1, 2, 3, 4, and 5, respectively. Furthermore, perceptions were collected from five types of stakeholders. Hence, nonparametric statistics are more appropriate than parametric statistics. Accordingly, contingency tables with chi-squared tests were carried out to test the hypothesis.

This study collected 94 observations, of which five observations were removed while cleaning. Participants in the survey were met at four conferences in two countries in 2019 and 2020. The themes

of the conferences were related to sustainability. The sample size was determined as prescribed by Park and Jung (2009), who point out that 65 observations are sufficient when the number of Likert items is three, the confidence level is 90%, the relative tolerable error is 5%, and the pairwise coefficient correlation is 0.5. The authors further prescribe that 257 observations are needed for 95% confidence level, which could not be met due to the COVID-19 pandemic environment. Hence, 89 observations were available for data analysis.

Cronbach's alpha was calculated for each of the four constructs. Each construct consists of three Likert items. Accordingly, Cronbach's alpha is 0.624 for green corporate governance, 0.660 for green corporate culture, 0.650 for the three pillars of sustainability, and 0.403 for green reporting. These Cronbach's alpha values are sufficient to satisfy the internal consistency even though higher values are preferred over lower values. In support, Cronbach (1951) asserts that even though higher alpha values are preferred over lower values, the most crucial point is that the values are interpretable. Adding one Likert item for each construct adds eight Likert items and makes the readability and answerability of the instrument difficult. Cronbach (1951) further indicates that even though Cronbach's alpha value can be increased by adding more questions, additional questions may be redundant if they add little information. Correspondingly, three Likert items for each construct provide sufficient information to test the hypothesis.

DATA ANALYSIS AND FINDINGS

Wu (2007) asserts that the Likert Scale (Likert, 1932) is a vital device to measure constructs that refer to abstract concepts difficult to explain in numeric terms, such as opinions, attitudes, and images. In this study, there are four constructs: Green corporate governance, Green corporate culture, Three pillars of sustainability, and Green reporting. Perceptions were ranked from strongly disagree = 1 to strongly agree = 5.

Three Likert items for each concept totaling 12 Likert items were used to collect ordinal data. They were analysed with contingency tables and Pearson's chi-squared test (X^2) (Table 1 to Table 4). Each contingency table consists of two rows and five columns (2×5) table of frequencies.

The five columns display five groups of internal stakeholders. The first column represents 15 professors as group one. The second, third, fourth, and fifth columns represent 24 senior lecturers, 16 academic managers, 13 non-academic managers, and 21 students. Two rows are used to demonstrate the five points summarized into two. The first row denotes 'Agreed,' consisting of two points, 'Agree =4' and 'Strongly Agree = 5'. The second-row displays 'Strongly disagree,' 'disagree,' and 'Undecided.' The second row included 'undecided' to prevent small values of expected counts. The collapsing 'undecided' into the second row does not reverse the trend that appears in the data set. Consequently, there is no danger of misleading the results by collapsing Simpson's paradox, also known as Yule's paradox. In other words, collapsing does not affect the hypothesis.

Findings: the chi-square statistic of 5.56 is less than the critical value of 7.78. It indicates that H_0 cannot be rejected. In other words, there is no significant difference in perceptions among the stakeholders at α at the 0.1 level of significance.

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Finding: the chi-square statistic of 0.997 is less than the critical value of 7.78. It indicates that H_0 cannot be rejected. In other words, there is no significant difference in perceptions among the stakeholders at α at the 0.1 level of significance.

Table 1. Contingency Table: Perceptions of Green corporate governance

Green Corporate Governance						
		Group 01	Group 02	Group 03	Group 04	Group 05	
Agreed		40	61	42	28	53	224
Expected		37.75	60.40	40.27	32.72	52.85	224
Disagreed & Undec		5	11	6	11	10	43
Expected		7.25	11.60	7.73	6.28	10.15	43
		45	72	48	39	63	267
Sigma(O/E)^2/E		0.13	0.01	0.07	0.68	0.00	0.90
		0.70	0.03	0.39	3.55	0.00	4.66
				Chi-Square Statistics			5.56
		D/F = 4 and at 10% significance level					7.78

Table 2. Contingency Table: Perceptions of the green corporate culture

Green Corporate Culture						
		Group 01	Group 02	Group 03	Group 04	Group 05	
Agreed		37	62	42	29	56	226
Expected		38.09	60.94	40.63	33.01	53.33	226
Disagreed & Undec		8	10	6	10	7	41
Expected		6.91	11.06	7.37	5.99	9.67	41
		45	72	48	39	63	267
Sigma(O/E)^2/E		0.031	0.018	0.046	0.487	0.134	0.717
		0.172	0.101	0.255	2.687	0.739	3.954
				Chi-Square Statistics			4.671
		D/F = 4 and at 10% significance level					7.78

Table 3. Contingency Table: Perceptions of Three pillars of sustainability

Three Pillars of Sustaianbility						
		Group 01	Group 02	Group 03	Group 04	Group 05	
Agreed		40	65	40	33	58	236
Expected		39.78	63.64	42.43	34.47	55.69	236
Disagreed & Undec		5	7	8	6	5	31
Expected		5.22	8.36	5.57	4.53	7.31	31
		45	72	48	39	63	267
Sigma(O/E)^2/E		0.001	0.029	0.139	0.063	0.096	0.328
		0.010	0.221	1.057	0.478	0.732	2.499
				chi-Square Statistics			2.827
		D/F = 4 and at 10% significance level					7.78

DISCUSSION

The institutional logic of universities is evolving from the production of disciplinary knowledge to the production of green knowledge. The underlying philosophy is the third mission, universities'

Table 4. Contingency Table: Perceptions of Green Reporting

Green Reporting						
	Group-1	Group-2	Group-3	Group-4	Group-5	
Agreed	41	63	43	33	55	235
Expected	39.61	63.37	42.25	34.33	55.45	235
Disagreed & Undec	4	9	5	6	8	32
Expected	5.39	8.63	5.75	4.67	7.55	32
	45	72	48	39	63	267
Sigma(O/E)^2/E	0.049	0.002	0.013	0.051	0.004	0.119
	0.360	0.016	0.099	0.376	0.027	0.877
		Chi-Square Statistics				0.997
	D/F = 4 and at 10% significance level					7.78

contribution to economic development (Miotto et al., 2018). In this mission, the Quintuple Helix innovation model intends to align national-level knowledge structures to produce green knowledge. However, innovation cannot be achieved without organizational change at the micro-level of universities. The change is imperative because learners have to learn complex social and ecological issues to act as problem solvers and change agents of sustainable development (Burns, 2013).

Correspondingly, Areed et al. (2020) articulate that the organizational learning and knowledge creation processes drive organizational innovation and competitive advantage in the modern world. Liyanage and Netswera (2021) introduced a Green University System model and suggested reconfiguring eight knowledge management processes. Four of them relate to the organizational learning view to develop the tacit knowledge of internal stakeholders. They are green corporate governance, green corporate culture, three pillars of sustainability, and green reporting. These processes create a knowledge management system for information processing by encoding, storing, retrieving, and using (green) knowledge (Akbar, 2022).

Green corporate governance: universities' current governance structure is not conducive to green knowledge management. A fundamentally different structure is required to produce green knowledge and innovation (Dale & Newman, 2005; Farley & Smith, 2014; Weisser, 2017). Galpin et al. (2015) point out that the organization's multiple governance processes, vision, mission, values, strategies, goals and objectives, and human resource value chain should be aligned for sustainability as a competitive strategy. Jennex (2019) expressed that the functionality of the structure, strategy, and leadership under governance is not restricted to making information processing effective for achieving the organization's goals. They can be used to align knowledge management to organizational competitive strategy.

Hence, Likert item 01 is designed to ascertain the tacit knowledge of internal stakeholders if "a system of governance consists of rules, regulations, procedures, processes, and practices to strategize for greening a university is an essential aspect in greening a university." Apart from the structure and strategy, another important aspect of green governance is leadership. Hence, items 2 and 3 were focused on leadership. Ghosh et al. (2022) demonstrate that knowledge leaders are facilitators and integrators of knowledge management. They are a product of both transformational and transactional leadership. Jennex et al. (2012) explain the two-way positive causal relationship between knowledge leadership and knowledge management. They point out that the knowledge leader can successfully implement a knowledge management system needed for innovation. On the other hand, leadership fortifies successful knowledge management (Jennex, 2019). The finding of data analysis reflects that internal stakeholders' mental models are not different from each other.

Green corporate culture: Jennex (2007) clarifies that knowledge management does not necessarily mean only an information system and its components. Still, governance and the organizational culture

are also imperative to make an effective knowledge management system. Schein (2004:17) defines organizational culture as "the patterns of shared basic assumptions learned by the organization as it solves its problems of external adaptations and internal integration that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel concerning those problems." According to Schein (2004), people in the organization resolve the problems and develop values and beliefs over time when they have resolved issues successfully. Hence, Jennex (2009; Jennex & Olfman, 2005) identifies culture as a critical success factor that needs to be aligned with the organization's structure, strategy, and leadership.

Accordingly, organizational culture plays an instrumental role in achieving the goals and objectives of the organization. Correspondingly, the first Likert question was framed to ascertain stakeholders' tacit knowledge about green values and beliefs. However, communication of culture among members of the organization to create institutional behaviour is a challenge (Martin & Murray, 2011). Galpin et al. (2015) discuss a holistic view of how an organization's existing culture could be transformed into a green culture. Accordingly, they require aligning and communicating green values and beliefs through multi-processes of an organization. They are vision, mission, values, strategies, goals and objectives, and the human resource value chain with the sustainability culture. Hence, the second Likert item ascertained whether the communication of the values and beliefs of sustainability culture through vision and the mission are necessary for greening a university's culture. Further, the third Likert item intended to know if the green values and beliefs of sustainability should be embedded with multiple processes of the university. The finding of data analysis reflects that internal stakeholders' mental models are not different from each other.

Three pillars of sustainability: This process is a newer knowledge management process introduced in this study. The Brundtland Commission (1987) advocated sustainable development focusing on the three pillars of sustainability, economic growth, environmental protection, and social equity. Accordingly, another dimension that needs to be considered in reconfiguring a knowledge management system for green knowledge management is the three pillars of sustainability. Hence, the first Likert item investigated whether the internal stakeholders perceive all three pillars are essential in greening universities.

Murphy (2012) points out that the social pillar's meanings and objectives are vague compared to the other two pillars. Conner et al. (2018) point out that the university under study is more robust in environmental and social pillars, while the economic pillar is the weakest. Panatsa and Malandrakis (2018) argue that even though education for sustainable development relates to all three pillars of sustainability, social and economic sustainability are usually ignored. The metaphors of the three pillars are interrelated, and therefore, a trade-off among these three pillars (SDG 17) is inherent (Mischen et al., 2019; Weisser, 2017). Hence, the second Likert item investigated the mental model of internal stakeholders concerning the necessity of reconciliation of three pillars.

Universities can contribute to sustainable development at the national, regional, (North, 2005; Vekic et al., 2020), and global levels of sustainability (Cartwright & Craig, 2006). Gallardo-Vazques and Folgado-Fernández (2020) point out that the university's role is to provide quality teaching and research while reconciling the three pillars of sustainability to improve the quality of life. Hence, the third Likert item ascertained if the internal stakeholders believe that the focus on local, national, and global perspectives is necessary. The finding of data analysis reflects that internal stakeholders' mental models are not different from each other.

Green reporting: Sustainability practices in a green knowledge management system contribute to organizational knowledge creation. These practices create green knowledge with teaching, research, internal operations, and university community outreach. However, assessing sustainability practices remains a complex process because of the infancy level of sustainability reporting (Sassen & Azizi, 2018). Hence, the first Likert item examined how internal stakeholders perceive the importance of sustainability reporting.

However, universities' sustainability reporting tools are still in the early stages because of the voluntary nature of disclosure in all territories (Lopatta & Jaeschke, 2014). These tools have their strengths and weaknesses. However, measuring the progress is essential (Lozano, 2006). As well said, "What gets measured, gets managed." Hence, the second Likert item probed how the internal stakeholders perceive measuring the progress of sustainability practices of a green university. The third Likert question tested the tacit knowledge of internal stakeholders about measuring and reporting green culture. The finding of data analysis reflects that internal stakeholders' mental models are not different from each other.

CONCLUSION

Universities are expected to contribute to the national economy under the third mission of universities. In response to this appeal, several innovation models have been developed. This study advocates the Quintuple Helix innovation model. It is superior to other Helix models because the natural environment of society as a helix enables universities to produce green knowledge.

The Helix models intend to make national-level structural changes for knowledge production. However, national-level structural changes cannot be achieved without micro-level knowledge management changes. It reflects that the universities do not explicitly produce green knowledge in their mainstream knowledge production process. In contrast, internal stakeholders are actively creating green knowledge in sub-streams such as published research papers, academic books, research conferences, and guest speakers. Hence, it is necessary to improve existing knowledge management processes at universities. A change in the knowledge management system facilitates the users to adopt it (Jennex, 2008; Veeravalli & Vijayalakshmi, 2021).

On this premise, the null hypothesis was set to ascertain if the different stakeholders of universities perceive in the same direction that the knowledge management processes, *Green corporate governance, Green corporate culture, Three pillars of sustainability, and Green reporting* need reconfirmation to be a greening a university. The results demonstrate that all five types of internal stakeholders of universities have the same mental models that the above knowledge management processes need reconfiguration into a green knowledge management system.

The findings encourage policymakers to rethink of restructuring of conventional knowledge management processes to produce green knowledge platform in the mainstream knowledge production process. However, this study did not include stakeholders, such as parents of the students, employers, sponsors, and public educational authorities. Their mental models are also essential to complete the full picture of their tacit knowledge. Furthermore, this research paper did not focus on green curriculum, green research, green internal operations, and green community outreach (Liyanage, 2022). They can also be studied under the knowledge creation view. Hence, further research are needed in these areas.

CONFLICT OF INTEREST

The authors of this publication declare there is no conflict of interest.

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APPENDIX A - A FRAMEWORK FOR GREENING OF UNIVERSITIES IN SOUTHERN AFRICAN COUNTRIES

We asked you to complete this survey to help us develop a framework for the greening of universities in South African countries so that the universities in South African countries would be able to transform their universities into sustainable universities.
THIS SURVEY DOES NOT HAVE YOUR NAME ON IT, SO YOUR COMMENTS AND INPUTS ARE CONFIDENTIAL, which means that no one will know how you answer these questions.
Please make sure you read each question carefully and select the response that best suits you. Mark your answers by placing a tick mark in the appropriate answer, 1, 2, 3, 4, or 5 (1 denotes strongly disagree to 5 denotes strongly agree).
The questionnaire begins to be completed by those who are passionate about sustainable/green universities in Southern African Countries.
A Framework for Greening of Universities in Southern African Countries.
We kindly request that you take a few minutes of your time to answer the following questions. This will help us develop a framework for greening a university in South African countries.
a) Are you aware of greening universities in South African countries? Yes No
b) In which country is your university located?
For each of the statements below, please rate how much you agree or disagree as follows.
1 2 3 4 5
Strongly Disagree Disagree Undecided Agree Strongly Agree
Thank you very much for completing the Research Questionnaire!

Table 5. Questionnaire questions

Green Corporate Governance								
GG01	A system of governance consisting of rules, regulations, procedures, processes, and practices for greening a university is an important aspect of greening a university.	Strongly Disagree	1	2	3	4	5	Strongly Agree
GG02	For greening a university, a top-down approach rather than a bottom-up approach is required	Strongly Disagree	1	2	3	4	5	Strongly Agree
GG03	A member of the board of directors/governing council is required for accountability of the greening of the university to the rest of the board or governing council of the university	Strongly Disagree	1	2	3	4	5	Strongly Agree
Green Culture								
GC01	A sustainability culture with necessary values and beliefs is also another important aspect of greening a university	Strongly Disagree	1	2	3	4	5	Strongly Agree
GC02	The communication of values and beliefs for sustainability culture to the stakeholders by way of policy documents such as vision, mission, etc., are required for greening university	Strongly Disagree	1	2	3	4	5	Strongly Agree
GC03	The values and beliefs for sustainability culture embedded in multi processes of the university, such as human resource, marketing, financing, etc. is required for greening the university	Strongly Disagree	1	2	3	4	5	Strongly Agree
Triple Bottom Line								
GT01	The three pillars of sustainability (environmental, social, and economic sustainability) is also an important aspect of greening a university	Strongly Disagree	1	2	3	4	5	Strongly Agree
GT02	When designing sustainable practices needed for greening a university, a reconciliation of three pillars, environmental, social, and economic sustainability, is required	Strongly Disagree	1	2	3	4	5	Strongly Agree
GT03	The local, regional and global context of the three pillars of sustainability(environmental, social, and economic sustainability) is required to be taken into consideration in sustainability practices to be adopted in greening	Strongly Disagree	1	2	3	4	5	Strongly Agree

continued on following page

Table 5. Continued

Green Corporate Governance								
Green Reporting								
GA01	Sustainability reporting is another important aspect of greening a university	Strongly Disagree	1	2	3	4	5	Strongly Agree
GA02	Measuring and reporting of sustainability is able to understand the progress of sustainability practices of the green university	Strongly Disagree	1	2	3	4	5	Strongly Agree
GA03	Measuring and reporting of sustainability is able to understand the green culture of the green university	Strongly Disagree	1	2	3	4	5	Strongly Agree