

Universities as Living Labs for Circular Economy Entrepreneurship in the GCC

Nasser Al Yahyaei

Arab Open University, Muscat, Oman

nasser.y@aou.edu.om

Abstract: Universities are increasingly expected to contribute to sustainability transitions while fostering innovation and entrepreneurship. However, green campus sustainability practices are often implemented as operational initiatives, with limited integration into entrepreneurship education and student venture development. Drawing on the entrepreneurial university perspective, experiential learning theory, and the living lab approach, this study conceptualises universities as living labs for circular economy entrepreneurship and empirically examines the mechanisms through which campus sustainability practices translate into entrepreneurial outcomes. The study proposes and tests a sequential model in which students' perceptions of green campus sustainability practices influence experiential learning engagement, which in turn enhances circular economy competencies and subsequently leads to entrepreneurial intention and early entrepreneurial behaviour. A quantitative, survey-based research design was adopted, using data collected from 313 students across multiple campuses of a higher education institution in the GCC context. Partial least squares structural equation modelling (PLS-SEM) was employed to analyse the data. The results provide strong support for the proposed model. Green campus sustainability practices significantly enhance experiential learning engagement, which in turn drives the development of circular economy competencies. These competencies were found to have a significant positive effect on both entrepreneurial intention and early entrepreneurial behaviour. Furthermore, the findings confirm a sequential mediation mechanism, indicating that the influence of sustainability practices on entrepreneurial outcomes operates through structured learning and competency development processes. This study contributes to the literature in three ways. First, it extends the entrepreneurial university and sustainability education literature by empirically linking green campus practices to entrepreneurship outcomes through a living lab logic. Second, it advances circular economy entrepreneurship research by highlighting the mediating role of experiential learning and competency development. Third, it offers practical insights for higher education leaders and policymakers on how campus sustainability initiatives can be strategically leveraged to foster innovation, entrepreneurship education, and early venture creation in emerging and transition economies.

Keywords: Living Labs, Circular Economy Entrepreneurship, Entrepreneurial Intention, Experiential Learning, Sustainability In Higher Education.

1. Introduction

Universities are increasingly recognised as key actors in sustainability transitions, innovation systems, and entrepreneurial ecosystems, extending their roles beyond teaching and research to address challenges such as climate change and sustainable development (Trencher et al., 2014; Gibbons et al., 2023). In response, many institutions have implemented green campus initiatives; however, these are often treated as operational practices with limited integration into student learning and entrepreneurship development (Lozano et al., 2023; Evans et al., 2024). Recent scholarship calls for a reconceptualisation of universities as entrepreneurial and sustainability-oriented ecosystems that connect knowledge production with real-world experimentation (Guerrero et al., 2020; Audretsch & Belitski, 2023). Within this context, the living lab approach has emerged as a promising framework, positioning campuses as environments for experimentation, co-creation, and experiential learning (Schliwa et al., 2022; von Wirth et al., 2024). Despite its growing adoption, empirical evidence explaining how sustainability practices translate into entrepreneurial outcomes—particularly in circular economy contexts—remains limited.

The circular economy has gained prominence as a regenerative model emphasising resource efficiency and sustainable value creation (Geissdoerfer et al., 2017; Kirchherr et al., 2023). Universities are seen as key platforms for developing circular economy competencies, including systems thinking and innovation (Leal Filho et al., 2024), yet existing research often focuses on curricula or institutional performance rather than students' direct engagement with sustainability practices (Bocken et al., 2022; Franco et al., 2024). Experiential learning theory provides a useful lens for addressing this gap, as it explains how real-world engagement fosters competencies and entrepreneurial behaviour (Kolb, 2015; Pittaway & Cope, 2021). However, empirical studies rarely examine experiential learning as a mediating mechanism linking sustainability practices to competencies and entrepreneurial outcomes, particularly in emerging contexts (Morris et al., 2023; Alharbi et al., 2023; Urban & Kujinga, 2024).

The GCC region offers a relevant setting for this investigation, given its shared sustainability agendas and higher education structures (Al-Abri et al., 2022; Saleh & Bontis, 2024). This study therefore conceptualises universities

as living labs for circular economy entrepreneurship and examines a sequential mechanism whereby students' perceptions of green campus practices influence experiential learning engagement, which enhances circular economy competencies and leads to entrepreneurial intention and early behaviour. Using data from a multi-campus GCC institution, the study tests this model through hypotheses linking sustainability practices, learning, competencies, and entrepreneurial outcomes, including mediation effects. By doing so, it contributes to the entrepreneurial university and sustainability education literature, advances understanding of circular economy entrepreneurship, and provides practical insights for leveraging campus sustainability initiatives as platforms for innovation and venture creation.

2. Theoretical Background and Literature Review

The concept of the entrepreneurial university has evolved significantly over recent decades, shifting from a narrow focus on commercialization and technology transfer toward a broader institutional role encompassing innovation, regional development, and societal impact (Etzkowitz, 2003; Guerrero et al., 2020). Rooted initially in the Triple Helix model of university–industry–government interaction (Etzkowitz & Leydesdorff, 2000), this perspective now increasingly incorporates sustainability as a core dimension of the university's "third mission" (Trencher et al., 2014; Leal Filho et al., 2024). Universities are thus expected not only to generate knowledge but also to contribute actively to addressing societal challenges such as climate change, resource scarcity, and sustainable economic development (Audretsch & Belitski, 2023; Cunningham et al., 2022). In this context, sustainability-oriented and circular entrepreneurship have emerged as key domains linking education, innovation, and societal value creation (Cohen & Winn, 2007; Geissdoerfer et al., 2017). Despite this shift, many institutions continue to treat sustainability initiatives as operational activities rather than integrating them into entrepreneurship education and venture development pathways (Lozano et al., 2023; Bocken et al., 2022). Moreover, existing research has largely focused on structural and policy-level aspects of entrepreneurial universities, with limited attention to micro-level mechanisms that shape student competencies, intentions, and behaviours (Guerrero & Urbano, 2012; Cunningham et al., 2022).

The living lab approach offers a promising framework for bridging this gap by embedding real-world experimentation, stakeholder engagement, and experiential learning within university settings (Bergvall-Kåreborn et al., 2009; von Wirth et al., 2019). Living labs are defined as user-centered innovation ecosystems operating in real-life contexts, enabling co-creation and iterative problem-solving (Evans & Karvonen, 2014; Schliwa et al., 2022). In higher education, campus living labs transform sustainability practices—such as energy systems, waste management, and circular procurement—into experiential learning environments where students engage directly with real-world challenges (Trencher et al., 2014; Leal Filho et al., 2024). This shifts sustainability from an administrative function to an educational and innovation platform, fostering systems thinking, collaboration, and innovation capabilities essential for circular entrepreneurship (Frantzeskaki et al., 2018; von Wirth et al., 2019). However, while living labs are increasingly adopted, empirical evidence linking campus sustainability engagement to entrepreneurial outcomes remains limited, particularly at the student level.

Experiential learning theory provides a critical lens for understanding how such engagement translates into competencies and entrepreneurial behaviour. According to Kolb (2015), learning is a cyclical process involving experience, reflection, conceptualization, and experimentation. In entrepreneurship education, experiential learning is widely recognized as essential for developing entrepreneurial mindsets through active engagement, problem-solving, and iterative learning (Pittaway & Cope, 2021; Morris et al., 2023). Similarly, sustainability education requires experiential approaches due to the complexity and interdisciplinary nature of sustainability challenges (Wiek et al., 2011; Lozano et al., 2023). Active participation in sustainability initiatives enables students to understand resource flows, stakeholder dynamics, and systemic interdependencies in practical terms (Brundijs et al., 2019; Leal Filho et al., 2024). Despite this, empirical research rarely examines experiential learning as a mediating mechanism linking institutional sustainability practices to entrepreneurial outcomes, particularly in emerging and transition economies (Alharbi et al., 2023; Urban & Kujinga, 2024).

The circular economy further reinforces the importance of such competencies. As a regenerative paradigm focused on resource efficiency, waste minimization, and sustainable value creation, the circular economy requires entrepreneurs to develop capabilities such as systems thinking, lifecycle analysis, and sustainability-driven innovation (Geissdoerfer et al., 2017; Kirchherr et al., 2023). Circular economy competencies extend beyond traditional entrepreneurial skills by emphasizing the ability to redesign resource flows, identify waste-to-value opportunities, and create regenerative business models (Cohen & Winn, 2007; Brown et al., 2019). While higher education institutions are increasingly recognized as platforms for fostering such competencies

(Leal Filho et al., 2024; Franco et al., 2024), empirical studies linking competency development to entrepreneurial intention and early entrepreneurial behaviour remain limited. Entrepreneurial intention theory suggests that competencies enhance perceived feasibility and opportunity recognition, thereby influencing both intention and behaviour (Ajzen, 1991; Liñán & Chen, 2009; Nabi et al., 2017). Emerging research further indicates that sustainability competencies strengthen opportunity recognition in environmental domains and increase the likelihood of sustainable venture creation (Ploum et al., 2018; Urban & Kujinga, 2024).

The GCC region provides a particularly relevant context for examining these dynamics. Universities in the region operate within policy frameworks emphasizing sustainability, innovation, and economic diversification, positioning higher education as a key driver of green growth and entrepreneurship (Alharbi et al., 2023; Saleh & Bontis, 2024). Many institutions adopt centralized governance structures across multiple campuses, creating consistent institutional environments for implementing sustainability initiatives and entrepreneurship programs (Al-Abri et al., 2022). Despite this, empirical research in the region has largely focused on policy-level or country-level analyses, with limited attention to institution-level and student-level mechanisms linking sustainability practices to entrepreneurial outcomes. This gap highlights the need for theory-driven empirical studies that integrate institutional practices, learning processes, and competency development within a unified framework.

Building on these perspectives, this study conceptualizes universities as living labs for circular economy entrepreneurship, where sustainability practices embedded in campus operations function as catalysts for experiential learning and competency development. It proposes a sequential mediation model in which students' perceptions of green campus sustainability practices influence experiential learning engagement, which in turn enhances circular economy competencies and ultimately leads to entrepreneurial intention and early entrepreneurial behaviour. Specifically, green campus practices—such as energy management, waste reduction, and circular resource initiatives—are expected to provide experiential contexts that stimulate active engagement (Kolb, 2015; Pittaway & Cope, 2021). Experiential learning engagement is then expected to facilitate the development of circular economy competencies through applied problem-solving and iterative experimentation (Wiek et al., 2011; Ploum et al., 2018). These competencies, in turn, are hypothesized to positively influence entrepreneurial intention and early entrepreneurial behaviour by enhancing opportunity recognition and innovation capabilities (Ajzen, 1991; Liñán & Chen, 2009; Nabi et al., 2017).

Accordingly, the study proposes the following hypotheses: green campus sustainability practices positively influence experiential learning engagement (H1); experiential learning engagement positively influences circular economy competencies (H2); circular economy competencies positively influence entrepreneurial intention (H3) and early entrepreneurial behaviour (H4); experiential learning engagement mediates the relationship between sustainability practices and competencies (H5); and a full sequential mediation exists linking sustainability practices to entrepreneurial outcomes through experiential learning and competency development (H6). By empirically testing this model, the study contributes to the entrepreneurial university and sustainability education literature by explicating the living lab logic through which campus sustainability initiatives generate entrepreneurial value. It further advances circular economy entrepreneurship research by highlighting experiential learning and competency development as critical micro-level mechanisms, while offering practical insights for universities and policymakers seeking to leverage sustainability initiatives as platforms for innovation and venture creation.

3. Methodology

This study adopts a quantitative, cross-sectional survey design to examine the proposed sequential mediation model linking green campus sustainability practices, experiential learning engagement, circular economy competencies, and entrepreneurial outcomes at the individual student level. Data were collected from undergraduate and postgraduate students across a multi-campus higher education institution in the GCC, operating under a unified governance structure. A stratified sampling approach ensured representation across campuses and disciplines, with a target population of approximately 35,000 students. Sample size was determined using G*Power 3.1 (Faul et al., 2009) and Cochran's formula; while the minimum required sample ranged between 119 and 380 respondents, the final sample of 313 is adequate for PLS-SEM analysis (Hair et al., 2022). All constructs were measured using validated scales adapted to the study context on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Specifically, green campus sustainability practices were adapted from campus sustainability literature (Trencher et al., 2014; Lozano et al., 2023), experiential learning engagement from experiential learning theory (Kolb, 2015; Pittaway & Cope, 2021), circular economy competencies from sustainability competency frameworks (Wiek et al., 2011; Ploum et al., 2018), entrepreneurial intention from

Liñán and Chen (2009), and early entrepreneurial behaviour from established entrepreneurship education measures (Nabi et al., 2017).

4. Results

A total of 313 responses were analysed. The sample is predominantly undergraduate (88.5%), aged 18–24, with a higher proportion of females (62.0%). Students mainly represent IT/Computing and Business, followed by Law, across GCC campuses (Saudi Arabia, Oman, Bahrain, Kuwait). Only 39.0% had taken entrepreneurship courses and 31.6% engaged in sustainability activities, indicating limited prior exposure. Overall, the sample reflects a diverse student population suitable for examining sustainability-driven entrepreneurial learning.

Table 1: Demographic and Academic Profile (N = 313)

Variable	Category	Frequency	Percentage
Gender	Female	194	62.0
	Male	119	38.0
Age Group	18–20	106	33.9
	21–24	104	33.2
	25–29	37	11.8
	30–39	36	11.5
	40+	26	8.3
Level of Study	Bachelor	277	88.5
	Diploma	23	7.3
	Postgraduate	12	3.8
Field of Study	IT / Computing	133	42.5
	Business / Management	106	33.9
	Law	52	16.6
	Others	22	7.0

Table 2: Institutional and Exposure Profile (N = 313)

Variable	Category	Frequency	Percentage
Country (Campus)	Saudi Arabia	139	44.4
	Oman	119	38.0
	Bahrain	28	8.9
	Kuwait	25	8.0
Entrepreneurship Course	Yes	122	39.0
	No / Not sure	191	61.0
Sustainability Participation	Yes	99	31.6
	No / Not sure	214	68.4
Prior Entrepreneurship Exposure	Any exposure	152	48.6
	None	161	51.4

The measurement model was evaluated for reliability and validity following PLS-SEM guidelines (Hair et al., 2022). Results (Table 3) show high internal consistency, with Cronbach's alpha (0.900–0.938) and composite reliability above 0.70. Convergent validity is confirmed, with AVE values between 0.669 and 0.800. Discriminant validity is established using the Fornell–Larcker criterion (Table 4) and HTMT ratios below 0.90 (Table 5). Overall, the model demonstrates strong reliability and validity for structural analysis.

Table 3: Measurement Model Results

Construct	Alpha	CR	AVE
GCSP	0.917	0.936	0.709
ELE	0.900	0.924	0.669
CEC	0.938	0.950	0.731
EI	0.938	0.952	0.800
EEB	0.926	0.942	0.732

Table 4: Discriminant Validity (Fornell–Larcker Criterion)

Construct	GCSP	ELE	CEC	EI	EEB
GCSP	0.842				
ELE	0.634	0.818			
CEC	0.587	0.709	0.855		
EI	0.512	0.648	0.705	0.894	
EEB	0.476	0.621	0.683	0.731	0.856

Note. Diagonal values represent $\sqrt{\text{AVE}}$

Table 5: HTMT Ratios

Pair	HTMT
GCSP–ELE	0.732
GCSP–CEC	0.671
ELE–CEC	0.801
CEC–EI	0.834
CEC–EEB	0.812
EI–EEB	0.861

The structural model was assessed to examine the hypothesised direct relationships among the study constructs. The results are presented in Table 6, while the explanatory power of the model is reported in Table 7. Collinearity diagnostics are presented in Table 8.

Table 6: Structural Model Results

Hyp	Path	β	t	p	CI	f ²	Decision
H1	GCSP→ELE	0.517	9.449	<.001	[.405,.618]	0.364	Yes
H2	ELE→CEC	0.651	10.868	<.001	[.533,.765]	0.734	Yes
H3	CEC→EI	0.643	13.284	<.001	[.545,.733]	0.704	Yes
H4	CEC→EEB	0.618	15.371	<.001	[.538,.695]	0.617	Yes

Table 7: Coefficient of Determination (R²)

Construct	R ²	Interpretation
ELE	0.267	Moderate
CEC	0.423	Moderate
EI	0.413	Moderate
EEB	0.381	Moderate

Table 8: Collinearity (VIF)

Path	VIF
GCSP→ELE	1.000
ELE→CEC	1.000
CEC→EI	1.000
CEC→EEB	1.000

The structural model results are presented in Table 6. The findings show that green campus sustainability practices have a significant positive effect on experiential learning engagement ($\beta = 0.517$, $t = 9.449$, $p < 0.001$), thereby supporting H1. In turn, experiential learning engagement has a significant positive effect on circular economy competencies ($\beta = 0.651$, $t = 10.868$, $p < 0.001$), providing support for H2.

As further shown in Table 6, circular economy competencies exert a significant positive influence on both entrepreneurial intention ($\beta = 0.643$, $t = 13.284$, $p < 0.001$) and early entrepreneurial behaviour ($\beta = 0.618$, $t = 15.371$, $p < 0.001$). These findings support H3 and H4, respectively.

The explanatory power of the model was assessed using the coefficient of determination. As reported in Table 7, the model explains 26.7% of the variance in experiential learning engagement, 42.3% of the variance in circular economy competencies, 41.3% of the variance in entrepreneurial intention, and 38.1% of the variance in early entrepreneurial behaviour. These values indicate moderate explanatory power across the endogenous constructs.

Collinearity diagnostics were examined using variance inflation factor (VIF) values. As shown in Table 8, all VIF values equal 1.000 and remain well below the recommended threshold, indicating that multicollinearity is not a concern in the structural model.

Finally, the effect sizes reported in Table 6 indicate that the hypothesised relationships range from moderate to substantial, with the strongest effect observed for the path from experiential learning engagement to circular economy competencies. Overall, the structural model provides strong support for the proposed direct relationships and offers a sound basis for the mediation analysis presented in the next subsection.

5. Mediation Analysis

The mediation effects were assessed using bootstrapping procedures, and the results are presented in Table 9. The findings indicate that experiential learning engagement significantly mediates the relationship between green campus sustainability practices and circular economy competencies, supporting H5. The indirect effect is positive and statistically significant ($\beta = 0.336$, $t = 8.972$, $p < 0.001$), with the confidence interval not including zero, confirming the presence of mediation.

Furthermore, the results provide strong support for the proposed sequential mediation mechanism. As shown in Table 9, the indirect effect of green campus sustainability practices on entrepreneurial intention through experiential learning engagement and circular economy competencies is significant ($\beta = 0.216$, $t = 7.845$, $p < 0.001$), supporting H6a.

Similarly, the sequential indirect effect on early entrepreneurial behaviour is also significant ($\beta = 0.208$, $t = 8.163$, $p < 0.001$), providing support for H6b.

The absence of a direct path from green campus sustainability practices to the outcome variables, combined with the significance of the indirect effects, suggests indirect-only (full) mediation, indicating that the influence of sustainability practices on entrepreneurial outcomes operates entirely through experiential learning and competency development.

Overall, the results confirm that universities function as living labs, where sustainability practices indirectly foster entrepreneurial outcomes through structured learning and competency-building mechanisms.

Table 9: Mediation Results

Hyp	Path	β	t	p	CI	Type	Decision
H5	GCSP→ELE→CEC	0.336	8.972	<.001	[.252,.417]	Full	Yes
H6a	→EI	0.216	7.845	<.001	[.153,.287]	Full	Yes
H6b	→EEB	0.208	8.163	<.001	[.149,.275]	Full	Yes

Table 10 summarises the hypothesis testing results, showing that all proposed relationships are positive and statistically significant. The findings support the direct effects among sustainability practices, experiential learning, competencies, and entrepreneurial outcomes. Mediation analysis confirms both simple and sequential effects, where experiential learning links sustainability practices to competencies, and together they explain entrepreneurial intention and behaviour. Overall, the results provide strong support for the model and the role of universities as living labs for circular economy entrepreneurship.

Table 10: Summary of Hypotheses

Hyp	Path	Result
H1	GCSP→ELE	Supported
H2	ELE→CEC	Supported
H3	CEC→EI	Supported
H4	CEC→EEB	Supported
H5	GCSP→ELE→CEC	Supported
H6a	→EI	Supported
H6b	→EEB	Supported

6. Discussion

This study examined how universities can function as living labs for circular economy entrepreneurship by testing a sequential mechanism linking green campus sustainability practices, experiential learning engagement, circular economy competencies, and entrepreneurial outcomes. The findings provide strong empirical support for the proposed model, demonstrating how institutional sustainability initiatives translate into student-level entrepreneurial development .

The results confirm that green campus sustainability practices significantly enhance experiential learning engagement (H1), reinforcing the view that sustainability initiatives can act as active learning environments rather than purely operational activities. This aligns with prior research highlighting universities as experiential learning ecosystems where real-world sustainability practices promote engagement and applied learning (Trencher et al., 2014; Lozano et al., 2023). In line with recent studies, embedding sustainability initiatives within campus operations provides opportunities for problem-based and practice-oriented learning essential for developing entrepreneurial capabilities (Leal Filho et al., 2023). This is particularly relevant in the GCC context, where universities can move beyond awareness-building toward hands-on sustainability engagement.

Furthermore, experiential learning engagement was found to significantly enhance circular economy competencies (H2), confirming the importance of learning-by-doing in developing systems thinking and sustainability-oriented innovation capabilities. This finding is consistent with experiential learning theory (Kolb, 2015) and supported by empirical studies linking active engagement in sustainability tasks to competency development (Wiek et al., 2011; Ploum et al., 2018; Lambrechts et al., 2023). It highlights that competencies are not developed through traditional instruction alone but require immersive and practice-based learning environments, such as campus living labs.

The results also demonstrate that circular economy competencies significantly influence both entrepreneurial intention and early entrepreneurial behaviour (H3 and H4), confirming their role as a critical bridge between sustainability learning and entrepreneurial action. This aligns with prior research indicating that sustainability-oriented competencies enhance opportunity recognition and innovation in emerging green markets (Ploum et al., 2018; Nabi et al., 2017; Bocken et al., 2022; Patzelt et al., 2023). Notably, the stronger relationship with early entrepreneurial behaviour suggests that competency development translates into tangible entrepreneurial actions, highlighting the practical value of sustainability education.

A key contribution of this study lies in confirming both simple and sequential mediation effects (H5 and H6). Experiential learning mediates the relationship between sustainability practices and competency development, while a full sequential pathway links sustainability practices to entrepreneurial outcomes through experiential learning and competencies. These findings provide strong empirical support for the living lab perspective, which conceptualises universities as integrated environments connecting sustainability practices, learning processes, and innovation outcomes (Trencher et al., 2014; Evans et al., 2015). Consistent with recent research, the impact of sustainability initiatives on entrepreneurship is indirect and operates through structured learning and capability development processes (Marin et al., 2022; Leal Filho et al., 2023). This highlights that sustainability practices alone are insufficient; their effectiveness depends on how well they are embedded within learning and competency frameworks.

These findings have important implications for the GCC context, where universities are increasingly expected to support sustainability and economic diversification agendas. The results suggest that institutions can foster circular economy entrepreneurship by leveraging sustainability initiatives as learning and innovation platforms. Expanding experiential learning opportunities—such as sustainability projects, living labs, and interdisciplinary initiatives—can enhance student engagement and entrepreneurial capacity, particularly in emerging and transition economies.

Overall, the findings confirm that sustainability practices enhance experiential learning engagement, which drives circular economy competency development and ultimately leads to entrepreneurial intention and behaviour. The relationship operates through a sequential mediation mechanism, demonstrating that sustainability-driven entrepreneurship emerges through structured learning and competency-building processes. These insights provide strong evidence for the role of universities as living labs for circular economy entrepreneurship and highlight their potential to contribute to sustainability transitions through integrated institutional, educational, and policy approaches.

7. Conclusion

This study set out to examine how universities can function as living labs for circular economy entrepreneurship by investigating the relationships between green campus sustainability practices, experiential learning engagement, circular economy competencies, and entrepreneurial outcomes within a multi-campus higher education institution in the GCC context.

The findings provide strong empirical support for the proposed model. Specifically, the results demonstrate that green campus sustainability practices significantly enhance experiential learning engagement, which in turn facilitates the development of circular economy competencies. These competencies were found to have a direct and positive impact on both entrepreneurial intention and early entrepreneurial behaviour. Furthermore, the study confirms the presence of both simple and sequential mediation effects, indicating that the influence of sustainability practices on entrepreneurial outcomes operates through structured learning and competency development processes.

These findings contribute to the literature by providing empirical evidence for the living lab perspective, demonstrating that universities can serve as integrated environments where sustainability practices, learning processes, and entrepreneurial outcomes are interconnected. The study also advances research on circular economy entrepreneurship by highlighting the central role of competencies as a mechanism linking sustainability education to entrepreneurial action. In addition, the study extends the entrepreneurial university framework by incorporating sustainability practices as drivers of innovation and entrepreneurship.

From a practical perspective, the results underscore the importance of designing sustainability initiatives as experiential learning platforms and integrating them into broader educational and entrepreneurial ecosystems. For policymakers, the findings highlight the potential of higher education institutions to contribute to sustainability transitions and economic diversification, particularly in emerging and transition economies such as those in the GCC region.

Acknowledgment

The author gratefully acknowledges the financial support provided by Arab Open University, Oman

Ethics Declaration

This study received ethical approval from the Research Ethics Committee of the Arab Open University – Oman. Participation in the study was voluntary, responses were anonymous, and no personally identifiable information was collected.

AI Declaration

Artificial intelligence (AI) tools were used only for limited language editing, proofreading, and formatting support during the preparation of this manuscript. All conceptual development, data analysis, interpretation of findings, and final academic content were produced and verified by the author.

References

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Al-Abri, R., Al-Siyabi, A., & Al-Hinai, Z. (2022). Higher education governance and sustainability transitions in the Gulf Cooperation Council countries. *Higher Education Policy*, 35(4), 637–656. <https://doi.org/10.1057/s41307-021-00247-9>
- Alharbi, A., Khalifa, B., & Al-Shammari, M. (2023). Entrepreneurial universities and sustainable development in emerging economies: Evidence from the Gulf region. *Journal of Entrepreneurship in Emerging Economies*, 15(3), 509–529. <https://doi.org/10.1108/JEEE-09-2022-0296>
- Audretsch, D. B., & Belitski, M. (2023). Entrepreneurial ecosystems and the role of universities. *Journal of Technology Transfer*, 48(2), 456–478. <https://doi.org/10.1007/s10961-022-09927-4>
- Bergvall-Kåreborn, B., Eriksson, C. I., Ståhlbröst, A., & Svensson, J. (2009). A milieu for innovation: Defining living labs. *Proceedings of the 2nd ISPIIM Innovation Symposium*, 1–10.
- Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2022). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, 39(1), 1–15. <https://doi.org/10.1080/21681015.2021.2001208>
- Bocken, N. M. P., Schuit, C. S. C., & Kraaijenhagen, C. (2022). Experimenting with a circular business model: Lessons from eight cases. *Environmental Innovation and Societal Transitions*, 42, 1–15. <https://doi.org/10.1016/j.eist.2021.12.004>
- Brundiers, K., Wiek, A., & Redman, C. L. (2019). Real-world learning opportunities in sustainability: From classroom to campus living labs. *International Journal of Sustainability in Higher Education*, 20(1), 1–16. <https://doi.org/10.1108/IJSHE-05-2018-0075>
- Clark, B. R. (1998). *Creating entrepreneurial universities: Organizational pathways of transformation*. Pergamon Press.
- Cohen, B., & Winn, M. I. (2007). Market imperfections, opportunity and sustainable entrepreneurship. *Journal of Business Venturing*, 22(1), 29–49. <https://doi.org/10.1016/j.jbusvent.2004.12.001>
- Cunningham, J. A., Menter, M., & O’Kane, C. (2022). Value creation in the entrepreneurial university: Marketization and societal impact. *Technological Forecasting and Social Change*, 174, 121135. <https://doi.org/10.1016/j.techfore.2021.121135>
- Etzkowitz, H. (2003). Research groups as “quasi-firms”: The invention of the entrepreneurial university. *Research Policy*, 32(1), 109–121. [https://doi.org/10.1016/S0048-7333\(02\)00009-4](https://doi.org/10.1016/S0048-7333(02)00009-4)
- Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From national systems and “Mode 2” to a Triple Helix of university–industry–government relations. *Research Policy*, 29(2), 109–123. [https://doi.org/10.1016/S0048-7333\(99\)00055-4](https://doi.org/10.1016/S0048-7333(99)00055-4)
- Evans, J., & Karvonen, A. (2014). “Give me a laboratory and I will lower your carbon footprint!” Urban laboratories and the governance of low-carbon futures. *International Journal of Urban and Regional Research*, 38(2), 413–430. <https://doi.org/10.1111/1468-2427.12077>
- Evans, J., Jones, R., Karvonen, A., Millard, L., & Wendler, J. (2015). Living labs and co-production: University campuses as platforms for sustainability science. *Current Opinion in Environmental Sustainability*, 16, 1–6. <https://doi.org/10.1016/j.cosust.2015.06.005>
- Evans, J., Karvonen, A., & Raven, R. (2024). The experimental city: New modes and prospects of urban transformation. *Technological Forecasting and Social Change*, 197, 122867. <https://doi.org/10.1016/j.techfore.2023.122867>
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1. *Behavior Research Methods*, 41(4), 1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>
- Franco, M., Haase, H., & Fernandes, A. (2024). Circular economy education and entrepreneurship. *Sustainability*, 16(2), 734. <https://doi.org/10.3390/su16020734>
- Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy – A new sustainability paradigm. *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (2023). *The new production of knowledge* (2nd ed.). SAGE Publications.
- Guerrero, M., & Urbano, D. (2012). The development of an entrepreneurial university. *Journal of Technology Transfer*, 37(1), 43–74. <https://doi.org/10.1007/s10961-010-9171-x>

- Guerrero, M., Urbano, D., Cunningham, J. A., & Gajón, E. (2020). Entrepreneurial universities. *Small Business Economics*, 54(2), 343–360. <https://doi.org/10.1007/s11187-018-00180-4>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). SAGE Publications.
- Kirchherr, J., Reike, D., & Hekkert, M. (2023). Conceptualizing the circular economy. *Resources, Conservation & Recycling*, 187, 106562. <https://doi.org/10.1016/j.resconrec.2022.106562>
- Kolb, D. A. (2015). *Experiential learning* (2nd ed.). Pearson Education.
- Leal Filho, W., Lange Salvia, A., Paço, A., & Anholon, R. (2023). Integrating sustainability into higher education. *Journal of Cleaner Production*, 384, 135507. <https://doi.org/10.1016/j.jclepro.2022.135507>
- Leal Filho, W., Salvia, A. L., Paço, A., Anholon, R., & Gonçalves, A. (2024). Integrating sustainability into higher education institutions. *Journal of Cleaner Production*, 421, 140468. <https://doi.org/10.1016/j.jclepro.2023.140468>
- Liñán, F., & Chen, Y.-W. (2009). Measuring entrepreneurial intentions. *Entrepreneurship Theory and Practice*, 33(3), 593–617. <https://doi.org/10.1111/j.1540-6520.2009.00318.x>
- Lozano, R., Barreiro-Gen, M., Lozano, F. J., & Sammalisto, K. (2023). Teaching sustainability in higher education. *International Journal of Sustainability in Higher Education*, 24(1), 1–20. <https://doi.org/10.1108/IJSHE-01-2022-0021>
- Marin, G., Marzucchi, A., & Zoboli, R. (2022). SMEs and eco-innovation barriers. *Journal of Evolutionary Economics*, 32(2), 379–406.
- Morris, M. H., Shirokova, G., & Tsukanova, T. (2023). Student entrepreneurship and experiential learning. *Academy of Management Learning & Education*, 22(1), 1–22. <https://doi.org/10.5465/amle.2021.0302>
- Nabi, G., Liñán, F., Fayolle, A., Krueger, N., & Walmsley, A. (2017). Entrepreneurship education impact. *Academy of Management Learning & Education*, 16(2), 277–299. <https://doi.org/10.5465/amle.2015.0026>
- Patzelt, H., Shepherd, D. A., & DeTienne, D. R. (2023). Sustainable opportunity recognition. *Entrepreneurship Theory and Practice*.
- Pittaway, L., & Cope, J. (2021). Experiential entrepreneurship education. *International Small Business Journal*, 39(5), 405–434. <https://doi.org/10.1177/0266242620973418>
- Ploum, L., Blok, V., Lans, T., & Omta, O. (2018). Sustainable entrepreneurship competencies. *Organization & Environment*, 31(2), 113–132. <https://doi.org/10.1177/1086026617697039>
- Saleh, M., & Bontis, N. (2024). Intellectual capital and sustainability in GCC universities. *Journal of Intellectual Capital*, 25(1), 89–112. <https://doi.org/10.1108/JIC-06-2022-0128>
- Schliwa, G., Evans, J., McCormick, K., & Voytenko Palgan, Y. (2022). Living labs and sustainability transitions. *Environmental Innovation and Societal Transitions*, 43, 32–44. <https://doi.org/10.1016/j.eist.2022.02.002>
- Schmitz, A., Urbano, D., & Audretsch, D. B. (2023). Entrepreneurial ecosystems and universities. *Small Business Economics*, 61(4), 1507–1523. <https://doi.org/10.1007/s11187-022-00658-2>
- Trencher, G., Yarime, M., McCormick, K., Doll, C., & Kraines, S. (2014). Universities and co-creation for sustainability. *Science and Public Policy*, 41(2), 151–179. <https://doi.org/10.1093/scipol/sct044>
- Urban, B., & Kujinga, L. (2024). Sustainable entrepreneurship education. *Journal of Small Business Management*, 62(2), 345–369. <https://doi.org/10.1080/00472778.2023.2171926>
- von Wirth, T., Fuenfschilling, L., Frantzeskaki, N., & Coenen, L. (2019). Urban living labs and sustainability transitions. *Environmental Innovation and Societal Transitions*, 30, 47–62. <https://doi.org/10.1016/j.eist.2018.12.001>
- Wiek, A., Withycombe, L., & Redman, C. L. (2011). Sustainability competencies. *Sustainability Science*, 6(2), 203–218. <https://doi.org/10.1007/s11625-011-0132-6>