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Entrepreneurship Training as a Catalyst for the Circular Economy and Sustainable Innovation in Technical and Vocational Education and Training (TVET) in Tanzania: Evidence from Arusha Technical College

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Abstract: *This study assessed the association between entrepreneurship training and circular economy adoption, evidence from Arusha Technical College in Tanzania. The purpose of this study was to determine the extent to which entrepreneurship training (knowledge of resource efficiency, understanding of the circular economy concept, awareness of environmental impact, business commitment, and understanding of sustainable models influences CE adoption. A cross-sectional research design was employed, involving a population of 509 Bachelor's degree TVET students across 11 Engineering programs. The study employed Yamane's (1967) formula to determine a sample size of 224 respondents who were selected using stratified random sampling. A structured questionnaire was used for data collection, and its validity and reliability were confirmed through expert review and Cronbach's alpha (α = 0.82). Data were analyzed using multiple linear regression. Results revealed a strong positive association between entrepreneurship training and circular economy adoption. Knowledge of resource efficiency, awareness of environmental impact, and understanding of CE concepts were significant predictors. The study concludes that Entrepreneurship Training is critical for embedding CE principles in TVET curricula and recommends that TVET institutions, policymakers, and entrepreneurship development stakeholders ensure that the circular economy concept, sustainability-oriented innovation, and practical green entrepreneurship approaches are integrated into entrepreneurship training curricula to enhance students' sustainability and green innovation capacity.*

Keywords: *Entrepreneurship training, Circular Economy, Sustainability, Innovation, TVET institutions, green skills.*

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1. Introduction

Various economies around the globe are transitioning from traditional linear practices that emphasize a "take-make-dispose approach towards circular economy (CE) practices that focus on reuse, recycle, reduce, and regeneration of material and resources. The circular economy model has become crucial in addressing environmental pollution and

promoting a green economy (Kirchherr et al., 2017). Technical and Vocational Education and Training (TVET) institutions around the globe are recognized for their vital role in equipping learners with not only technical skills that are relevant to the labor market but also with entrepreneurship and innovative skills to help them establish business ventures (Adeniyi et al., 2023).

In Tanzania, TVET institutions are mandated to adopt Competence-Based Education and Training (CBET) to provide practical skills that foster industrialization, the establishment of new business ventures, and promote sustainable development. Most of the entrepreneurship training programs in these institutions focus on profit-oriented business ventures that are tied in a traditional linear model with minimal emphasis on waste management, resource efficiency, or sustainable innovation. Subsequently, graduates are less equipped and prepared to develop enterprises that are in line with sustainable development.

Despite the fact that circular economy concept has gained international recognition, its adoption within the Tanzania TVET sector remains low (Hamid et al., 2024). Moreover, the empirical evidence linking entrepreneurship training with CE adoption in Tanzanian TVET institutions is still scarce. A study by Rosário et al. (2022a) was able to primarily describe sustainability integration challenges without quantitatively assessing the relationship between entrepreneurship training and CE model adoption. This knowledge gap hinders the development of evidence-based strategies that would embed CE principles in TVET sector entrepreneurship training curricula.

Therefore, this study assessed the association between entrepreneurship training and CE model adoption among students in Arusha Technical College. The findings of this study provide a quantitative empirical understanding of how TVET institutions can promote sustainable industrial transformation.

1.2 Justification of the study

This study addresses the literature gap that exists by providing empirical evidence on the extent to which entrepreneurship training influences CE principles adoption within the TVET institutions sector, which is a topic that has received limited scholarly attention and focus. The findings of this study provide policymakers, curriculum developers, and educators with an urgent need to integrate sustainability-oriented competencies in TVET entrepreneurship curricula.
Furthermore, this study aligns with not only Tanzania's Vision 2025 that promotes industrial transformation and economic growth but also with global Sustainable Development Goal (SDG) 4 (quality education for all) and 12(responsible consumption and production). These can be achieved through promoting education that enhances sustainable livelihoods. Lastly, by focusing on one of the leading institutions in Tanzania, Arusha Technical College, the study provides a model for other TVET institutions in the region to learn from and emulate to promote green entrepreneurship training.

2. Literature Review

Around the world, there has been a lot of transformation in entrepreneurship education as it integrates sustainability and circular economy concepts. A study argues that the integration of circular economy principles in entrepreneurship learning not only promotes sustainable business development but also environmental conservation. (Hörisch et al., 2017) argue that equipping entrepreneurs with sustainability-oriented competencies helps them conserve the environment and perform well in business. In Europe, incorporating the circular economy principles into technical education tends to boost both innovation and employability skills in students (Moreno-Virgen et al., 2024).

In Africa, various economies have begun to adopt the CE model as a strategy for achieving sustainable industrialization (Marinov, 2025). However, due to limited awareness and a weak institutional framework, the adoption of CE principles has been difficult (Naydenov, 2024). In Tanzania, a study by Makuya & Changalima (2024) argued that environmental management and CE principles are inadequately addressed in most TVET entrepreneurship curricula. (Rosário et al., 2022b) Further argued that despite the existence of entrepreneurship training programs in TVET, they still lack sustainability-oriented content. Therefore, this study fills a vital existing gap by quantitatively analyzing the extent to which entrepreneurship training influences CE adoption in Tanzanian TVET institutions.

2.1 Theoretical Framework

This study is anchored on the Human Capital theory, which stipulates that education enhances skills, knowledge, and innovation capacity. Entrepreneurship education provides students with human capital that enables them to design and develop sustainable business models (Marvel et al., 2016). In this context, the TVET Entrepreneurship Training program enhances competencies in resource efficiency, sustainable design, and green innovation, key enablers of CE adoption. Based on this theoretical framework, the contextual framework is illustrated in Figure 1, and it also hypothesized that:

$H_{O:}$ *There is no statistical evidence on the relationship between Entrepreneurship training and circular economy practices adoption in TVET Institutions.*

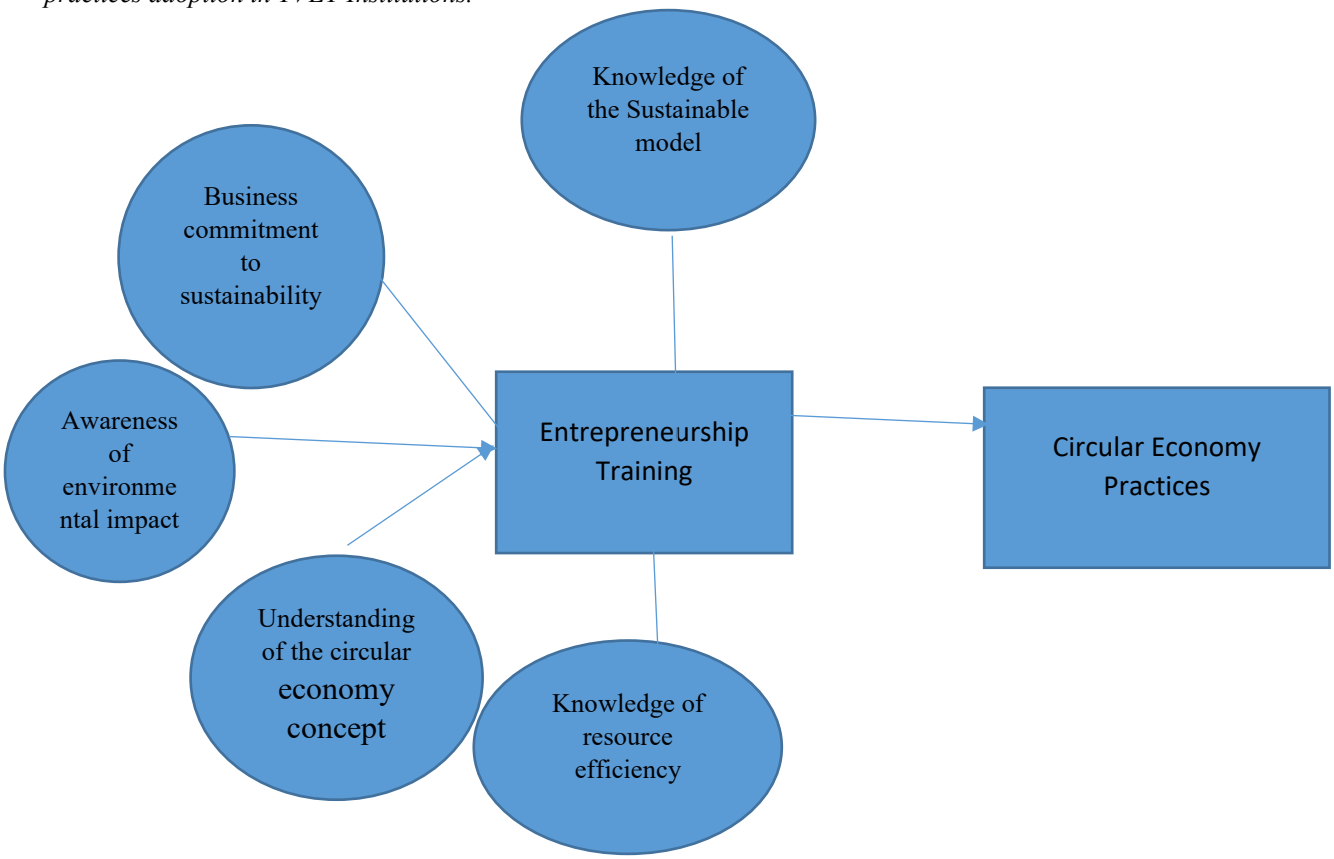

Figure 1: Conceptual Framework

adoption in TVET Institutions.

Therefore, Figure 1 clarifies the conceptual framework for the study linking the predictors of the entrepreneurship training program and circular economy practices adoption (outcome variable). Consequently, Entrepreneurship training programs affect circular economy practces adoption in TVET institutions in Tanzania.

3. Methodology

3.1Research Design

The study employed a cross-sectional design was used in this study in order to collect a large amount of data from the population or sample at a single point in time (Hunziker & Blankenagel, 2024).

3.2 Population and Sampling

The study targeted 509 first-year Bachelor's degree students from Arusha Technical College. Using Yamane's (1967) formula, to determine the sample size of 224 through stratified random sampling across 11 programs, since the population was heterogeneous.

3.3 Data Collection Method

This study employed a survey method since it facilitates the gathering of a large amount of data, which provides a broad perspective (Moilanen & Toikka, 2023). It was carried out by administering copies of a structured questionnaire with Likert scale questions measuring Entrepreneurship Training (Knowledge of Resource Efficiency, Understanding of CE concepts, Awareness of environmental impact, Business commitment to sustainability, and Knowledge of sustainable models). The questionnaire was used because it helps to collect a large amount of data from a large number of people in a short period of time.

3.4 Validity and Reliability

Content validity was confirmed by two subject experts. The instrument's reliability was tested using Cronbach's alpha, with a result of ($\alpha = 0.82$) which the data were reliable.

3.5 Data Analysis

Data were analyzed using SPSS, where Multiple Linear Regression examined the relationship between Entrepreneurship Training and Circular Economy model adoption in TVET Institutions.

3.6 Ethical consideration

The study ensured adherence to ethical principles whereby participants involved in the study were informed about the purpose and objective of the research before participating, This was done to ensure informed and free consent from the respondents.

4. Results and Discussion

This study called to testing the null hypothesis:
$H_{O:}$ *There is no statistical evidence on the relationship between Entrepreneurship training and circular economy practices*

Table 1: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change
1	.926[a]	.858	.857	.212	.858	1340.705	1	222	.000
2	.977[a]	.954	.953	.121	.954	2282.869	2	221	.000
3	.983[a]	.966	.966	.104	.966	2109.796	3	220	.000
4	.984[a]	.969	.968	.100	.969	1701.067	4	219	.000
5	.985[a]	.971	.970	.098	.971	1434.940	5	218	.000

a. Predictors: (Constant), Knowledge of resource efficiency
b. Predictors: (Constant), Knowledge of resource efficiency, Understanding of the circular economy concept,
c. Predictors: (Constant), Knowledge of resource efficiency, Understanding of the circular economy concept, Awareness of environmental impact,
d. Predictors: (Constant), Knowledge of resource efficiency, Understanding of the circular economy concept, Awareness of environmental impact, Business commitment to sustainability,
e. Predictors: (Constant), Knowledge of resource efficiency, Understanding of the circular economy concept, Awareness of environmental impact, Business commitment to sustainability, Knowledge of the Sustainable model.

The findings in Table 1 show the R values (0.926-0.985), indicating a very strong positive relationship between entrepreneurship training and circular economy practices adoption. This implies that as entrepreneurship training indicators increase, circular-economy practices also increase.
The result in Table 1 show R square value 0.971, indicating that 97.1% of the variance (change) in Circular Economy adoption can be explained by the Entrepreneurship training variables included in the model. Only 2.9% of the change in CE adoption is due to other factors outside this model.

The findings in Table 1 show that Knowledge of Resource Efficiency was only included as the predictor variable. The model produced a very strong correlation coefficient (R=0.926), implying a strong positive association between the independent and the dependent variable. The coefficient of determination (R^2=0.858) indicates that 85.8% of the variation in the dependent variable is explained by knowledge of resource efficiency alone. The model was statistically significant (F=1340.705, P<0.001), implying that knowledge of resource efficiency is a significant predictor of sustainable or circular economy practices. The finding is in line with the study by Mohammedi et al. (2025), which found that resource efficiency knowledge significantly influences SMEs' adoption of circular practice and sustainable production systems.

The findings in Table 1 show that Understanding of the Circular Economy Concept was added alongside Knowledge of resource efficiency. The result shows that the correlation coefficient increased to R=0.977, while the explanatory power rose to R2=0.954, indicating that the two variables jointly explain 95.4% of the variance in the dependent variable. The significant improvement in the model suggests that understanding circular economy principles plays a critical role in promoting sustainable practices. The findings are supported by the study Al-Awlaqi et.al (2022) established that knowledge and understanding of circular economy concepts significantly enhance SMEs' adoption of circular business models and sustainability innovations.

Moreover, the findings in Table 1 show that when Business Commitment to Sustainability was added to the Model the regression results were R=0.984 and explanatory power rose R2=0.969, showing that the predictors explain 96.9% of the variance in the dependent variable. The result shows that the model was statistically significant (P<0.001), indicating that organizational commitment toward sustainability strengthens the adoption of sustainable and circular economy practices. This finding is in line with the study Rehman et.al (2023) established that sustainability commitment and environmental innovation significantly improve SMEs' sustainability performance and competitiveness.

Furthermore, the final model incorporated Knowledge of the Sustainable Model together with all previous predictors. The model demonstrated the highest correlation (R=0.985) and explanatory power (R^2=0.971), signifying that the five predictors collectively explain 97.1% of the variation or changes in the dependent variable. The model remained statistically significant **(P<0.001),** the knowledge of sustainable business models further enriches the prediction of sustainable or circular economy practices. The finding aligns with the study **by** Guevara-Otero et al. (2026), which established that sustainability knowledge, entrepreneurial orientation, and commitment to sustainable business models significantly influence SMEs' intentions to adopt circular business practices.

Table 2.ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	60.481	1	60.481	1340.705	.000[b]
	Residual	10.015	222	.045		
	Total	70.496	223			
2	Regression	67.241	2	33.620	2282.869	.000[b]
	Residual	3.255	221	.015		
	Total	70.496	223			
3	Regression	68.128	3	22.709	2109.796	.000[b]
	Residual	2.368	220	.011		
	Total	70.496	223			
4	Regression	68.297	4	17.074	1701.067	.000[b]
	Residual	2.198	219	.010		
	Total	70.496	223			
5	Regression	68.417	5	13.683	1434.940	.000[b]
	Residual	2.079	218	.010		
	Total	70.496	223			

From the results in Table 2: the study tested the hypothesis (H_O), which states: There is no statistical evidence on the relationship between Entrepreneurship training and circular economy practices adoption in TVET Institutions. Results show that p-value=0.000<0.05, which is smaller than the significance level. This implies that the null hypothesis is rejected, which means there is enough statistical evidence to explain the relationship between Entrepreneurship Training and Circular economy practices adoption in TVET institutions. This finding is supported by the study of Doukali et al (2024), which argued that entrepreneurship training fosters sustainability- oriented innovation and significantly affects the adoption of green and circular business practices among SMEs.

4. Conclusion and Recommendation

The following are the conclusions and recommendations of the study derived from the study findings/results.

5.1 Conclusion

The study concludes that Entrepreneurship Training is critical for embedding CE principles in TVET curricula. Meaning that Entrepreneurship training should not only focus on business creation and profit generation but also integrate the sustainability concepts, green innovation, resource efficiency, and circular economy principles. TVET institutions such as Arusha Technical College have a critical role in producing graduates with not only technical and entrepreneurial competencies but also sustainability competencies capable of addressing environmental challenges and promoting sustainable industrial transformation in Tanzania.

5.2 Recommendation

The study recommends that:

1. TVET institutions, policymakers, and entrepreneurship development stakeholders ensure that the circular economy concept, sustainability-oriented innovation, and practical green entrepreneurship approaches are integrated into entrepreneurship training curricula to enhance students' sustainability and green innovation capacity.
2. TVET institutions should ensure they collaborate with industries and Small and Medium Enterprises practicing circular economy models to provide internships, industrial attachments, and real life learning opportunities.
3. The government and education regulatory bodies should ensure they support the implementation of circular economy education through funding, policy frameworks, and capacity building initiatives.

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