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Sustainability marketing education and circular marketing adoption in the Saudi industry

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Abstract

The research paper examines how sustainability-oriented marketing education influences the implementation of circular marketing in Saudi industrial companies with a focus on the mediating effects of circular economy awareness. A quantitative research design based on the Theory of Planned Behavior and the Diffusion of Innovations was employed, and a structured questionnaire was administered. A sample of 377 employees and managers in marketing, sustainability, and quality-related activities at Saudi industrial companies yielded a response rate of 78.5%. The proposed hypotheses were tested using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results indicate that marketing education is more sustainability-oriented, significantly increases awareness of the circular economy, and directly stimulates the implementation of circular marketing practices. Moreover, circular economy awareness partially mediates this relationship, indicating its essential cognitive role in translating educational inputs into organizational action. Multi-group analysis also shows that large companies are more productive than small and medium-sized businesses at translating awareness into practice. The paper suggests that companies should strategically invest in sustainability-oriented marketing training to enhance awareness and accelerate the adoption of the circular economy, thereby achieving Saudi Arabia's sustainability goals and Vision 2030.

Keywords: Sustainability; Marketing education; Circular economy adoption; Saudi industrial firms; Circular economy awareness.

1. Introduction

The increasing environmental degradation and the rapid depletion of natural resources have become major challenges for industrial organizations worldwide. Under these pressures, the circular economy has emerged as an alternative to the linear take-make-dispose model. It emphasizes resource efficiency, reuse, and sustainable consumption patterns [1], [2]. In this regard, the manufacturing sector has been singled out as one of the main locations where the circulatory economy can be applied, especially in those economies where resources are

highly utilized, like Saudi Arabia. Although the world is increasingly moving towards a circular trend, the industrial implementation is diverse, which implies that regulatory action and technological innovation might be inadequate to initiate a radical organizational change [3], [4].

Another crucial element that contributes to such an unequal uptake is the human aspect of sustainability transitions. The knowledge base, attitudes, and awareness levels of the employees and managers that are directly involved in sustainability related initiatives are the main determinants of organizational behavior and strategic decision making. As a result, academic discourse has been losing focus on education and training as basic tools to facilitate organizational change. The existing literature shows that sustainability related education does more than just increase the environmental awareness of employees and does not reduce their desire to contribute to responsible organizational behavior [5], [6]. Among the specific marketing functions, sustainability-based education has helped redefine the value creation definition, design strategies, and stakeholder communications in firms. Nevertheless, there is little empirical research involving the connection of these educational initiatives with the real implementation of circular economy behaviors, especially in the Saudi industrial scenario [7].

In this respect, awareness of the circular economy is a crucial but under researched factor. Circular economy awareness (CEA) is the understanding of employees about the circular principles and their practical application to organizational operations. Although examples of successful top-down mandate based or technology investments-based introductions of circular initiatives exist, the latest literature on sustainability suggests that to establish lasting change, organizational attitudes and thinking patterns should be altered at a deeper level [8], [9]. Awareness, then, goes beyond the passive learning of information and serves as an initiator of behavior change, in that it allows to transform the information received within the education into tangible organizational behavior. Although awareness has been examined as a mediator in areas such as green supply chain management and environmental management systems, little empirical research has explored this role in circular marketing adoption within industrial companies [10], [11].

The dynamics are of particular interest in Saudi Arabia. Being a nation with a significant industrial potential and an overall national agenda on economic diversification, Saudi industrial companies have to contend with increasing sustainability demands, as well as strategic opportunities to re-architect their business models according to Vision 2030. Companies in manufacturing and processing industries in various industries have to deal with limited resources, international environmental standards, and competition to show environmental accountability. Marketing and sustainability experts become the driving force in this setting and can affect the organizational culture and strategic direction as internal change agents. The success of their contribution to the principles of the circular economy, however, is highly dependent on the quality of their professional education and the level of their familiarity with the principles of the circular economy and its implementation [12], [13].

It is on this background that the current research paper places these interconnected issues into perspective by investigating the impact of sustainability-focused marketing education on the use of circular marketing practices through the mediating variable of the CEA. The study aims at demystifying how educational initiatives can be translated into organizational practices by targeting Saudi industrial companies, thus serving to further the theoretical development and managerial informational progress in an area where little empirical data have been gathered. At the heart of such a view lies the fact that awareness of employees and managers about the economic and environmental worth of circular economy initiatives will constitute an essential cognitive interface between the educational exposure and behavioral execution [14], [15].

This study, through an empirical study of marketing, sustainability, and quality practitioners in Saudi industrial organizations, seeks to shed light on the educational direction through which organizations can speed up their move towards practicing the Circular Economy. The findings are expected to offer practical guidance for organizational leaders seeking to use human capital development as a driver of sustainability transformation. They also contribute to the broader literature on how organizational learning can be translated into sustainable practice adoption.

2. Literature review and hypothesis development

Sustainability-oriented marketing education has become a vital source of organizational change to more responsible and circular business models, especially in the industrial setting, in recent years. Sustainability-based marketing education is a further expansion of the marketing training by incorporating environmental responsibility, life cycle perspective, and stakeholder-based value creation into the marketing decision-making [5]. According to previous research, education and training are critical in developing environmental knowledge, values, and strategic orientations of employees, which in turn affect the sustainability outcomes of firms [16], [17]. In industrial companies, marketing education in line with sustainability ideas can improve the capacity of employees to convey environmental value, facilitate circular business models, and align marketing strategies with overall sustainability objectives [18], [19]. This education orientation is especially applicable in the emerging economies like Saudi Arabia, where sustainability agendas are becoming part of national development strategies [20], [21].

CEA is a pre-cognitive state that is beneficial to achieving a successful uptake of circular practices in organizations. Rather than simple familiarity, this form of awareness reflects employees' understanding of key circular economy principles, such as resource efficiency, waste minimization, product life extension, and closed-loop production. It also captures how these principles are reflected in strategic decision-making and operational processes [8], [22]. However, empirical data continues to suggest that environmental and CEA correlate positively with the likelihood of individuals backing sustainability initiatives and actively engaging in the enactment and implementation of circular practices in their respective organizations [23], [24]. The development of this awareness is generally achieved in the industrial and manufacturing setting through coordinated training methods, organizational knowledge sharing processes, and transforming abstract ideas on sustainability into practical organizational habits [25], [26]. In that regard, the concept of sustainability-oriented marketing education can be viewed as a vital precursor of CEA, as it provides marketing and managerial staff with the conceptual models to conceptualize, communicate, and implement the circular strategies [27], [28].

Circular marketing practices involve the application of circular economy concepts to the marketing-related operations, such as product positioning, communication strategies, customer engagement, and developing value propositions in line with sustainability objectives [29]. Circular marketing supports the broader goals of the circular economy by promoting product longevity, reuse, recycling, and responsible consumption through marketing activities [30], [31]. Nonetheless, research shows that industrial companies are facing facilitating and hindering elements in adopting a circular marketing model that include organizational inertia, internal capacity, and a lack of awareness [13], [32]. In these regards, the strategic purpose of marketing becomes especially prominent, as it helps organizations to define the sustainability-driven market visions, educate consumers, and transform environmental activities into competitive advantage sources [14], [33]. Nevertheless, the success of the circular marketing activities heavily relies on the inner devotion and consciousness of the marketing practitioners, which explains the significance of the awareness creation based on education as a prerequisite for the successful adoption [8], [9], [29].

An increasing amount of literature also highlights the mediating role of awareness in education/sustainable organizational behavior relationships. Education and training interventions have both direct and indirect effects on organizational outcomes, i.e., organizational results are shaped by their impact on awareness, attitudes, and behavioral intentions towards sustainability among employees [10], [34]. In the context of environmental management and green innovation, the concept of awareness has been empirically confirmed as one of the mediators through which educational inputs are translated into improved sustainability practices and performance results [35], [36]. This mediating process is especially applicable to the situation of circular economy adoption, where the core of redefining value creation, resource utilization, and waste management in organizations is required [2], [8], [12]. In turn, sustainability-focused marketing education will have both a direct and indirect impact on the circular marketing adoption due to the increase in the awareness of the circular economy, thus providing a solid theoretical basis to the hypotheses presented in this study [27], [28].

Such theoretical perspectives should be understood not as mutually exclusive and separate explanations, but rather as complementary layers of interpretation. The Theory of Planned Behavior serves as the fundamental theoretical rationale for the education-awareness-practice process, offering insights into how educational factors influence beliefs and cognitive attitudes that underlie behavioral action [22], [23]. The Diffusion of Innovations model extends this logic and helps to explain how awareness helps to reduce uncertainty and facilitate the adoption of circular marketing as a marketing innovation [8], [9]. The Dynamic Capabilities model adds a further layer of interpretation for the business, offering insights into why some businesses are more able than others to translate awareness into practice, especially where this involves existing resources [25], [26].

2.1. Circular economy awareness and sustainability-oriented marketing education

Sustainability-based marketing education is critical to the development of employees' cognitive frameworks and the environmental knowledge of industrial organizations. Based on the Theory of Planned Behavior (PB), education improves the beliefs and attitudes of people by increasing the knowledge base and developing positive assessments of sustainability-related actions [22], [23]. In the marketing functions, sustainability education provides employees with conceptual clarity on principles of the circular economy, such as resource efficiency, life cycle thinking, and value retention, and, as a result, increases the degree of awareness of the circular economy [16], [27]. In terms of Dynamic Capabilities, this kind of education enhances sensing capabilities of firms by allowing employees to be aware of environmental challenges and circular opportunities that are inherent in markets and regulatory environments [25], [26]. Previous empirical research is unanimous that focused sustainability training improves environmental awareness and knowledge among organizational members, especially in industrial and manufacturing settings [6], [11]. Sustainability-based marketing education is thus likely to play a critical role in improving awareness of the circular economy among industrial workers in emerging economies, such as Saudi Arabia, where sustainability transitions are currently gaining strategic traction.

H1: Sustainability-oriented marketing education has a positive effect on circular economy awareness.

2.2. Circular economy knowledge and the implementation of circular marketing

CEA is an important antecedent of the implementation of circular marketing practices in industrial firms. The Theory of PB states that awareness enhances attitudes and perceived behavioral control, which consequently increases the chances of individuals taking on pro-environmental actions, such as undertaking sustainability oriented marketing activities [1], [22]. Considering the theory of Diffusion of Innovations (DOI), awareness is the first stage of the knowledge in the process of innovation adoption, which lowers uncertainty and makes positive judgments about circular marketing as an organizational innovation [8], [29]. Empirical studies of manufacturing settings reveal that companies that have a stronger degree of CEA tend to be more inclined to incorporate the principles of the circular economy in product communications, branding, and customer interaction approaches [30], [31]. In addition, awareness allows marketing professionals to match sustainability narratives with the market expectations, and circularity ceases to be a technical concept and becomes a strategic marketing asset [4], [14]. Therefore, the increased awareness of the marketing and sustainability staff about the circular economy is likely to have a positive impact on the implementation of the circular marketing practices.

H2: Circular economy awareness has a positive effect on the adoption of circular marketing practices.

2.3. Sustainability oriented marketing education and the implementation of circular marketing

The effect of sustainability-oriented marketing education on the implementation of circular marketing practices may have a direct impact, as well as an effect on awareness alone. According to Dynamic Capabilities, education can improve the skills of employees to integrate, reconfigure, and deploy marketing resources to support circular strategies, which will allow firms to operationalize sustainability oriented value propositions [26], [37]. Sustainable education provides marketing practitioners with the practical skills connected to green communication, sustainable branding, and stakeholder engagement that they need to apply the practices of

circular marketing in the competitive industrial markets [18], [19]. The theory of DOI also indicates that training leads to a decrease in perceived complexity and an increase in the relative advantage of adopting circular marketing innovations, which accelerates the uptake of the innovation within the organization [3], [32]. The idea that sustainability focused education has a beneficial impact on the internalization of green and circular practices due to the enhancement of organizational preparedness and orientation is supported by empirical studies [28], [33]. Based on this, marketing education that focuses on sustainability should be directly used to facilitate the implementation of circular marketing in Saudi industrial companies.

H3: Sustainability oriented marketing education has a positive effect on the adoption of circular marketing practices.

2.4. The mediating position of circular economy awareness.

Although sustainability focused marketing education can have a direct effect on the adoption of circular marketing, it is probable that this effect will be mediated by CEA to some extent. The Theory of PB highlights the idea that education influences behavior indirectly through influencing knowledge, attitudes, and perceptions that come before behavior [22], [23]. On the same note, the DOI theory holds that awareness is a precondition to transitioning between knowledge and persuasion and subsequent adoption of innovations [8], [9]. The empirical literature in the field of environmental management and green innovation shows that awareness acts as an intermediary between training programs and sustainability [10], [34]. In the framework of Dynamic Capabilities, awareness is a basic sensing process that helps firms to understand the strategic applicability of the concept of circular marketing and convert educational inputs into practical activities [25], [26]. Hence, the marketing education based on sustainability is likely to promote the adoption of circular marketing directly and indirectly through the increase in awareness of the circular economy.

H4: Circular Economy Awareness mediates the relationship between Sustainability Oriented Marketing Education and the Adoption of Circular Marketing Practices.

These hypothesized causal relationships are presented visually in Figure 1.

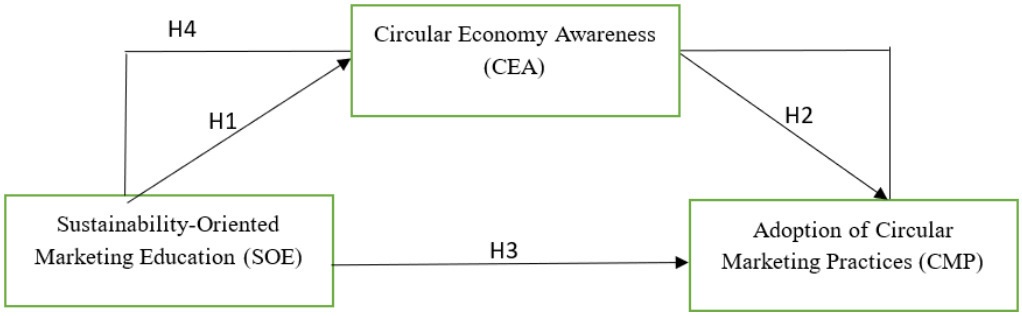

Figure 1. Hypothesized model

3. Research methodology

3.1. Research design

The current research adopts a quantitative approach to empirically test the relationships between sustainability-oriented marketing education and CEA, and the implementation of circular marketing practices among Saudi industrial companies [5], [6]. The quantitative design is especially suitable, considering the aim of the study to prove theory-oriented hypothetical ideas and statistically determine the causal relationships between the latent constructs using advanced analytical methods [34], [36]. A structured survey tool was used to collect data, as it is a well-established tool to use in the study of perceptions, attitudes, and behavioral patterns in organizational and sustainability-related research settings [22].

Each measurement item was evaluated on a five-point Likert scale between strongly disagree (1) and strongly agree (5), in which respondents were free to give a different level of agreement with the statements made [23].

The scaling technique is widely used in sustainability and marketing research because it can produce valid quantitative data applicable to strong statistical analysis [16]. The questionnaire was conducted electronically using Google Forms, which allowed it to be distributed widely in various sectors of industry and geographical locations in Saudi Arabia [35]. The survey site was set up to demand that all survey items be filled out before submitting the survey to exclude missing data, as well as to have all the responses collected complete and fit to be used later to analyze the statistics [6].

3.2 Measurement instrument

A structured questionnaire was employed as a measurement tool for the study's constructs. The questionnaire was based on existing literature concerning sustainability-oriented marketing education, circular economy awareness, and circular marketing practices in organizational and industrial settings [6]. The questionnaire had a total of 15 questions, of which five pertained to sustainability-oriented marketing education (SOE), five pertained to circular economy awareness (CEA), and five pertained to the adoption of circular marketing practices (CMP), as indicated by the measurement model proposed later in this study. The questions concerning sustainability-oriented marketing education were intended to measure the extent of sustainability-oriented marketing education provided by the organization, as indicated by existing literature [16]. The questions concerning circular economy awareness were intended to measure respondents' level of awareness of the five main principles of circular economies, including resource efficiency, waste reduction, reuse, recycling, and extension of product life, as indicated by existing literature concerning circular economies, where awareness is a prerequisite for the development of circular economies [8], [9]. The questions concerning circular marketing practices were intended to measure the extent to which the firm adopted circular economy principles in this area, including environmental value, sustainable products, and consumer responsibility, as indicated by existing literature on circular marketing and sustainability-oriented marketing practices [14], [29]. The questions were adjusted for better contextualization of the questionnaire for the Saudi industrial sector, although the meaning of each question remains consistent with the original questions. All questions were based on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), which is commonly employed by existing literature concerning marketing and sustainability studies as a measurement scale for respondents' evaluations, as indicated by existing studies [16], [23].

3.3. Population and sample

The target population was employees and managers in marketing, sustainability, and quality functions in Saudi industrial organizations, including manufacturing, processing, and factory-based organizations [8], [9]. These participants were targeted because they are directly involved in sustainability-related activities, marketing decisions, and processes that are relevant to the implementation of the circular economy [13]. A non-probability sampling method was employed to access relevant participants from different industrial sectors and geographic locations, which is in agreement with previous research in organizational and sustainability studies where the whole population is difficult to access [3], [15]. A total of 480 questionnaires were distributed online using Google Forms, and the study obtained 377 valid responses from the participants, representing a response rate of 78.5% [33]. Since the survey required all the questions to be answered before the survey could be submitted, the study did not exclude any responses because of missing data [6].

4. Data analysis and results

4.1. Measurement model assessment

The structural equation model that is estimated in Figure 2 was estimated in SmartPLS 4, which is a software package relying on the Partial Least Squares (PLS) method of structural equation modeling. The use of PLS-SEM in research is common in empirical studies because it can be effective in investigating complex associations between latent constructs as well as the reported indicators, especially in exploratory research and theory testing research.

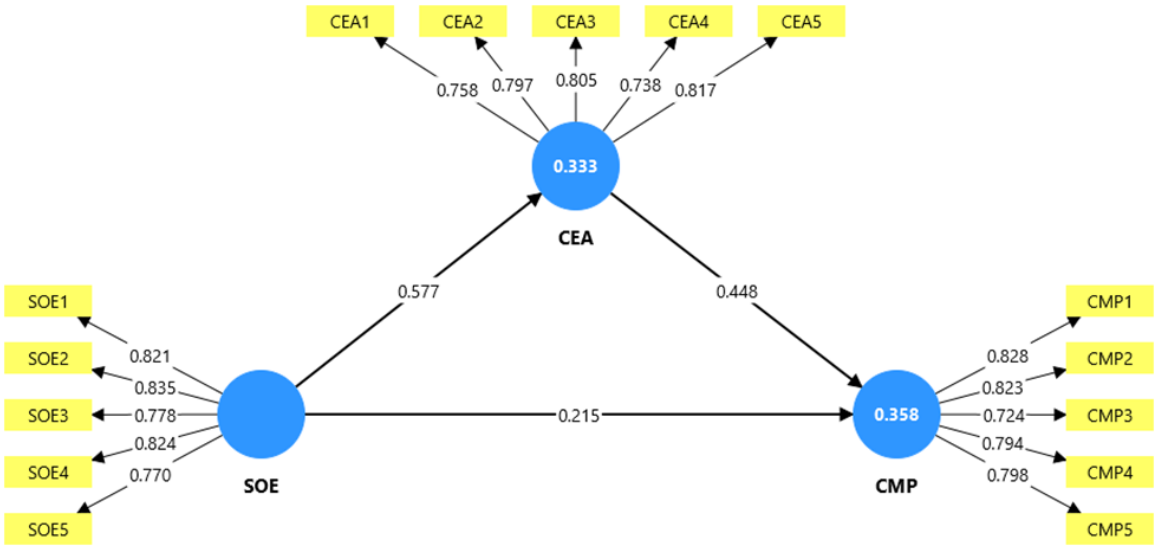

Figure 2. Structural model estimation using PLS-SEM

The measurement (outer) model is used to assess the extent to which the observed indicators measure the latent constructs. Outer loadings are mostly used to test the reliability of the indicators with values that are above 0.70, normally indicating a good construct validity. The estimated path coefficients also show that there were positive correlations between the latent variables incorporated in the model. Measurement model in Smart PLS is assessed with regard to internal consistency reliability and construct validity. Cronbach's Alpha, Composite Reliability (CR), and Dijkstra Henselers rho (rhoA) are used to measure internal consistency, with a 0.70 or higher being considered acceptable, with a 0.70 -0.90 being desirable. The reliability of the indicators studies how much an item contributes to the construct. Even though loadings greater than 0.70 are suggested, loadings 0.4-0.70 can be kept when overall composite reliability and average variance extracted (AVE) values are satisfactory. Items with low loadings of less than 0.40 are usually left out unless there is a heavy theoretical rationale and justification for why it should be included. Convergent validity will be achieved through making sure that the construct explains at least half of the variance of its measures expressed in AVE values of 0.50 and above. The Fornell-Larcker criterion is used to test discriminant validity, which assures specification of the uniqueness of the constructs whereby the square root of the AVE of each construct should be greater than the correlations of the other constructs in the model. Moreover, the multicollinearity is also analyzed using the variance inflation factor (VIF), and the results are under the 5 marks, which means that there are no collinearity issues to consider that will influence the findings of the estimation process.

4.2. Fornell-Larcker criterion

The provided Fornell-Larcker matrix helps analysts evaluate discriminant validity in Smart-PLS SEM analysis as an important assessment tool for research. The results in Table 1 indicate that Discriminant validity confirms that model-based latent constructs maintain unique identification from other constructs in the analysis.

Table 1. Fornell-Larcker Criterion

	CEA	CMP	SOE
CEA	0.784		
CMP	0.572	0.794	
SOE	0.577	0.473	0.806

4.3. Heterotrait-monotrait ratio-matrix

In addition to the Fornell-Larcker criterion, the Heterotrait-Monotrait ratio (HTMT) Matrix was conducted to ensure the discrimination of the variables. HTMT is a more accurate method for assessing conceptual discrimination between the latent variables in the PLS-SEM models. The results showed that all values fell

below the maximum acceptable threshold of 0.90 [38]. This confirms that there is sufficient discrimination between the variables (SOE, CEA, and CMP). Therefore, it can be said that the model possesses strong discrimination validity, supporting the validity of the proposed causal relationships between the variables in the structural model.

Table 2. Heterotrait-monotrait ratio (HTMT)–Matrix

	CEA	CMP	SOE
CEA			
CMP	0.669		
SOE	0.675	0.552	

4.4. Measurement properties

Table 3 displays the results of the measurement model validity test that precedes the structural analysis in the PLS-SEM methodology. This section aims to ensure the validity and reliability of the measurement tools for each of the study variables before moving on to testing the hypotheses. The table includes a set of basic statistical indicators such as factor loadings for each item, Cronbach's Alpha, composite reliability (CR), and average variance extracted (AVE).

Table 3. Measurement properties

		Convergence validity		Discriminant validity	Reliability		
Construct	Items	Outer loading	AVE	Fornell-Larcker Criterion: Is the square root of AVE for each construct greater than its correlations with other constructs?	Composite reliability (rho_a)	Composite reliability (rho_c)	Cronbach's alpha
Circular Economy Awareness	CEA1	0.758	0.614	YES	0.847	0.888	0.843
	CEA2	0.797					
	CEA3	0.805					
	CEA4	0.738					
	CEA5	0.817					
Adoption of Circular Marketing Practices	CMP1	0.828	0.631	YES	0.856	0.895	0.853
	CMP2	0.823					
	CMP3	0.724					
	CMP4	0.794					
	CMP5	0.798					
Sustainability -Oriented Marketing Education	SOE1	0.821	0.650	YES	0.867	0.903	0.865
	SOE2	0.835					
	SOE3	0.778					
	SOE4	0.824					
	SOE5	0.770					

Table 3 shows that all scales perform well and have valid relationships with one another. The Circular Marketing Practices (CMP) element is sufficient in the explanation of the variance of the indicators, and its external loadings vary between 0.724 and 0.828 with an AVE value of 0.631. The reliability tests indicate high consistency between the variables as indicated by the composite reliability and Cronbach alpha values: rho_c=

0.895 and rho_a= 0.856, and Cronbach alpha= 0.853. Equally, both SOE and CEA had reliability indices (rho c, rho a) of 0.847 and 0.865, respectively, which exceed all the recommended indices of reliability assessment.

4.5. Variance inflation factor

Table 4 shows the variance inflation factor (VIF) values for the measurement model variables: SOE, CEA, and CMP. Multicollinearity assessment through the VIF values protects the structural model results from potential distortions that may occur as a result of high correlations between indicators [39]. Therefore, multicollinearity problems will not affect the results when the VIF value is less than 5. The results demonstrate that the measurement model meets all criteria for reliable and appropriate use in SEM analysis.

Table 4. Variance inflation factor (VIF)

Items	VIF	Items	VIF	Items	VIF
CEA1	1.666	CMP1	2.044	SOE1	2.013
CEA2	1.765	CMP2	1.964	SOE2	2.109
CEA3	1.899	CMP3	1.526	SOE3	1.770
CEA4	1.543	CMP4	1.800	SOE4	2.007
CEA5	1.907	CMP5	1.843	SOE5	1.706

4.6. Model fit

Table 5 presents goodness of fit statistics for the saturated and estimated models in the PLS-SEM analysis. Several fit indices were analyzed in accordance with the established methodological principles [39], [40] to assess the general adequacy of the suggested model, which are the standardized root mean square residual (SRMR), d_ULS, d_G, chi square, and normed fit index (NFI).

Table 1 Model fit Indices for both the saturated model and the estimated model

	Saturated model	Estimated model
SRMR	0.052	0.052
d_ULS	0.327	0.327
d_G	0.097	0.097
Chi-square	210.462	210.462
NFI	0.920	0.920

The SRMR value (0.052) is quite low compared to the accepted value (0.08), indicating that the model fits satisfactorily. Moreover, the difference between the model-implied correlation matrix and the observed correlation matrix is not large, as indicated by d_ULS (0.327) and d G (0.097), which are acceptable. These findings indicate that the model is sufficient to replicate the empirical relations of the constructs. In addition, the NFI of 0.920 exceeds the proposed value of 0.90, indicating a significant improvement in fit relative to the null model. Altogether, these fit statistics help conclude that the PLS-SEM model has a tolerable-to-high level of fit, which justifies its appropriateness for testing the structural relationships suggested within the framework of the current methodological standards.

4.7. Structural model

The proposed research model examines three concepts, namely SOE, CEA, and CMP, and the relationships between the concepts are analyzed through a PLS-SEM Analysis, which quantifies the relationships between variables. Bootstrapping was employed to get the probability values of the path coefficients to test the research hypotheses. Path coefficients were used as the main criterion for hypothesis testing in the PLS-SEM analysis. Following [41], a relationship was considered significant when the t-value exceeded 1.96, and the p-value was below 0.05. These are the criteria that will guarantee that the relationship is not by chance. In this regard, Figure 3 illustrates the study's structural model:

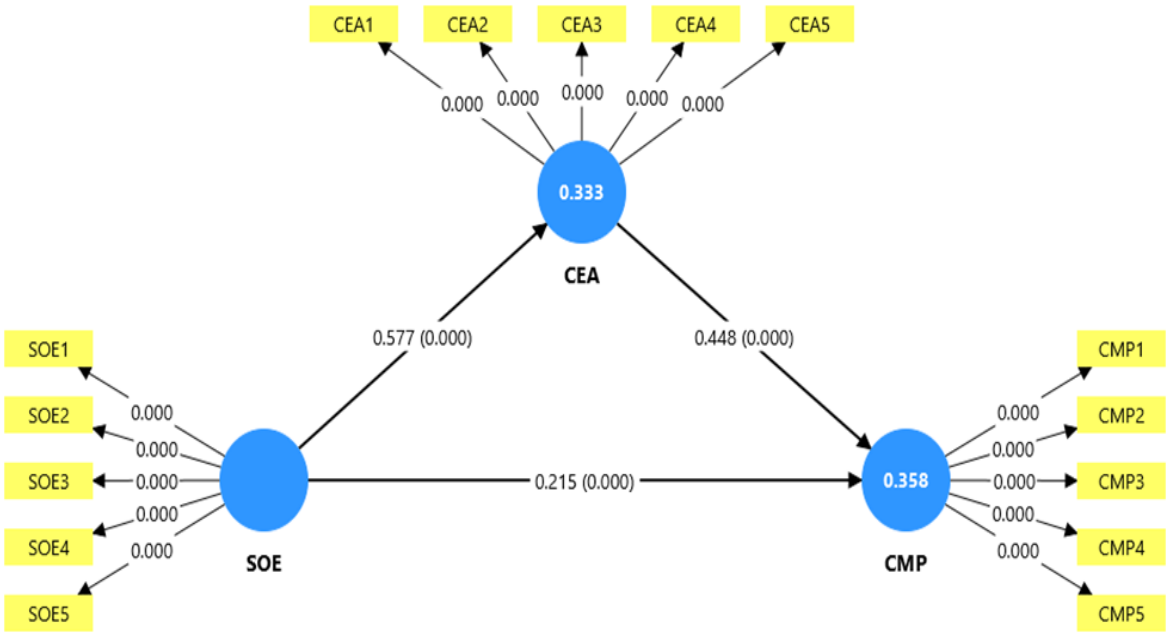

Figure 3. Bootstrapping results of the structural model

5. Hypothesis testing

Table 6 with the results of the structural model finds a very good empirical validation of the proposed relationships between Sustainability Oriented Marketing Education (SOE), CEA, and CMP. The comparison shows that there is a statistically significant and positive correlation between SOE and CEA (β = 0.577, = 16.625, p = 0.001), which indicates the importance of sustainability-oriented marketing education in raising awareness of the organization about the principles of the circular economy [5], [6]. This finding confirms earlier empirical studies that emphasized the significance of structured education and training programs by developing environmental literacy and sustainability-oriented cognition in industrial organizations [8], [9].

Table 6. Hypothesis testing

Hypothesis	Path	Direct effect	Indirect effect	Total effect	T statistics	P values	Decision
H1	SOE to CEA	0.577		0.577	16.625	0.000	Supported
H2	CEA to CMP	0.448		0.448	9.346	0.000	Supported
H3	SOE to CMP	0.215		0.215	4.369	0.000	Supported
H4	SOE to CEA CEA to CMP SOE to CMP SOE to CEA to CMP	0.577 0.448 0.215	0.259	0.474	11.692	0.000	Supported Partial mediation

The results also indicate that CEA has a significant positive impact on the implementation of circular marketing practice (β = 0.448, = 9.346, p = 0.001), implying that the higher the awareness, the higher the chances of adopting circular marketing programs. Moreover, sustainability-focused marketing education shows the direct and statistically significant impact on CMP (β = 0.215, t = 4.369, p = 0.001), but with a relatively lower value. This trend means that although education has a direct role to play in the process of adopting circular marketing, its main role is to fortify the underlying cognitive and knowledge base that makes such activities to be successfully executed. The results align with previous studies, indicating a complementary effect of education and awareness when it comes to promoting sustainable and circular organizational practices [22], [23]. Findings of the mediation test prove that CEA mediates the connection between sustainability-oriented marketing education and the incorporation of circular marketing in part. Namely, the indirect effect of SOE on CMP is

positive and statistically significant when mediated by CEA (β = 0.259, = 11.692, p = 0.001), however, the direct effect is also significant, which means the partial mediation. It implies that marketing education with a sustainability focus affects the adoption of circular marketing directly and indirectly through improving the levels of awareness of the ideas of a circular economy [6], [10]. On balance, the results support the primary importance of awareness as a cognitive process that transforms the sustainability related knowledge into organizational action, which is consistent with earlier studies that attribute awareness to the mediation of education and sustainable behavior in an organizational environment [34], [35].

5.1. Model predictive accuracy

Table 7 shows that the model has good explanatory power as the R2 coefficient of determination (R2) is 33.3 and 35.8, which are high percentages in behavioral research. The F2 values also indicate that SOE had a high impact on CEA (0.500), which is significant as per [39]. In addition, the values of Q2 indicate that all the variables possess positive predictive power, with CMP predictive value of 0.220, and CEA predictive value of 0.329, showing the potential of the model to predict future behavior of sustainability.

Table 2. Model predictive accuracy indicators

		CEA	CMP
f-square	R-square	0.333	0.358
	SOE	0.500	0.048
	CEA		0.208
	Q-square Predict	0.329	0.220

5.2. Analysis of differences between types of firms

The Partial Least Squares Structural Equation Modelling (PLS-SEM) approach was used within the framework of Multi-Group Analysis to examine the differences in path coefficients between the two study groups (Large ≥ 200 employees and Medium/Small < 200 employees). To achieve this goal, the (PLS-MGA) test was used, which is a test that relies on randomly redistributing the data for the groups many times (replication in this research). The model is then re-estimated each time, and the differences in the resulting path coefficients are calculated [38], [40].

Table 3: Bootstrap MGA test results

Hypothesis	Path	Difference (Large - Medium/Small)	p value
H1	SOE -> CEA	0.071	0.297
H2	CEA -> CMP	0.209	0.022
H3	SOE -> CMP	-0.031	0.705
H4	SOE -> CEA -> CMP	0.157	0.017

Table 8 is a summary of the outcome of the multi-group analysis (MGA), which tests the possible variation in structural connections between big companies and small and medium sized enterprises (SMEs). The comparison results indicate that firm size moderates certain relationships in the proposed model, whereas other paths are not dependent on organizational scale.

The results obtained show that there is no significant difference in the interrelation between sustainability-oriented marketing education and CEA (H1) between the firms of different sizes (p = 0.297). This result is indicative that sustainability-oriented education has a similarly significant effect on the process of awareness development in both large companies and SMEs, indicating the universality of the education as a cognitive, knowledge formation process that is independent of the size of the organization.

Conversely, the statistically significant difference appears in the correlation between the awareness of the circular economy and the implementation of circular marketing practices (H2), and the impact is greater in the

large companies ($p = 0.022$). It does not suggest that small organizations are ineffective in converting awareness to functional marketing use. This may be explained by the fact that large firms have more access to organizational, human, and technological resources that help operationalize the knowledge about the environment into tangible marketing behaviors, as was mentioned earlier by [3], [4].

Regarding the direct impact of sustainability-oriented marketing education on the implementation of the circle marketing context (H3), the MGA findings show that there are no statistically significant differences between the large companies and SMEs ($p = 0.705$). This implies that the short-term influence of education on practice adoption is quite universal in any organization, irrespective of its size. Yet the mediation analysis (H4) proves that there is a significant group difference ($p = 0.017$), and the role of CEA as a mediator is stronger in large firms than in SMEs. This observation highlights the significance of organizational capabilities in capitalizing on awareness to implement them successfully and supports previous studies that highlight the importance of firm level resources and capabilities to facilitate successful shifts in changes to circular economy practices [13], [32].

A more interpretive interpretation of the above finding is that the basis upon which the divergence is taking place is not necessarily the level of understanding and recognition of the principles of the circular economy, but rather the level of organizational ability that is present in the firm to effectively implement and operationalize the level of understanding and recognition of the principles of the circular economy. Larger organizations are more likely to have the ability to convert the level of understanding and recognition of the principles of the circular economy into circular marketing practice, given the level of processes, coordination, and technological and human resource support that are available within larger organizations.

6. Discussion

The results of this paper can be used to further the theoretical and practical insights into the role of sustainability-focused marketing education in facilitating the shift to the circular economy among Saudi industrial enterprises, as both a knowledge-based strategy and as a behavioral and organizational change tool. The findings show that marketing education based on sustainability does not work in a vacuum, but it generates its real effect when implemented in the form of an ingrained awareness of the concept of a circular economy. This is consistent with the literature that sustainable change involves a change in the thinking patterns first, before practices can be altered [6], [8].

The findings also indicate that marketing education that is sustainability-oriented is an effective driver towards the creation of awareness about the circular economy. The theory of PB can explain this because it assumes that knowledge and education can impact beliefs and attitudes and, as a result, intentions and behaviors [22], [23]. In an industrial setting, education does not only involve the transfer of information; it also helps in redefining the sense of value, resources, and lifecycle of the product among the employees. This is consistent with what [2], [9] suggested that the awareness of the circular economy is a cumulative outcome of organizational learning, rather than the outcome of individual management choices.

The results also favored the positive correlation between the awareness of the circular economy and the adoption of the circular marketing practices, as a way of showing that it is not merely a cognitive state but an enabling factor of organizational behavior. In the light of the diffusion theory, awareness is the initial step of innovation adoption, which decreases uncertainty and makes new practices more acceptable in the organization [8], [9]. The past research proves that companies whose staff is aware of the concepts of circularity can more easily incorporate them in their marketing communication plans and create market values [4], [14], [29].

Concerning the direct influence of continuous marketing education on the implementation of circularity marketing practices, the findings reveal that the former has an impact, but it is not as potent as the indirect one via awareness. This is justified by the fact that the literature about organizational learning and dynamic capabilities suggests that education is not enough to facilitate change unless it is mentally absorbed and redefined in the framework of everyday work [25], [26], [37]. Education can provide employees with the tools,

yet they will not use them without turning it into a belief and inner understanding of the usefulness of the circular economy as a strategic decision, not as an environmental obligation [18], [19].

One of the most important findings in the literature is that the awareness of the circular economy is a partial mediating factor. It evaluates the fact that sustainable marketing education has a two-fold effect on the uptake of circular marketing, directly and indirectly via awareness. The given form of mediation is consistent with the earlier research findings in environmental management and green innovation that have revealed that awareness serves as the knowledge mediator between training and practice [10], [34], [35]. This result also confirms the rationale of the PB theory according to which behavior is not necessarily determined by knowledge, but it is mediated by cognitive and psychological processes [22], [23].

This result provides insights into the reasons why awareness was identified as a stronger driver in the model. Marketing education in the field of sustainability may provide knowledge, concepts, and even strategic exposure; however, this does not necessarily translate into behavior. The effectiveness of this education is magnified when it is internalized as awareness of the circular economy, as awareness converts the educational input into a more actionable cognitive framework by which to approach sustainability issues and make marketing decisions in accordance with the principles of the circular economy. Awareness, therefore, is not just a correlate of education but rather the mechanism by which educational input becomes behaviorally meaningful in the context of the organization [8], [23].

Moreover, the multigroup analysis findings indicated that company size is a factor in the capability of an organization to convert awareness into action, with bigger organizations having greater capacity to use awareness to implement circular marketing practices. This is in line with the literature that suggests that bigger companies have access to organizational, human, and technological resources that allow them to put knowledge into practical use better [3], [4], [32]. On the other hand, the absence of variations in the effect of education on awareness indicates that education as a cognitive instrument is similar in its operation, irrespective of the size of the organization, and therefore, the holistic aspect of sustainable education [5], [6], [11].

This research supports the idea that the transition to the model of circular marketing in Saudi industrial companies is impossible without investment in education or without awareness campaigns without education. Instead, it needs a mental assimilation that renders education an initiator, awareness a transformative tool, and marketing the field where the strategic implementation of the circular economy could be applied. This observation strengthens the fact that sustainability is not an issue of tools, but an issue of mindsets and organizational culture

7. Conclusion

7.1. Theoretical implications

The paper contributes to relevant theory in the field of sustainability, marketing, and the circular economy. First, it is an extension of the Theory of PB using empirical evidence to support that marketing education about sustainability can impact organizational behavior through a cognitive process, which is manifested as the awareness of the circular economy. The awareness is placed between the cognition of individual sustainability and the marketing practices of organizations, which makes the study move a step closer to meso-level concretizations of the theory [22], [34].

Second, the results contribute to the literature of DOI theory through supporting awareness as the important knowledge level condition enabling the conversion of an educational input into the adoption of a circular marketing behavior, especially in an industrial setting with structural rigidity [8], [9]. Third, the paper adds to the growing body of literature in circular marketing by highlighting the significance of sustainability-based marketing learning, and not generic environmental learning, as a strategic route, through which the notion of a circular economy can be instilled and applied in companies. Taken as a whole, the study incorporates scattered research streams into a common framework highly applicable in the emerging economic phase like Saudi Arabia.

7.2. Practical implications

In practical terms, the results can be used by managers, policymakers, and educators seeking to accelerate the adoption of the circular economy in industrial companies. The findings suggest that sustainability-focused marketing training should be treated as a strategic investment rather than a compliance exercise. They also highlight the need to build a comprehensive understanding of the circular economy among marketing and sustainability professionals. Implementing the idea of a circular economy into marketing education, internal training courses, and strategic communications systems can help develop the skills of the employees to transform the knowledge about sustainability into market-focused practices [14], [16].

Moreover, the fact that the awareness practice relationship is stronger in large firms indicates that organizational resources are significant in translating awareness into implementation. This highlights the necessity of specific policy support of small and medium-sized enterprises, including a common training platform, advisory services, and industry-related learning networks, to go beyond the limits of capabilities [13], [32]. The results show that, while supporting small and medium-sized enterprises (SMEs) in terms of creating awareness is necessary, it is not sufficient. More precisely, it appears that the key factor is the provision of tools that can facilitate the actual implementation of the circular idea, i.e., providing guidance for the implementation process, learning support between departments, and access to expertise. In other words, training activities need to be accompanied by supporting structures that can facilitate the application of circular principles by SMEs with limited internal resources, thereby actualizing circular marketing. In this way, the existing gap between awareness-raising and actual marketing can be bridged.

The findings on the national level are consistent with Saudi Vision 2030 as they focus on the development of human capital as a scaled mechanism of imprinting the principles of the circular economy into industrial marketing practices.

7.3. Limitations and directions for future research

However, this research has several limitations that could be addressed in future research. To begin with, a cross-sectional research design does not allow us to trace causal dynamics, as well as the changes in education, awareness, and circular marketing uptake over time. To gain a better insight into the effect of sustainability-oriented marketing education on behavioral transformation, longitudinal studies are suggested. Second, the use of self-reported survey data can bring in the common method bias and social desirability. Objective performance measures or qualitative research designs, including interviews or case studies, can be used in the future to improve validity.

Third, the sample of Saudi industrial firms could restrict the ability to generalize the results to other institutional and cultural backgrounds. Cross-country comparative research methods may be employed to investigate the relationship between education, awareness, and adoption within national sustainability agendas and institutional pressures. Lastly, the research can be expanded in the future with a range of new mediators or moderators, like organizational culture, leadership commitment, or digital marketing capabilities, to elaborate further on how sustainability-oriented marketing education can contribute to the transformation of the circular economy.

Declaration of competing interests

The authors declare that they have no conflict of interest and all of the authors agree to publish this paper under academic ethics.

Author contributions

Khaled Alshaketheep: Conceptualization, methodology, Writing, review & editing. Hind Al-Ahmed: Conceptualization, investigation, visualization. Barween Al Kurdi: Methodology, formal analysis, validation. Ahmad Shajrawi: Project administration, resources, Data curation, writing - original draft.

Data availability statement

In accordance with Jordanian data privacy regulations and the Hashemite University Economic and Management Sciences Research Ethics Committee's data access restrictions, the dataset used in this study is not publicly available. However, the corresponding author can provide the relevant data upon reasonable request, in compliance with the applicable legal and ethical guidelines.

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Institutional review board statement

The study was conducted with ethical approval from the Economic and Management Sciences Research Ethics Committee, Hashemite University, Jordan. Date of approval: 5 December 2024.

Use of AI in Writing

The authors used AI language support only in limited capacities, including grammatical, clarity, and readability assistance in editing. All interpretation, analysis, argumentation, and final manuscript revisions were carried out and verified by the authors.

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