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CLOSED-LOOP SUPPLY CHAIN INTEGRATION: ASSESSING MARKETING IMPACTS AND CUSTOMER PERCEPTIONS OF SUSTAINABLE BRAND VALUE IN THE SAUDI PHOTOVOLTAIC INDUSTRY

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ABSTRACT

Purpose: This investigation addresses the influence of closed-loop supply chain integration (CLSCI) on consumer perception of sustainable brand value, examining its effect on purchasing decisions, brand loyalty, and image.

Theoretical framework: The study operates within a framework that posits CLSCI as a potential enhancer of sustainable brand value, mediated by demographic variables and consumer consciousness of sustainability practices.

Design/methodology/approach: A cross-sectional analysis was performed with 240 Saudi participants using Multivariate Analysis of Variance (MANOVA) to assess the hypotheses derived from the theoretical framework.

Findings: Results indicate a direct correlation between CLSCI and brand image, strengthened by consumer awareness. Moreover, age and awareness significantly mediate the relationship between CLSCI and perceived brand value and purchasing decisions.

Research, Practical & Social implications: Findings underscore the necessity for Saudi photovoltaic (PV) firms to elevate CLSCI awareness and its linkage to brand image. The study also prompts further examination of age-related influences and sustainable waste management practices.

Originality/value: his study contributes to the limited research on CLSCI's role within the Saudi PV sector, providing empirical evidence and a conceptual model for CLSCI implementation, offering insights for enhanced consumer engagement and sustainable brand development.

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INTEGRAÇÃO DA CADEIA DE FORNECIMENTO DE CICLO FECHADO: AVALIANDO IMPACTOS DE MARKETING E PERCEPÇÕES DO CLIENTE SOBRE O VALOR SUSTENTÁVEL DA MARCA NA INDÚSTRIA FOTOVOLTAICA SAUDITA

RESUMO

Objetivo: Esta investigação aborda a influência da integração da cadeia de suprimentos de circuito fechado (CLSCI) na percepção do consumidor sobre o valor sustentável da marca, examinando seu efeito nas decisões de compra, fidelidade à marca e imagem.

Enquadramento teórico: O estudo opera dentro de um enquadramento que postula o CLSCI como um potencial potenciador do valor sustentável da marca, mediado por variáveis demográficas e pela consciência do consumidor relativamente às práticas de sustentabilidade.

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Desenho/metodologia/abordagem: Uma análise transversal foi realizada com 240 participantes sauditas usando Análise de Variância Multivariada (MANOVA) para avaliar as hipóteses derivadas do referencial teórico.
Resultados: Os resultados indicam uma correlação direta entre o CLSCI e a imagem da marca, fortalecida pela consciência do consumidor. Além disso, a idade e o conhecimento medeiam significativamente a relação entre o CLSCI e o valor percebido da marca e as decisões de compra.
Implicações de pesquisa, práticas e sociais: As descobertas ressaltam a necessidade de as empresas fotovoltaicas (PV) sauditas elevarem o reconhecimento do CLSCI e sua ligação à imagem da marca. O estudo também solicita um exame mais aprofundado das influências relacionadas com a idade e das práticas sustentáveis de gestão de resíduos.
Originalidade/valor: seu estudo contribui para a pesquisa limitada sobre o papel do CLSCI no setor fotovoltaico saudita, fornecendo evidências empíricas e um modelo conceitual para a implementação do CLSCI, oferecendo insights para maior envolvimento do consumidor e desenvolvimento sustentável da marca.

Palavras-chave: Integração da Cadeia de Suprimentos em Ciclo Fechado, Indústria Fotovoltaica, Arábia Saudita, Valor Sustentável da Marca, Decisões de Compra.

INTEGRACIÓN DE LA CADENA DE SUMINISTRO DE CICLO CERRADO: EVALUACIÓN DE LOS IMPACTOS DEL MARKETING Y LAS PERCEPCIONES DE LOS CLIENTES SOBRE EL VALOR DE MARCA SOSTENIBLE EN LA INDUSTRIA FOTOVOLTAICA SAUDITA

RESUMEN
Propósito: Esta investigación aborda la influencia de la integración de la cadena de suministro de circuito cerrado (CLSCI) en la percepción del consumidor sobre el valor de marca sostenible, examinando su efecto en las decisiones de compra, la lealtad a la marca y la imagen.
Marco teórico: El estudio opera dentro de un marco que postula a CLSCI como un potencial potenciador del valor de marca sostenible, mediado por variables demográficas y la conciencia del consumidor sobre las prácticas de sostenibilidad.
Diseño/metodología/enfoque: Se realizó un análisis transversal con 240 participantes sauditas utilizando el Análisis de Varianza Multivariado (MANOVA) para evaluar las hipótesis derivadas del marco teórico.
Hallazgos: Los resultados indican una correlación directa entre CLSCI y la imagen de marca, fortalecida por la conciencia del consumidor. Además, la edad y la conciencia median significativamente la relación entre CLSCI y el valor percibido de la marca y las decisiones de compra.
Implicaciones prácticas, sociales y de investigación: los hallazgos subrayan la necesidad de que las empresas sauditas de energía fotovoltaica (PV) eleven el conocimiento de CLSCI y su vínculo con la imagen de marca. El estudio también impulsa un mayor examen de las influencias relacionadas con la edad y las prácticas sostenibles de gestión de residuos.
Originalidad/valor: su estudio contribuye a la investigación limitada sobre el papel de CLSCI dentro del sector fotovoltaico saudita, proporcionando evidencia empírica y un modelo conceptual para la implementación de CLSCI, ofreciendo ideas para mejorar la participación del consumidor y el desarrollo de marca sostenible.

Palabras clave: Integración de la Cadena de Suministro en Circuito Cerrado, Industria Fotovoltaica, Arabia Saudita, Valor de Marca Sostenible, Decisiones de Compra.

INTRODUCTION

A CLSC (Closed-Loop Supply Chain) describes “the design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time” (Guide, 2009). It may involve the return of products to recover added value through some reuse, which is an environmentally responsible arrangement that could preserve value, reduce costs, and improve productivity (Tseng et al., 2016). As such, it incorporates both forward and reverse supply chains (SC’s) with the aim of improving their sustainable performance (Zhen et al., 2019).

The latter concerns the point of consumption to origin to recapture the product's value or ensure its proper disposal (Nagasawa et al., 2019), thereby addressing environmental concerns to reduce negative environmental impact (Das & Poinasetti, 2015; Jalil & Shaharudin, 2019).

CLSCs have been examined in the literature since Fleischmann et al.'s pioneering study (2001). The need for a CLSC developed further due to the volatile outcomes of multidirectional flows and decentralisation in supply-chain management (Richter et al., 2012). Market growth and competition, among other factors, have prompted the need to strengthen, improve, and integrate supply chains. However, this usually requires significant investment in operational and technical resources, while customer demand may be uncertain (Georgiadis et al., 2012). Inadequate investment and inefficient supply chains can hamper the viability of reuse and recycling (Kadambala et al., 2017).

Aim and significance of the study

In the supply chain network of PV systems, it is imperative to consider recycling and sustainability initiatives because of their limited lifespan and increasing usage. The study focuses on closed-loop supply chain integration (CLSCI). It investigates whether it directly affects customer perceptions of sustainable brand value (CPSBV) and has marketing impacts (MI) in terms of purchasing decisions (PD), brand loyalty (BL), and brand image (BI). It further examines mediating factors in these relationships with respect to age and gender demographics, consumer awareness of CLSC (CAC), and prior experience with sustainable brands (PESB). The precise objectives are as follows:

1. To know whether CLSCI positively affects CPSBV and the MIs of PD, BL, and BI.
2. To know whether the relationships between CLSCI and CPSBV and the three MI's (PD, BL, and BI) are mediated by age and gender as demographic factors and CAC and PESB.

The study is significant because Saudi Arabia has set itself a high target for energy generation from renewable sources by 2030, and due to the need to devise a national strategy for dealing with the potential PV waste that would ensue. A CLSC and CLSCI could be seen as essential for such an industry, but research is still ongoing, and findings take time to be transferred as knowledge and become company policies. Moreover, academic knowledge, particularly of CLSCs for PV panels, is scarce (Besiou & Wasenhove, 2015), as are studies specifically on the Saudi PV industry and its readiness for Vision 2030.

LITERATURE REVIEW

CLSCs: Sustainability, Recycling and Reverse Logistics

Increasing environmental awareness is simultaneously leading to more sustainable industry practices. Sustainability in SC management resolves the perceived duality between economic, environmental, and social aspects while promoting renewable energy development in the industry under study (Cucchiella & D'Adamo, 2013). Its patterns require both innovative concepts and actors who innovate and provide the necessary services to achieve them.

Sustainability in CLSCs has been studied recently, for example, in the tyre industry (Fazli-Khalaf, 2020), the steel industry (Pourmehdi et al., 2020), the walnut industry (Salehi-Amiri et al., 2021), the food industry (Fadhel, 2021), the mining industry (Soleimani, 2021), the copper industry (Akbari-Kasgari et al., 2022), and the Saudi textile industry (Bhatti et al., 2023). Studies in the same PV industry as the present study include Chen et al. (2017), who implemented a particle swarm approach to optimize a multi-stage CLSC, and Mili et al. (2021), who proposed a multi-objective optimization model for a sustainable CLSC in Iran. The results of the study by Chen et al. (2017) support the need for an adequate recycling strategy or energy-saving technology and an integrated CLSC design. Recycling is beneficial for companies pursuing sustainable policies because it allows manufacturers to acquire otherwise expensive raw materials from their customers, thereby reducing their burden (Kim & Jeong, 2016).

Moreover, a CLSC design can assist in the transition to a circular economy (CE) at the supply chain level. It would dispense with the environmentally unfriendly and unsustainable production, consumption, and disposal culture through a more effective use of resources (Ghisellini et al., 2016). While governments have their own role in bringing this about, implementing CLSC structures is a bottom-up effort. They integrate both forward and reverse networks within a centrally managed system (Rezapour et al., 2015) and are characterised by aftermarket recovery operations and product reprocessing (Van Engeland et al., 2020) that lead to environmental, economic, and social benefits.

However, previous literature focuses mainly on the economic aspects and with a reductionist interpretation of the CE concept (MahmoumGonbadi et al., 2021). Also, CLSC approaches usually require large investments of dedicated facilities for product reprocessing (Nagasawa et al., 2017). Although EOL (end-of-life) product collection can be handled by retailers through customer incentives, recovery, refurbishing, and repair works would have to

be managed by a pool of trained service providers. Nonetheless, CLSC practices create business growth potential while also reducing waste and resource depletion.

Integration in CLSCs

Closed-loop supply chain integration is managed in two directions, with upstream suppliers and downstream customers, making it important to have strong relationships with both. Buyers also form an important component so that CLSCI can help achieve a competitive advantage (Lambert & Enz, 2017) and develop customer loyalty (Cai & Li, 218). Integration is an important aspect of supply chain management due to its potential to reduce demand uncertainty to enhance operational performance (Ricciardi et al., 2018; Roespinoedji et al., 2019). Internal and external integration of supply chains can lead to stronger SC resilience (Tarigan et al., 2021). Given such benefits, SC integration with strong upstream and downstream interaction is becoming a popular trend (Wang et al., 2022). SC integration is also important in reverse distribution to ensure forward and reverse supply chains operate well together.

The lead-acid battery industry provides a good example for explaining forward and reverse logistics supply chain networks, and such batteries are often used in solar- powered systems. Jayant et al. (2014) developed an integrated supply chain model incorporating forward and reverse chains for lead-acid battery recycling. The important factors they identified in the network included the number and type of participants, consumers, battery collection and recycling centers, material and product flow characteristics, and inverter batteries. They also devised a flow diagram for the entire network. A similar identification would need to be made for the Saudi solar panel sector to devise a workable and integrated CLSC network. Nili et al. (2021) developed one such model for a sustainable solar PV CLSC but in the Iranian sector. They took environmental pollution, social values, and customer service levels into account and applied their multi-objective supply chain model in a real-world case in Iran to test its efficiency.

A comprehensive and integrated CLSC system is particularly essential to address the tradeoff between economic and environmental sustainability, although demand is an added complexity (Soleimani et al., 2021). Further integration within a CE is beneficial for improved sustainability (Winkler, 2011), reduced waste generation (Herczeg et al., 2018), greater social benefits (Despeisse et al., 2017), proper EOL strategies (Jabbour et al., 2019), improved resource availability (Goyal & Surampalli, 2018), and enhanced value proposition (Mishra et

al., 2018). By simultaneously achieving economic and environmental goals and improving eco-efficiency, it is also possible to shift from a flow or linear economy to a circular one (Winkler, 2011).

Consumer Awareness

Consumer awareness is necessary to generate market demand. It is also a prominent driving factor of CLSCM in helping to achieve sustainable practices, prompting remanufacturing companies to engage in customer awareness programmes (Mondal et al., 2022). A sustainable strategy for the PV sector can only succeed if there is widespread consumer awareness of the collection channels (Alkahtani et al., 2021).

Consumer awareness of how well products are compatible with their own values determines the extent to which they can make informed valuations and decisions (Wang et al., 2018). With recycled products, consumers also seek reassurance about the product quality because they are unaware of how it may have been used previously and what steps the manufacturer took during the reverse engineering (Yilmaz & Belbag, 2016).

Prior Experience

Previous experience with remanufactured products is an important factor for consumers when compared with new ones due to uncertainty over previous uses, possible lack of manufacturer recognition, and the restoration methods employed (Hazen et al., 2017). Russo et al. (2019) examined the influence of past purchase experience of eco-products on purchase intention, willingness to pay for them, and switching intention. Their data confirmed the impact on purchase intention and switching intention but not willingness to pay.

CLSC in the Solar Power Sector

Solar or PV panels, which generate electrical energy from solar radiation, are a promising solution to alleviate the problems of fossil fuel-generated electricity shortages and rising energy costs. They generally last around 25-30 years, depending on monitoring, maintenance, and timely detection of defects (Nili et al., 2021), setup features, and other factors.

Still, it is worth considering the recyclability options because global PV waste is expected to reach 78 million tons by 2050. The most environmentally hazardous materials in PV systems that can benefit from recovery are lead (Pb) and cadmium (Cd) and the valuable

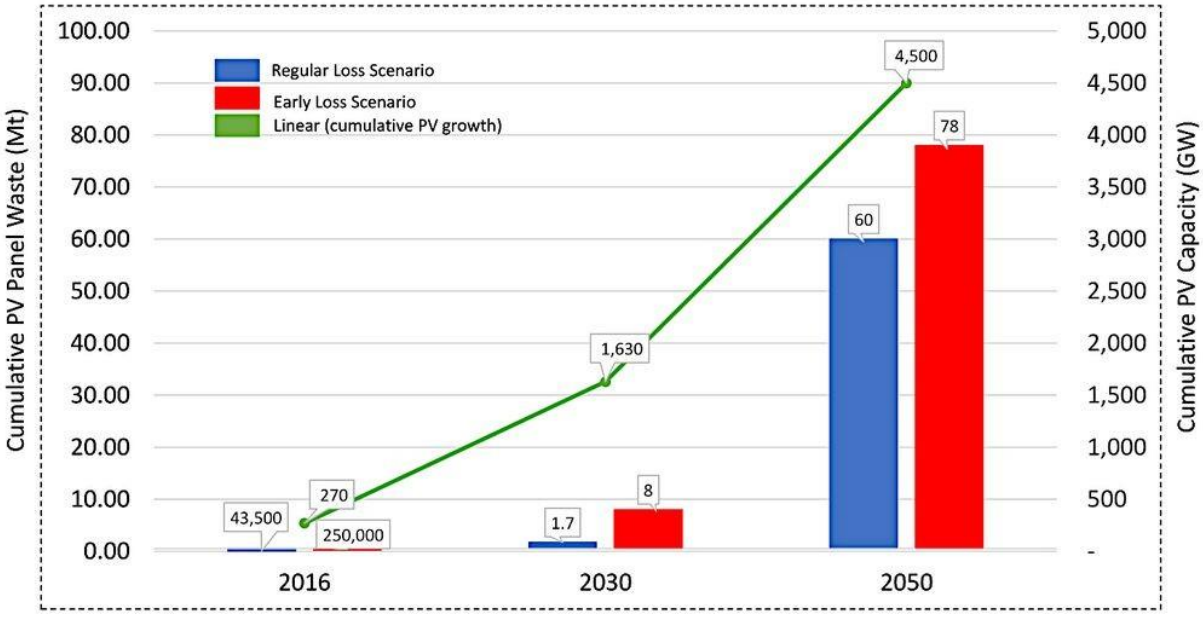
ones are gallium (Ga), indium (In), and tellurium (Te). Specifically, CdTe PV systems can be recycled more efficiently than c-Si (carbon- silicon) ones (Kim & Jeong, 2016).

CLSC in the Saudi Solar Power Sector

As in many other countries, with the notable exception of Germany, Saudi Arabia does not presently have a PV end-of-life policy, yet it is poised to drastically increase its electricity generation capacity from renewable energy sources to 50% by 2030, mostly through PV panels (Aleid et al., 2023). Its target is to generate 40GW of solar energy from the present 1.028GW as of 2022, out of the target 58.4GW for renewable energy projects overall (Mordor Intelligence, 2023). To this end, Saudi Arabia has launched several PV power plants across the kingdom with the aim of becoming more reliant on solar power instead of fossil fuels.

The goal is possible to achieve because the Saudi kingdom is blessed with abundant solar energy and one of the world's highest solar irradiation at approximately 2,200 kWh of solar radiation per square metre (Abdelkader, 2023). However, it amounts to a 3900% increase in the number of PV modules and will lead to preparing for a potential 60-78 megatons of PV waste by around 2050 (Ali & Malik, 2023). It would not be an understatement to describe the situation as a "ticking time bomb" if not dealt with in a timely manner (see Figure 1).

Figure 1: Cumulative PV capacity (in GW) and panel waste (in Mordor Intelligence)



Source: Mordor Intelligence. (2023). Disponível em https://www.mordorintelligence.com/industry-reports/saudi-arabia-solar-energy-market

Like lead-acid batteries, solar panels are largely recyclable, making them ideal for subjecting to CLSC policies. With present technological innovations, it is possible to recover around 95% of the materials used in them, including glass, semiconductor materials, and ferrous and non-ferrous metals. However, the recycling process is complex, as it involves a combination of operational and technical processes from collection to complex material recovery facilities (Azzarone, 2017). Recycling solar cells reduces the environmental burden of developing new ones, including the environmental costs of disposal.

The Closed-Loop Solar Cell Supply Chain

The amount of expired solar-powered system returns depends on the environmental awareness level of customers, the efficiency of solar panel cells, the return price of used solar panels, and the collection efforts of third-party logistics (Manouchehrabadi & Yaghoubi, 2020). In this system, the latter are the followers, the chain leaders are the assemblers and suppliers, and the government's role is to encourage maximum returns in the cycle through subsidies and other means.

Customer Perceptions

Brand value

The role of the consumer has only recently begun to be examined in relation to CLSCs (Abbey et al., 2015), whereas a CLSC relies on customer acceptance of the remanufactured products (Guide & van Wassenhove, 2009). Wang & Hazen (2016) also emphasised the importance of understanding the role of consumers in the process, particularly how they value remanufactured products. The knowledge could help shape more effective CLSC strategies (Agrawal et al., 2015). However, emotional aspects have still not been adequately examined (Pisitsankkhakarn & Vassanadumrongdee, 2020), nor have value creation studies adequately focused on CLSCs (Schenkel et al., 2015).

Four categories of value have been identified in the literature (Koppius et al., 2014), namely, informational value of data on production, supply, and customers; environmental value of reduced consumption of raw materials and natural resources, and reduced waste and emissions; customer value, particularly in terms of satisfaction and loyalty; and, sourcing value, such as direct cost reductions and savings.

Purchasing decisions

The perceived value given by customers could affect, for example, their decision to purchase new or recycled PV panels from a particular company with environmentally friendly and sustainable practices. Purchase intention has long been seen as significantly influenced by consumer perceived value in the literature, as shown, for example, in research in e-commerce (Chen & Dubinsky, 2003), telecommunications (Bolton & Drew, 1991), and computer manufacturing (Change & Wildt, 1994). Earlier, it was also mentioned that past experience influences consumers' purchase intention, whereas the product involved does not affect it (Russo et al., 2019). Age was also found to be a significant influencing factor in the same research, where older consumers were found to be more willing to pay than the younger generation.

Purchasing intention in CLSCs has been investigated, for example, by Zhang & He (2018), who identified the level of service as important in affecting purchasing behaviour; Jain & Singhal (2019); and Abbasi (2022). Wang et al. (2018) also showed empirically that certain components of consumer perceived value of remanufactured automobile parts relate to their purchase intention. Those components are environmental benefits, price advantage, and perceived quality, which are related positively to perceived value, and perceived risk, which is related negatively.

Abbasi (2022) investigated this phenomenon by applying the Theory of Planned Behaviour (TPB) and Stimulus Organism Response (SOR) to explain purchase intention towards remanufactured products with a sample size of 253 in Malaysia. Their results showed that perceived knowledge and subjective norms do not significantly affect attitude and purchase intention, respectively, but various factors shape purchase intention. Besides the aforementioned, other such factors include environmental consciousness and its perceived benefits, seller reputation, perceived risk, and behavioural control. Of these, consumer attitude has been shown to be a key determinant of consumer adoption by Jain & Singhal (2019). Irrespectively, a deeper understanding of customer perceptions is required not only in the Saudi context but also for its potential to support the transition to a CE.

Loyalty

Customer loyalty is a great asset for companies, as it provides a strong base for continued business. It is gained by attending to customers' needs in a way that satisfies them to the extent that they desire to remain in a long-term strategic relationship (Ahmed, 2021).

Loyalty can potentially contribute to improving a company's profitability, as can an improved brand image (Ivanov, 2020) when having a sustainable supply chain (Mehrotra et al., 2020). Importantly, customer loyalty can also be gained by having an integrated supply chain structure (Cai & Li, 2018).

One strategy that PV remanufacturers can consider to improve brand loyalty is highlighting the importance of their product category in the perception of their consumers, which Bauer et al. (2006) termed product involvement. PV panels may be considered as high involvement products given how connected they can potentially be with consumers' interests, values, and inherent needs. Product involvement also determines consumers' values (Xue, 2008).

Brand image

It may be assumed that consumers generally prefer brands that implement sustainable practices. Recycling products is one way of demonstrating environmental friendliness and creating a positive and green brand image for environmentally- conscious customers. Green innovation provides positive public and social images (Shete et al., 2020). Companies engage in such practices to exploit their green image and because they see the potential for greater performance, which makes it an inevitable choice in sustainability (Zhu & Yu, 2019). Brand image is also affected by other factors detrimentally, making it necessary to avoid those practices that could damage brand image, such as damage to a company's reputation (Wang et al., 2022).

RESEARCH METHOD

A multivariate analysis of variance (MANOVA) was conducted to determine whether the independent variable of CLSCI (Closed-Loop Supply Chain Integration) has an effect on the following dependent variables:

- CPSBV (Customer Perceptions of Sustainable Brand Value)
- MI (Marketing Impact) in terms of PD (Purchasing Decisions), BL (Brand Loyalty), and BI (Brand Image)

The variables are assumed to be independent and linearly related, and the response variable is random, with a normal distribution. Additionally, the analyses were done to see whether a demographic factor, CAC (Consumer Awareness of CLSC) and PESB (Prior

Experience with Sustainable Brands) mediate the above relationships. Table 1 summarises all the tested variables.

Table 1: Variables of the study

Independent	Dependent	Mediating
CLSCI (independent) – Closed-Loop Supply Chain Integration	CPSBV – Customer Perceptions of Sustainable Brand Value MI – Marketing Impacts: • PD – Purchasing Decisions • BL – Brand Loyalty – Brand Image	D – Demographics CAC – Consumer awareness ofCLSC PESB – Prior Experience withSustainable Brands

Source: Authors' Own (2023)

The following hypotheses were formed based on the literature review to guide the analysis:

- H1. CLSCI leads to more positive CPSBV and greater MI in terms of PD, BL, and BI.
- H2. The relationship between CLSCI and CPSBV and CLSCI and MI's is mediated by demographic factors (age, gender), CAC, and PESB.

The data were collected from a representative sample of 240 Saudi respondents. Values of the categorical variables ranged from 1 (least or lowest) to 5 (most, highest, or greatest). Cronbach alphas for the scales range between 0.90 and 0.96, suggesting a very dependable relationship (Guilford, 1954). Also, a confirmatory factor analysis supports the convergent validity of the measures, with factor loadings exceeding the

0.60 threshold, and discriminant validity is confirmed.

Results of the Study

The main MANOVA results of this study are presented in Table 2. CLSCI has no significant effect on CPSBV, PD, and BL, but a significant effect was found for BI ($F(1, 214) = 3.16$). We can, therefore, accept the first hypothesis (H1) only for the relationship between CLSCI and BI.

In terms of the dependent variables, CPSBV is only affected significantly by CLSCI when mediated by age ($F(1, 214) = 7.19$) and CAC ($F(1, 214) = 23.63$); PD when mediated by age ($F(1, 214) = 5.81$) and CAC ($F(1, 214) = 25.57$); and BI directly and when mediated by CAC ($F(1, 214) = 26.96$). CAC is, therefore, an important mediating factor in the aforementioned relationships and also age to a lesser extent. The study's results support their importance, and this has implications for CLSCI strategies, which are discussed further below. The second hypothesis (H2) is thus also only partially supported for mediating

variables mentioned above as significant for certain dependent variables. Notably, neither is BL significantly affected by CLCI, directly or through mediation nor are gender or PESB significantly influential in the relationship between any of the dependent variables and CLSCI.

Table 2: Results of the MANOVA analysis

	CPSBV	PD	MI BL	BI
CLSCI Low, High Main effect of CLSCI: F df1, df2, partial η2	- 3.09, 3.31 0.31 1, 214, 0.01	- 3.54, 3.66 1.85 1, 214, 0.00	- 2.87, 2.95 1.12 1, 214, 0.02	* 3.73, 3.90 3.16 1, 214, 0.00
Age Young (<30), Old (30+) Interaction of CLSCI: F df1, df2, partial η2	* 4.08, 3.68 7.19 1, 214, 0.03	* 3.99, 3.72 5.81 1, 214, 0.01	- 3.75, 3.67 2.45 1, 214, 0.00	- 3.81, 3.70 2.99 1, 214, 0.00
Gender Male, Female Interaction of CLSCI: F df1, df2, partial η2	- 3.22, 3.17 1.56 1, 214, 0.00	- 3.43, 3.33 1.72 1, 214, 0.00	- 3.37, 3.25 1.60 1, 214, 0.00	- 3.52, 3.40 1.87 1, 214, 0.01
CAC Low, High Interaction of CLSCI: F df1, df2, partial η2	* 4.11, 4.35 23.63 1, 214, 0.02	* 3.97, 4.21 25.57 1, 214, 0.00	- 3.68, 3.77 19.52 1, 214, 0.01	* 4.17, 4.42 26.96 1, 214, 0.04
PESB Low, High Interaction of CLSCI: F df1, df2, partial η2	- 2.97, 3.11 2.44 1, 214, 0.00	- 2.73, 2.88 3.14 1, 214, 0.00	- 2.68, 2.71 2.74 1, 214, 0.00	- 3.08, 3.19 3.52 1, 214, 0.00

* Indicates a significant difference ($p < 0.001$)
Source: Authors' Own (2023)

DISCUSSION

The study enriches the literature on CLSCI with a sample from the Saudi solar power or photovoltaic industry. The discussion highlights the contributions and makes some recommendations based on the quantitative analysis of a range of factors that may affect CLSCI, including mediating ones. It covers the significant factors revealed by the study's results and gives suggestions to support Saudi Arabia's CLSC-based green initiatives and guide its future development by highlighting necessary measures for Vision 2030.

The results of this study support the importance of CAC (consumer awareness of CLSC) in all the impact relationships with CLSCI except for BL. They make it a significant factor for targeting in marketing strategies. It is not only about environmental awareness but

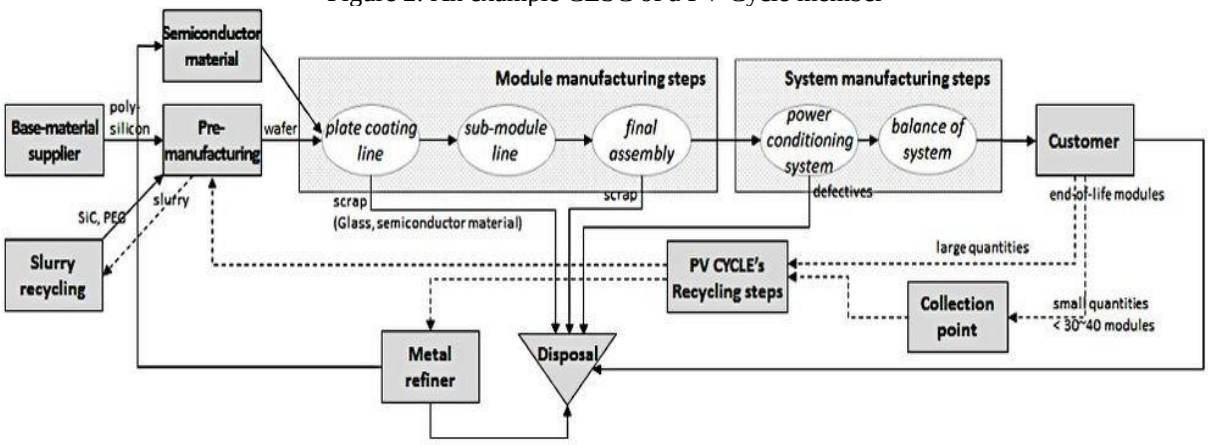
also awareness of sustainable practices (Mondal et al., 2022), PV panel collection channels (Alkahtani et al., 2021), and how compatible the Saudi PV industry could be compatible with public values (Wang et al., 2018). Furthermore, the strategy should include informing customers about the reverse engineering process and quality reassurance (Yilmaz & Belbag, 2016).

The importance of age as a mediating factor is an anomalous finding because it contradicts Russo et al.'s (2019) study that found older consumers more willing than the younger generation to make a purchase. Older consumers may have greater PESB (prior experience with sustainable brands), but the present study suggests younger consumers may have a greater perception of sustainable brand value. This aspect would need to be investigated further in the Saudi context.

Achieving and maintaining CLSC integration is an essential part of SC management. As shown in this study, it is particularly so for strengthening brand image, which is also mediated by consumer awareness. Brand image, in turn, can potentially contribute to profitability (Ivanov, 2020) and performance (Zhu & Yu, 2019). Saudi companies in the PV industry should, therefore, give prominence to developing a strong brand image, not only through green innovation (Shete et al., 2020) but also through sustaining their reputation (Wang et al., 2022).

Saudi Arabia is striving to significantly increase electrical energy generation through solar panels as part of its 2030 vision, but it does not presently have a PV waste management policy (Aleid et al., 2023). The Waste Management Law promulgated on 15 September 2021 regulates the safe disposal of waste and related activities in general but not specifically for the renewable energy sector. In this regard, it should follow the excellent example of Germany and also implement general laws to regulate PV and related waste, as in China and Japan. Germany maintains a national register for electrical equipment waste, provides national financing schemes, and undertakes R&D initiatives to reduce recycling costs and increase the potential revenue from recovered PV panels. PV Cycle is a European recycling association that collects EOL solar systems for recycling in Germany. Figure 2 shows an example of a CLSC of a PV Cycle member that could be adopted with necessary adaptations in Saudi Arabia.

Figure 2: An example CLSC of a PV Cycle member



Source: Kim & Jeong, 2016.

Furthermore, Saudi Arabia could develop an EPR (Extended Producer Responsibility) framework as part of an overall PV waste management law. Although not the focus of this study, the 2030 Vision would also require a transition to a more CE, generally. Future research should also consider the wider solar power sector in Saudi Arabia, which includes products for regulating, controlling, and storing the power generated using solar panels.

CONCLUSION

The study investigated the impact of CLSCI on a set of variables – CPSBV and three MIs, namely PD, BL, and BI. Additionally, it investigated whether the relationships are mediated by demographic factors (age and gender), CAC, and PESB. The researcher hypothesised that CLSCI has a positive impact on CPSBV and the three MIs, and that the relationship between CLSCI and CPSBV and the three MI's is mediated by age, gender, CAC, and PESB. MANOVA analysis of the data from a sample of 240 Saudi respondents revealed partial support for both hypotheses. The most important factors for a Saudi PV company seeking to develop a more integrated CLSC are consumer awareness, brand image, and CPSBV, PD, and age. Recommendations are given based on these findings for Saudi Arabia to successfully achieve its Vision 2030's goals for safely expanding the use of renewable energy sources.

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