

Integrating Circular Economy Through Refuse, Rethink and Reduce in Vocational Education for Sustainable Development

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Abstract

Advancements in sustainable development have expanded into vocational education, highlighting the teaching of circular economy as pivotal in realizing the global vision for Sustainable Development Goals. However, there is no specific tool used to study the smarter product consumption and manufacturing in circular economy management, especially in refuse, rethink, and reduce constructs, as detailed in the 9R circular economy framework, has prompted the current study to conduct a preliminary study throughout the instrument's development and validation. The determination of content validity occurs at two levels; instrument development, and instrument validation. This study aims to obtain item-level content validity index (I-CVI) and scale-level content validity index (S-CVI) for instrument to evaluate smarter product use and manufacture in teaching circular economy. Findings from the first research question indicated that there was agreement on 39 of 44 items (I-CVI at least 0.83), while 5 items did not meet the CVI cutoff value from the six experts who validated the instrument, were subject to revision. The instrument's overall item-level content validity index (I-CVI) for all three constructs is 40.00. The second research question revealed an S-CVI value (on average) of 0.91 for the entire session, with an S-CVI (Universal Agreement) of 0.57. In conclusion, the completed 39-item instrument demonstrates content validity and holds potential for enhancing evaluation efforts on smarter product use and manufacture (refuse, rethink, and reduce) in teaching circular economy for vocational education.

1. Introduction

Circular economy introduces a new perspective on production and consumption, guaranteeing long-term sustainable development. This model optimizes the use of resources, reduces the use of raw materials and reuses waste through recycling or reusing it in the creation of new products. Anchored in three core principles (refuse, rethink and reduce), the circular economy promotes smarter product consumption and manufacturing (Mast et al., 2022; Potting et al., 2017; Tjahjono et al., 2023). Taking inspiration from nature's cyclical processes, where

each component retains value and waste turns into a resource, this concept upholds a harmonious balance between progress and sustainability.

Despite the global push towards sustainable practices, many countries, including Malaysia, face major challenges in implementing circular economy principles. For example, Malaysia generates about 38,000 tons of waste per day (Muhammad, 2023; Woon, 2021), with a recycling rate of only 24.6% in 2020, far below the target set by the Malaysian government (Kasmuri et al., 2023). The country struggles with high levels of plastic waste and an inefficient waste management system, which leads to environmental pollution and resource depletion (Raudhah et al., 2020).

Malaysia's waste management infrastructure is underdeveloped, with limited capacity for recycling and composting, leading to high levels of waste sent to landfills (Daud et al., 2024; Hariri et al., 2024). According to Supian et al., (2024) 98% of green waste is directed to landfill, while only 2% is diverted for composting or recycling. In contrast, advanced economies such as Germany, Japan, and Switzerland have largely phased out landfills through strict regulatory frameworks and policies such as Extended Producer Responsibility, mandatory household waste separation, and economic incentives that encourage recycling and energy recovery (Themelis, 2023). These measures have produced recycling rates above 60%, showcasing how integrated policy and infrastructure can shift waste management towards a circular system (Carrillo et al., 2024; Dehio et al., 2023; Sheoran & Das Gupta, 2024). These examples illustrate the critical need for context-specific strategies that address local challenges while drawing lessons from successful international models. Similar challenges occur in other countries, such as Indonesia, where insufficient infrastructure and public awareness hinder effective waste management and recycling efforts (Kurniawan et al., 2023; Oh & Hettiarachchi, 2020). These issues emphasize how important it is to integrate circular economy principles into the education curriculum to foster a culture of sustainability from a young age.

One of the key components in accomplishing Sustainable Development Goal (SDG) 12 is the circular economy. Responsible Consumption and Production (Dantas et al., 2021; Ivan Kurniawan & Yudi Fernando, 2023), which aligns with vocational education's goal of fostering sustainable practices. Studies suggest that integrating circular economy principles into vocational education can effectively support SDG 12 objectives, such as reducing waste generation and promoting sustainable consumption patterns (Chen et al., 2020; Scalabrino et al., 2022). However, despite the increasing emphasis on sustainability in vocational education, the lack of validated items to teach circular economy concepts in this context is a major challenge. This gap hinders educators and curriculum developers in integrating circular economy principles into vocational programs, as existing materials may not align with the needs and competencies of vocational teachers. Without verified indicators of smarter product use and manufacture, educators face difficulties in accurately assessing students' understanding and competence in circular economy principles, hindering the effectiveness of teaching and learning initiatives in this area.

The urgency to develop and validate instruments for teaching circular economy principles arises from several critical factors. The absence of validated tools limits educators' ability to accurately assess students' understanding and application of these principles, particularly in areas such as smarter product use and manufacturing. Achieving the SDG 12 objectives requires concrete and measurable outcomes in education, which are challenging to attain without robust instruments. Moreover, existing teaching materials may not be well-suited to the vocational context, leading to inconsistencies in how circular economy concepts are conveyed and understood. The global challenges in waste management, as seen in countries like Malaysia and Indonesia, highlight the pressing need for education systems to equip students with the skills and knowledge necessary to address these urgent issues. To ensure relevance and effectiveness, it is crucial that these instruments be adapted to the local context, fostering a culture of sustainability that is both practical and impactful. Without verified indicators for smarter product use and manufacturing, educators face difficulties in accurately assessing students' understanding and competence in circular economy principles, ultimately hindering the effectiveness of teaching and learning initiatives in this area.

In line with this, existing research shows a growing interest in understanding knowledge, attitudes and behaviors towards the circular economy among students (Ab Hamid et al., 2024; Rahmatika Dewi et al., 2022). However, there are no specific tools used to study the smarter product consumption and manufacturing in circular economy management, especially in refusing, rethinking, and reducing practices, as detailed in the 9R framework by Potting et al., (2017). Therefore, there is a critical need to develop instruments adapted to the Malaysian context to measure these dimensions. This paper thus seeks to add to the instrument (instrument development study) designed to evaluate the content validity index (CVI) at the scale and item levels in accordance with two research questions:

- RQ1: What is the instrument's item-level content validity index (I-CVI) of assessing smarter product use and manufacture in teaching the circular economy?
- RQ2: What is the instrument's scale-level content validity index (S-CVI) of assessing smarter product use and manufacture in teaching the circular economy?

1.1 Teaching Circular Economy for Vocational Education

The integration of circular economy principles into vocational education is essential for fostering sustainable development in various industries. However, several research efforts have highlighted critical gaps that need to be addressed to improve the effectiveness of circular economy education for vocational training. Graf et al. (2022) stress the need to align educational programs with industry demands. While projects like e-CIRP provide practical insights, adapting modular training to sector-specific challenges are essential for students' skill relevance. Napathorn (2021) points out the traditional education system's failure to meet green skills demands. Collaboration between vocational colleges, universities, and industry is vital in designing curricula responsive to industry needs. Pansera et al. (2021) highlights socio-political aspects, urging their integration into vocational education for a holistic understanding. Despite progress, gaps persist in waste management and curriculum focus, necessitating more attention to circular economy education's specifics.

The shift towards a circular economy (CE) has received significant attention in recent years, with researchers exploring various strategies to foster sustainable practices in product consumption and manufacturing. However, a closer examination of existing research reveals several key gaps that need to be addressed in order to advance the understanding and effective implementation of CE principles. Research by Shevchenko et al. (2023) underlines the need for a comprehensive framework that encompasses the role of users across the product life cycle. Despite efforts to elucidate consumer contributions to CE, more research is required to explore the subtleties of consumer behaviour and how they affect CE techniques such as refusing, rethinking and reducing.

In studying smarter product use and manufacture, Morseletto (2020) criticizes existing targets for their limited scope, urging research into targets promoting waste reduction and efficiency. Valencia et al. (2023) emphasize integrating socioeconomic strategies into CE, lacking empirical research on their effectiveness. Garusinghe et al. (2023) and Ho et al. (2024) offer insights into CE practices but advocate a holistic approach considering all 9R strategies. Suski et al. (2022) call for adequacy-oriented concepts in CE, highlighting the need for empirical research on sufficiency integration. They propose bridging this gap to promote sustainable consumption behaviors through vocational education. While existing research provides valuable insights into various aspects of integrating circular economy principles into vocational education, there are still significant gaps in tackling waste, rethinking and reducing strategies across the board. By bridging this gap, vocational education can play an important role in fostering a skilled workforce capable of driving the transition towards a circular economy.

Similarly, expert validation is necessary to guarantee that the items are relevant to the instrument's structures. In order to make sure that an instrument measures what it is intended to measure, content validity is crucial during the instrument creation process. (DeVellis, 2017; Ramli et al., 2020). However, I-CVI is frequently limited to methodological descriptions in explaining the content validation process. Most instrument authors do not explain their S-CVI calculation method. The S-CVI (average) and S-CVI (universal agreement) are the two approaches; however, only the Rubio et al. (2003) study recognizes them. They were worried that content validity would be compromised because S-CVI (universal agreement) demands 100% agreement when incorporating numerous raters, therefore they chose the averaging strategy. Researchers clearly proved both the average and universal agreement S-CVI approaches in this study, outlining different methods for calculating S-CVI to determine content validity.

1.2 Conceptions of Validation

Validation has been widely explored in various fields, including psychology, education, and philosophy, referring to the process of verifying the accuracy or truth of something. In the context of psychological research, validation is essential to ensure the reliability and validity of measures used to assess human behavior and mental processes (Allen et al., 2022; Chester & Lasko, 2021). Researchers such as Cronbach & Meehli, (1955) emphasized the important role of validation, highlighting the importance of aligning measurements against external criteria to ensure that they accurately reflect the constructs to be measured.

In education, validation is important to assess student learning outcomes and evaluate the effectiveness of teaching strategies. According to Black & Wiliam, (1998), verification in education involves verifying the accuracy of student learning by comparing it with external criteria, such as national standards or professional standards. This approach ensures that the assessment used in education reflects student learning accurately and is not biased towards a particular teaching method or curriculum (Chan & Luk, 2021; Sailer et al., 2021).

In philosophy, verification is closely related to the concept of truth. Philosophers such as Plato, (2016) Aristotle (1960) have extensively discussed the nature of truth and how it can be verified. Plato, for example, believed that truth could be verified using reason and the examination of eternal and unchanging forms. Aristotle, on the other hand, believed that truth could be verified using empirical observation and examination of nature.

In determining validity, instruments are developed using various approaches. Pohjamies et al., (2022) details the development and testing of the Preceptor Orientation Competency Instrument (POCI) according to COSMIN guidelines. The study established the validity and reliability of the instrument to evaluate preceptor orientation competency through four stages, including content validity, structural validity, and internal consistency testing. Kusaeri et al., (2018) describe a development study focused on the integration of Higher-Level Thinking Skills test items with the Islamic context. Following the Mardapi development model, Kusaeri et al., (2018) has gone through various stages, emphasizing the incorporation of Islamic principles into the evaluation instrument. Initially, test specifications were determined, guiding the development of items aligned with thinking dimensions such as analyzing, evaluating, and creating.

In the other hand, Wesnawa et al., (2022) details the creation of a digital instrument to measure pedagogical competence, using expert tests for content validity analysis. Testing the content validity of the instrument was conducted through expert testing using Gregory's formula (Gede et al., 2020; Saptono et al., 2021; Sumandya & Widana, 2022). In conclusion, instrument validation ensures the robustness of assessment instruments across multiple contexts, demonstrating the concept of cross-disciplinary validation in verifying accuracy and truthfulness in assessment practices.

2. Methodology

There are three common forms of validity: construct, content, and criterion-related. As a requirement for other types of validity, content validity is essential to the development and validation of instruments (Yusoff, 2019). According to Ramli et al. (2020), content validation requires expert judgment of item suitability. In this study, a 44-item instrument was constructed to measure refuse, rethink, and reduce practices in circular economy education. The instrument was subjected to a two-stage process: development and validation (Lynn, 1986). In Stage 1, items are created after content and constructs are determined. Stage 2 evaluated the instrument's overall content validity of the items, relying on feedback and evaluations from six experts regarding the relevance of the items to the constructs in the 9R circular economy framework. Therefore, the Content Validity Index (CVI) is commonly used in instrument development reports because of its ability to offer transparent information about each item, facilitating refinement or removal of the instrument. This serves as a basis for ensuring the overall validity of the instrument (Yusoff, 2019). The content validation process highlights two essential aspects: item representativeness and relevance in measurement, which align with the objectives of measurement researchers (Kamaluddin et al., 2017). The creation and verification of instruments are presented in this research aimed at assessing more intelligent product utilization and manufacturing (refuse, rethink, and reduce) in the context of teaching circular economy in vocational education.

2.1 Stage 1: Instrument Development Stage

This study identified three constructs: refuse (R0), rethink (R1), and reduce (R2), as introduced in the 9R circular economy framework (Potting et al., 2017) for the development of instruments aimed at the use and smarter product manufacturing. A comprehensive literature search was conducted using keywords such as "circular economy," "refusal," "rethink," "reduce," "questionnaire" and "validity" across Scopus, Web of Science (WoS) and Google Scholar databases. A search in Scopus using the search string TITLE-ABS-KEY ("circular economy" AND (refuse OR rethink OR reduce) AND questionnaire) yielded 90 documents, while the same search in WoS database yielded 106 documents. After filtering, 51 Scopus and 69 WoS articles remained. Inclusion criteria were: studies published between 2020 and 2024, open access, and focused on circular economy or education. Exclusion criteria included non-empirical papers, languages other than English or Malay, and studies unrelated to vocational education. Based on these criteria, 44 items were generated and adapted for the instrument. Additionally, a search in the Google Scholar database yielded 440 relevant articles. Inclusion and exclusion criteria were then used to select the most relevant up-to-date items in the field, with a particular focus on understanding the circular economy questionnaire, especially as it relates to TVET education.

The process begins with checking and adjusting the current instrument. Items identified from the literature were adapted to align with the scope of this study. The instrument was formed through a literature review and adaptation from several researchers (Allison et al., 2022; Amirudin & Gim, 2019; Bag et al., 2021; Barr et al., 2013; Cordova-Buiza et al., 2022; Fraccascia & Nastasi, 2023; Rahmatika Dewi et al., 2022). Information obtained from this extensive search guided the item generation process, with the creation of items categorized to reflect the objectives of the study. Construct categories include:

- Refuse (R001-R016);
- Rethink (R101-R114);
- Reduce (R201-R214)

The first construct, refusing unnecessary products or services is the first step in the 9R framework. By saying no to items that are not essential or negatively impact the environment, individuals and businesses can reduce waste generation and minimize their ecological footprint (Bag et al., 2021; Barr et al., 2013). The second construct, rethinking traditional production and consumption patterns is another key aspect of the 9R framework. By fostering innovation and creativity, the rethinking principle aims to promote sustainable practices that are in harmony with the environment (Allison et al., 2022; Amirudin & Gim, 2019).

The third construct, reducing resource consumption and waste generation emphasizes the importance of efficiency and resource conservation in driving sustainable development (Cordova-Buiza et al., 2022; Fraccascia & Nastasi, 2023; Rahmatika Dewi et al., 2022). This study does not involve other R constructs because refuse, rethink and reduce are constructs that are closest to the meaning of CE and are grouped in the same group by Potting et al. (2017) compared to other R constructs such as reuse, repair, refurbish, remanufacture, repurpose, recycle and recover. By focusing on waste prevention and material efficiency, vocational education can play a pivotal role in equipping individuals with the knowledge and skills necessary to implement the principles of the 9R framework effectively.

After determining the construct, the English items are translated into Malay (*Bahasa Melayu*), chosen due to its status as the national language and lingua franca (Abd Rahim et al., 2023; Omar et al., 2021; Zuber & Mansor, 2023). The process of translating English items into *Bahasa Melayu* involved several steps. Initially, a bilingual researcher in environmental education translated the English version into *Bahasa Melayu* while maintaining the item's original meaning. Subsequently, a native *Bahasa Melayu* speaker proficient in English re-translated the *Bahasa Melayu* version into English. These two versions were then reviewed and finalized by a panel of five experts in sustainability and vocational education, all of whom are native *Bahasa Melayu* speakers with over ten years of expertise. Discrepancies were addressed, ensuring alignment with the original English version. Additionally, cultural appropriateness for the Malaysian population was evaluated by the panel. Ten undergraduate students assessed the clarity of the final *Bahasa Melayu* version, providing feedback that was consistent and required no further adjustments.

2.2 Stage 2: Instrument Validation Stage

Expert input is essential in early quantitative research to validate survey items, ensuring relevance, alignment with study objectives, and supported by experts with both subject knowledge and instrument development expertise (Heale & Twycross, 2015; Yusoff, 2019). In line with this, Lynn, (1986) and Zamanzadeh et al., (2015) suggest involving between five and ten content experts to achieve adequate agreement levels. Polit & Beck (2006) also emphasized that including more than ten experts may weaken the consensus. Therefore, six experts were purposively selected to validate the instrument, which falls within the recommended range. The population of interest consisted of academicians and professionals in the fields of circular economy, sustainability, and curriculum development, as they represent the most relevant group for evaluating the constructs of refuse, rethink, and reduce in vocational education.

The sampling method applied was purposive sampling, with experts chosen based on several criteria: (i) a minimum of five years of academic or professional experience in vocational education, (ii) established expertise in circular economy, sustainability, or curriculum and assessment, and (iii) current positions in universities or national agencies related to education or skills development. This approach ensured that the panel of experts possessed the necessary academic background, professional credibility, and practical experience to evaluate item clarity and relevance. Their expertise spanned a wide range of fields, with Experts A, D, and E specializing in circular economy and sustainability, while Experts B, C, and F focused on curriculum and assessment. This distribution ensured a balance between technical content knowledge and pedagogical assessment expertise, aligning with the study's aim of validating tools for assessing refuse, rethink, and reduce in vocational education. The criteria of experts involved in this study is shown in Table 1 below.

Table 1 The experts' criteria

Experts	Specialization	Years of experience	Occupation
A	Circular economy and sustainability	More than 10 years	Assistant Director, Institut Pendidikan Guru Malaysia.
B	Curriculum and assessment	6 - 10 years	Lecturer, Universiti Teknologi Malaysia.
C	Curriculum and assessment	More than 10 years	Chief Assistant Director, Jabatan Pembangunan Kemahiran.
D	Circular economy and sustainability	More than 10 years	Lecturer, Universiti Teknologi MARA.

E	Circular economy and sustainability	6 – 10 years	Lecturer, Universiti Kebangsaan Malaysia.
F	Curriculum and assessment	More than 10 years	Lecturer, Institut Pendidikan Guru Kampus Pendidikan Teknik.

Initially, each panel of experts received a letter of appointment confirming their involvement in validating the instruments for this study. Moreover, an email including a full set of 44 items across 3 constructs in the instrument for validation, together with additional details about the study's goal and conceptual framework, was given to them (Waltz, 1991). In order to improve sentence construction, experts are expected to use their professional judgement to spot any errors. This ensures that any potential difficulties faced by vocational teachers in interpreting the item instructions when they receive the instrument can be addressed during this stage.

In order to prevent a neutral midway, the instrument uses a 4-point scale, as opposed to a 3- or 5-point scale (Polit et al., 2007; Polit & Beck, 2006). This scale offers the instrument developer accurate data to calculate a meaningful Content Validity Index (CVI) for instrument validation, which will then evaluate refuse, rethink and reduce for teaching circular economy in vocational education. Each expert, independently of the others, was tasked with using a scale to rank each item's significance by "not relevant (1)", "somewhat relevant (2)", "relevant (3)", or "very relevant (4)". After the panel of experts completed the validation of the questionnaire (Fig. 1), they individually sent the completed instrument back to the researcher via WhatsApp or email.

Bahagian B: Ekonomi kitaran.
 Mohon Professor/Dr/Tuan/Puan :

i. Menandakan (✓) pada item-item yang sesuai dengan elemen ekonomi kitaran berpandukan skala di bawah:

Tidak Relevan	Kurang Relevan	Relevan	Sangat Relevan
1	2	3	4

ii. Mengutarakan sebab ketidaksesuaian setiap item/komen lain dalam ruang yang disediakan.

Kod	Item	1	2	3	4	Komen	Cadangan
R0 Refuse							
<i>Refuse</i> adalah tindakan menolak atau enggan menggunakan produk yang tidak diperlukan. <i>Refuse</i> melibatkan aktiviti kesedaran untuk menghindari daripada perbuatan yang boleh menyebabkan kesan buruk kepada alam sekitar. Aktiviti di bawah menggambarkan <i>refuse</i> dalam ekonomi kitaran.							
R001	Enggan terima: Enggan terima produk yang tidak diperlukan untuk mengelak pembaziran.						
R002	Berinovasi: Mengubah produk sedia ada menjadi produk baharu yang berbeza secara inovatif.						
R003	Penerimaan bersyarat: Menerima produk dengan syarat ia memberikan nilai maksimum.						
R004	Sistem pengelasan sisa: Mewujudkan sistem pengelasan sisa.						
R005	Mengenalpasti sisa: Mengenalpasti apa yang boleh dimasukkan ke dalam tong sisa makanan.						

Fig. 1 Questionnaire for content validation that exhibits constructs, definitions and items that represent a specific construct, written in Bahasa Melayu

After expert review, the content validity index (CVI) was calculated. Items deemed conceptually untrustworthy will be excluded (Hinkin, 1998). Following items refinement and expert panel feedback, a pilot study can evaluate the instrument's additional psychometric qualities (Rubio et al., 2003). The content validity index (CVI) score is the source of the overall content validity score. Due to inadequate construct specification or a lack of expertise in the assessment process, a low CVI score suggests that the item is poor in defining the primary construct (Polit et al., 2007).

A dichotomous scale was created for the CVI computation by coding a rating of (1) or (2) as "0" and a rating of (3) or (4) as "1" (Guraya et al., 2022; Mat Said et al., 2022; Sangoseni et al., 2013). As shown below, there are two ways to calculate the CVI: item-level score (I-CVI) and scale-level score (S-CVI);

- The percentage of content experts who give an item a relevance score of three or four is represented by the I-CVI (item-level content validity index). I-CVI = (number of agreed items) / (total number of experts) is its formula.
- Polit & Beck, (2006) describe two methods for detemining S-CVI:
 - a) The S-CVI/Ave, which is an average-based scale-level content validity index, is the average of the I-CVI scores for all items on the scale, or the average proportion of relevance judged by all experts. The formula is S-CVI/Ave = (sum of I-CVI scores) / (total number of items).

Alternatively, S-CVI/Ave can be calculated as the sum of the proportion relevance ratings divided by the total number of experts.

- b) The S-CVI/UA, which is the universal agreement method-based scale-level content validity index, represents the proportion of items on the scale that receive a relevance rating of 3 or 4 from all experts. A Universal Agreement (UA) score of 1 is given when all experts agree, otherwise, it's 0. The formula is $S\text{-CVI}/UA = (\text{sum of UA scores}) / (\text{total number of items})$.

Therefore, S-CVI/UA and S-CVI/Ave are both scale-level CVIs calculated using different formulas (Shi, 2012). However, there is also a chance that agreement among raters in the I-CVI may happen coincidentally. According to Lynn (1986); Polit et al. (2007); Polit & Beck (2006) when there are at least six experts involved, the CVI should be at least 0.83. This indicates that each item in the instrument must be agreed upon by 5 out of 6 experts for content validity. If the CVI value is less than 0.83, it suggests that the instrument's items might not accurately represent the construct and should be updated (Sangoseni et al., 2013). Table 2 provides the recommended number of experts and how it affects the acceptable CVI cutoff score.

Table 2 *The experts' quantity and their impact on the acceptable CVI cut-off score*

Experts	CVI value	Source
2	At least 0.8	Davis (1992)
3 to 5	Should be 1	Polit et al., (2006); Polit & Beck, (2007)
At least 6	At least 0.83	Polit et al., (2006); Polit & Beck, (2007)
6 to 8	At least 0.83	Lynn, (1986)
At least 9	At least 0.78	Lynn, (1986)

Source: adapted from Yusoff, (2019)

3. Results

In this study, a 44-item instrument was developed based on three constructs derived from the 9R circular economy framework. Distribution of items on each construct is shown in Table 3. Each item's scores from six experts and the subsequent CVI calculation are depicted in Table 4. The validation of the entire research rubric and assessment items was conducted quantitatively using the content validity index (CVI).

Table 3 *Distribution of items on each construct*

Construct	Item Code	Item Details
Refuse (R0)	R001 – R016	Give a totally other product with the same functionality, or discontinue the product's function, rendering it unnecessary.
Rethink (R1)	R101 – R014	Increasing the intensity of product use.
Reduce (R2)	R201 – R014	Reducing resource usage and raising production effectiveness.

3.1 Item-Level Content Validity Index (I-CVI) Values

The validity and relevance of items are determined by the item-level content validity index (I-CVI). An electronics spreadsheet is used to determine the I-CVI value for each component in a single column. The I-CVI value for every item is displayed in Table 3 and is determined by adding up the total number of experts who rated an item as "relevant (3)" or "very relevant (4)," with a "1" assigned to each of these judgements. The instrument's total item-level content validity index (I-CVI), which is 40.00 for 44 items across three constructs, is displayed in Table 3.

3.2 Scale Level Content Validity Index (S-CVI) Values

To guarantee the content validity of the complete scale, the S-CVI was calculated. It is shown as S-CVI (universal agreement) and S-CVI (average). Table 3 demonstrates that, although all six experts concurred that 25 items (I-CVI = 1.00) were relevant, there were differences in viewpoints regarding 19 items. A few modest tweaks were made to the instruments to improve their relevance and understandability in the context of the study, such removing repetitions and redundancies. The acceptable S-CVI/Ave value of 0.91 indicates strong consensus among experts, which reflects the content clarity and appropriateness of the items (Polit & Beck, 2006). This level is considered adequate for early-stage instrument development in health and education research. Table 3 shows

the percentage of 44 items that all S-CVI experts (on average) gave a relevance scale of three or four. S-CVI(UA) was at 0.57.

Table 4 *The number of experts and their influence on the acceptable score for the CVI cut-off*

Item/ expert	Expert A	Expert B	Expert C	Expert D	Expert E	Expert F	Experts in Agreement	I-CVI	Universal Agreement(UA)
R001	0	1	1	1	0	1	4	0.67	0
R002	1	0	1	1	1	1	5	0.83	0
R003	0	1	1	1	1	1	5	0.83	0
R004	1	0	1	1	1	1	5	0.83	0
R005	1	0	1	1	1	1	5	0.83	0
R006	0	1	1	1	0	1	4	0.67	0
R007	1	0	1	1	1	1	5	0.83	0
R008	1	1	1	1	1	1	6	1.00	1
R009	1	1	1	1	0	1	5	0.83	0
R010	1	1	1	1	1	1	6	1.00	1
R011	1	1	1	1	1	1	6	1.00	1
R012	1	1	1	1	0	1	5	0.83	0
R013	1	1	1	1	1	1	6	1.00	1
R014	1	1	1	1	1	1	6	1.00	1
R015	1	1	1	1	1	1	6	1.00	1
R016	1	1	1	1	0	1	5	0.83	0
R101	1	1	1	1	1	1	6	1.00	1
R102	1	1	1	1	1	1	6	1.00	1
R103	1	1	1	1	0	1	5	0.83	0
R104	1	0	1	1	0	1	4	0.67	0
R105	1	1	1	1	1	1	6	1.00	1
R106	1	0	1	1	0	1	4	0.67	0
R107	1	0	1	1	0	1	4	0.67	0
R108	1	0	1	1	1	1	5	0.83	0
R109	1	1	1	1	1	1	6	1.00	1
R110	1	1	1	1	0	1	5	0.83	0
R111	1	1	1	1	1	1	6	1.00	1
R112	1	1	1	1	1	1	6	1.00	1
R113	1	1	1	1	1	1	6	1.00	1
R114	0	1	1	1	1	1	5	0.83	0
R201	1	1	1	1	1	1	6	1.00	1
R202	1	1	1	1	1	1	6	1.00	1
R203	1	1	1	1	1	1	6	1.00	1
R204	1	1	1	1	0	1	5	0.83	0
R205	1	1	1	1	1	1	6	1.00	1
R206	1	1	1	1	1	1	6	1.00	1
R207	1	1	1	1	1	1	6	1.00	1
R208	1	1	1	1	1	1	6	1.00	1
R209	1	1	1	1	1	1	6	1.00	1
R210	1	1	1	1	0	1	5	0.83	0
R211	1	1	1	1	1	1	6	1.00	1
R212	1	1	1	1	1	1	6	1.00	1
R213	1	1	1	1	1	1	6	1.00	1
R214	1	1	1	1	1	1	6	1.00	1
<i>proportion relevance</i>	0.91	0.82	1.00	1.00	0.73	1.00		Sum = 40.00	Sum = 25

Calculations based on data provided in Table 4;

- **Experts concur:** Add up all the pertinent ratings that each expert has given for each item; for instance, the consensus among experts for R001 is $(0+1+1+1+0+1) = 4$.
- **Universal agreement (UA):** Assign a score of 1 to items with 100% agreement among experts; for example, R008 receives a score of 1 because all experts rated it as relevant, while R001 receives a score of 0 because not all experts rated it as relevant.

- **I-CVI:** Divide the expert consensus by the total number of experts. For instance, the I-CVI of R001 is 4 divided by 6 experts, yielding a result of 0.67.
- **S-CVI/Ave (based on I-CVI):** Determine the I-CVI score average for each item; for instance, the S-CVI/Ave $[(\text{sum of I-CVI scores})/(\text{total number of items})]$, $[(4+5+5+5+5+4+5+6+5+6+6+5+6+6+6+5+6+6+5+4+6+4+4+5+6+5+6+6+6+5+6+6+6+5+6+6+6+6+5+6+6+6+6)/44]$ is equal to 0.91.
- **S-CVI/Ave (based on proportion relevance):** Using proportion relevance as the basis, find the average proportion relevance score for each expert; for instance, the S-CVI/Ave $[(0.91 + 0.82 + 1 + 1 + 0.73 + 1)/6]$ equals 0.91
- **S-CVI/UA:** Determine the average UA score for each item in the S-CVI/UA. For instance, the S-CVI/UA $[(\text{sum of UA scores})/(\text{total number of items})]$ $[(0+0+0+0+0+0+0+1+0+1+1+0+1+1+1+0+1+1+0+0+1+0+0+0+1+0+1+1+1+0+1+1+1+0+1+1+1+1+1+0+1+1+1+1+1+0+1+1+1+1)/44]$ equals 0.57.

Table 5 Total of I-CVI and UA

I-CVI total		UA total	
I-CVI total	40	UA total	25
S-CVI Average (Sum of I-CVI/No. of items)	40/44= 0.91	S-CVI Relevance (Sum of UA/No. of items)	25/44= 0.57

Source: adapted from Yusoff (2019)

Table 5 shows while the S-CVI (average) meets the CVI cutoff value (>0.83), the S-CVI (universal agreement) is less than the acceptable cutoff value (<0.83) for six experts (Lynn, 1986; Polit et al., 2007). To reach this cutoff value, each item in the instrument must be rated 3 or 4 (coded as “1”) by all six experts. As a result, five of the 44 items were dropped. This result is in line with Lynn, (1986); Polit et al., (2007) that the final instrument typically excludes items that fail to meet this threshold. Five items that were marked for deletion because their I-CVI values were less than 0.83 are shown in Table 6. Removing these items is important for the next phase of instrument validation. Specifically, R001, R006, R104, R106, and R107 were rated at 0.67, all falling below the 0.83 threshold.

Table 6 Items flagged for deletion due to I-CVI values below 0.83 (n = 5)

Item/ expert	Expert A	Expert B	Expert C	Expert D	Expert E	Expert F	Experts in Agreement	I-CVI
R001	-	√	√	√	-	√	4	0.67
R006	-	√	√	√	-	√	4	0.67
R104	√	-	√	√	-	√	4	0.67
R106	√	-	√	√	-	√	4	0.67
R107	√	-	√	√	-	√	4	0.67

3.3 Discussion

This study addresses a research gap by developing and validating instruments to evaluate refuse, rethink, and reduce in teaching circular economy for vocational education. Out of 44 initial items based on the adjusted 9R framework, only 39 were retained after expert verification and CVI analysis, as five items failed to reach the 0.83 cut-off (Lynn, 1986; Polit & Beck, 2006). This highlights the importance of rigorous validation to ensure content representativeness and reliability before field application.

As a scale developer in this study, researchers must first commit to creating high-quality products and precise specifications, as well as choosing a qualified panel of experts, before beginning the content validation procedure. Six experts' consensus was established for 39 out of the 44 items derived from the three components in this study. These professionals assess the management strategies for more intelligent product use and manufacture, which include the circular economy's reject, rethink, and decrease concepts. While the S-CVI (universal agreement) approach has benefits, the S-CVI (average) method is clearly the better option for scale-level CVI. This is due to the possibility that if many experts are involved in content verification, the universal agreement will be overly stringent. Acknowledging complete unanimity appears too cautious, particularly when there are professionals who disagree or don't fully comprehend the issue at hand. As demonstrated in this work, utilising both approaches to determine S-CVI is therefore a more informative approach.

Three key implications can be drawn from the study's findings. First, the CVI-based content validity measurement (I-CVI and S-CVI) demonstrates that this instrument was created and approved to assess the practice of reject, reconsider, and minimise while teaching the circular economy to vocational education students. Second, in order to achieve Sustainable Development Goal No. 12, the circular economy is a prerequisite. As a result, this study advances the creation and validation of more intelligent manufacturing and product usage management tools (refuse, rethink, and reduce) for vocational education, which forms the cornerstone of fostering circular economy behaviours.

Third, the study's conclusions alert vocational educators to the need to modify their methods and make sure that circular economy principles are incorporated into skill-building exercises. It is important to supply the skills needed by the industry considering its importance in developing a more sustainable society and job market for the future (Mohd Kamaruzaman et al., 2023). By introducing the concepts of refuse, rethink, and reduce to vocational students, they will have an understanding of the principles and significance of circular economy activities in efforts towards sustainable development. Therefore, this research also makes an important contribution in strengthening vocational education as an important site in providing a skilled and competitive workforce in a changing economic era.

4. Conclusion

This study represents an initial attempt to design and validate an instrument that measures the practice of refuse, rethink, and reduce in teaching circular economy within vocational education. The involvement of six experts provided constructive input that improved item clarity and strengthened content validity. Although content validation is inherently subjective, the use of CVI introduced objectivity and ensured that the retained items accurately reflect the intended constructs. This provides a foundation for developing reliable tools to embed sustainability principles in vocational learning.

The findings highlight the need for vocational educators to reconsider their teaching approaches. Beyond technical training, educators should integrate circular economy concepts into skill-building exercises so that students develop awareness of resource efficiency and waste reduction. Incorporating refuse, rethink, and reduce into classroom practice helps students connect theoretical principles with practical applications, which is essential for preparing them to meet the demands of sustainable industries. Such integration not only enhances vocational competence but also contributes to shaping responsible and environmentally conscious graduates.

Finally, while this instrument has shown initial validity, further testing with vocational teachers from diverse backgrounds is necessary to confirm its reliability. Field application and pilot studies will provide insights into how well the tool captures teaching practices and supports long-term implementation of circular economy education. This will guide educators in refining their pedagogical strategies and ensure that vocational training equips students with both technical proficiency and sustainable mindsets for future employment markets.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design:** N.A.H; **data collection:** N.A.H, N.N.J.N.O; **analysis and interpretation of results:** N.A.H, S.S; **draft manuscript preparation:** N.A.H; **review and editing:** F.M.K, M.S.R; **fund:** F.M.K. All authors reviewed the results and approved the final version of the manuscript.*

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