Development of Content Validity Index Module in Jamovi to Simplify Research Processes

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Abstract

The Content Validity Index (CVI) is necessary for research instrument validation, but calculating it can be complicated and time-consuming, especially for non-programmers. This study shows how a CVI module was implemented in Jamovi statistics, an open-source software written in R. Using extreme programming streamlined the procedure. The module simplifies the computation of the Item-Level Content Validity Index (I-CVI) and Scale-Level CVI, improving accessibility and efficiency. Researchers may do precise and fast CVI calculations in Jamovi without programming skills with this module. Discussion of module installation and validation focusses on the module's ability to dramatically reduce content validity evaluation time and effort. This discovery gives researchers an open source that facilitates instrument validation across several research fields.

Keywords: Content Validity Index, Instrument Validation, Jamovi, Open Source, R Programming

1. Introduction

The Content Validity Index (CVI) is a widely recognized method used to measure the degree of agreement or the validity of the content among the subject matter experts on the relevance and clarity of individual items in surveys or assessment tools. Validity is defined as the ability of an instrument to measure the properties of the construct under the specific study (Zamanzadeh et al., 2015). Its role is particularly crucial in ensuring that the content being evaluated truly reflects the domain of interest, thereby enhancing the overall validity of the instrument. An assessment instrument refers to the method of acquiring data in psychological assessment such as questionnaire items, response formats, and instructions (Yusoff, 2019). Without adequate validation, survey items may not fully capture the essential dimensions of the measured construct, potentially resulting in inaccurate or biased conclusions. In this paper, it outlines the concept of CVI. Literature Review sections elaborate the general concept and the application of CVI. Methodology sections, findings and conclusion presented in the following section.

1.1 Problem Statement

The accuracy and reliability of research findings depend on the validity of the instruments used to collect data. Content validity, assessed by the CVI is essential for ensuring that an instrument accurately measures the intended construct. However, many researchers find it challenging and time-consuming to calculate CVI manually, leading to inconsistent validation practices. Besides, the absence of readily available tools for automating CVI calculations has created a gap in the research process, particularly for researchers without advanced statistical knowledge. This can result in the use of instruments that lack sufficient content validity, leading to inaccurate data, flawed conclusions, and limited applicability of research findings. Without a reliable method for assessing CVI, the quality of the instruments used in research is compromised, affecting the overall credibility and impact of the research. To address these challenges, the need for an automated and user-friendly solution for calculating CVI has become evident. By integrating a CVI module into the Jamovi software, we aim to provide researchers with a more accessible and efficient way to assess content validity, ensuring the development of valid and reliable instruments that enhance the quality of research outcomes.

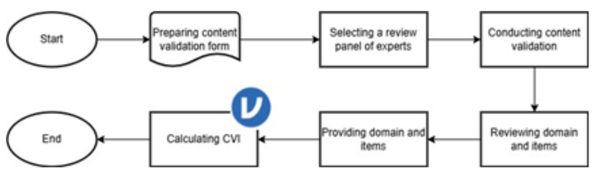
2. Literature Review

The significance of the CVI stems from its capacity to offer a quantifiable measure of content validity, helping researchers ensure their assessment tools are both reliable and valid. By involving a panel of experts to evaluate each item, researchers gain a more objective assessment of the content's appropriateness and relevance. This approach minimizes subjectivity and bolsters the credibility of the measurement, which is essential in both research and practical applications (Rodrigues et al., 2017).

The absence of a CVI can significantly undermine the effectiveness and reliability of assessment instruments across various fields. Without conducting a content validity study, researchers might risk developing measures that fail to accurately reflect the constructs they aim to assess, leading to several detrimental outcomes. First, misalignment with the objectives of the research conducted (Gumaa Siddiek, 2010). Additionally, inaccurate measurement becomes a concern, as instruments that do not capture the intended constructs may yield misleading results and interpretations, particularly in complex fields like social work and healthcare (R. Roy et al., 2023). Finally, the credibility of the research may be reduced. The absence of rigorous validation processes can diminish the trustworthiness of the findings, as stakeholders may question the reliability of the measures used (P. Roy & Sahu, 2024). The absence of a CVI can limit the comparability of research studies. Inconsistent or unreliable measurement tools can introduce extraneous variability that obscures the true nature of the construct being investigated.

To address these challenges, we have integrated a CVI calculation module into the Jamovi software. This integration has allowed researchers to calculate the CVI directly within the software, simplifying the validation process and making it more accessible. By including this module, we aim to promote research rigor by providing tools that support the development of valid and reliable measurement instruments. Jamovi's accessible UI and automated CVI calculation functionality streamline the frequently complex process of content validation. This allows researchers, even those without advanced statistical knowledge, to easily engage with CVI methodology. By integrating this feature, we aim to ensure that even novice researchers can improve the validity of their instruments, leading to higher standards in data collection and analysis. By integrating the CVI module into Jamovi, we aim to reduce the risks that associated with using invalidated instruments. The automated calculations not only save time but also improve accuracy, ensuring that the content validity of the instrument is thoroughly assessed before its use in research. This is particularly valuable for large-scale studies where manual content validation would be time-consuming and prone to human error.

Figure 1 Content validation procedure adopted from Yusoff (2019)



2.1 Existing Tools And Methods For CVI Calculation

The CVI is an essential instrument for evaluating the content validity of assessment tools, especially in healthcare and education sectors (Felthun et al., 2021). It offers a quantitative assessment of the significance and accuracy of items in a test or questionnaire (Ocké et al., 2021). The CVI is crucial for quantitative evaluation, improving reliability, and enabling cross-cultural adaption. It also contributes to programmatic evaluation, facilitating high-stakes decision-making through the provision of comprehensive and representative assessment instruments (Yusoff, 2019). CVI's emphasis on item relevance may neglect additional facets of validity; therefore, it should be employed alongside other validation methods for a thorough assessment of a measurement tool's validity (Yusoff, 2019).

$$I - CVI_i = \frac{N_a}{N_e} \tag{1}$$

Item-Level Content Validity Index (I-CVI) as calculated to assess the content validity of each item within the instrument (Yusoff, 2019). Equation 1 is where I-CVI_i is the item-level content validity index, Na is the number of experts who rated the item as either “3” or “4” on a 4-point relevance scale and Ne is the total number of experts who rated the item.

$$S - CVI\ /\ Ave = \frac{1}{N_i}\sum_{i=1}^{N_i} I - CVI_i \tag{2a}$$

$$S - CVI/Ave = \frac{1}{N_e}\sum_{j=1}^{N_e}\frac{1}{N_i}\sum_{i=1}^{N_i}\frac{R_{ij}}{R_{max}} \tag{2b}$$

Scale-level content validity index based on the average method (S-CVI/Ave) is a metric used to assess the overall content validity of a scale by averaging the I-CVI values across all items within the scale (Yusoff, 2019). Equation 2 is where N_i is the total number of items in the scale, R_{ij} is the rating given by the j^{th} expert to the i^{th} item and R_{max} is the maximum possible rating which corresponding to a rating of "very relevant". 2a is referring to the average of the I-CVIs scores for all items on the CVI while 2b is referring to the average of proportion relevance judged by all experts.

$$S-CVI\ /\ UA = \frac{\sum_{i=1}^{N_i} UA_i}{N_i} \quad (3)$$

Scale-level content validity index based on the universal agreement method (S-CVI/UA) was calculated to assess the extent of universal agreement among experts for each item on the scale (Yusoff, 2019). Equation 3 is where UA_i is equal to 1 if all experts rated the i^{th} item as relevant and 0 if there was any disagreement among the experts. N_i is the total number of items in the scale.

$$CVR = \frac{(N_a - {N_e}/{2})}{{N_e}/{2}} \quad (4)$$

Content Validity Ratio (CVR) was developed by (Lawshe, 1975) to provide a quantitative measure of content validity. Equation 4 is where Na is the number of experts who rated the item as either "3" or "4" on a 4-point relevance scale and Ne is the total number of experts who rated the item.

Three common tools for computing CVI include Excel Spreadsheets, SPSS Macros, and R Packages. Excel is widely used for its accessibility and flexibility, enabling researchers to manually enter data and execute calculations through integrated functions and formulas (Madadizadeh & Bahariniya, 2023). SPSS provides macros that automate procedures, minimising human error and enhancing efficiency . R Packages tailored for psychometric analysis are highly customisable and open-source, facilitating ongoing updates and enhancements by the community (Sahin & Aybek, 2020). These instruments are advantageous for managing extensive datasets and executing complex analysis.

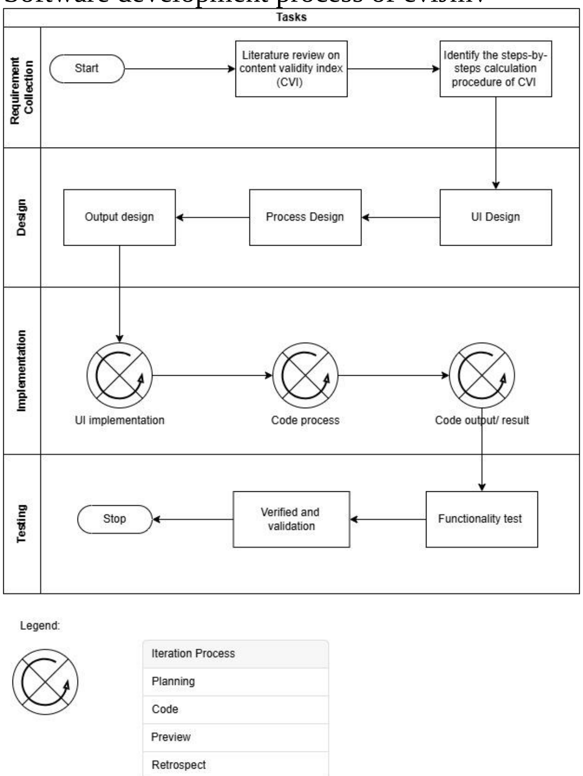
When calculate CVI, various tools offer distinct advantages and limitations. Excel spreadsheets are widely accessible and user-friendly for basic calculations, allowing customization to fit specific needs (Ozgur et al., 2022). However, they are prone to manual errors, limited in advanced statistical features, and can be time-consuming when dealing with large datasets. SPSS macros, integrated with the powerful SPSS statistical software, automate CVI calculations and are well-suited for handling larger datasets. Yet, they require an SPSS license, offer limited flexibility for customization, and may necessitate some programming knowledge (Ozgur et al., 2022). On the other hand, R packages provide a highly customizable, open-source option capable of managing complex calculations and large datasets (Lüdecke et al., 2021). The trade-off is a steeper learning curve and the need for basic programming skills, with additional packages potentially required for data visualization (Wickham & Bryan, 2023). While Jamovi provides an open-source framework that enables programmers to develop modules for its extensive library, the creation of these modules is executed using R, HTML, CSS, and JavaScript (Jamovi, 2024; Love, 2024). The development process is relatively straightforward for programmers to undertake (Jamovi, 2024).

3. Methodology

This study used Extreme Programming (XP) methodology that emphasizes user satisfaction, flexibility, and rapid delivery of high-quality software (Shrivastava et al., 2021). It is characterized by frequent releases in short development cycles which improves productivity and introduced checkpoints at which new user requirements can be adopted (Shrivastava et al., 2021).

Figure 2

Software development process of cviJmv



3.1 Extreme Programming Approach

In executing the XP method, our development process was organised into brief, iterative cycles. According to Figure 2, we categorise the tasks into four phases. Each phase lasts around 2 to 3 weeks. Each phase has around 3 to 4 cycles. Each cycle lasts approximately 4 to 5 days. We began with the fundamental capability of transforming data into binary format, implementing basic CVI scores, and subsequently included more advanced features. The iterative approach enabled us to always maintain a functional version of the module, which was essential for ongoing testing and integration with Jamovi. We employed pair programming methodologies for delicate algorithms, improving code quality and facilitating knowledge exchange across the team.

During the development process, we kept frequent communication with anticipated end-users, including researchers and mathematicians knowledgeable about CVI calculations. User feedback was systematically integrated into each iteration, ensuring the module consistently corresponded with user requirements. This user-focused methodology resulted in multiple improvements, including the improvement of output report clarity. Test-driven development was a key component of our methodology, with unit tests composed prior to the actual code implementation. This method ensured the reliability of each new feature and permitted simpler integration with Jamovi's existing framework. The XP methodology's focus on adaptability was very beneficial in tackling unexpected challenges, such as compatibility issues with various Jamovi versions.

3.2 Development Environment And Tools

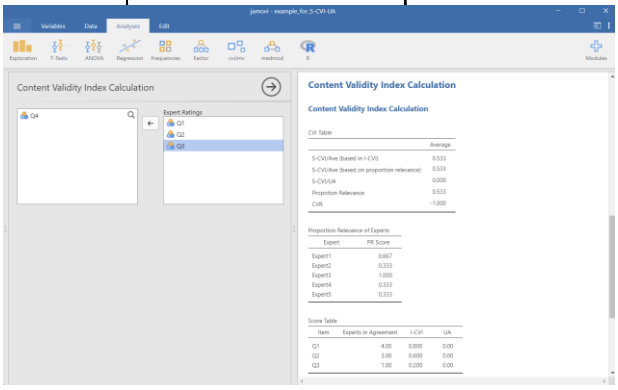
The CVI module for Jamovi was developed using RStudio version 204.09.0 build 375 as the integrated development environment (IDE) and R version 4.3.2 as the main programming language. We employ jmvtools version 2.6.0 to accelerate the building and integration of Jamovi modules, since it offers key utilities for this process. Furthermore, we utilised Git version 2.27.0 and GitHub Desktop Version 3.4.5 (x64) as our version control system, facilitating effective communication and code management during the development process. The module was evaluated for compatibility with Windows 10 and subsequent operating systems. We utilised markdown for documentation and code sharing, enabling the creation of thorough consistent documentation. Finally, we applied the module for unit testing to guarantee the dependability and robustness of our module's functionalities.

3.3 Module Requirements And Specifications

The cviJmv module was designed for complete compatibility with Jamovi version 2.6.13.0, ensuring smooth integration and operation within this statistical software framework. It is intended for operation on Windows 10 and Windows 11 operating systems, accommodating a diverse array of users with current Windows installations. The module necessitates a minimum of 4GB of RAM and 100MB of available disc space for effective functionality. It accommodates input data in multiple formats, including CSV and XLSX files. The CVI module can do both item-level and scale-level CVI computations, supporting up to 20 expert raters and 10 items per study. The module's user interface is built for compatibility with standard screen readers and includes high-contrast display options to ensure accessibility. The module complies with Jamovi's standards, facilitating seamless updates and maintenance that are compatible with future Jamovi versions.

3.4 Key Features Of The Cvi Module

Figure 3
Screen Capture of cviJmv User Input and Result



The CVI module for Jamovi (https://github.com/lerlerchan/cviJmv) provides a comprehensive set of features aimed at optimising and improving the calculation of the content validity index. The module fundamentally facilitates the straightforward computation of vital indices such as I-CVI, UA, S-CVI/Ave, S-CVI/UA and CVR, thereby greatly simplifying an often-involved process. The user-friendly interface is completely incorporated into Jamovi's existing environment, providing a familiar and easy experience for those already accustomed with the platform as seen in Figure 3. The module acknowledges the varied demands of researchers by including customisable input choices, enabling users to adapt data entry to their own research objectives. The module produces a detailed output, displaying all computed indices with applicable statistics, so offering users an extensive and insightful examination of their content validity data in an organised format.

3.5 Results Of Functionality Test

The CVI module in Jamovi was tested with a series of predefined cases to validate its functionality. The results showed that all core functions, including data transformation, relevance proportion calculation, I-

CVI, S-CVI/Ave, and universal agreement, executed successfully. The module transformed ordinal data values of 0, 1, and 2 to 0, while values of 3 and 4 were transformed to 1 as expected. Additionally, the calculations of the proportion of relevance, expert agreement, and all CVI indices (I-CVI, S-CVI/Ave, and S-CVI/UA) were accurate and displayed in data frames. The functionality test confirmed that the module's outputs consistently matched the manually computed values. User feedback helped refine the module's S-CVI/UA calculations, resulting in the accurate implementation of the module.

Table 1
Functionality Test Case

Test Case ID	Description	Pre-conditions	Test steps	Expected result	Actual result	Status
TD1	Transform data of 0,1,2 to 0 while 3, 4 to 1	Ordinal data	Load the data	Ordinal data in 0 and 1 according to conditions	Data values of 0, 1, and 2 were converted to 0, while values of 3 and 4 were converted to 1.	Accepted
TD2	Function to calculate proportion relevance	Completed TD1	Load the data	Result in data frame	The function calculated the proportion of relevance correctly, and the result was displayed in a data frame as expected.	Accepted
TD3	Function to calculate average of proportion relevance	Completed TD2	Load the data	Result in float	The function calculated the average of proportion relevance correctly and displayed the result as a float.	Accepted
TD4	Function to calculate expert in agreement	Completed TD1	Load the data	Result in data frame	The function calculated expert agreement accurately and displayed the result in a data frame.	Accepted
TD5	Function to calculate I-CVI	Completed TD1	Load the data	Result in data frame	The function successfully calculated I-CVI, and the result was displayed in a data frame.	Accepted
TD6	Function to calculate SCVI/Ave	Completed TD5	Load the data	Result in data frame	The function successfully calculated S-CVI/Ave, and the result was displayed in a data frame.	Accepted
TD7	Function to calculate universal agreement	Completed TD1	Load the data	Result in data frame	The function successfully calculated the universal agreement, and the result was displayed in a data frame.	Accepted

3.6 Performance Evaluation

The module's performance was evaluated based on speed, memory usage, and user satisfaction. Computational tests demonstrated that it processed datasets efficiently, completing all test cases in under 5 seconds, while memory usage remained within acceptable limits. User feedback indicated a high level of satisfaction with the module's intuitive interface and automated calculations. Suggestions from users, including the addition of visual aids for easier navigation, were incorporated into the final version. Overall, researchers noted a reduction in manual errors and significant time savings, enhancing the accessibility of CVI calculations for non-programmers

5. Conclusion

The study successfully developed and integrated the cviJmv module into the Jamovi statistical platform, providing researchers with an accessible and efficient solution for Content Validity Index (CVI) calculation. The module automates the computation of I-CVI, S-CVI/Ave, S-CVI/UA, and CVR through a graphical user interface, allowing researchers to perform content validity analysis without programming knowledge. Functionality and performance testing confirmed that the module produces accurate results while reducing the time and effort required for instrument validation.

A notable contribution of this study is the provision of a free and open-source CVI tool within Jamovi that combines automated analysis with ease of use. Compared with manual spreadsheet calculations and programming-based solutions, the module offers a more standardized and user-friendly workflow, helping researchers reduce calculation errors and improve consistency in content validation practices. The module can support instrument development across disciplines such as education, social sciences, healthcare, and psychology, where rigorous content validation is required.

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Microsoft Copilot was used solely to improve grammar, sentence structure, and language clarity. All research content, analyses, interpretations, and conclusions were produced and verified by the authors.

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