CHAPTER 2

INTEGRATED MODULAR MULTIDIMENSIONAL SCORING SYSTEM (SPMI) AND INTEGRATED MODULAR SYSTEM FOR COLOR-BASED CLASSIFICATION AND DEFINITION (SCDMIC)

Marcos Borba Salomão
Master's Program in Computer Science (PMCC).
University of Campo Limpo Paulista (UNIFACCAMP), Campo Limpo Paulista/SP, Brazil.
http://lattes.cnpq.br/5849230040130429
https://orcid.org/0000-0002-1175-5922

ABSTRACT — The development of evaluative systems capable of accurately and deeply measuring complex phenomena and constructs demands instruments that articulate metric structure, analytical modularity, and interpretive flexibility. This article presents two complementary and original measurement systems: the Integrated Modular Multidimensional Scoring System (SPMI) and the Integrated Modular System for Color-Based Classification and Definition (SCDMIC). Both were designed to address critical gaps in traditional instruments by enabling the structured quantification of constructs, technological objects, and subjective experiences. The SPMI introduces a structured scoring logic based on scales ranging from -5 to +10, in both integer and decimal formats, allowing precise evaluation of multiple integrated dimensions, with control over polarity, intensity, and inferential value. Its modular architecture allows the adaptation of metrics to distinct elements, from qualitative parameters to objective technical indicators, operating under rigorous principles of validity and representativeness. The SCDMIC, in turn, introduces a modular chromatic scale with interpretive color-volume units, enabling the representation of experiences and evaluative states in a continuous, intuitive, and highly discriminative manner. The logical equivalence between color and number, linking SCDMIC and SPMI, establishes a unified measurement approach applicable to both subjective and objective domains, as well as to qualitative and quantitative dimensions. Together, the two systems provide a foundation for in-depth analysis and strategic decision-making in the evaluation of constructs, technologies, interactions, and phenomena, offering robust tools for refined measurement across diverse scientific and operational contexts.

KEYWORDS — SPMI; SCDMIC; Scoring System; Complex Constructs; Subjective and Objective Evaluation; Qualitative and Quantitative Measurement.

1 INTRODUCTION

The construction of rigorous measurement systems depends on the formal definition of what is to be measured and on the logical correspondence between the empirical phenomenon and the adopted numerical structure. Stevens (1946) establishes the foundations of this correspondence by defining measurement as a process of assigning numerals governed by consistent rules, in which the mathematical structure of the scale must reflect observable empirical operations. The classification into nominal, ordinal, interval, and ratio scales imposes distinct constraints and permissions regarding the nature of numerical transformations and the types of inference permitted. The nominal scale, for instance, is limited to labeling without ordering, whereas the ordinal scale allows hierarchical ranking but does not imply equality between intervals. The interval scale admits additive operations and distance comparisons, though without an absolute zero point, which poses challenges to proportional interpretations. Therefore, the choice of scale is not merely technical, but epistemological, as it determines the model by which reality is represented.

Selecting an appropriate statistical method requires compatibility with both the scale type and the empirical constraints of the measured phenomenon. Anderson (1961) highlights the increasing acceptance of nonparametric tests, driven by concerns over the use of parametric tests when assumptions of normality and homogeneity of variances are not met. He emphasizes that the adequacy of the measurement scale is essential in choosing between parametric and nonparametric procedures. Parametric tests are widely used in statistics due to their versatility and statistical power, especially in variance analysis and complex experimental designs. Anderson reinforces that the issue of the scale is intrinsically tied to the measurement of the underlying phenomenon, revealing the complexity in selecting statistical methods.

Representing empirical reality through classificatory systems requires not only metric structure but also a pertinence model that accommodates semantic variability and the subjective judgment inherent to many evaluation domains. Zunde & Dexter (1969), in their investigation of indexing consistency, argue that consistency should not be assessed solely by the formal agreement among indexers regarding selected terms, but also by the relevance of those terms. Drawing on the concept of fuzzy sets, which allow the classification of elements with varying degrees of pertinence, they define indexing consistency as the degree of agreement among indexers in representing the essential content of a document through individually and independently selected sets of terms. This approach considers that term selection reflects the subjective judgment of indexers regarding the information contained in the document, and that agreement on more relevant terms should be valued over agreement on less significant ones.

Evaluative constructs exhibit a structure composed of multiple interdependent components. This complexity was examined by Ostrom (1969), who investigated the relationship among the affective, behavioral, and cognitive components of attitude. The results supported the proposed hypotheses, yet the dominant feature was the high intercorrelation among the three components, with each one's uniqueness contributing little additional variance. All three share a common set of antecedents or determinants. However, for the tripartite distinction to be meaningful, it must be demonstrated that evaluative responses within each component are influenced by a distinct set of determinants, separate from those influencing the others. If such exclusive determinants cannot be established, then maintaining this distinction without empirical effect becomes conceptually unparsimonious. Within the context of attitude theory, the tripartite model predicts that part of the evaluative heterogeneity of responses may be attributed to the classification of the component to which the response belongs.

Defining the number of points on a scale constitutes a critical decision that directly affects the precision, reliability, and inferential validity of the results. Martin (1978) emphasizes that when computing correlations using variables with fewer than 10 scale points, a common practice in marketing research, the loss of information increases significantly as the number of categories decreases. He recommends the use of scales with 10 or more points whenever possible to preserve precision and reliability. This principle is central to the construction of systems that, like those proposed in this research, aim to maximize informational content without compromising consistency and interpretability.

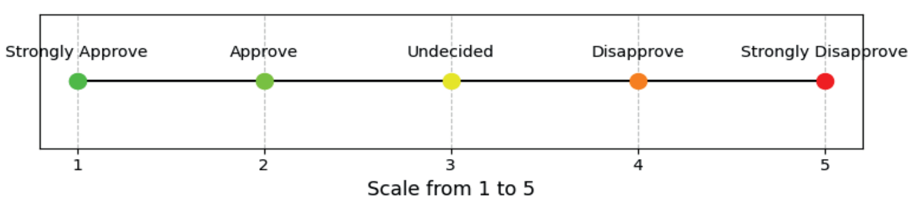
Technological objects, constructs, and evaluative phenomena exhibit structural complexity and interaction conditions shaped by situational variables, including environmental and cultural factors. In light of this contingent nature, the Integrated Modular Multidimensional Scoring System (Sistema de Pontuação Multidimensional Modular Integrado – SPMI) and the Integrated Modular System for Color-Based Classification and Definition (Sistema de Classificação e Definição Modular Integrado de Cores – SCDMIC) are proposed. These systems were developed to enhance the discriminative and interpretive capacity of evaluative instruments, based on rigorous psychometric foundations articulated through a modular logic that enables flexibility, adaptation, and analytical depth. The following sections present the structural principles, scoring axes, and operational guidelines that define these systems.

2 INTEGRATED MODULAR MULTIDIMENSIONAL SCORING SYSTEM (SPMI)

The analysis of measurement scales used in evaluative contexts is a fundamental step toward understanding both the limitations and potential of traditional instruments, as well as grounding the development of new systems that are more responsive to contemporary demands. The SPMI is the result of this critical analysis and the need for a modular, precise, and adaptable system capable of representing multiple dimensions, including positive and negative values, and integrating both quantitative and qualitative, subjective and objective variables (see Chapter 1). The following sections present the referential models, along with their structures, internal logics, and limitations, as considered in the construction of the SPMI.

Likert (1932) proposed a method for attitude measurement based on the assignment of numerical values to participant responses. The scale, composed of five alternatives, receives progressive scores from 1 to 5 (Figure 1), with the intermediate position (value 3) assigned to the neutral option. This structure allows the intensity of expressed attitudes to be quantified by distributing scores along an attitudinal continuum. The technique was developed to facilitate application in statistical analyses without requiring subjective judgments from evaluators. The method assigns fixed values to responses, allowing the results to be organized in a standardized manner.

FIGURE 1: LIKERT SCALE

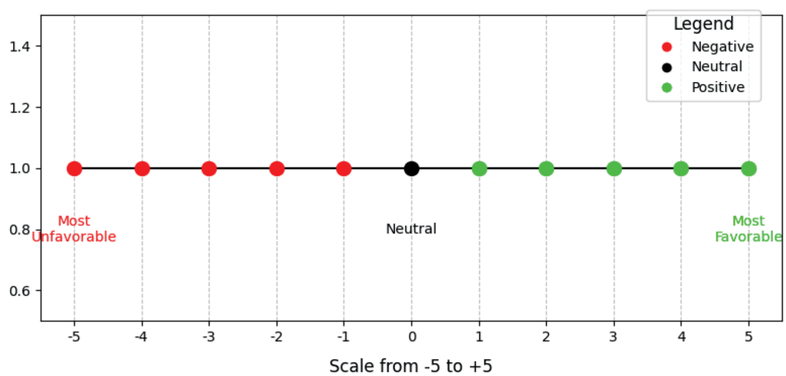


Source: Author. Adapted from Likert, R. A. (1932)

The ordinal and symmetrical structure proposed by Likert marked a milestone in attitudinal quantification; however, its structural rigidity and limitation to five fixed points restrict metric sensitivity in more complex contexts.

In response to these structural limitations, Cliff (1959) proposed that intensifying adverbs such as "very" and "extremely" modify the intensity of adjectives multiplicatively, approximating vector algebra operations. The model is based on five postulates, among which are the assignment of numerical values to adjectives and adverbs, and the hypothesis that the intensity of adverb-adjective combinations corresponds to the product of these values (Figure 2). Cliff argues that the proposed formulation could be applied to other evaluative dimensions, such as size or intensity, extending the model beyond the emotional domain. The multiplicative relationship between adverbs and adjectives observed in the data is considered analogous to scalar multiplication in Euclidean vector spaces, implying a psychological zero point and a unit of measurement for adjectives.

FIGURE 2: FIVE POSTULATES. ASSIGNMENT OF NUMERICAL VALUES: ADJECTIVES AND ADVERBS



Source: Author. Adapted from Cliff (1959)

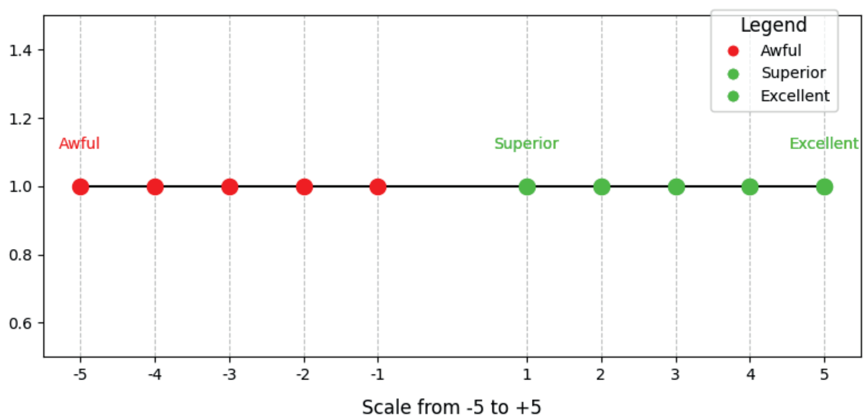
Conceptually structured, the proposal requires the precise definition of a psychological zero point and a measurable unit of evaluation for adjectives, imposing limitations on its empirical operationalization in applied settings. Its contribution, however, lies in introducing an algebraic structure for analyzing semantic intensity, anticipating the need for more expressive metric models, such as those underlying the SPMI proposal.

This limitation in representing subjective intensity vectorially highlighted the necessity for models capable of handling semantic imprecision and gradual classifications, such as the one proposed by Zadeh (1965), which introduced the concept of fuzzy sets. These assign degrees of membership within the interval between 0 and 1, extending classical set theory to address classes of objects whose membership criteria are not precisely defined. Zadeh emphasizes that fuzzy sets address imprecision related to indeterminate membership boundaries, while probabilistic theory deals with random uncertainties. This fundamental difference renders fuzzy sets an appropriate tool for problems where imprecision is qualitative rather than statistical.

The need to capture evaluative nuances with greater balance led to the development of models incorporating response symmetry and bias control. In this regard, Crosby (1969) employs the bipolar numerical scale (Stapel) (Figure 3), which ranges from +5 to -5, as one of the tools to measure attitudes. The Stapel scale was chosen for its ability to balance extreme emotional responses, enabling more precise comparisons between groups with differing cultural contexts.

Through its balanced structure, the Stapel scale allows for responses equally in both positive and negative directions, proving particularly useful for neutralizing cultural biases in responses. It is noteworthy that the choice of balanced scales is essential to ensure validity in comparative attitude research.

FIGURE 3: BIPOLAR NUMERICAL SCALE (STAPEL)

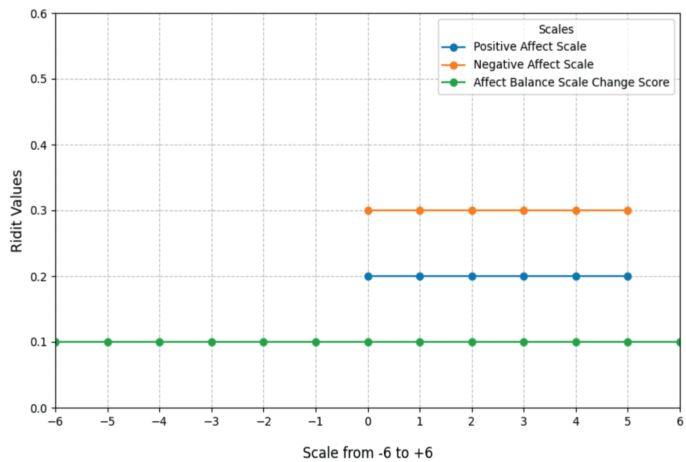


Source: Author. Adapted from Crosby, R. W. (1969) - Stapel (1969)

Structured and symmetrical, the Stapel scale helped highlight the importance of measurement systems capable of incorporating polarity, intensity, and situational control, fundamental elements considered in the architecture of the SPMI.

Measuring affective states required the development of models able to quantify emotional direction and intensity based on self-reported responses. Bradburn (1969) conceptualizes psychological well-being as the balance between Positive Affect and Negative Affect. The Affect Balance Scale (ABS) (Figure 4) is obtained by subtracting the number of responses indicating Negative Affect from the number of Positive Affect responses, resulting in a score that reflects the individual's affective balance. This measure is directly associated with self-perceived happiness: Relation of Affect Balance Scale (Positive Affect - Negative Affect) to Self-Ratings of Happiness at Each Level of Difference, for Wave I.

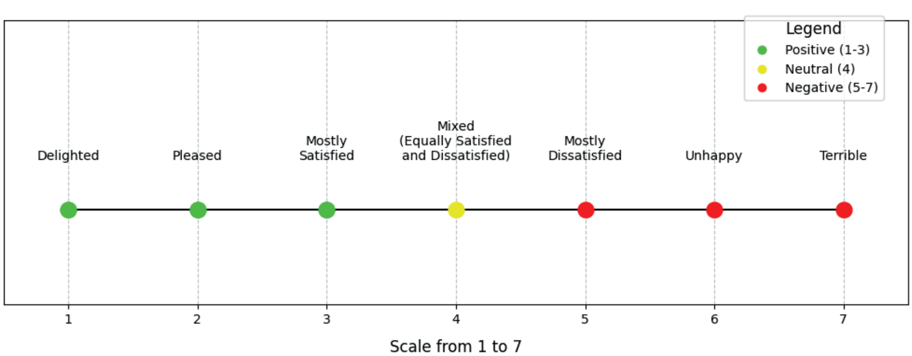
FIGURE 4: AFFECT BALANCE SCALE (ABS)



Source: Author. Adapted from Bradburn (1969)

Following studies on subjective well-being, Andrews & Withey (1976) developed the Delighted-Terrible Scale (D-T Scale) (Figure 5) to capture nuances of personal satisfaction across various aspects. The scale ranges from "1" (delighted) to "7" (terrible), providing a direct assessment of well-being with seven categories that allow participants to express states from extreme satisfaction to profound dissatisfaction.

FIGURE 5: DELIGHTED-TERRIBLE SCALE (D-T SCALE)

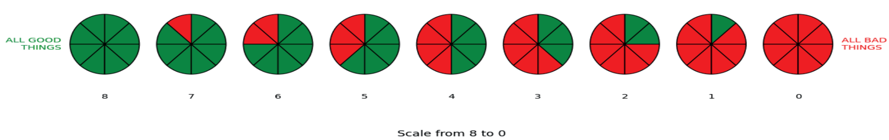


Source: Author. Adapted from Andrews & Withey (1976)

Although direct and intuitive, this scale operates with limited resolution, which restricts its discriminative power in complex assessments. Nevertheless, its structure contributed to consolidating affective measurement parameters that precede more refined approaches such as those proposed by the SPMI.

Complementing this model, the Scale of Circles with Pluses and Minuses (Figure 6) was proposed to measure well-being from a graphical perspective. This scale begins at "8", representing an ideal life filled with positive aspects (all "+"), down to "0", indicating a wholly negative life (only "-"). The intermediate circles capture varying degrees of well-being, offering a visual and intuitive representation that goes beyond numerical categories, allowing respondents to place themselves along a continuous line of satisfaction and dissatisfaction.

FIGURE 6: SCALE OF CIRCLES WITH PLUSES AND MINUSES

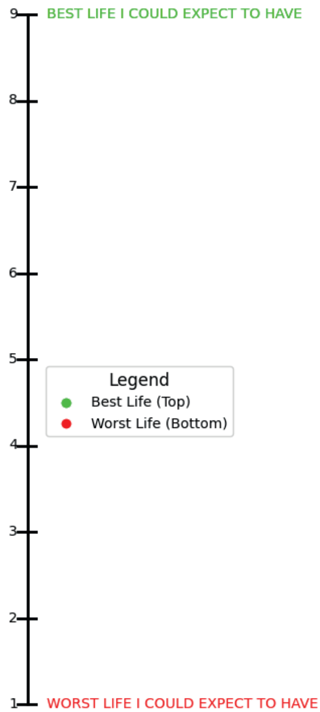


Source: Author. Adapted from Andrews & Withey (1976)

This graphical representation reinforces the instrument's accessibility but limits the granularity required for measurements involving multiple analytical vectors. The absence of a formal metric structure restricts its application in technical contexts, indicating the need for more structured systems, such as the SPMI.

The Ladder or Cantril Self-Anchoring Striving Scale (CSASS) (Figure 7) is highlighted, developed by Kilpatrick & Cantril (1960), and presented as a tool for assessing subjective perceptions of quality of life. Originally, Cantril's scale ranged from "1" at the bottom of the ladder (representing the worst possible life one can imagine) to "9" at the top (the best possible life). Respondents select the step that best reflects their current state, life expectation, or aspirations.

FIGURE 7: LADDER OR CANTRIL: SELF-ANCHORING STRIVING SCALE (CSASS)

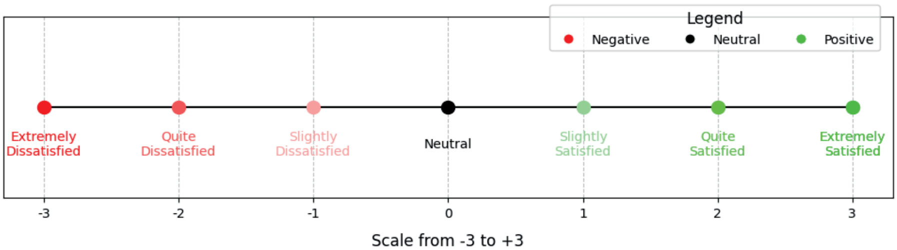


Source: Author. Adapted from Andrews & Withey (1976)

Although intuitive and adaptable to diverse audiences, the CSASS operates on a unidimensional, self-anchored logic which, while useful in population studies, does not support integrated multivector evaluations. Its contribution lies in the recognition of self-perception as a meaningful metric, anticipating more structured approaches such as the one proposed by the SPMI.

Pearson & Bailey (1980) proposed the Satisfaction Scale (Figure 8), a standardized, symmetrical interval scale developed to quantitatively measure users' satisfaction with information systems. The scale consists of seven categories that simultaneously assess the direction (satisfaction or dissatisfaction) and intensity of user perceptions. These categories are described by the adjectives: Extremely Satisfied, Quite Satisfied, Slightly Satisfied, Neither Satisfied nor Dissatisfied, Slightly Dissatisfied, Quite Dissatisfied, and Extremely Dissatisfied. The intervals associated with these categories are assigned numerical values of "-3", "-2", "-1", "0", "+1", "+2", "+3", corresponding to the intensity of responses.

FIGURE 8: SATISFACTION SCALE

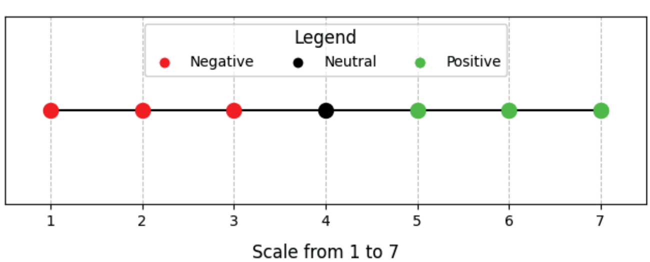


Source: Author. Adapted from Pearson & Bailey (1980)

This structure enables the capture of nuances in affective responses, both in intensity and polarity, within a standardized psychometric model. Nonetheless, its unidimensionality and the absence of modular mechanisms reduce its potential in contexts requiring multiple analytical vectors. These limitations underscore the need for more comprehensive evaluative systems, such as the SPMI, designed to operate at more complex and interdependent structural levels.

As an advancement in the assessment of subjective satisfaction, Diener, Emmons, Larsen, & Griffin (1985) developed the Satisfaction With Life Scale (SWLS) (Figure 9), a five-item tool designed to measure global life satisfaction. The scale demonstrates high internal consistency and temporal reliability, validated through rigorous psychometric analyses. Each SWLS item is rated on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree", allowing for precise and reliable measurement of global satisfaction judgments.

FIGURE 9: SCALE SATISFACTION WITH LIFE (SWLS)

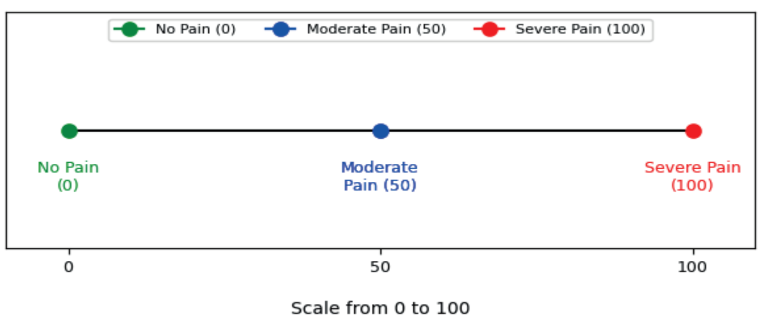


Source: Author. Adapted from Diener et al. (1985)

The instrument focuses on the cognitive judgment of life as a whole, prioritizing the aggregated subjective perception. Although it demonstrates high psychometric consistency, it is limited in its ability to represent multiple dimensions simultaneously, a gap the SPMI seeks to address through a modular and integrated architecture.

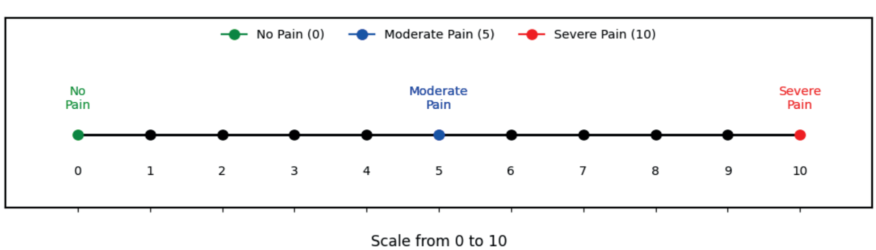
Numerical scales have been developed to capture subjective intensities, among which the proposals by Jensen, Karoly, & Braver (1986) stand out for their analysis and description of two widely used tools. The 101-point Numerical Rating Scale (NRS-101) (Figure 10) is a numerical scale ranging from "0" to "100". This scale can be applied either verbally or in writing, making it versatile across different contexts. The 11-point Box Scale (BS-11) (Figure 11) consists of a series of eleven numbers ("0" to "10"), each enclosed in a box. Respondents mark with an "X" the number that best represents the perceived intensity. This visual format is simple and intuitive, facilitating comprehension and quick response from individuals.

FIGURE 10: 101-POINT NUMERICAL RATING SCALE (NRS-101)



Source: Author. Adapted from Jensen, Karoly, & Braver (1986)

FIGURE 11: 1-POINT BOX SCALE (BS-11)

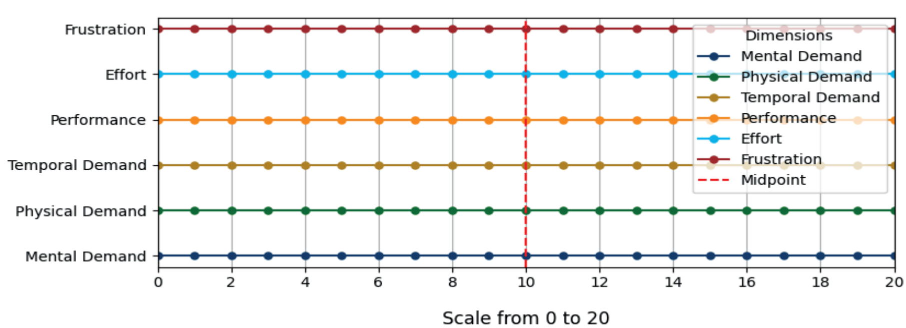


Source: Author. Adapted from Jensen, Karoly, & Braver (1986)

However, both scales remain unidimensional and do not account for the multiplicity and interdependence of dimensions present in complex phenomena. Integrating these scales into a modular system such as the SPMI can enhance the capture of both qualitative and quantitative nuances, addressing limitations inherent to traditional instruments.

In response to the constraints of unidimensional scales, new instruments have emerged that expand measurement by capturing human experience in specific tasks. In this regard, Hart & Staveland (1988) developed the NASA-TLX (Task Load Index) (Figure 12), a tool designed to measure perceived workload in task execution. The index assesses six core dimensions: mental demand, representing the cognitive effort involved; physical demand, related to the physical exertion required; temporal demand, reflecting the time pressure during the task; performance, based on self-assessment of effectiveness, ranging from "Good" to "Poor"; effort, indicating the overall level of perceived exertion; and frustration, associated with irritation or dissatisfaction experienced. These dimensions are rated on a scale from "0" to "100" (often converted to a 20-point scale for simplicity), with descriptors ranging from "Low" to "High", enabling precise identification of workload levels associated with task performance.

FIGURE 12: TASK LOAD INDEX SCALE (NASA-TLX)

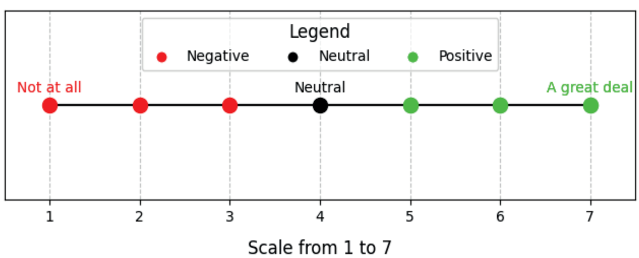


Source: Author. Adapted from Hart, S. G., & Staveland, L. E. (1988); and Hart (2006)

This modular and integrated approach exemplifies the necessary advancement to overcome the unidimensionality of conventional instruments, reinforcing the conceptual foundation that underpins the SPMI.

Considering this expanded evaluative focus, centered on the integration of subjective judgments and contextual interpretations, one may highlight the proposal by Lyubomirsky & Lepper (1999), who developed the Subjective Happiness Scale (SHS) (Figure 13), a measure of subjective happiness that globally and subjectively assesses individuals' perception of happiness. The scale consists of four items: two ask respondents to evaluate themselves regarding their overall happiness and in comparison to their peers; the other two present descriptions of happy and unhappy individuals and ask respondents to indicate the extent to which these descriptions apply to them. Items are rated on a 7-point scale ranging from "1" (strongly disagree) to "7" (strongly agree), and the responses are used to compute an average score, where higher values indicate higher levels of subjective happiness.

FIGURE 13: SUBJECTIVE HAPPINESS SCALE (SHS)



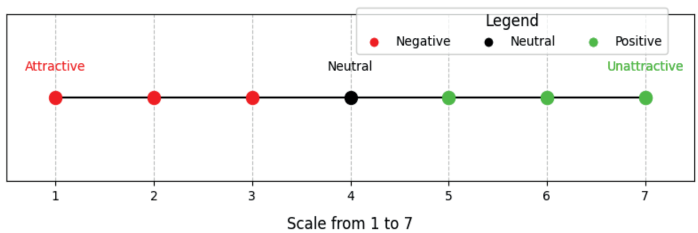
Source: Author. Adapted from Lyubomirsky, S., & Lepper, H. S. (1999)

Despite its breadth, the model remains centered on a single dimension of evaluation, underscoring the need for modular and multidimensional systems, such as the SPMI, to capture the complexity inherent in human experiences within technological and social contexts.

Following investigations into subjective workload in operational settings, with an emphasis on dimensional independence and contextual validity of measurements, Hart (2006) states that the dimensions of the National Aeronautics and Space Administration–Task Load Index (NASA-TLX) (Figure 12) were selected to represent independent aspects of the subjective workload experience, designed to capture distinct facets of this construct. He emphasizes that contextual adaptations require prior validation to ensure measurement sensitivity and validity.

Continuing the assessment of subjective experience in computational environments, Laugwitz, Held, & Schrepp (2008) employed the User Experience Questionnaire (UEQ) (Figure 14), which uses a 7 point semantic differential scale with opposing extremes such as "attractive" and "unpleasant". This scale was designed to capture the agent's perception of software products, minimizing central tendency biases in responses.

FIGURE 14: USER EXPERIENCE QUESTIONNAIRE (UEQ) SCALE

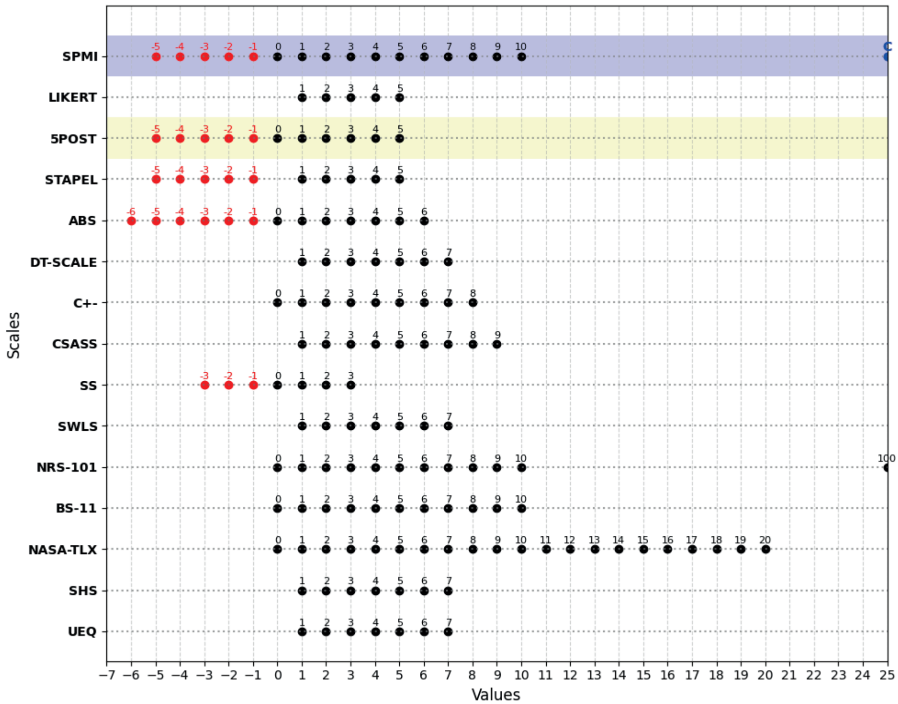


Source: Author. Adapted from Laugwitz, Held, & Schrepp (2008)

Although it presents a semantic differential structure, the scale does not incorporate modular scoring mechanisms nor multidimensional logic. This limitation underscores the need for instruments like the SPMI, which integrate multiple evaluative vectors with the capacity for contextual adaptation and superior metric granularity.

The approaches examined were selected to address specific measurement purposes in varied contexts. Considering the specialized literature surveyed, the dimensional diversity, and the complexity of the phenomena analyzed, these scales are compared to the SPMI regarding their structural and functional properties (Figure 15).

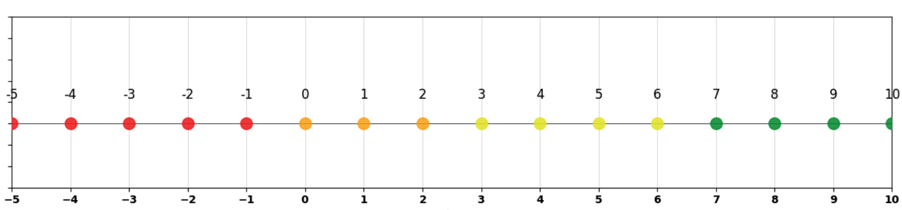
FIGURE 15: SPMI AND SCALES: COMPARISON AND SCOPE



Source: Author.

The SPMI was developed to address diverse integrated dimensions and elements. The system's scoring ranges from "-5" to "10" (Figure 16), enabling critical investigation and evaluation of evaluative constructs.

FIGURE 16: INTEGRATED MODULAR MULTIDIMENSIONAL SCORING SYSTEM (SPMI) — INTEGER SCALE

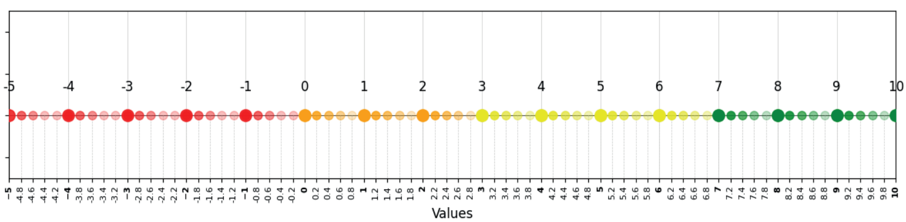


Source: Author.

The system also allows the application of two distinct scoring methods, integer and decimal, to address specific characteristics of certain dimensions. However, adequate technical expertise is essential to measure values separately in order to ensure effective processing of metrics and scores in combined sets.

The SPMI is designed to support the inclusion of decimal values (Figure 17), which are essential for detailed analyses of parts, components, lines of code, functions, microelements, and complex phenomena. The use of this feature requires rigorous knowledge to guarantee correct application and precision in data collection for each integrated dimension.

FIGURE 17: INTEGRATED MODULAR MULTIDIMENSIONAL SCORING SYSTEM (SPMI) — DECIMAL SCALE



Source: Author.

2.1 Methodological Principles and Modular Adaptation

Due to its flexibility and adaptability, the SPMI encompasses multiple dimensions and elements, allowing for the adequate collection of data according to the definition of specific parameters (see Chapter 1). The non-uniform distribution of scoring among elements within a dimension is supported, reflecting their particularities and ensuring precision in the processing of metrics and scores.

The system presents a well-defined logical structure, integrating theoretical and operational foundations. Each component contributes coherently to the evaluation, ensuring precise interpretation of results. Its construction follows a rigorous process of empirical validation and thorough literature review, guaranteeing the representativeness of each element within the assessed dimension.

A central characteristic of the SPMI is its adaptability: the system is designed to incorporate new evidence and technologies, remaining relevant amidst the evolution of evaluative fields. Based on a multidimensional approach, it enables comprehensive analyses that surpass unidimensional metrics, providing an integrated understanding of the evaluated objects.

2.2 Applications and Analytical Potential

The SPMI is an advanced evaluative technique designed to measure and interpret, with precision and depth, usability, effectiveness, and multiple aspects of technological objects, evaluative constructs, and situational phenomena. Its modular and multidimensional model allows for isolated or combined applications across various dimensions, ensuring that scores faithfully reflect the properties of the assessed elements.

Its architecture supports both the analysis of objective indicators and the investigation of subjective, hedonic, and pragmatic variables in empirical and experimental contexts. This capability renders it applicable to qualitative and quantitative studies, as well as diagnostic processes, technical evaluations, operational analyses, and scientific research.

Data collection within the SPMI is systematic, rigorously structured, and enables the production of detailed reports, facilitating comparative analysis, pattern identification, and decision-making support in technological and interactional contexts. When incorporated into investigations of complex constructs, the system allows an expanded understanding of factors influencing the evaluated phenomena, contributing to knowledge advancement and the development of solutions aligned with contemporary demands of agents and the systems in which they operate.

3 INTEGRATED MODULAR COLOR CLASSIFICATION AND DEFINITION SYSTEM (SCDMIC)

O SCDMIC (Sistema de Classificação e Definição Modular Integrado de Cores – SCDMIC) constitutes a chromatic evaluative architecture designed to represent, with high inferential resolution, the position of each element relative to complex constructs defined within the analyzed technical scope. Its logic relies on five colors, blue, red, orange, yellow, and green, used as codifiers of distinct evaluative states associated with graduated levels of compliance, severity, and intervention requirement. Each color expresses not only a degree of conformity to design requirements but also the nature of the expected response in the process of correction, refinement, or validation of the element.

During measurement cycles, direct visualization of the assigned colors is often restricted to preserve evaluative neutrality and prevent premature interpretive interference. The system operates integrally with data inferred by the SPMI, transforming numerical scores into continuous visual projections via a Modular Heatmap that organizes data into chromatic patterns for easy reading. This representation enables immediate identification of technical attention zones, critical states, and areas of full compliance, providing a functional reading of the overall performance status of the evaluated elements.

Analytical components are also articulated, such as the Error Severity Map and the Modular Risk Map, which expand the system's inferential power. The Error Severity Map classifies errors by technical severity, highlighting the magnitude of identified dysfunctions. The Risk Map structures the analysis through matrices crossing the probability of occurrence with the potential impact of each failure, guiding decisions based on technical or interactive threat scenarios. The combination of these maps enables a holistic diagnosis that is simultaneously granular and systemically articulated, essential for precise and technically justified interventions. Table 1 formalizes the chromatic levels and their respective definitions, serving as a normative reference for the interpretation of evaluations within the SCDMIC context..

TABLE 1: INTEGRATED MODULAR COLOR CLASSIFICATION AND DEFINITION SYSTEM (SCDMIC)

Level/ Color	Meaning	Technical Definition
1	Excellent	Indicates full compliance with the technical and functional requirements of the evaluated construct. Represents ideal performance, without operational restrictions, with maximum adherence to design parameters and no compromise to experience or functionality.
2	Moderate	Reflects intermediate states requiring targeted adjustments or additional technical checks. Does not compromise overall operation but signals the need for localized interventions to prevent failure propagation or functional degradation of the construct.
3	Problematic	Denotes significant deficiencies in evaluated requirements, indicating structural or operational faults that impair flow, usability, or interaction safety. Requires specific corrective actions to restore minimum compliance levels.
4	Critical	Corresponds to severe failure states, with dysfunctions that render the object unsafe, inefficient, or nonfunctional. Implies significant operational risks, requiring immediate intervention and priority corrective measures.
5	Systemic Conditional	This level represents a special analytical category, not assigned by direct evaluation but activated by systemic inference. The blue color operates as an inferential emergency marker, triggered when the validity of one dimension logically depends on the performance of another in interdependent construct structures. Requires interdimensional reading, contextualized analysis, and understanding of the relationship among functional intent, operational action, and systemic outcome. Its application is restricted and based on high-level technical-evaluative cross-analyses.

The chromatic levels employed in the SCDMIC framework are presented, assigning precise semantic and operational meanings to each color category. These classifications articulate gradations of conformity, functional adequacy, and intervention urgency, ranging from optimal compliance to critical system failures. The SCDMIC further includes a unique systemic conditional level, reflecting complex interdependencies within multidimensional constructs. This structure offers a clear, normatively grounded guide to interpret evaluation results, ensuring accuracy and contextual depth across diverse technical and interactional scenarios.

Source: Author.

Designed as a functional module within the evaluative framework, the SCDMIC does not operate in isolation but as an integrated modular component of the assessment system. Its core strength lies in the ability to transform abstract data into highly organized visual representations, enabling intuitive reading without compromising technical accuracy. This capability provides development, validation, or auditing agents with refined judgment tools, guided by structured evidence and rigorous inferential criteria.

By articulating scoring, color, inference, and mapping, the SCDMIC functions as a deep analytical interface between quantitative data and functional interpretation, establishing itself as an indispensable tool in contexts demanding precision, adaptability, and reliability in the evaluation of technologies, interactions, and complex systems.

4 DISCUSSION

The literature on measurement scales reveals enduring methodological tensions relevant to contemporary evaluation systems. Cox III (1980) emphasizes that defining the optimal number of response alternatives in a scale must maximize the transmission of meaningful information without inducing excessive response error. This balance is achieved when the ratio between systematic variance and total variance is optimized. The SPMI advances this landscape by introducing a scoring architecture that not only balances the number of alternatives and discriminative sensitivity but also expands the analytical scope through decimalized scales controlled by polarity and inference. Consequently, the information conveyed by the scale depends not solely on the number of points but on the integration of intensity, direction, and contextual coherence, parameters that elevate analytical potential and decision granularity.

In the realm of subjective experiences, Russell & Bullock (1986) argue that emotional categories are not mutually exclusive but rather overlapping concepts with varying degrees of membership. This view proposes an intercategorical structure where relationships between emotions are systematic and reflect similarities that reinforce the fuzzy nature of emotions, characterized by gradual and interdependent boundaries. This conception is directly incorporated into the SCDMIC, which replaces static classifications with continuous, graded, and inferential chromatic coding. Assigned colors do not correspond to fixed labels but to adherence states varying according to the intensity and quality of the evaluated value. This structure enables representation of areas of functional ambiguity, hybrid states, and nonlinear systemic behaviors, elements that evade traditional metrics and require higher-order interpretive coding.

Highlighting the need for alignment and coherence, Carifio & Perla (2007) argue that a scale's validity depends on the integration between its logical content and mathematical components, stressing that psychometric scales encompass both an empirical and logical structure (macro level) and specific response properties (micro level). They emphasize that instrument reliability requires consideration of the analytical unit, internal consistency, and a rigorous item construction and validation process. The SPMI and SCDMIC embody this alignment through systemic integration of logical macrostructure (evaluative dimensions, value functions, applicability domain) and empirical microstructure (analysis points, observed variables, inference mechanisms). The result is a modular, scalable system whose analytical units can be calibrated according to construct nature and complexity, measurement purpose, and inference type. This architecture maximizes internal consistency and supports a contextualized validation process sensitive to domain-specific demands.

The methodological originality of both systems lies precisely in rejecting oversimplification. The SPMI breaks away from unidimensional models by proposing scales structured on multiple analytical axes, while the SCDMIC shifts static result visualization toward dynamic, inferentially integrated maps such as the Heat Map, Error Severity Map, and Risk Map. This resource integration enables deeply articulated analyses linking form, function, outcome, and context, raising interpretive levels in evaluation.

These contributions transcend technical innovation, proposing a paradigmatic redefinition of measurement in high-complexity contexts. By simultaneously operating at logical-inferential, perceptual-interpretive, and empirical-numerical levels, the systems establish an evaluative model capable of meeting emerging demands in applied science, interaction engineering, and systemic performance analysis. They underscore the relevance of classical foundations while expanding them through an integrated modular architecture toward a new scientific evaluation grammar.

5 CONCLUSION

The SPMI establishes an evaluative architecture grounded in the logical representation of polarity and intensity of the analyzed states. By assigning values that accurately reflect both the direction (positive or negative) and the magnitude of the evaluated experience, the system overcomes structural limitations of conventional scales, which tend to conflate negative evaluations with expressions of low positivity, generating interpretative noise. Operating with scales ranging from -5 to +10, in both integer and decimal versions, the SPMI offers a numerical syntax more faithful to the perceptual and inferential logic of the evaluating agent, enabling a more transparent, granular, and technically defensible reading of the collected data.

This model not only translates subjective evaluations with greater fidelity but also aligns with cognitive principles that organize the agent's understanding around affective and functional polarities. The direct association between symbolic value and numeric value ensures greater adherence between perception and outcome, expanding the representational validity of measurements in subjective, technical, and operational contexts. The system's modular architecture further enables its application across multiple evaluative domains, from technological objects to interactive systems, preserving internal coherence and contextual sensitivity without compromising inferential rigor.

Complementarily, the SCDMIC provides an interpretative visual layer that enhances the intelligibility of results and chromatically translates the evaluative states inferred by the SPMI. The integration between numerical values and color codifiers establishes a visual semantics that facilitates the reading of critical patterns, transition zones, and optimal states, incorporating a continuous and interpretive logic into the analysis.

Together, these two systems offer an unprecedented and highly applicable methodological proposal, capable of supporting analytical decisions across multiple levels, from engineering to psychometrics, usability to risk management. By integrating logical formalism, metric rigor, visual coding, and modular adaptability, the SPMI and SCDMIC represent a paradigmatic inflection in the measurement of complex constructs, not only enhancing evaluative precision but redefining the very limits of what can be coherently, deeply, and intelligibly measured.

6 REFERENCES

Anderson, N. H. (1961). Scales and statistics: Parametric and nonparametric. *Psychological Bulletin, 58*(4), 305–316. https://doi.org/10.1037/h0042576

Andrews, F. M., & Withey, S. B. (1976). Social indicators of well-being: Americans' perceptions of life quality. Plenum Press. https://doi.org/10.1007/978-1-4684-2253-5

Bradburn, N. M. **(1969).** The structure of psychological well-being. Aldine.

Burks, A. W. (1949). Icon, index, and symbol. Philosophy and Phenomenological Research, 9(4), 673–685. https://doi.org/10.2307/2103298

Carifio, J., & Perla, R. J. (2007). Ten common misunderstandings, misconceptions, persistent myths and urban legends about Likert scales and Likert response formats and their antidotes. Journal of Social Sciences, 3(3), 106–116. https://doi.org/10.3844/jssp.2007.106.116

Cliff, N. (1959). Adverbs as multipliers. *Psychological Review, 66*(1), 27–44. https://doi.org/10.1037/h0045660

Cox III, E. P. (1980). The optimal number of response alternatives for a scale: A review. Journal of Marketing Research, 17(4), 407. https://doi.org/10.2307/3150495

Crosby, R. W. (1969). Attitude measurement in a bilingual culture. Journal of Marketing Research, 6(4), 421–426. https://doi.org/10.1177/002224376900600403

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. Journal of Personality Assessment, 49(1), 71–75. https://doi.org/10.1207/s15327752jpa4901_13

Hart, S. G. (2006). NASA-task load index (NASA-TLX); 20 years later. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 50(9), 904–908. https://doi.org/10.1177/154193120605000909

Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In P. A. Hancock & N. Meshkati (Eds.), Human mental workload (pp. 139–183). North-Holland. https://doi.org/10.1016/S0166-4115(08)62386-9

Jensen, M. P., Karoly, P., & Braver, S. (1986). The measurement of clinical pain intensity: A comparison of six methods. Pain, 27(1), 117–126. https://doi.org/10.1016/0304-3959(86)90228-9

Likert, R. (1932). A technique for the measurement of attitudes (Publication No. 140). *Archives of Psychology, 22*, 1–55.

Lyubomirsky, S., & Lepper, H. S. (1999). A measure of subjective happiness: Preliminary reliability and construct validation. Social Indicators Research, 46(2), 137–155. https://doi.org/10.1023/a:1006824100041

Martin, W. S. (1978). Effects of scaling on the correlation coefficient: Additional considerations. Journal of Marketing Research, 15(2), 304. https://doi.org/10.2307/3151268

Ostrom, T. M. (1969). The relationship between the affective, behavioral, and cognitive components of attitude. Journal of Experimental Social Psychology, 5(1), 12–30. https://doi.org/10.1016/0022-1031(69)90003-1

Pearson, S. W., & Bailey, J. E. (1980). Measurement of computer user satisfaction. *ACM SIGMETRICS Performance Evaluation Review, 9*(1), 59–68. https://doi.org/10.1145/1041872.1041881

Russell, J. A., & Bullock, M. (1986). Fuzzy concepts and the perception of emotion in facial expressions. *Social Cognition, 4*(3), 309–341. https://doi.org/10.1521/soco.1986.4.3.309

Stevens, S. S. (1946). On the theory of scales of measurement. Science, 103(2684), 677–680. https://doi.org/10.1126/science.103.2684.677

Zadeh, L. A. (1965). Fuzzy sets. Information and Control, 8(3), 338–353. https://doi.org/10.1016/s0019-9958(65)90241-x

Zunde, P., & Dexter, M. E. (1969). Indexing consistency and quality. American Documentation, 20(3), 259–267. https://doi.org/10.1002/asi.4630200313