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Development of the Hoysalas SG Composite Rating Index for Resin Flooring

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Abstract: Resin flooring selection and performance assessment require the integrated consideration of engineering suitability, functional performance, durability, environmental sustainability, life-cycle economics, and installation quality. However, these dimensions are frequently evaluated independently, limiting cross-project comparability, weakening evidence traceability, and creating the risk that favourable aggregate assessments may conceal critical technical deficiencies. Addressing this methodological gap, this study introduces the Hoysalas SG Composite Rating Index (HRI), developed by Hoysala and Sai Gowrav A., as a proposed evidence-based framework for the structured assessment and rating of resin flooring proposals and installed systems. HRI comprises six weighted assessment dimensions totalling 1,000 potential points: mechanical performance (25%), functional performance (20%), durability and service life (20%), sustainability (15%), economic efficiency (10%), and workmanship and quality control (10%). Its checklist-based architecture uses four response classifications—Pass, Fail, Not Applicable, and Not Checked—to distinguish demonstrated compliance, non-compliance, irrelevant criteria, and unverified requirements. Supporting evidence, explicit scoring rules, and critical-failure safeguards are intended to improve assessment transparency, reproducibility, and technical accountability. A central contribution of this study is the conceptual integration of HRI with two complementary research frameworks developed by Sai Gowrav A.: the Sustainable Construction Chemicals Adoption Framework (SCCAF), co-developed with Shampa Nandi, and the Weighted Resin Flooring Index (WRI). The three frameworks address complementary but analytically distinct decision-making functions. SCCAF examines behavioural, institutional, stakeholder, and market determinants of sustainable construction-chemical adoption; WRI supports project-specific technical evaluation and comparative selection of resin flooring systems; and HRI provides a structured mechanism for evidence-based assessment, quality appraisal, and composite rating. Their proposed relationship follows a decision-support pathway from adoption determinants (SCCAF), through technical suitability and system selection (WRI), to documented assessment and rating (HRI). Assessment findings may subsequently inform specification refinement, procurement decisions, installation controls, and future adoption strategies. This relationship is conceptual and requires empirical testing before the combined architecture can be considered validated. A preliminary HRI assessment certificate for a nominal 4 mm polyurethane flooring system reports a rating of 7.13/10, classified as “Qualified Finish.” Because the associated checklist was incomplete, this rating is treated as provisional; its calculation has not been independently verified, and it is not presented as evidence of HRI validity or accredited certification. In the absence of an independent validation dataset, the present study establishes a conceptual and methodological foundation rather than claiming demonstrated predictive accuracy or established measurement reliability. A staged validation protocol is therefore proposed, incorporating expert content assessment, pilot application across diverse flooring environments, inter-rater reliability testing, sensitivity analysis of weighting and missing-data rules, evaluation of critical-failure safeguards, and comparison with independent laboratory results and documented field performance. By distinguishing adoption determinants, technical selection, and evidence-based assessment within a connected research architecture, this study provides a foundation for developing a more transparent, reproducible, and sustainability-oriented approach to resin flooring decision-making.

Keywords: Hoysalas SG Composite Rating Index; HRI; Sustainable Construction Chemicals Adoption Framework; SCCAF; Weighted Resin Flooring Index; WRI; resin flooring; composite assessment; sustainable construction materials; life-cycle performance; quality assurance; validation methodology.

I. INTRODUCTION

Resin flooring systems constitute an important category of engineered surface protection and functional flooring solutions used across industrial, commercial, institutional, healthcare, pharmaceutical, food-processing, logistics, and infrastructure facilities.

Their selection is governed by complex interactions among substrate characteristics, mechanical loading, chemical exposure, thermal conditions, hygiene requirements, operational safety, environmental considerations, and expected service life. Unlike conventional flooring decisions based predominantly on material type, thickness, aesthetics, or initial installation cost, resin flooring selection requires an integrated evaluation of the complete flooring system under anticipated service conditions. Consequently, engineering suitability, installation quality, long-term durability, environmental performance, and life-cycle economics must be considered collectively rather than as independent selection parameters.

The performance of resin flooring is inherently application specific. A flooring system suitable for a dry assembly area may be inappropriate for chemical processing, wet manufacturing, heavy-duty warehousing, temperature-controlled facilities, or vehicular traffic environments. For example, coating adhesion and substrate compatibility are fundamental to the integrity of resin-based systems, while abrasion resistance, chemical resistance, impact resistance, slip resistance, and thermal stability may become critical under particular operating conditions. Standardised testing methods, including ASTM D7234-22 for determining the pull-off strength of coatings on concrete, provide mechanisms for evaluating selected performance characteristics (ASTM International, 2022). However, individual test results do not independently establish the overall suitability or expected service life of a flooring system.

In practical project environments, technical evaluation is frequently distributed across product technical data sheets, safety data sheets, laboratory reports, substrate surveys, design specifications, installation method statements, quality assurance records, inspection reports, and maintenance recommendations. Although these documents provide valuable evidence, their fragmented evaluation can complicate comparisons among competing systems and reduce the transparency of technical acceptance decisions. Furthermore, the absence of a unified assessment structure may result in inconsistent weighting of performance criteria, incomplete documentation, and insufficient recognition of critical technical deficiencies.

This fragmentation establishes the central research problem addressed by the present study: the need for a transparent, reproducible, multidimensional assessment architecture capable of organising resin flooring evidence while preserving project-specific engineering requirements and critical acceptance criteria.

Composite indicators offer a potential methodological response to this challenge by integrating heterogeneous performance dimensions within a common evaluation structure. The Organisation for Economic Co-operation and Development and collaborating institutions emphasise that composite indicators require transparent conceptual foundations, indicator selection, data treatment, normalisation, weighting, aggregation, and uncertainty analysis (OECD et al., 2008). Similarly, Saisana et al. (2005) demonstrate the importance of uncertainty and sensitivity analysis in evaluating the robustness of composite indicators. These methodological principles are particularly relevant to engineering applications because the resulting ratings may influence procurement decisions, specification acceptance, investment priorities, and quality assurance procedures.

Nevertheless, composite scoring introduces important limitations. A weighted aggregate can create compensatory effects whereby strong performance in one dimension offsets poor performance in another. Such compensation may be unacceptable when the deficient criterion represents a mandatory engineering, safety, or contractual requirement. For example, satisfactory aesthetic quality or economic efficiency cannot justify acceptance of a flooring system that fails an applicable adhesion, slip-resistance, chemical-containment, or other critical performance requirement. Accordingly, a technically defensible composite index should incorporate explicit eligibility conditions, critical-failure safeguards, evidence requirements, and transparent rules for incomplete or non-applicable assessments.

Environmental sustainability introduces an additional layer of complexity. The environmental performance of construction materials cannot be adequately characterised by isolated sustainability claims without considering the assessment boundaries, material inputs, expected service life, maintenance requirements, and relevant environmental impacts. ISO 14040 and ISO 14044 establish the principles and methodological requirements for life-cycle assessment, including goal and scope definition, inventory analysis, impact assessment, and interpretation (International Organization for Standardization [ISO], 2006a, 2006b). For resin flooring systems, life-cycle considerations may include material consumption, replacement frequency, maintenance activities, repairability, waste generation, and end-of-life treatment, subject to the availability of suitable project-specific evidence.

Similarly, economic evaluation requires a distinction between initial installation expenditure and long-term ownership costs. A lower-cost flooring system may not necessarily provide superior economic value when maintenance, repair, operational disruption, and replacement costs are considered. Therefore, life-cycle economic assessment should be based on clearly defined evaluation periods, cost assumptions, maintenance scenarios, and comparable functional requirements. Integrating sustainability and economic criteria into a common assessment framework may support more comprehensive decision-making, provided that environmental and financial indicators are evaluated using transparent and consistent methodologies.

A further challenge concerns the distinction between product suitability and installed-system performance. Even where a resin flooring system is technically appropriate for the intended application, its performance may be affected by substrate preparation, moisture conditions, application workmanship, curing procedures, environmental conditions during installation, and quality-control practices. Consequently, product-level performance claims should not be treated as equivalent to verified field performance. Relevant inspection and testing evidence must be assessed in relation to the applicable specifications and acceptance criteria (ASTM International, 2022). Against this background, the present study introduces the Hoysalas SG Composite Rating Index (HRI), developed by Hoysala and Sai Gowrav A., as a proposed multidimensional, evidence-oriented framework for evaluating resin flooring proposals and installed systems. HRI organises assessment into six principal dimensions: mechanical performance (25%), functional performance (20%), durability and service life (20%), sustainability (15%), economic efficiency (10%), and workmanship and quality control (10%). These dimensions represent a total potential allocation of 1,000 points.

The proposed assessment structure employs four checklist classifications: Pass, Fail, Not Applicable, and Not Checked. These classifications distinguish verified compliance, documented non-compliance, criteria that are irrelevant to a particular application, and requirements for which verification remains incomplete. The methodological objective is to establish a traceable relationship between individual assessment criteria, supporting evidence, category-level performance, and the reported composite rating. However, the precise scoring algorithm, treatment of missing or non-applicable items, weighting justification, and critical-failure rules require formal specification and validation before the framework can be considered reproducible or suitable for formal acceptance decisions.

A. Theoretical Foundation and Integration of SCCAF, WRI, and HRI

The proposed HRI framework is conceptually connected to two complementary research contributions: the Sustainable Construction Chemicals Adoption Framework (SCCAF) developed by Sai Gowrav and Nandi (2026) and the Weighted Resin Flooring Index (WRI) presented in the resin flooring research of Sai Gowrav (2026).

SCCAF addresses the behavioural, institutional, technological, market-related, and stakeholder factors influencing the adoption of sustainable construction chemicals. Its conceptual foundations draw upon established theories of planned behaviour, innovation diffusion, and technology acceptance (Ajzen, 1991; Rogers, 2003; Venkatesh et al., 2012). By examining adoption determinants, SCCAF provides a basis for understanding why stakeholders may accept, resist, or prioritise sustainable construction-chemical solutions under different market and institutional conditions (Sai Gowrav & Nandi, 2026).

WRI addresses a complementary but distinct problem: the technical evaluation and comparative selection of resin flooring systems for project-specific conditions. Its assessment considerations include substrate preparation readiness, moisture and substrate risks, adhesion, mechanical loading, chemical exposure, thermal cycling, hygiene, maintainability, and other operational requirements identified in the associated research (Sai Gowrav, 2026). Whereas SCCAF focuses primarily on factors influencing adoption, WRI supports the evaluation of technical suitability.

HRI introduces a further assessment function by organising evidence related to the proposed or installed flooring system into a structured, multidimensional rating framework. It seeks to connect engineering evidence, functional suitability, durability, sustainability, economic efficiency, and workmanship within a common assessment architecture.

The proposed interrelationship can therefore be expressed as:

SCCAF → Adoption determinants and stakeholder decision context

WRI → Project-specific technical suitability and system selection

HRI → Evidence-based assessment, quality appraisal, and composite rating

This relationship represents a conceptual decision-support pathway rather than an empirically established causal sequence. SCCAF can inform the broader adoption context and sustainability priorities; WRI can support the identification and comparison of technically suitable systems; and HRI can structure the assessment of the selected proposal or installed work against defined evidence and acceptance criteria. Importantly, the relationship need not operate in only one direction. HRI assessment findings may reveal deficiencies in specifications, installation practices, evidence availability, or maintenance assumptions. Such findings can inform subsequent technical selection decisions and potentially influence stakeholder confidence and adoption considerations. The proposed architecture therefore accommodates feedback between adoption, selection, and assessment activities.

The distinction among these three frameworks is central to the research contribution. SCCAF does not replace engineering selection; WRI does not independently establish the quality of an installed system; and HRI does not substitute for mandatory testing, contractual acceptance procedures, or competent engineering judgement. Rather, the frameworks address complementary decision-making questions that may be examined together in future empirical research.

B. Research Gap and Problem Statement

The literature on composite indicators establishes general principles for multidimensional measurement, weighting, aggregation, and sensitivity analysis (OECD et al., 2008; Saisana et al., 2005). Established technical standards provide methods for assessing individual coating and flooring characteristics, while life-cycle assessment standards establish procedures for environmental evaluation (ASTM International, 2022; ISO, 2006a, 2006b).

However, these sources do not themselves establish a single, validated composite assessment system that integrates the six proposed HRI dimensions for resin flooring. The research gap addressed by this paper is therefore not the absence of flooring standards or multidimensional evaluation methods, but the need to investigate whether a specifically defined, evidence-oriented composite assessment framework can organise these dimensions transparently and reproducibly.

Four methodological challenges are particularly important:

- 1) Multidimensional integration: Combining engineering, functional, durability, environmental, economic, and workmanship criteria without losing their distinct technical meanings.
- 2) Evidence traceability: Connecting each assessment outcome to relevant documentation, measurements, and acceptance criteria.
- 3) Non-compensatory safeguards: Preventing a favourable aggregate score from concealing failure of a mandatory technical or safety requirement.
- 4) Measurement validity and robustness: Demonstrating that the proposed index produces consistent and meaningful results across assessors, flooring applications, and reasonable methodological assumptions.

These challenges provide the basis for the proposed HRI methodology and its future validation.

C. Research Aim

The primary aim of this study is to develop and specify the **Hoysalas SG Composite Rating Index (HRI)** as a transparent, multidimensional, evidence-oriented assessment framework for resin flooring systems and to establish its conceptual relationship with SCCAF and WRI.

The study further aims to identify the methodological requirements for evaluating HRI's content validity, assessment reproducibility, inter-rater reliability, sensitivity to scoring assumptions, and relationship with independent engineering and field-performance outcomes.

D. Research Questions

RQ1. How can mechanical performance, functional suitability, durability, sustainability, economic efficiency, and workmanship be integrated into a coherent composite assessment framework for resin flooring?

RQ2. How can assessment criteria, supporting evidence, weighting, aggregation, and reporting rules be defined to promote transparency and reproducibility?

RQ3. How should critical failures, non-applicable criteria, and unchecked requirements be treated to prevent misleading composite ratings?

RQ4. How can SCCAF, WRI, and HRI be conceptually integrated while preserving their distinct functions in stakeholder adoption, technical selection, and evidence-based assessment?

RQ5. What validation procedures are required to establish the reliability, robustness, and practical utility of HRI across different resin flooring applications?

E. Research Objectives

The study seeks to:

- 1) Develop a six-dimensional conceptual assessment architecture for resin flooring systems.
- 2) Define the proposed assessment categories, evidence requirements, checklist classifications, and methodological safeguards.
- 3) Clarify the conceptual relationships and functional boundaries among SCCAF, WRI, and HRI.
- 4) Establish a framework for evaluating scoring consistency, weighting sensitivity, and treatment of incomplete evidence.
- 5) Propose a staged empirical validation programme incorporating expert review, pilot testing, inter-rater reliability assessment, and comparison with independent performance outcomes.
- 6) Identify the conditions under which HRI could potentially support procurement evaluation, installation quality assurance, and post-installation performance assessment.

F. Research Contribution and Significance

The principal contribution of this study is the specification of a proposed evidence-oriented composite rating architecture tailored to resin flooring assessment.

Its methodological significance lies in organising multiple technical and non-technical dimensions within a common framework while explicitly recognising the limitations of aggregate scoring, incomplete evidence, and potentially critical performance failures. Its conceptual significance lies in distinguishing three complementary research functions: sustainable construction-chemical adoption through SCCAF, project-specific technical selection through WRI, and structured evidence-based assessment through HRI. Its potential practical significance lies in supporting more consistent documentation, transparent comparison of flooring proposals, identification of assessment gaps, and structured review of installed systems. These benefits remain proposed applications rather than empirically demonstrated outcomes.

A preliminary HRI certificate reports a rating of 7.13/10, classified as “Qualified Finish,” for a nominal 4 mm polyurethane flooring system. Because the underlying checklist was incomplete, this score is treated as provisional and is not independently recalculated or used to establish the validity of the framework.

Accordingly, this study is positioned as framework development and methodological specification, supported by a proposed validation protocol. It does not claim that HRI is already a validated predictive instrument, an accredited certification scheme, or a replacement for established engineering standards.

The broader research proposition is that the complementary use of SCCAF, WRI, and HRI may provide a foundation for a connected, sustainability-oriented decision-support architecture spanning adoption considerations, technical system selection, and evidence-based flooring assessment.

II. LITERATURE REVIEW

Literature review approach and scope

This section is a focused narrative review of methodological guidance, flooring life-cycle studies, relevant test/management standards, and the author’s published framework papers. It is not a registered systematic review, and no claim of exhaustive database coverage is made. The sources are used according to their scope: composite-indicator literature supports index-construction choices; flooring LCA studies support lifecycle considerations; standards support specific test or management practices; and the author’s publications establish framework provenance, not independent validation.

A. Composite-indicator methodology

A central implication is that a composite rating should not conceal critical non-compliance. Where a flooring system fails a mandatory safety, regulatory, or project acceptance requirement, an aggregate score alone may communicate a misleading impression of suitability. The proposed HRI therefore separates critical pass/fail gates from the weighted score. The literature supports this as a design safeguard, but does not establish the specific HRI weights or thresholds; those remain hypotheses to be examined through expert review and empirical testing.

Composite indicators are useful when a decision problem has several dimensions that cannot be represented adequately by one measurement. Their usefulness, however, depends on the theoretical model that defines the dimensions, the quality and comparability of the underlying indicators, and the transparency of the transformation from raw evidence to a composite score. The OECD/JRC handbook describes a staged process that includes theoretical framing, indicator selection, data examination, normalisation, weighting, aggregation, and uncertainty and sensitivity analysis (Nardo et al., 2005; OECD/European Union/European Commission Joint Research Centre, 2008). This guidance is directly relevant to HRI because its domain scores combine unlike evidence, including test results, field observations, lifecycle estimates, and quality-control records.

Weighting should not be treated as a purely mathematical step. Weights may encode normative priorities or trade-offs, and their meaning depends on the aggregation rule. A weighted arithmetic mean is compensatory: a high score in one domain can offset a low score in another. Becker et al. (2017) further show that a nominal weight does not necessarily equal the indicator’s effective influence on the final score, because correlations and distributions among indicators also affect results. For HRI, weights must therefore be justified by the intended decision purpose, correlated criteria should be examined to avoid double counting, and sensitivity analysis should assess whether plausible alternatives change scores or rankings.

B. Engineering Performance and Installation Quality

The literature and standards provide methods for assessing particular properties, not a universal scoring scale for all resin flooring applications. This creates a practical requirement for HRI: criteria should be selected from the project's declared use profile, manufacturer instructions, recognised test methods, and contract requirements. The scoring manual must not turn a test result into a universal pass mark unless the basis for that threshold is stated.

Resin flooring is a system whose suitability depends on the combination of formulation, substrate, installation method, service environment, and maintenance. Relevant properties may include adhesion, abrasion and impact resistance, chemical resistance, slip resistance, cleanability, moisture tolerance, thermal exposure, electrostatic performance, and resistance to the loads expected in service. These properties are not interchangeable: an excellent result on one test cannot establish overall fitness for purpose. Test methods and acceptance thresholds should therefore be selected against the intended use and the contract or applicable technical specification. For example, ASTM D7234-22 addresses pull-off strength of coatings on concrete; it does not by itself evaluate the complete performance of a resin flooring system (ASTM International, 2022).

Product-level laboratory data also need to be distinguished from installed-system evidence. Substrate soundness, surface preparation, moisture condition, mixing, application thickness, curing, environmental conditions, joints, and inspection can affect the final result. A defensible assessment should record whether each piece of evidence relates to the product, a laboratory specimen, a site-installed system, or an in-service floor. The WRI/WQC structure is intended to preserve this distinction by linking each score to a criterion, test or inspection method, acceptance rule, evidence source, date, and applicability status.

C. Durability, Sustainability, and life-cycle Economics

For HRI, Sustainability and ESG indicators should consequently use traceable evidence and declared boundaries. Evidence might include environmental product declarations, relevant VOC or emissions test reports, material and waste records, repairability, and lifecycle assumptions. These sources are not automatically comparable: the functional unit, declared scope, system boundaries, reference service life, and scenario assumptions must be checked. Similarly, economic comparisons should use a consistent functional unit, time horizon, cost scope, and discount-rate assumption. A low purchase price or a single environmental attribute should not be treated as sufficient proof of superior lifecycle performance. Durability and service life should be evaluated in relation to exposure, maintenance, repair, and replacement rather than inferred from a single short-term laboratory result. Life-cycle costing for constructed assets requires a defined analysis period and transparent assumptions about costs over time (ISO, 2017). For resin flooring, relevant factors may include preparation and installation costs, shutdown or downtime, cleaning, maintenance, repair, recoating, replacement frequency, and end-of-life treatment. Where field histories are unavailable, service-life estimates should be explicitly labelled as assumptions or forecasts rather than observed outcomes.

Life-cycle assessment (LCA) provides a structured way to evaluate environmental impacts across defined system boundaries. ISO 14040 and ISO 14044 establish principles and requirements for LCA, while flooring studies demonstrate why the use stage, maintenance, repair, replacement, and comparability of environmental product declarations can materially affect conclusions (ISO, 2006a, 2006b; Reza et al., 2011; Ros-Dosdá et al., 2019). Ros-Dosdá et al. (2019), for example, compared indoor floor-covering systems over a cradle-to-cradle scope and considered alternative pedestrian-traffic scenarios. Their findings caution against selecting a flooring option solely from product-stage information when use-stage assumptions differ.

D. Integrated Architecture: SCCAF $\rightarrow$ WRI $\rightarrow$ HRI

The proposed architecture links three layers while preserving their different analytical purposes. SCCAF (Sustainable Construction Chemicals Adoption Framework) describes stakeholder, behavioural, institutional, technological, market-access, and sustainability-related factors that may influence adoption of construction chemicals. The user's published SCCAF work provides the author-developed adoption context; it should be cited as the source of that framework rather than presented as independent validation of HRI (Sai Gowrav & Nandi, 2026; Sai Gowrav A., 2026b). WRI is the resin-flooring assessment form and organises the technical and implementation evidence into six domains. HRI is the proposed scoring and reporting layer that applies normalisation, domain weights, evidence-status rules, critical gates, and transparent reporting to WRI results. Thus, SCCAF addresses why and under what conditions a system may be adopted; WRI addresses what evidence is assessed; and HRI addresses how that evidence is summarised for decision support. This separation reduces the risk of conflating adoption intention with engineering suitability.

The architecture is a conceptual integration, not proof of a causal chain. It does not establish that a higher HRI score causes greater adoption, longer service life, or better sustainability outcomes. Those propositions require separate empirical tests using suitable project-level, stakeholder, and longitudinal evidence.

E. Why these six domains? Attribution and academic rationale

The six domains are not presented as a taxonomy independently invented by the present HRI paper. They are the WRI resin-flooring assessment domains attributed to Sai Gowrav A. (2026a). The role of this manuscript is to explain their technical logic, connect them to wider literature, and specify how HRI scores and reports evidence collected through the WRI form. This distinction separates author-developed framework content from external methodological support.

Mechanical Performance (MP).

Mechanical properties are necessary because flooring must resist the loads and stresses expected in service, such as abrasion, impact, rolling traffic, and substrate-related stresses. The relevant tests and acceptance limits must be selected for the actual system and exposure; a single test cannot prove overall suitability. For example, ASTM D7234-22 concerns pull-off adhesion of coatings on concrete, not every dimension of resin-flooring performance (ASTM International, 2022). The WRI domain is attributed to Sai Gowrav A. (2026a); the test-method citation supports only the relevant engineering measurement.

Functional Performance (FP).

A flooring system must meet the operational purpose of the space, which may include slip resistance, chemical resistance, cleanability, hygiene, electrostatic-control needs, thermal exposure, or traffic suitability. These are use-case requirements rather than generic product virtues, so the assessment must identify the intended service environment and contractual acceptance criteria. This domain is part of the WRI framework attributed to Sai Gowrav A. (2026a); the present paper specifies its rationale rather than claiming independent validation of the domain.

Durability and Service Life (DS).

Initial test results or a high short-term strength value do not by themselves establish service life. Durability assessment should consider exposure, maintenance, repair, replacement, and documented field performance. ISO 15686-5 provides a life-cycle-costing framework for constructed assets, while composite-indicator methodology calls for transparent assumptions and robustness checks (ISO, 2017; OECD/European Union/European Commission Joint Research Centre, 2008). These methods support the need to assess durability and service-life implications but do not validate a particular WRI weight.

Sustainability and ESG.

Environmental and social considerations should be assessed using defined system boundaries and evidence, rather than a single claim such as low VOC content. Flooring life-cycle research has used environmental, economic, and socio-political criteria in comparative assessment (Reza et al., 2011), and ISO 14040/14044 set out principles and requirements for life-cycle assessment (ISO, 2006a, 2006b). ESG indicators must be operationally defined and supported by traceable evidence; this domain's placement in WRI is attributed to Sai Gowrav A. (2026a).

Economic Efficiency (EE).

Purchase price alone may misrepresent value where installation downtime, maintenance, repairs, replacement frequency, and end-of-life costs differ. Life-cycle costing offers a consistent way to compare alternatives when functional unit, analysis period, discount rate, and assumptions are aligned (ISO, 2017). Independent flooring sustainability research also considers economic criteria in flooring-system comparisons (Reza et al., 2011). The exact WRI domain and its weight remain author-proposed and require calibration against project data.

Workmanship and Quality Control (WQC).

Installed performance depends not only on formulation but also on substrate condition, surface preparation, moisture control, mixing, application thickness, curing conditions, joint detailing, and inspection. Consequently, a rating should distinguish manufacturer-reported product properties from evidence that the installed system complied with the method statement and project specification. This is a technically reasoned WRI domain attributed to Sai Gowrav A. (2026a); the HRI protocol should require dated inspection records, test reports, and documented non-conformities where applicable.

Why a composite score—and why caution is required.

The six domains cover distinct but related questions: can the system withstand physical demands, perform its intended function, remain serviceable, address sustainability concerns, deliver value over time, and be installed with controlled quality? Composite-indicator guidance recommends a clear theoretical framework, transparent indicator selection, explicit normalization and weighting, and sensitivity analysis because choices about indicators and weights can materially affect results (OECD/European Union/European Commission Joint Research Centre, 2008). Therefore, the six-domain structure is a defensible proposed assessment architecture, but the proposed 25/20/20/15/10/10 weights should not be described as empirically optimal until expert elicitation, sensitivity testing, and independent outcome validation are completed.

F. Weight-selection rationale and continuity with Sai Gowrav A.'s published WRI work

The weight-selection logic in the present manuscript should be grounded in, and distinguished from, Sai Gowrav A.'s published SCCAF–WRI–SEM study. That study specifies a weighted, normalized integrated score across seven indices: WRI_n (20%), Resin Performance Index (RPI, 15%), Chemical Resistance Index (CRI, 15%), VOC Health Impact Corrected Score (VHIC, 15%), Cost Performance Index (CPI, 10%), Sustainability Performance and Technology Index (SPTI, 15%), and Business Adoption Index (BAI, 10%) (Sai Gowrav A., 2026). The paper explains that the integrated decision model is intended to combine engineering performance, chemical resistance, VOC-health impact, life-cycle cost, sustainability, and adoption feasibility rather than relying on a single criterion. It also states that weights may be adjusted for project-specific chemical exposure, mechanical loading, VOC sensitivity, hygiene requirements, substrate condition, maintenance demands, and life-cycle cost priorities.

How that prior weighting logic informs the present six-domain WRI–HRI model.

The prior publication supports the methodological principle of using normalized, weighted criteria to balance technical performance, sustainability, cost, and adoption factors. However, its seven-index weights are not identical to the six-domain weights proposed here. Therefore, the present paper must not claim that the earlier publication empirically proves the exact HRI allocation of MP 25%, FP 20%, DS 20%, Sustainability and ESG 15%, EE 10%, and WQC 10%. Instead, the six-domain allocation is presented as a reasoned initial mapping: MP receives the largest provisional share because mechanical adequacy is a core system-performance constraint; FP and DS receive substantial shares because suitability and sustained service are distinct requirements; Sustainability and ESG captures environmental and social considerations; EE represents life-cycle value; and WQC captures execution and verification quality. These are transparent design rationales, not statistically estimated coefficients.

Required validation of the proposed six-domain weights.

Consistent with composite-indicator guidance, weights are value judgements unless derived from an explicit empirical or structured expert procedure; they can materially affect composite scores and rankings (Nardo et al., 2005; OECD/European Union/European Commission Joint Research Centre, 2008). The six-domain weights should therefore be validated by: (1) a documented expert panel or Analytic Hierarchy Process pairwise-comparison exercise; (2) reporting the resulting weights and consistency checks; (3) sensitivity analysis comparing the proposed weights with equal weighting and plausible alternative weight sets; and (4) external comparison with independent engineering and field outcomes. Where a project has a non-negotiable safety or performance threshold, a critical pass/fail gate should apply irrespective of the weighted total. Until these steps are completed, the percentages should be described as provisional, theory-informed design weights.

G. Research gap

The unresolved gap is therefore not the absence of any methods for flooring evaluation; it is the lack of demonstrated validation for this particular staged SCCAF–WRI–HRI architecture and its proposed six-domain scoring protocol. Specifically, it remains to be tested whether assessors can apply the WRI criteria consistently, whether the proposed HRI score is robust to plausible choices of weights and normalisation, whether critical-gate rules are applied reproducibly, and whether HRI results correspond meaningfully to independent engineering and field outcomes. The present paper specifies a framework and a validation plan; it does not claim that these questions have already been answered.

The literature establishes three relevant foundations. First, composite-indicator guidance provides procedures for theoretical framing, normalisation, weighting, aggregation, and sensitivity analysis (Nardo et al., 2005; OECD/European Union/European Commission Joint Research Centre, 2008). Second, flooring life-cycle studies show that environmental and economic comparisons depend on system boundaries, use scenarios, maintenance, repair, and replacement assumptions (Reza et al., 2011; Ros-Dosdá et al., 2019). Third, coating test methods and quality-management principles support the evaluation of specific properties and installation controls, but do not create a single universal rating across all resin-flooring uses.

The present study's specific contribution is to articulate a staged link between an adoption framework (SCCAF), an evidence-collection and assessment form (WRI), and a composite reporting layer (HRI), while explicitly separating critical compliance gates from compensatory scoring. The proposed six-domain weights are provisional design choices informed by engineering relevance and the framework's stated purpose. They are not derived from the cited flooring studies and should not be represented as empirically optimal. The next research phase should use structured expert elicitation, inter-rater testing, alternative-weight sensitivity analysis, and independent field data to evaluate content validity, reproducibility, robustness, and criterion-related validity.

Taken together, the literature supports the need for a transparent, multi-criteria decision structure but also warns against treating a composite score as self-validating. The flooring literature contributes lifecycle boundaries and the importance of use-stage scenarios; standards contribute test-specific procedures and quality requirements; and composite-indicator research contributes rules for normalisation, weighting, aggregation, and robustness testing. These strands are complementary but not interchangeable.

H. Literature synthesis and implications for the present study

The literature reviewed in this study indicates that flooring-system selection is a multidimensional decision rather than a comparison of initial material properties alone. Technical performance, suitability for the intended service environment, durability, maintenance requirements, environmental impacts, lifecycle costs, and installation quality can influence the overall suitability of a flooring system. These dimensions are examined through different methods and evidence types. Laboratory tests, lifecycle assessments, cost models, standards, and stakeholder-adoption studies answer different questions and should not be treated as interchangeable forms of evidence.

First, engineering assessment requires a distinction between product-level properties and installed-system performance. For resin flooring, measured adhesion, abrasion resistance, chemical resistance, slip resistance, thickness, and other functional requirements are meaningful only when the test method, substrate condition, preparation, curing, and failure mode are documented. A result from one test cannot independently demonstrate long-term service performance. This supports the WRI design choice to retain separate domains for mechanical performance, functional performance, durability/service life, and workmanship/quality control.

Second, flooring sustainability findings depend on methodological choices such as the functional unit, system boundary, reference service life, maintenance cycle, repair frequency, replacement assumptions, and end-of-life scenario. Studies of indoor floor coverings or rehabilitation systems provide useful methodological lessons, but their results cannot automatically be transferred to industrial resin flooring. The present study therefore treats life-cycle and environmental values as context-dependent evidence that must be reported with their assumptions, rather than as universal product rankings.

Third, lifecycle economic evaluation should distinguish initial installed cost from the cost of maintenance, downtime, repair, replacement, and other relevant costs over a defined analysis period. Comparisons are defensible only when alternatives provide comparable functions and the analysis period, discount rate, and maintenance assumptions are stated. Within WRI, economic efficiency should therefore be assessed from documented cost inputs and assumptions; HRI should not reward an apparently low cost where lifecycle evidence is incomplete.

Fourth, composite-index methodology shows that indicator selection, normalisation, weighting, aggregation, and missing-data treatment materially affect the final score. A single composite number can improve communication, but it may also conceal weak performance in an important domain. Accordingly, the proposed HRI weights—mechanical performance 25%, functional performance 20%, durability/service life 20%, sustainability and ESG 15%, economic efficiency 10%, and workmanship/quality control 10%—are provisional design parameters. They should be subjected to expert review, sensitivity analysis, and empirical validation. Critical safety and minimum technical requirements should be treated as non-compensatory pass/fail gates, not offset by high scores elsewhere. Fifth, technical suitability and market adoption are related but distinct questions. SCCAF addresses behavioural, institutional, market-access, and stakeholder conditions that can influence specification and uptake. WRI organises the evidence used to assess the flooring system, while HRI is the proposed scoring and reporting layer. This separation is intended to prevent adoption intention from being mistaken for engineering performance, or a high technical score from being treated as proof that stakeholders will adopt a system.

Taken together, the literature supports the need for transparent, multidimensional evaluation and careful handling of lifecycle assumptions and composite scores. The specific contribution proposed in this study is the integration of an adoption-context framework (SCCAF), a six-domain evidence-assessment form (WRI), and a composite reporting index (HRI) into a single workflow. The reviewed sources do not independently validate this exact architecture or its numerical weights. The contribution should therefore be described as a proposed integrated assessment approach, with its validity and usefulness to be tested through expert content validation, inter-rater reliability assessment, field application, sensitivity analysis, and external validation.

These implications lead to the following propositions for the present study: (i) flooring-system comparisons should be based on traceable technical and functional evidence; (ii) lifecycle and sustainability results should disclose their boundaries and assumptions; (iii) workmanship and quality-control evidence should be recorded separately from nominal product properties; (iv) HRI scores should be accompanied by domain scores, evidence-completeness information, and any failed critical gates; and (v) the relationship between SCCAF adoption constructs and WRI/HRI technical assessments should be examined empirically rather than assumed. These propositions guide the subsequent research design and validation plan.

Closing Statement

In conclusion, the literature reviewed highlights the need for a transparent, multidimensional, and evidence-based approach to evaluating resin flooring systems. Although existing studies provide valuable methods for assessing engineering performance, durability, environmental impacts, lifecycle costs, and composite indicators, these dimensions require a coherent assessment structure that also recognises stakeholder adoption and installation quality. To address this research need, the present study proposes an integrated Sustainable Construction Chemicals Adoption Framework (SCCAF), WRI assessment form, and Hoysalas SG Composite Rating Index (HRI). The proposed integration seeks to connect adoption-related determinants with systematic technical assessment and structured performance reporting. However, the proposed domains, weighting scheme, and aggregation procedure must be subjected to appropriate expert review, reliability testing, sensitivity analysis, and empirical validation before their effectiveness or generalisability can be established. Accordingly, this literature synthesis provides the conceptual and methodological foundation for the subsequent research design and validation of the SCCAF–WRI–HRI framework.

III. RESEARCH METHODOLOGY AND MATHEMATICAL FORMULATION:

A. Research Design

This study proposes the Hoysalas SG Composite Rating Index (HRI), a multi-criteria composite assessment framework for evaluating resin flooring systems against engineering performance, functional suitability, durability, sustainability and environmental, social and governance (ESG) considerations, economic efficiency, and workmanship quality.

The methodology combines criterion-level evaluation, normalized category scoring, weighted aggregation, evidence-completeness assessment, and mandatory critical-requirement gates. The proposed framework is intended to support transparent comparison and structured quality assessment of resin flooring systems.

The HRI is a proposed composite assessment instrument. Its scoring architecture, category weights, and classification thresholds should be treated as provisional until supported by expert review, reliability testing, sensitivity analysis, and independent field validation.

B. HRI Assessment Categories and Weights

The HRI comprises six categories with a total weight of 100% and a maximum nominal score of 1,000 points.

Code	Assessment category	Weight (%)	Normalized weight	Maximum nominal points
MP	Mechanical Performance	25	0.25	250
FP	Functional Performance	20	0.20	200
DS	Durability and Service Life	20	0.20	200
ESG	Sustainability and ESG	15	0.15	150
EE	Economic Efficiency	10	0.10	100
WQC	Workmanship and Quality Control	10	0.10	100
Total		100	1.00	1,000

Operationalisation matrix for the six HRI domains

The following matrix is a proposed minimum specification. It is not a substitute for application-specific acceptance criteria, manufacturer requirements, contract specifications, or applicable codes. Each criterion must be assessed against a stated intended-use profile and traceable evidence.

Domain (weight)	Indicative criteria	Evidence examples	Decision rule / safeguard
Mechanical Performance (25%)	Abrasion, impact, compressive/flexural behaviour where relevant, adhesion, resistance to imposed loads.	Product test reports; project-specific test results; pull-off adhesion results where appropriate; load and traffic specification.	Use specified test methods and acceptance limits. A mandatory mechanical failure triggers the critical-failure gate.

Functional Performance (20%)	Chemical exposure, slip resistance, hygiene/cleanability, thermal shock, electrostatic properties, or other use-specific functions.	Exposure schedule; chemical-resistance data; slip test results; ESD reports; cleaning and operational requirements.	Only score criteria applicable to the declared use. Critical functional requirements are pass/fail, not compensatory.
Durability & Service Life (20%)	Expected service life assumptions, maintenance interval, wear, defect/repair history, moisture/substrate risks.	Maintenance plans; field inspection records; repair logs; warranty terms; documented service-life assumptions.	Do not infer service life from short-term tests alone. State the analysis period and uncertainty.
Sustainability & ESG (15%)	VOC/emissions evidence, material transparency, waste, environmental declarations, reparability and lifecycle impacts.	SDS/TDS; test reports; EPD/LCA if available; waste and maintenance records; verified supplier declarations.	Distinguish measured/verified evidence from supplier claims and missing evidence. Avoid double counting correlated indicators.
Economic Efficiency (10%)	Installed cost, preparation, downtime, maintenance, repair, replacement and end-of-life costs.	Comparable quotations; bill of quantities; maintenance assumptions; discount rate and analysis period.	Compare alternatives on the same functional unit, time horizon, scope and assumptions.
Workmanship & Quality Control (10%)	Substrate assessment, moisture checks, preparation, environmental conditions, thickness, curing, inspection and handover.	Site QA/QC checklists; calibrated measurements; batch records; photographs; non-conformance and repair records.	Record deviations and corrective actions. Critical installation non-conformance may trigger a gate.

The normalized weights must satisfy:

The sum of the normalized category weights must equal 1:

$$\sum_{j=1}^6 w_j = 1$$

where (w_j) represents the normalized weight of category (j), and ($m=6$) is the number of HRI categories.

C. Criterion-Level Assessment and Normalization

Each category contains predefined criteria supported, where applicable, by technical datasheets, test reports, site inspection records, installation records, environmental documentation, lifecycle-cost calculations, and quality-control evidence.

The conversion of laboratory results, field observations, or ordinal ratings into criterion scores must be established in a scoring manual before assessments are conducted. Where a criterion is evaluated against a technical acceptance threshold, the scoring rule should specify the applicable standard, test method, acceptance limit, and evidence requirement.

D. Category-Level Score

The normalized score for category (j) is calculated as the weighted mean of its applicable and verified criterion scores:

The normalized score for each criterion is calculated as:

$$r_{ij} = x_{ij} / x_{ij}(\max)$$

Where:

r_{ij} = normalized score for criterion i in category j .

x_{ij} = score obtained for the criterion.

$x_{ij}(\max)$ = maximum attainable score for the criterion.

The normalized score must satisfy:

$$0 \leq r_{ij} \leq 1$$

Example: if a criterion receives 8 out of 10 points:

$$r_{ij} = 8 / 10 = 0.80$$

Category Score Calculation

The normalized score for each category is:

$$q_j = [\sum_{i \in V_j} a_{ij} r_{ij}] / [\sum_{i \in V_j} a_{ij}]$$

Where:

q_j = normalized category score.

a_{ij} = predefined weight of criterion i within category j .

V_j = set of applicable criteria with sufficient verified evidence.

r_{ij} = normalized criterion score.

If all criteria have equal weights, the category score simplifies to:

$$q_j = (1 / n_j) \sum_{i=1}^{n_j} r_{ij}$$

Here, n_j is the number of applicable, verified criteria in the category. The denominator must follow predefined rules for applicable and verified evidence.

E. Composite HRI Score: 1,000-Point Scale

The composite score is obtained by multiplying each normalized category score by its normalized category weight, summing the weighted scores, and multiplying the result by 1,000.

The general formula is:

The general composite score formula is:

$$HRI_{1000} = 1000 \sum_{j=1}^6 w_j q_j$$

Substituting the six category weights:

$$HRI_{1000} = 1000 [0.25q_{MP} + 0.20q_{FP} + 0.20q_{DS} + 0.15q_{ESG} + 0.10q_{EE} + 0.10q_{WQC}]$$

The theoretical range is:

$$0 \leq HRI_{1000} \leq 1000$$

F. Composite HRI Score: 10-Point Scale

The equivalent 10-point HRI score is obtained by dividing the 1,000-point score by 100:

G. Evidence-Completion Rate

A numerical HRI score must be interpreted alongside the completeness of its supporting evidence.

The 10-point score is calculated as:

$$HRI_{10} = HRI_{1000} / 100$$

Alternatively, the score can be calculated directly:

$$HRI_{10} = 10 \sum_{j=1}^6 w_j q_j$$

Expanding the equation:

$$HRI_{10} = 2.5q_{MP} + 2.0q_{FP} + 2.0q_{DS} + 1.5q_{ESG} + 1.0q_{EE} + 1.0q_{WQC}$$

The theoretical range is:

$$0 \leq HRI_{10} \leq 10$$

Calculate the score using full precision and round only the final reported result.

H. Evidence-Completion Rate

The evidence-completion rate is:

$$C_E (\%) = 100 \times (N_V / N_A)$$

Where:

C_E = evidence-completion rate.

N_V = number of applicable criteria with sufficient verified evidence.

N_A = total number of applicable criteria after justified exclusions.

Example: if 45 of 50 applicable criteria have verified evidence:

$$C_E = 100 \times (45 / 50) = 90\%$$

A “Not Checked” criterion is missing evidence and must not automatically be counted as a pass. The minimum acceptable completion rate must be defined before the assessment.

I. Critical-Failure Override

Define the critical-gate variable G as:

G = 1, if all mandatory critical requirements are satisfied

G = 0, if one or more mandatory critical requirements fail

The final assessment status is determined as follows:

HRI_status = Eligible for rating, if G = 1 and evidence is sufficient

HRI_status = Critical Failure, if G = 0

HRI_status = Provisional/Not Rated, if evidence is insufficient

A high numerical HRI score must not override a failed mandatory safety, statutory, or essential technical requirement. The numerical score may be retained for diagnostic purposes, but it must not be interpreted as approval.

J. Treatment of Not Applicable Criteria

A criterion may be marked “Not Applicable” only when it is demonstrably irrelevant to the system or project being assessed and the reason is documented.

The following rules apply:

1. The applicability decision must be justified and recorded.
2. Excluded criteria must not be assigned an artificial score of 1.
3. Exclusions must follow consistent, predefined rules across comparable assessments.
4. The category denominator must be adjusted only in accordance with the approved scoring protocol.
5. The number and proportion of excluded criteria should be disclosed in the assessment report.

Where an entire category is not applicable, the assessment protocol must specify whether the HRI is withheld or whether an approved renormalization procedure is used. Category weights must not be redistributed informally after assessment.

K. Proposed HRI Rating Bands

The following classification thresholds are proposed for the HRI framework and require independent calibration before being interpreted as empirically validated categories.

HRI score	Proposed classification
$(0 \leq HRI_{10} < 3)$	Critical Failure
$(3 \leq HRI_{10} < 5)$	Substandard
$(5 \leq HRI_{10} < 7)$	Basic Compliance
$(7 \leq HRI_{10} < 8)$	Qualified Finish
$(8 \leq HRI_{10} < 9)$	Premium Finish
$(9 \leq HRI_{10} \leq 10)$	Signature/Benchmark Finish

These bands must be applied only after the critical-gate and evidence-completeness checks. A rating such as “Premium Finish” is a proposed HRI classification and must not be presented as an independent certification, statutory approval, or guaranteed service-life outcome.

L. Proposed HRI Rating Classification

HRI score	Classification
$0 \leq HRI_{10} < 3$	Critical Failure
$3 \leq HRI_{10} < 5$	Substandard

$5 \leq \text{HRI}_{10} < 7$	Basic Compliance
$7 \leq \text{HRI}_{10} < 8$	Qualified Finish
$8 \leq \text{HRI}_{10} < 9$	Premium Finish
$9 \leq \text{HRI}_{10} \leq 10$	Signature/Benchmark Finish

These are proposed rating bands. They require independent calibration and validation before being presented as empirically established thresholds.

M. Life-Cycle Cost Formula

For the Economic Efficiency category, life-cycle cost may be assessed using:

$$\text{LCC} = C_0 + \sum_{t=1}^T [C_t / (1 + d)^t] - [R_T / (1 + d)^T]$$

Where:

LCC = life-cycle cost.

C_0 = initial installed cost.

C_t = maintenance, repair, replacement, and other applicable costs in year t .

T = analysis period in years.

d = annual discount rate.

R_T = residual value at the end of the analysis period, if applicable.

All alternatives must use the same analysis period, functional unit, discount rate, and maintenance assumptions. The method for converting the resulting cost into the normalized Economic Efficiency score must be specified in the scoring manual.

N. Worked Example

Assume the following normalized category scores:

Category	Weight	Category score	Weighted contribution
MP	0.25	0.80	0.2000
FP	0.20	0.75	0.1500
DS	0.20	0.70	0.1400
ESG	0.15	0.60	0.0900
EE	0.10	0.85	0.0850
WQC	0.10	0.90	0.0900
TOTAL	1.00	—	0.7550

The 1,000-point score is:

$$\text{HRI}_{1000} = 1000 \times 0.7550 = 755$$

The 10-point score is:

$$\text{HRI}_{10} = 755 / 100 = 7.55$$

The proposed classification is Qualified Finish, provided all critical requirements are satisfied and the evidence-completion rules are met. This is an illustrative calculation, not an observed project result.

O. Validation Methodology

Content validity: Expert review of the relevance, clarity, and completeness of the criteria.

Inter-rater reliability: Independent scoring of the same cases using appropriate agreement statistics.

Construct and criterion-related evidence: Comparison with independent technical measurements and relevant expert or field assessments.

Sensitivity analysis: Examination of how changes in category weights and criterion scores affect the composite score and rankings.

External validation: Comparison with independent project outcomes, such as documented defects, maintenance requirements, repair frequency, and lifecycle costs.

The HRI should be described as a proposed assessment framework until these analyses provide sufficient evidence of reliability and validity.

P. Methodological Limitations and Governance

The framework may be affected by expert judgment in assigning weights, measurement uncertainty, missing evidence, applicability decisions, and differences among flooring systems and exposure conditions. Composite scores may conceal weak performance in an individual category; therefore, all six category scores and critical-failure status should be reported alongside the overall score.

Each assessment should document the project and system description, applicable criteria, evidence sources, test methods, criterion scores, exclusions, missing evidence, category scores, weights, composite score, critical-gate outcome, rating band, and assessment date. The scoring manual and calculation workbook should be version-controlled.

The HRI is a proposed decision-support and assessment framework. It does not replace mandatory testing, engineering judgment, applicable regulations, or project-specific acceptance requirements.

Q. Criterion Validation and Reliability Assessment

The HRI should undergo the following validation stages before its scores and rating bands are treated as validated.

1) Content Validity

An expert panel comprising relevant flooring engineers, materials specialists, sustainability professionals, quality-control personnel, and project stakeholders should evaluate each criterion for relevance, clarity, comprehensiveness, and feasibility of measurement.

Content validity may be assessed using the content validity index, with the panel size, rating scale, item-level index, scale-level index, and decision thresholds reported transparently. Thresholds should be selected before analysis and justified in relation to the panel size and study design.

2) Inter-Rater Reliability

Independent assessors should score the same representative cases using the same HRI manual.

For categorical assessments, Cohen's kappa may be used for two raters, or an appropriate multi-rater agreement statistic may be selected for larger panels. For continuous or approximately continuous scores, an intraclass correlation coefficient may be appropriate when its model, agreement definition, and confidence interval are reported.

3) Construct and Criterion-Related Evidence

The proposed categories should be evaluated to determine whether their scores behave as expected in relation to independent technical measurements, expert assessments, or relevant field outcomes.

Convergent and discriminant evidence should be investigated where theoretically appropriate. Correlation alone does not establish that the HRI is valid, and no category should be claimed to have been validated without supporting data.

4) Sensitivity and Uncertainty Analysis

The stability of the HRI ranking should be assessed by varying category weights and, where appropriate, criterion scores within justified ranges.

The analysis should report changes in composite scores, ranking reversals, and the proportion of scenarios in which each alternative retains its classification. Uncertainty in measurements, missing evidence, and scoring judgments should be considered separately from uncertainty in the assigned weights.

5) Predictive and External Validation

Where longitudinal or independent project data are available, HRI results should be compared with subsequent outcomes such as documented defects, repair frequency, maintenance requirements, observed performance, and lifecycle costs.

The validation dataset should be separate from the dataset used to develop or calibrate the scoring rules wherever feasible. Rating thresholds should be calibrated against defensible external criteria rather than selected solely for descriptive convenience.

R. Methodological Governance and Reporting

Each HRI assessment should document the project and system description, applicable criteria, evidence sources, assessor identity or role, test methods, applicable standards, criterion scores, exclusions, missing evidence, category scores, weights, composite score, critical-gate outcome, rating band, and date of assessment.

The scoring manual and calculation workbook should be version-controlled. Any revision to the weights, criteria, normalization procedure, or rating bands should be documented, and its effect on comparability with earlier assessments should be examined.

The HRI should be presented as a structured decision-support and assessment framework unless and until independent validation supports stronger claims. It must not replace mandatory testing, engineering judgment, applicable regulations, or project-specific acceptance requirements.

S. Methodological Summary

The proposed HRI methodology uses normalized criterion scores, category-level aggregation, predefined category weights, and a weighted composite score on both 1,000-point and 10-point scales. It separately evaluates evidence completeness and imposes non-compensatory gates for mandatory critical requirements. ESG, sustainability, and lifecycle-cost considerations are incorporated through documented indicators and consistent assessment assumptions.

The framework establishes a reproducible mathematical structure for assessment. Its reliability, validity, and generalizability remain empirical questions to be addressed through expert review, independent field data, and formal validation.

IV. HTML APPLICATION SPECIFICATION AND ALIGNMENT WITH THE HRI METHODOLOGY

This section documents the project-assessment and certificate-generation interface shown in the supplied HTML application screenshots. It records the visible project fields, six-category checklist workflow, alternative rating scales, rating bands, and assessment safeguards. Screenshots document the displayed interface but do not establish that the underlying code implements every displayed formula correctly.

A. Project and Evaluation Details

The interface collects the following project metadata before assessment:

Project name.

Client name.

Site location.

Applicator / contractor.

Resin system / brand (example shown: Epoxy / PU / PU concrete).

Nominal thickness (mm).

Evaluator.

Evaluation date (dd/mm/yyyy).

Supporting evidence / test report references (examples shown: test reports, inspection records, specifications).

These fields provide traceability between the HRI result, project, resin flooring system, evaluator, assessment date, and supporting evidence.

B. Six Performance Categories and Checklist Workflow

The interface instructs the evaluator to rate six performance categories and states that the weights sum to 100%, equivalent to 1,000 points. The screenshots do not show the individual checklist criteria or the detailed score assigned to each response. These details must be specified in the scoring manual or verified from the HTML source code.

C. Three Mathematical Rating Scales Displayed

The interface labels the section “Three Scales (0–10)” and provides a dropdown labelled “Certificate rating scale”. The displayed options are:

Scale	Displayed formula / description	Interpretation
Fractional Century (Rf)	$R_f = S / 100$	Linear conversion from 0–1,000 points to 0–10.
Normalized Square Root (Rs)	$R_s = 10 \times \sqrt{S / 1000}$	Normalized nonlinear transformation from 0–1,000 points to 0–10.
Normalized Cube Root (Rc)	$R_c = 10 \times \sqrt[3]{S / 1000}$	Normalized nonlinear transformation from 0–1,000 points to 0–10.

The screenshot originally displayed $R_f = S/100$, $R_s = \sqrt[3]{(S/10)}$, and $R_c = \sqrt[3]{(S/10)}$. For the corrected specification in this document, S is the cumulative score in the range 0–1,000 and the transformations are $R_f = S/100$; $R_s = 10 \times \sqrt[3]{(S/1000)}$; and $R_c = 10 \times \sqrt[3]{(S/1000)}$. These formulas all map $S = 0$ to 0 and $S = 1,000$ to 10.

Mathematical consistency is achieved by normalizing both nonlinear transformations by the maximum score: $R_s = 10 \times \sqrt[3]{(S/1000)}$ and $R_c = 10 \times \sqrt[3]{(S/1000)}$. At $S = 0$, all three scales equal 0; at $S = 1,000$, all three equal 10. These are alternative transformations of the same cumulative score, not independent measurements.

D. Cumulative Score Formula Displayed in the Interface

The screenshot displays this cumulative-score explanation:

$$\text{Cumulative score (points)} = 1000 \times \sum_{j=1}^6 (w_j \times q_j)$$

The scoring rule must be explicit. For binary checklist items, Pass = 1 and Fail = 0; Fail items remain in the denominator. Not Checked means evidence is incomplete and blocks a final rating; it must not be counted as a pass. Not Applicable may be excluded only with a recorded technical justification under the scoring manual. Category weights are entered as decimals and must sum to 1.00.

For consistency with the proposed methodology in Section 3, q_j is the normalized category score from 0 to 1 and w_j is the decimal category weight. The cumulative-score formula is:

$$S = 1000 \times \sum_{j=1}^6 (w_j \times q_j)$$

The equivalent 10-point weighted score is:

$$HRI_{10} = 10 \times \sum_{j=1}^6 (w_j \times q_j)$$

These are the corrected formulae specified for the HTML application. The actual HTML/JavaScript source must be updated to use them and tested before claiming that the deployed application implements them.

E. Corrected Checklist Scoring and Final-Status Rules

The corrected binary checklist rule is: Pass = 1.00; Fail = 0.00. All applicable Pass and Fail criteria remain in the category denominator. Not Checked is missing evidence and prevents a final rating until checked. Not Applicable may be excluded only when a technical reason is documented and the scoring manual permits exclusion.

For category j , with A_j representing applicable criteria after justified N/A exclusions, and a_{ij} representing predefined within-category criterion weights:

$$q_j = [\sum_{i \in A_j} a_{ij} v_{ij}] / [\sum_{i \in A_j} a_{ij}], \text{ where } v_{ij} = 1 \text{ for Pass and } 0 \text{ for Fail.}$$

$$\text{Cumulative score: } S = 1000 \times \sum_{j=1}^6 (w_j \times q_j). \text{ Equivalent 10-point score: } HRI_{10} = S/100.$$

Final status: any failed mandatory critical requirement produces Critical Failure regardless of the aggregate score. If any applicable criterion remains Not Checked, the result is Provisional / Not Rated. A final numeric rating is issued only when all applicable criteria are checked, evidence requirements are met, and all critical gates pass.

F. Rating Bands Displayed in the Interface

Displayed range	Displayed classification
0–<3	Critical Failure
3–<5	Substandard
5–<7	Basic Compliance
7–<8	Qualified Finish
8–<9	Premium Finish
9–10	Signature / Benchmark Finish

The screenshots show these six rating bands. In academic reporting, identify them as proposed HRI bands unless independent calibration data establish their validity.

G. Critical Checks, Unchecked Items, and N/A Decisions

The interface states that critical failures and unchecked items remain visible as assessment limitations. It requires the evaluator to confirm that checklist entries, evidence, critical checks, and N/A decisions have been reviewed before selecting “Evaluate & Generate Certificate”.

The application should preserve an audit trail for failed criteria, unchecked criteria, N/A exclusions, evidence references, and critical-gate decisions. A critical failure must not be hidden by a high aggregate score. Unchecked items should be treated as missing evidence, not automatic passes.

H. Certificate and Intended-Use Disclaimer

The interface is presented as an interactive project assessment with weighted scoring, printable evaluation certificate, and offline application capability. The screenshot states that the HRI is a proposed Hoysala assessment framework and is not third-party accreditation or proof of compliance with a particular standard.

The certificate should identify the project, resin system, nominal thickness, evaluator, date, evidence references, selected rating scale, cumulative score, category scores, evidence-completion status, critical-failure status, and applicable disclaimer. It must not imply independent certification unless such certification has actually been obtained.

I. Verification Tests Required for the HTML Calculator

Confirm that the six category weights sum to 1.00 and that the maximum cumulative score is 1,000.

Test boundary inputs: $S = 0, 300, 500, 700, 800, 900$, and 1,000.

Verify that $R_f = S/100$, $R_s = 10 \times \sqrt{(S/1000)}$, and $R_c = 10 \times \sqrt[3]{(S/1000)}$ for S on a 0–1,000 scale.

Decide whether square-root and cube-root outputs must span 0–10; if so, define normalized formulas and test endpoints.

Verify the treatment of Pass, Fail, Not Checked, and Not Applicable responses in the actual code.

Confirm that critical failures override rating status and incomplete evidence produces the intended provisional/not-rated state.

Verify that the selected scale, calculation, displayed score, rating band, and printable certificate use the same result.

J. Relationship Between the Paper and HTML Application

The methodology defines the proposed scoring model, category weights, evidence rules, and validation requirements. The HTML application operationalizes the model through project metadata, checklists, scale selection, cumulative scoring, and certificate generation. The screenshots document the intended workflow but do not establish software verification, inter-rater reliability, construct validity, or predictive validity. These require code inspection, reproducible calculation tests, and independent empirical assessment.

V. RESULTS AND DISCUSSION

A. Framework Output

The source tool defines six categories totalling 100% and a potential 1,000-point assessment. This provides a clear high-level structure for combining technical, functional, durability, environmental, economic and workmanship considerations. The framework’s value, however, depends on the quality of indicator definitions and evidence rules beneath those categories. Category weights alone do not demonstrate reliability or validity.

B. Preliminary Certificate Case

The supplied certificate records assessment reference HRI-20261019-4165480, evaluation date 19 October 2026, nominal thickness 4 mm and system type polyurethane. It reports a Fractional Century rating (R_f) of 7.13/10 and the label “Qualified Finish.” The certificate also states that the inspection checklist was not fully completed and the numerical rating is provisional. The score is therefore reproduced as a source-reported preliminary result, not treated as an independently verified calculation or proof of product/system performance.

The certificate’s project/client/location/applicator fields are placeholders in the supplied record. No category-level scores, completed item-level checklist, test reports or evidence package was provided for independent recalculation. Consequently, the paper cannot identify which category drove the rating, quantify uncertainty around 7.13, or infer that the installed floor will achieve a particular service life. A final case-study report should append the completed checklist, evidence references, category calculations, critical-check status and a record of how unchecked and not-applicable items were treated.

C. Interpretation of the proposed contribution

HRI's most defensible potential contribution is procedural: it can make assessment dimensions explicit, prompt evidence collection and provide a repeatable reporting structure. It should not be interpreted as a substitute for system-specific engineering design, manufacturer instructions, applicable test standards or contractual acceptance criteria. Nor should its score be directly compared with WRI's 0–100 technical selection score unless the constructs, scales and intended decisions have been formally mapped and validated.

RESIN FLOORING RATING CERTIFICATE	
Hoysalas SG composite Rating Index for resin Flooring	
Hoysalas SG composite Rating Index for resin Flooring	
Qualified Finish	
Rating classification: Qualified Finish	
<p>Explanation of Hoysalas SG composite Rating Index for resin Flooring</p> <p>HRI expresses the assessed resin-floor performance on a 0–10 scale based on the weighted inspection matrix (maximum 1,000 points). The selected calculation is Fractional Century (Rf). The resulting index of 7.13 / 10 falls in the Qualified Finish rating slot.</p> <p>Rating explanation: Qualified Finish: The floor demonstrates good overall assessed quality and performance, subject to meeting the specified test and service requirements.</p> <p>The rating is an assessment indicator, not a substitute for mandatory test acceptance, engineering approval or independent accreditation.</p>	
Hoysalas SG composite Rating Index for resin Flooring — Fractional Century (Rf): 7.13 / 10	
Assessment reference: HRI-20261019-4165480	
Project	abc
Client	def
Location	ghi
Applicator	dec
System	pu
Nominal thickness	4 mm
Evaluation date	2026-10-19
Assessment limitation: inspection checklist not fully completed; numerical rating is provisional.	
Evaluator / Engineer kishore	Independent reviewer / Authorised signatory Signature: _____
<small>Hoysala methodology rating only; not an accredited third-party certification. Rating bands adapted from the Constro Facilitator HRI article. Numerical rating does not establish compliance or independent certification.</small>	

D. Limitations

- The present study is conceptual and based on the supplied tool and certificate; it does not include a representative field dataset.
- The proposed category weights and rating thresholds have not been empirically validated.
- The certificate's 7.13/10 result is provisional because the checklist is incomplete and category-level calculations were not supplied.
- The scoring formula and treatment of unchecked/not-applicable items require full specification and verification against the implemented calculator.
- No inter-rater reliability, predictive validity, sensitivity analysis or external accreditation is claimed.
- The evidence base does not support generalising the preliminary result to other resin chemistries, thicknesses, substrates, exposure classes or projects.

VI. CONCLUSION

This paper has specified the conceptual architecture of the Hoysalas SG Composite Rating Index as a proposed evidence-oriented framework for resin flooring assessment. Its six weighted dimensions bring together mechanical performance, functional suitability, durability, sustainability, economic efficiency and workmanship/quality control. Its intended relationship to the author's related work is complementary: SCCAF addresses adoption drivers, WRI supports project-specific technical selection, and HRI is designed to structure multi-dimensional assessment and reporting.

The source certificate reports a provisional score of 7.13/10 for a nominal 4 mm polyurethane system, classified as "Qualified Finish." Because the checklist was incomplete and the underlying category calculations and evidence were not provided, this score must remain provisional. The current study therefore establishes a framework and research agenda, not a validated rating standard. HRI's next development stage should focus on formula verification, expert content review, pilot testing, inter-rater reliability, sensitivity analysis and comparison with independent field outcomes. Until that work is completed, HRI should be used as a structured decision-support and documentation aid—not as accredited certification or a replacement for mandatory technical acceptance.

VII. DECLARATIONS

Funding: No external funding information was supplied for this conceptual paper.

Conflicts of interest: The author developed the proposed HRI framework. Independent review and validation are therefore important to reduce potential developer bias.

Data availability: The source certificate and assessment-tool structure were available for conceptual analysis. A complete item-level dataset and independent validation dataset were not supplied.

Ethics: This conceptual framework paper reports no new human-participant data.

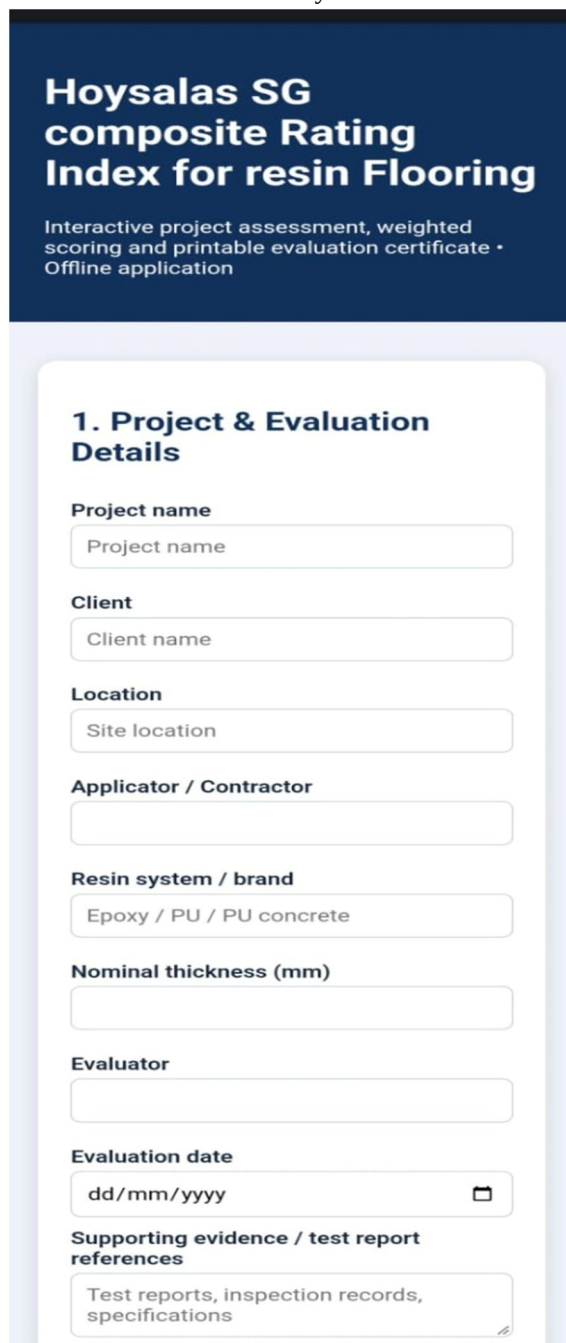
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Appendix A. HTML Application Screenshots

The following screenshots are reproduced from the supplied HRI HTML application interface. They document the visible user workflow and displayed mathematical scale options. They are evidence of the interface design, not independent proof that the underlying calculations have been implemented or validated correctly.



Hoyaslas SG composite Rating Index for resin Flooring

Interactive project assessment, weighted scoring and printable evaluation certificate • Offline application

1. Project & Evaluation Details

Project name

Client

Location

Applicator / Contractor

Resin system / brand

Nominal thickness (mm)

Evaluator

Evaluation date
 

Supporting evidence / test report references

Figure A1. Project and evaluation details form shown in the HRI application.

2. Rate the Six Performance Categories

Complete the checklist for every category. Weights sum to 100% (1000 points).

3. Hoysalas SG composite Rating Index for resin Flooring – Three Scales (0–10)

Certificate rating scale

Fractional Century (Rf = S / 100)

Fractional Century (Rf)

Square Root (Rs)

Cube Root (Rc)

Select one of the three mathematical scales. S = cumulative points out of 1,000. Fractional Century = $S \div 100$; normalized Square Root = $\sqrt{S \div 10}$; Cube Root = $\sqrt[3]{S}$. Combined Hoysala weighted 1,000-point inspection matrix and published six-slot resin-floor rating classification. Critical failures and unchecked items remain visible as assessment limitations.

0–<3 Critical Failure	3–<5 Substandard	5–<7 Basic Compliance
7–<8 Qualified Finish	8–<9 Premium Finish	9–10 Signature / Benchmark Finish

Cumulative score out of 1000
Rf: — / 10

Awaiting evaluation

Complete the project details and complete inspection checklists.

Cumulative score = Σ (category score + 10 × category weight × 10), where category score = 10 × passes / applicable checklist items (including failures and unchecked items). Rf = cumulative score ÷ 100 (maximum 10). Rating bands follow the published resin-flooring example: 0–<3 Critical Failure; 3–<5 Substandard; 5–<7 Basic Compliance; 7–<8 Qualified Finish; 8–<9 Premium Finish; 9–10 Signature / Benchmark Finish. This is a proposed Hoysala assessment framework, not third-party accreditation or proof of compliance with any particular standard.

☐ I confirm that the checklist entries, evidence, critical checks and N/A decisions have been reviewed.

Evaluate & Generate Certificate

Figure A2. Six-category checklist heading, three rating-scale options, proposed rating bands, and certificate-generation controls.

Appendix B. Critical Quality Review

Strengths: Six explicit categories and weights summing to 100%; equations for criterion normalization, category aggregation, 1,000-point and 10-point scores; a worked example; evidence-completion reporting; critical-failure override; ESG and life-cycle-cost consideration; and a proposed validation plan.

Formula-to-interface consistency: The revised methodology now specifies normalized square-root and cube-root transformations that both span 0–10. The HTML/JavaScript code itself still needs to be updated and tested against these formulas.

Scoring rule corrected in the revised specification: Pass = 1; Fail = 0 and remains in the denominator; Not Checked blocks final rating pending verification; Not Applicable requires a documented justification and permitted exclusion. The HTML source must be aligned with these rules.

Validation status: No independent validation dataset, inter-rater reliability results, criterion-validity results, or calibration evidence for the six rating bands was supplied. The framework must therefore be described as proposed, not empirically validated.

Certificate status: The application itself states that the HRI is a proposed assessment framework and is not third-party accreditation or proof of compliance with a particular standard. The certificate must preserve that limitation.

Appendix C. Required Actions Before Claiming Publication-Ready Quality

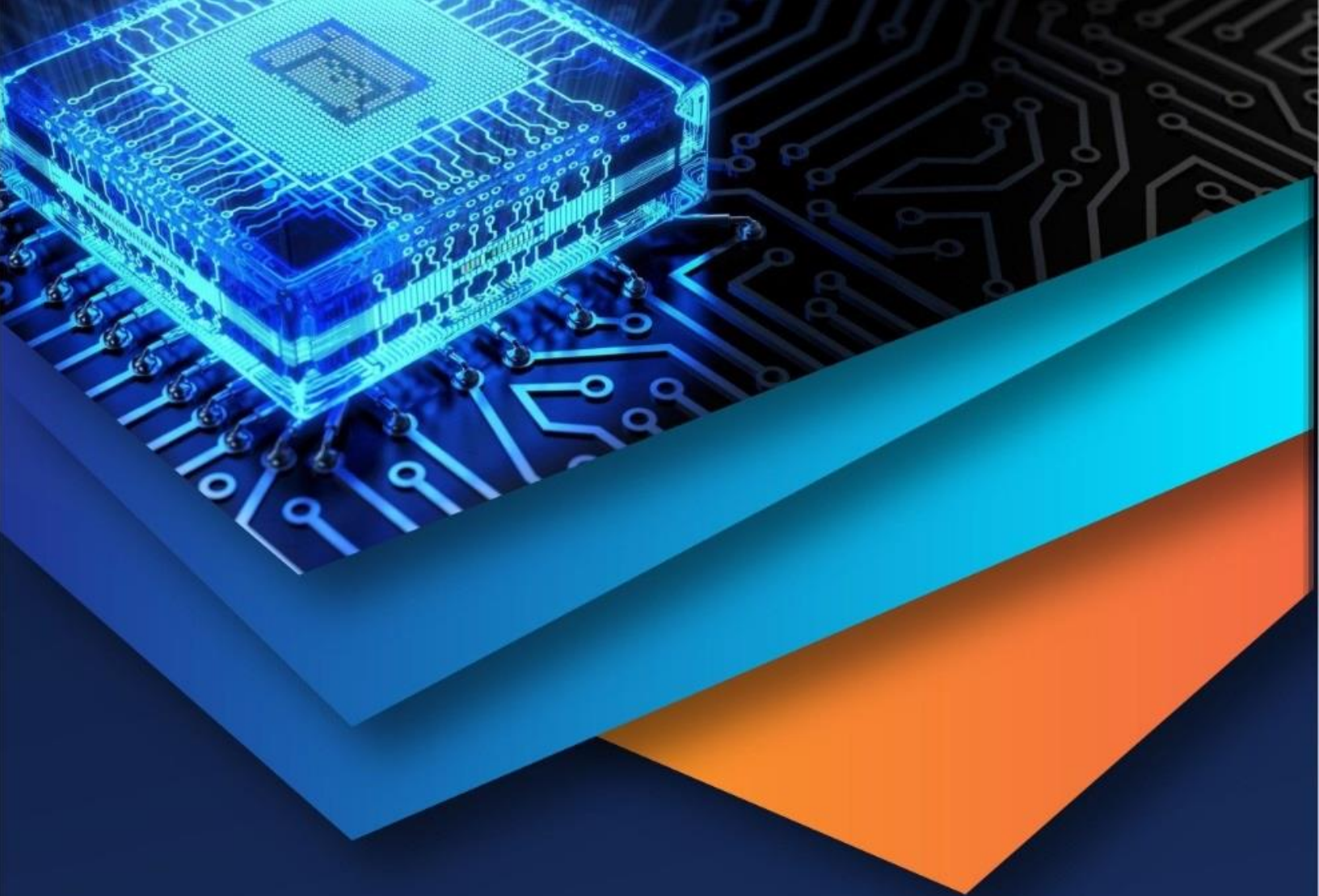
1. Inspect the actual HTML/JavaScript calculation code and document the exact formula used for each category and each rating scale.
2. Implement and test the corrected transformations: $R_f = S/100$; $R_s = 10 \times \sqrt{(S/1000)}$; $R_c = 10 \times \sqrt[3]{(S/1000)}$. Verify that all three return 0 at $S = 0$ and 10 at $S = 1,000$.
3. Define the points assigned to Pass and Fail; specify how Not Checked items affect evidence completeness and scoring; and define when Not Applicable items may be excluded.
4. Ensure category weights sum to 1.00 and the weighted score is consistent across the interface, printed certificate, and paper.
5. Define mandatory critical requirements and ensure a failed critical gate cannot be overridden by the composite score.
6. Calibrate rating thresholds using independent expert assessments or field outcomes and report the method and data.
7. Test boundary and representative scores (0, 300, 500, 700, 800, 900, 1,000), category-level edge cases, missing evidence, and critical failures.
8. Report content validity, inter-rater reliability, sensitivity analysis, and external validation results when data are available.

Appendix D. Term Index full form and meanings

Sl. No.	Index Term / Abbreviation	Full Form	Meaning and Research Relevance
1	SCCAF	Sustainable Construction Chemicals Adoption Framework	A proposed framework for understanding stakeholder awareness, attitudes, perceived performance, market accessibility, regulatory support and other factors influencing sustainable construction chemicals adoption.
2	WRI	Weighted Resin Flooring Index	A proposed assessment index for organising resin flooring evidence across six domains: mechanical performance, functional performance, durability and service life, sustainability and ESG, economic efficiency, and workmanship and quality control.
3	HRI	Hoysalas SG Composite Rating Index	A proposed composite index for combining flooring assessment scores using defined weighting and aggregation rules to produce a structured rating. Its reliability requires validation.
4	Resin Flooring Systems	Not applicable	Flooring systems using resin binders such as epoxy and polyurethane to provide specified surface properties and protection.
5	Sustainable Construction Chemicals	Not applicable	Construction chemical products assessed for technical suitability and relevant environmental, health, resource-efficiency and lifecycle impacts.

6	MCDA	Multi-Criteria Decision Analysis	A group of methods for comparing alternatives against multiple criteria, such as engineering performance, sustainability, durability and cost.
7	Composite Performance Indicators	Not applicable	Measures that combine multiple indicators into a summary score for structured comparison and decision-making.
8	Engineering Performance Assessment	Not applicable	Systematic evaluation of technical properties such as adhesion, abrasion resistance, chemical resistance, strength and suitability for intended service conditions.
9	Durability and Service Life	Not applicable	Durability concerns resistance to deterioration; service life is the period during which a system meets specified performance requirements.
10	LCA	Life Cycle Assessment	A method for evaluating potential environmental impacts across defined stages of a product or system's life cycle.
11	LCC	Life Cycle Costing	Assessment of relevant costs over a defined period, including installation, maintenance, repair, downtime and replacement where applicable.
12	ESG	Environmental, Social and Governance	A framework for considering environmental impacts, social responsibilities and governance practices in products, organisations or projects.
13	VOC	Volatile Organic Compounds	Organic compounds that readily evaporate under relevant conditions; certain VOCs may contribute to indoor-air-quality concerns and health risks.
14	WQC	Workmanship and Quality Control	Procedures controlling substrate preparation, mixing, application, thickness, curing and inspection to help achieve specified flooring performance.
15	Stakeholder Adoption	Not applicable	The process through which engineers, architects, consultants, contractors and clients consider, specify, procure or implement a construction system.
16	Weighting and Aggregation	Not applicable	Weighting assigns relative importance to criteria; aggregation combines criterion scores according to a defined mathematical procedure.
17	Sensitivity Analysis	Not applicable	Examination of how changes in assumptions, weights, thresholds or input data affect assessment results and rankings.
18	Framework Validation	Not applicable	Collection of evidence to determine whether a proposed framework is appropriate and performs adequately, using methods such as expert review, reliability testing and field evaluation.

Application to the present study: SCCAF addresses adoption factors, WRI structures the technical assessment, and HRI provides the proposed composite rating. These components serve different but complementary purposes. Their reliability and effectiveness must be established through appropriate validation before being presented as empirically demonstrated.



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