

DEVELOPMENT AND ANALYSIS OF THE SUPERVISOR COMPETENCY EFFECTIVENESS INDEX (SCEI): A COMPETENCY-BASED MEASURE FOR EMPLOYEES

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ABSTRACT

Competency assessment provides organisations with a systematic approach to evaluating employee capabilities and identifying developmental needs. However, competency frameworks have to be adapted to correspond to the behavioural expectations of specific organisational contexts. The present study developed and evaluated the psychometric properties of the Supervisor Competency Effectiveness Index (SCEI), a competency-based assessment instrument designed for employees within manufacturing environments. The scale was constructed through an internal organisational study and an extensive literature review, resulting in the identification of 15 competencies across individual and managerial domains. An initial pool of 150 items was generated and reviewed by subject matter experts in Human Resources and Organisational Development for content relevance, clarity, and representativeness. Following expert review, the instrument was pilot-tested with 111 employees from three manufacturing plants of Prince Pipes and Fittings Limited. Responses were collected using a four-point rating scale. The findings seek to establish an empirical foundation for a contextually relevant competency assessment instrument to support competency-based human resource practices, including performance management and employee development. Further validation with larger and more diverse samples is necessary to confirm its wider applicability.

Keywords: competency assessment, psychometric validation, competency framework, manufacturing, exploratory factor analysis

INTRODUCTION

Background

Competencies have become increasingly important in business because successful work performance depends on combining knowledge, skills, abilities, and other behavioural traits that enable individuals to perform their responsibilities effectively. Competency-based approaches, according to Campion et al. (2011) and Shippmann et al. (2000), provide an organisation with a systematic framework for identifying the skills associated with successful performance and incorporating them into processes such as hiring, performance management, training, and employee development. By further arranging these competencies into structural

areas, competency frameworks help communicate performance goals and provide a basis for employee assessment and growth (Marrelli et al., 2005).

Competency assessment is critical in organisations with different roles and organisational hierarchies, as the skills required for individual contributions differ from those needed for management, resource coordination, and decision-making. Competency frameworks generally encompass both individual and managerial competencies, allowing organisations to identify and deploy talent effectively through multiple roles and responsibilities. Differentiating between these competencies provides a complete understanding of personnel capabilities, rather than limiting evaluation to task-specific performance.

Competency assessment has become increasingly relevant in manufacturing because technological advancements have transformed the knowledge and skills required of managers and personnel. The implementation of Industry 4.0 has heightened expectations for technical and digital competencies, as well as analytical, problem-solving, communication, teamwork, flexibility, and decision-making abilities (Saniuk et al., 2023). Recent studies have shown that the shift to digital technologies in the manufacturing industry has increased the need for both technical and business skills (Mondolo et al., 2026). To achieve top performance in modern manufacturing, employees need a combination of general behavioural and management skills, along with the specific technical knowledge required for their position. To understand the workforce's capabilities across manufacturing roles, organisations need a systematic method to identify and evaluate these competencies.

NEED FOR A COMPETENCY ASSESSMENT SCALE

Established competency frameworks help organisations identify and structure the competencies associated with successful performance. However, competency models differ in both accuracy and intended application. Broad competency taxonomies provide a common conceptual language across professions, whereas organisation-specific models translate these general areas into competencies suited to particular positions, the organisation's circumstances, performance requirements, and standards (Bartram, 2005; Campion et al., 2011). Consequently, the value of a competency framework depends not only on the competencies it outlines but also on how well they align with the context in which they are applied. The literature suggests that frequently used competency frameworks might need contextual adjustment to reflect the specific behavioural requirements of particular organisational and occupational settings, such as manufacturing environments.

Contextualization matters because different businesses have varied job structures, workforce characteristics, strategic priorities, and expectations for effective performance. Therefore, competency modelling considers organisational and job context rather than assuming a generic model can capture all work circumstances (Shippmann et al., 2000). A contextually suitable framework can therefore provide a stronger basis for identifying and improving the competences employees need in different organisational roles.

Another requirement is to translate general competency constructs into observable, assessable behaviours. Competency categories in our study, such as communication, decision-making, or achievement orientation, define broad areas of functioning but do not provide sufficiently specific criteria for consistent evaluation. Behavioural indicators operationalise these ideas and provide a basis for systematic assessment by showing how a capability manifests in workplace behaviour (Marrelli et al., 2005). Research on competency modelling further highlights the importance of organising competency data so that behavioural expectations can be accurately defined and subsequently applied in organisational procedures (Campion et al., 2011).

Accordingly, the Supervisor Competency Effectiveness Index (SCEI) was developed as a systematic competency assessment instrument for employees in manufacturing companies. Behaviorally focused evaluation items operationalise each of the 15 competencies within the individual and management domains of the framework. The instrument is designed to facilitate a structured self-assessment of managers' competency-related behaviours and abilities. However, developing a competency assessment tool is only an initial phase; empirical evidence of its psychometric properties is needed to determine whether the items show sufficient internal consistency and whether the proposed competency structures are empirically supported. Therefore, this study examines the SCEI's factor structure, factorability, and reliability.

METHOD

Participants

The pilot sample consisted of 111 people who were working at three manufacturing plants of Prince Pipes and Fittings Limited located in Athal and Dadra, Diu and Daman and Chennai, Tamil Nadu, India, with their length of service in the organisation varying from one month to 372 months (that is, 31 years and 2 months; mean = 76.12 months, standard deviation = 87.37). Participants included those in the lowest employee category (E1), such as junior officers or trainees in some departments, through those in the E4 employee category, who were senior executives or engineers.

Participants were drawn from the following departments: Accounts and Indirect Tax, Administration, Compounding/Recycling, Production (Extrusion/Roto Moulding, Post Extrusion, and Injection Moulding), Projects, Manufacturing (Manufacturing Operations Excellence/Environment, Health and Safety, and Packing and Shifting), Plant Engineering, Supply Chain Management (Planning and Despatch), Support (Information Technology and Human Resources), Purchase, Quality, Solvent, Stores, and Tool Room.

Participants were recruited using convenience sampling. Eligibility criteria required participants to be employees in the E1 to E4 categories and to maintain direct, daily contact with their supervisors. Data collection was conducted through face-to-face surveys at the manufacturing plants. Before participating, all respondents provided informed consent, and their responses remained strictly confidential.

DEVELOPMENT OF THE BEHAVIOURAL DICTIONARY

An internal study of the manufacturing plant, conducted at the beginning of the year, together with an extensive literature review presented in a previous paper (Vira et al., 2026), identified 15 competencies as critical for the company's supervisor and managerial contributor role. These included Achievement Orientation, Analytical Ability, Interpersonal Skills, Planning and Attention to Detail, Communication and Listening, Creativity and Innovation, Technical Knowledge, Customer Orientation, Discipline, Impact and Influence, People Leadership, Initiative and Anticipation, Decision-Making, Team Management and People Development, and Resource Management.

Based on these broad competencies, extensive research was conducted to identify behavioural indicators that demonstrate each competency. Five behavioural indicators were selected for each competency to best describe the expected behaviours associated with each competency.

Item Generation

The item generation process included a systematic evaluation of established literature and scales related to existing competency frameworks. To begin with, a group of 150 items was

prepared for expert review, with 10 statements being drafted for each competency in order to evaluate the behaviours listed in the behavioural dictionary. The content of each item was aligned with the behavioural indicators appropriate to its particular competency area. The items were written in the second person and assessed on a 4-point scale from 1 (Below Expectations) to 4 (Exceeds Expectations) to minimise central tendency bias (Akbari et al., 2023).

EXPERT REVIEW AND VALIDATION

To ensure content validity and appropriate item phrasing, five Subject Matter Experts (SMEs) in Organisational Development and Human Resources, each with 15 to 35 years of professional experience ($M = 26$ years, $SD = 8.07$), were invited to review the initial pool of 150 items. These experts possessed prior experience in competency frameworks and Training and Development (TnD).

Each expert assessed the clarity, relevance, and representativeness of the items against the theoretical dimensions of the Supervisor Competency Effectiveness Index (SCEI). Additionally, experts provided qualitative feedback regarding redundant or ambiguous wording, overlapping content, and domain coverage. The evaluations adhered to established content validation procedures, including the Item-Level Content Validity Index (I-CVI) and Scale-Level Content Validity Index (S-CVI) criteria (Lynn, 1986).

Based on the collective feedback, items with lower I-CVI scores were revised to strengthen precision and conceptual clarity. The expert review process retained all 150 items as the final pool for pilot testing, supporting comprehensive representation of the SCEI.

PROCEDURE

Ethical Consideration

Before accessing the survey, participants received an informed consent form detailing the study's purpose, the types of questions included, and the estimated completion time. The form emphasised that participation was voluntary, that participants could withdraw at any point without providing a reason, and that all responses would be treated as anonymous and confidential.

No personally identifiable information was collected, except for essential job-related data necessary for analysis. The study adhered to ethical guidelines for research with human participants as established by the American Psychological Association.

Pilot Testing

After expert validation, pilot testing was implemented at three manufacturing plants of Prince Pipes and Fittings Limited located in Athal, Dadra, and Chennai to assess the psychometric properties of the newly developed Supervisor Competency Effectiveness Index (SCEI). Data were obtained from 111 participants who met the inclusion criteria.

The survey was administered online using Google Forms and structured into five sections. The first section contained the informed consent agreement. The second section gathered participants' company email addresses, tenure, and current designation. The third section presented the 150 SCEI items, which were rated on a 4-point scale from 1 (Below Expectations) to 4 (Exceeds Expectations). The survey concluded with a debrief section that informed participants about the study and its objectives.

Each survey took approximately 20 to 30 minutes to complete.

RESULTS

Descriptive Statistics

Descriptive statistics for the 150 items of the Supervisor Competency Effectiveness Index (SCEI) indicate that participants in most cases provided favourable self-assessments across the measured competencies. Most items produced mean scores of approximately 3.00 or higher on the four-point rating scale, with values ranging from 2.555 to 3.342. The highest mean score was observed for AO1 ($M = 3.342$, $SD = 0.681$), and the lowest for CL7 ($M = 2.555$, $SD = 0.499$). The median and mode were predominantly 3 across items, demonstrating that responses were concentrated in the Meets Expectations category. Standard deviations ranged from 0.499 to 0.914, indicating some variability in responses. Nevertheless, the limited dispersion across most items suggests that participants' ratings were generally consistent.

Additionally, skewness values were predominantly negative, indicating that responses clustered toward the higher end of the rating scale. This pattern likely reflects participants' generally favourable perceptions of their competencies. The Shapiro–Wilk tests were statistically significant for all items ($p < .001$), indicating departures from normality. These results show that item responses were not normally distributed in the pilot sample.

Internal Consistency Reliability

Internal consistency was assessed using Cronbach's alpha (α) to evaluate item consistency within each of the 15 competencies comprising the Supervisor Competency Effectiveness Index (SCEI). Since the SCEI includes 15 distinct competencies, Cronbach's alpha was calculated separately for each competency rather than using a single coefficient for the entire instrument. This approach is appropriate for multidimensional measures, since an overall alpha may not accurately represent the internal consistency of individual dimensions (Tavakol & Dennick, 2011).

Cronbach's alpha coefficients ranged from .8748 to .9381, indicating high internal consistency across the competency scales in the pilot sample. Team Management and People Development exhibited the highest coefficient ($\alpha = .9381$), while Communication and Listening exhibited the lowest ($\alpha = .8748$). All 15 competencies demonstrated reliability estimates above .87, offering preliminary evidence of strong internal consistency.

The results should be interpreted with caution, as this preliminary psychometric analysis was based on a pilot sample of 111 participants. Although high alpha coefficients indicate consistency among items within each competency scale, they do not independently establish construct validity or confirm optimal item functioning. Furthermore, high alpha values do not necessarily indicate unidimensionality and may, in some cases, reflect item redundancy (Tavakol & Dennick, 2011). Consequently, reliability findings should be considered alongside item–rest correlations and subsequent factor-analytic results when evaluating the suitability of individual items and modifying the SCEI.

FACTORABILITY ASSESSMENT

Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy

The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was assessed to determine the appropriateness of the SCEI items for factor analysis. The overall KMO values, calculated separately for the 15 competencies, ranged from .804 to .905, exceeding the minimum criterion of .60. Initiative and Anticipation demonstrated the highest KMO value

(.905), while People Leadership exhibited the lowest (.804). These results indicate adequate sampling adequacy across all 15 competencies.

Item-level KMO values were also examined to identify items with insufficient sampling adequacy. All items except CL7 demonstrated KMO values above .60. CL7 yielded a value of .210, which falls significantly below this threshold and indicates inadequate item-level sampling adequacy (Kaiser, 1974; Watkins, 2018). Consequently, CL7 was excluded from subsequent factor-analytic procedures. This decision of exclusion was further supported by the item's negative item-rest correlation observed during the internal consistency analysis. The remaining items met the specified item-level KMO criterion and were retained for further evaluation.

Bartlett's Test

Bartlett's test of sphericity was performed individually for each of the 15 competencies to check whether the correlation matrices significantly differed from identity matrices. Statistically significant results show that the correlations among items are sufficiently distinct from zero to warrant factor analysis. All 15 competencies yielded statistically significant results ($p < .001$), with each test having 45 degrees of freedom ($df = 45$). These results confirm that the item correlation matrices for all competencies were significantly different from identity matrices, supporting the suitability of the item sets for subsequent factor-analytic procedures.

EXPLORATORY FACTOR ANALYSIS

Factor Extraction and Item Retention

Exploratory Factor Analysis (EFA) was conducted separately for each of the 15 competencies comprising the Supervisor Competency Effectiveness Index (SCEI). Each competency was initially represented by ten items intended to evaluate a distinct workplace competency. The analyses examined the internal factor structure of each competency and assessed the extent to which its items reflected a coherent, potentially unidimensional construct. Given the pilot sample size of 111 participants relative to the initial pool of 150 items, analyses were conducted at the competency level to focus on the item structure within each theoretically defined competency. This approach supported the identification of items that did not sufficiently represent their intended competency and supported the systematic refinement of the individual competency scales.

The minimum residual (MINRES) method was employed for factor extraction. As a common-factor extraction method, MINRES minimises the residual differences between the observed correlation matrix and the correlation matrix reproduced by the factor model. Because the objective was to investigate the underlying factor structure of the SCEI items rather than reduce the number of observed variables, a common-factor approach was considered appropriate. This decision is consistent with methodological recommendations that emphasise selecting factor extraction procedures based on research objectives and the intention to investigate underlying latent constructs (Costello & Osborne, 2005; Fabrigar et al., 1999).

Oblimin rotation was selected to allow extracted factors to correlate. Although the 15 competencies represent conceptually distinct workplace attributes, relationships among competencies are conceptually possible. For example, Communication and Listening may relate to Interpersonal Skills, while People Leadership may relate to Team Management and People Development. An oblique rotation was therefore appropriate because it does not assume that the extracted factors are uncorrelated. This decision corresponds with

methodological recommendations that researchers consider oblique rotation when the underlying constructs may be interrelated (Fabrigar et al., 1999; Watkins, 2018).

Factor loadings were examined to evaluate the strength of the relationship between individual items and their corresponding factors. A minimum factor-loading criterion of .50 was established during item refinement to retain items exhibiting considerable associations with the extracted factors. Items with factor loadings below .50 were excluded from subsequent analyses because they did not meet the item-retention criterion. The explicit factor-loading criterion is consistent with methodological recommendations that emphasise transparent and justified item-retention decisions in EFA (Costello & Osborne, 2005; Watkins, 2018). After item refinement, internal consistency reliability for each competency was reassessed using the retained items.

FACTOR EXTRACTION AND ITEM RETENTION BY COMPETENCY

Achievement Orientation

EFA of Achievement Orientation revealed a three-factor result, as seen from Table A1. The first factor had an eigenvalue of 6.178, accounting for 61.78% of the variance in the unrotated solution and 74.30% in the rotated solution. Factor loadings indicated that AO1 (.786), AO2 (.990), AO3 (.810), and AO4 (.731) loaded strongly on the first factor. AO7 loaded at .589 on the first factor and .436 on the third factor. Even though AO7 exhibited a secondary loading, only its factor loading on Factor 1 exceeded the retention criterion of .50. AO8 was excluded because of the loadings below .50 on both the first (.391) and third (.453) factors. AO5 and AO6 were not retained because they loaded onto the second factor, which was defined by only two items. The third factor included only AO10, with a loading above .50. Consequently, only 5 items, AO1, AO2, AO3, AO4, and AO7, were retained for further analysis.

Analytical Ability

The EFA yielded a three-factor solution, accounting for 76.04% of the variance after rotation. As seen from Table A2, items AA4 (1.029), AA5 (.756), AA6 (.734), and AA3 (.576) loaded on the first factor, whereas AA1 (.889), AA8 (.628), and AA2 (.531) loaded on the second factor. Item AA7 was excluded due to its factor loading (.447) falling below the established .50 retention criterion. Although AA9 (.845) and AA10 (1.012) loaded on the third factor with loadings above the threshold, both were excluded because the factor comprised only two items. As a result, seven items—AA1, AA2, AA3, AA4, AA5, AA6, and AA8—were retained for further analysis.

The identification of multiple factors implies that Analytical Ability comprises associated but different dimensions, rather than a single underlying construct. The results should be interpreted cautiously given the preliminary nature of the pilot study. Additional research with a larger sample is necessary to evaluate the stability of the observed factor structure and to determine whether the retained items adequately represent Analytical Ability.

Interpersonal Skills

EFA of Interpersonal Skills produced a two-factor solution, accounting for 72.15% of the variance after rotation as seen from table A3. Factor loadings showed that IS9 (.932), IS3 (.925), IS1 (.831), IS4 (.764), IS10 (.702), IS8 (.638), and IS7 (.625) loaded on the first factor, with all seven items exceeding the minimum factor-loading criterion of .50. IS8 also showed a secondary loading of .310 on the second factor, which did not meet the retention threshold. IS2 demonstrated loadings of .416 on the first factor and .470 on the second factor; as neither met the .50 criterion, this item was excluded from further analysis. IS5 (.907) and IS6 (.736) loaded on the second factor, but these items were not retained in the refined

Interpersonal Skills competency because the analysis prioritized items representing the primary factor. Therefore, seven items—IS1, IS3, IS4, IS7, IS8, IS9, and IS10—were retained for further analysis. The clustering of these items on the first factor provides preliminary evidence for a coherent primary dimension of Interpersonal Skills. The emergence of a second factor indicates that the competency may include additional subdimensions. Further research with a larger sample is required to clarify the underlying structure and to determine whether the excluded items represent a distinct aspect of Interpersonal Skills.

Planning and Attention to Detail

As seen in Table A4, the EFA of the Planning and Attention to Detail generated a single-factor solution, with this factor accounting for 66.91% of the variance. All ten items met the minimum loading criterion of .50, with loadings ranging from .724 for PAD6 to .925 for PAD9. As each item surpassed the specified threshold on the single factor, all ten items were retained for further analysis. The emergence of a single factor, along with consistently high loadings, provides initial evidence supporting a unidimensional structure for the Planning and Attention to Detail competency in the pilot sample, suggesting that the items collectively assess a coherent underlying construct. Nevertheless, this interpretation is preliminary and warrants further investigation in subsequent validation studies with larger samples.

Communication and Listening

EFA of the Communication and Listening competency, which consists of nine items after elimination of item CL7 due to KMO values below 0.60, generated a single-factor solution accounting for 60.86% of the variance, as seen from table A5. Each item surpassed the minimum factor loading threshold of .50. The emergence of a single factor with adequate loadings across all items provides preliminary evidence supporting a unidimensional structure for the Communication and Listening competency in the pilot sample. Nevertheless, this conclusion is tentative and necessitates further assessment in future validation studies with larger samples.

Creativity and Innovation

EFA of Creativity and Innovation produced a two-factor solution, as seen from table A6, which accounted for 69.07% of the variance following rotation. The factor loadings indicated that CI1 (1.004), CI2 (.922), CI6 (.764), CI3 (.589), CI5 (.552), CI9 (.533), and CI4 (.516) loaded on the first factor. Additionally, CI5, CI9, and CI4 demonstrated secondary loadings of .362, .378, and .345, respectively, on the second factor. For the second factor, CI10 loaded at .524, CI7 at .998, and CI8 at .555. Since all ten items loaded at least .50 on the second factor, all items were retained.

The identification of two factors, each with substantial item loadings, suggests that Creativity and Innovation may comprise similar yet separate subdimensions, rather than representing a unidimensional construct. Although the items were initially intended to evaluate a single competency, the observed factor structure indicates that the item pool may capture multiple facets of creativity and innovation. Given the preliminary nature of this pilot study and the sample size of 111 participants, further research with a larger sample is required to examine the potential subdimensions of Creativity and Innovation.

Technical Knowledge

The EFA of the competency of Technical Knowledge yielded a two-factor solution that explained 73.59% of the variance after rotation. Factor loadings in table A7, indicated that TK4 (.967), TK1 (.884), TK3 (.841), TK2 (.789), TK5 (.604), TK6 (.547), and TK9 (.532)

loaded on the first factor. TK6 and TK9 also showed secondary loadings of .399 and .355, respectively, on the second factor; these values did not meet the minimum retention criterion of .50. On the second factor, TK8 loaded at .526, TK10 at .537, and TK7 at 1.028. Since both factors contained items with substantial factor loadings, all items are provisionally retained for further examination. These results show that Technical Knowledge comprises potential subdimensions rather than representing a strictly unidimensional construct.

Customer Orientation

From table A8, EFA of the competency of Customer Orientation produced a two-factor solution, which accounted for 69.00% of the variance after rotation. Factor loadings showed that CO7 (.941), CO5 (.851), CO3 (.705), and CO8 (.664) loaded on the first factor. CO2 loaded at .454 on the first factor and .418 on the second factor, while CO1 loaded at .319 and .478, respectively. The second factor included CO9 (.984), CO10 (.769), CO4 (.669), and CO6 (.660). Eight items, CO3, CO4, CO5, CO6, CO7, CO8, CO9, and CO10, were retained in the two-factor solution to support further investigation of the underlying structure of Customer Orientation.

The identification of two factors with substantial loadings indicates that Customer Orientation may include multiple subdimensions rather than representing a strictly unidimensional construct. Although the items were originally designed to assess a single competency, the observed factor structure implies that the item pool may capture distinct aspects of customer orientation.

Discipline

EFA for the competency of Discipline delivered a two-factor solution, as evident in table A9, accounting for 72.20% of the variance after rotation. Factor loadings indicated that D1 (.945), D9 (.850), D10 (.811), D3 (.747), D7 (.747), D8 (.719), and D2 (.567) loaded on the first factor, while D5 (.950), D4 (.921), and D6 (.819) loaded substantially on the second factor. All ten items surpassed the minimum factor loading criterion of .50 on one of the two factors and were therefore retained in the two-factor solution. The two-factor result may suggest that the Discipline competency may encompass potential subdimensions, rather than constituting a strictly unidimensional construct, even though the items were originally developed to assess a single competency.

Impact and Influence

Exploratory factor analysis (EFA) of the Impact and Influence scale produced a three-factor solution, accounting for 72.57% of the variance following rotation. As evident from table A10, Items InI3 and InI8 failed to meet the minimum factor loading threshold of .50, with maximum loadings of .457 and .440, respectively. Five items (InI2, InI4, InI5, InI6, and InI7) loaded on Factor 1, with loadings between .586 and .980. Factor 2 comprised InI1, InI9, and InI10, all of which exceeded the .50 threshold. InI2 also demonstrated a secondary loading of .498 on Factor 3. Consequently, InI3 and InI8 were excluded, and the remaining eight items were provisionally retained.

The three-factor solution suggests that Impact and Influence may comprise subdimensions rather than a single homogeneous construct. However, the present factor structure does not establish distinct subdimensions or confirm the dimensionality of the construct. Given the preliminary nature of this pilot study and the sample size of 111 participants, further research with a larger sample is necessary to evaluate the stability of the factor structure and to determine whether the competency is best conceptualized as unidimensional or multidimensional.

People Leadership

The EFA for People Leadership, with all ten initial items, produced a two-factor solution, as seen in table A11, accounting for 69.33% of the variance following rotation. Factor 1 comprised PL3 (.673), PL4 (.979), PL7 (.895), and PL9 (.648), while Factor 2 included PL1 (.500), PL2 (.967), PL5 (.750), and PL6 (.706). PL8 and PL10 were excluded because their factor loadings (.493 and .434, respectively) fell below the established threshold of .50. Accordingly, eight items were provisionally retained. The emergence of two factors implies that the competency of People Leadership may encompass potential sub-dimensions, which would violate the assumption of unidimensionality which was kept in mind while formulating the SCEI framework.

Initiative and Anticipation

EFA of Initiative and Anticipation produced a single-factor solution, as seen in A12, with this factor accounting for 65.54% of the variance. Examination of the factor loadings indicated that all ten items met the minimum loading criterion of .50; therefore, all items were retained for later analysis. The emergence of a single factor, combined with consistently high loadings across all items, provides preliminary evidence for the unidimensional structure of Initiative and Anticipation, indicating a coherent underlying competency rather than separate subdimensions.

Decision Making

EFA for Decision-Making yielded a two-factor solution, accounting for 67.99% of the variance after rotation. Factor loadings from table A13, indicate that DM2 (.930), DM4 (.904), DM8 (.776), DM1 (.669), DM10 (.579), and DM7 (.524) loaded on the first factor, each exceeding the minimum factor-loading criterion of .50. Items DM3 and DM9 did not reach the .50 threshold on any factor and were therefore excluded from further analysis. Although DM5 showed a strong factor loading of .963 on the second factor, it was not retained because it was the only item surpassing the threshold for that factor. The factor loading of DM6 (.476) on the second factor was also not considered, as it did not meet the .50 criterion. Consequently, six items (DM1, DM2, DM4, DM7, DM8, and DM10) were retained, while DM3, DM5, DM6, and DM9 were excluded.

Team Management and People Development

Exploratory factor analysis (EFA) for Team Management and People Development yielded a single-factor solution, as seen from table A14, accounting for 70.48% of the variance. All ten items demonstrated factor loadings above the minimum criterion of .50 and were therefore retained. The emergence of a single factor, coupled with consistently high loadings, provides preliminary evidence for the unidimensional structure of Team Management and People Development, rather than distinct sub-dimensions within this competency. Further validation using a larger, independent sample is required to confirm the stability of this factor structure and to strengthen the evidence for unidimensionality in this framework.

Resource Management

Exploratory factor analysis (EFA) for Resource Management yielded a two-factor solution, accounting for 74.93% of the variance after rotation. Examination of factor loadings from table A15 indicated that RM3 (.941), RM1 (.897), RM6 (.883), RM4 (.828), RM5 (.718), RM2 (.664), and RM9 (.650) loaded onto the first factor, each surpassing the minimum factor-loading criterion of .50. RM10 showed loadings of .463 on the first factor and .374 on the second factor, neither meeting the threshold. RM7 loaded at .452 on the first factor and .541 on the second factor, meeting the criterion only on the second factor. RM8 exhibited a

strong loading of .975 on the second factor, exceeding the .50 threshold, but was not retained, as it was one of the two items meeting the threshold. Consequently, seven items—RM1, RM2, RM3, RM4, RM5, RM6, and RM9—were retained for further analysis, while RM7, RM8, and RM10 were excluded. RM7 and RM8 were excluded because they would have been the only items in the second factor after applying the loading criterion, whereas RM10 did not meet the threshold on either factor.

Internal Consistency of the Refined Item Pool

Internal consistency was reassessed by calculating Cronbach's alpha (α) and McDonald's omega (ω) after the EFA for the retained items within each competency. This was conducted to determine whether the refined item sets maintained satisfactory reliability after the removal of items based on factor loadings and the interpretability of the factor structures.

The results showed that the retained items maintained satisfactory internal consistency throughout the range of the competencies for which post-EFA estimates were available. For example, Achievement Orientation demonstrated a Cronbach's alpha of .8934 and McDonald's omega of .8953. Analytical Ability yielded coefficients of .9012 and .9016, respectively. Communication and Listening yielded an alpha of .8953 and an omega of .8969. Customer Orientation demonstrated an alpha of .8955 and an omega of .8962. These data suggest that the item refinement process did not compromise the internal consistency of these competency scales.

Comparing reliability estimates before and after EFA provides insight into whether the refined item sets maintain adequate internal consistency. However, reliability coefficients should not be interpreted in isolation or used as the only criterion for item retention. As Tavakol and Dennick (2011) note, Cronbach's alpha is affected as a result of factors such as the number of items and their interrelationships (McNeish, 2018). Therefore, post-EFA reliability estimates should be considered alongside factor-loading patterns, the theoretical relevance of the items, and the intended conceptual coverage of each competency.

DISCUSSION

Overview of the Principal Findings

Initial reliability analyses of the 15 competencies demonstrated that items within each competency scale exhibited strong internal consistency, providing preliminary evidence for the coherence of the proposed measures. In contrast, EFA revealed variation in the underlying structures of the competencies, suggesting that the alignment between the proposed competency definitions and their empirical measurement warrants further investigation, as evident from various competencies having multi-factorial loadings. Clark and Watson (1995) emphasised that scale development calls for not only consistent measurement but also a clearly defined construct and evidence that items are adequately representing the intended dimensions.

The observed variation in factor structures throughout the SCEI competencies suggests that their behavioural indicators differ in the extent to which they represent a common underlying dimension. Some competencies produced single-factor results, while others yielded multiple factors in EFA, conceivably indicating the conceptual breadth of certain competencies or differences in the behavioural content of the items or the competencies. The presence of multiple factors does not necessarily imply that a competency is inherently multidimensional. Factors such as wording of the item, overlapping behavioural content of the item, and the stability of factor solutions in the pilot sample may add to these patterns. Additional investigation is required to determine whether the observed structures represent theoretically

meaningful subdimensions or demand refinement of the corresponding items. This interpretation is consistent with recommendations that EFA should be directed by both empirical evidence and the conceptual characteristics of the constructs under investigation (Worthington & Whittaker, 2006).

These findings show the distinction between the theoretical organisation of a competency framework and its empirical measurement structure. Although the 15 competencies were identified and operationalised as distinct workplace attributes, their proposed definitions alone do not confirm that the corresponding items function as intended. Psychometric evaluation is essential to determine whether the behavioural indicators adequately represent their intended constructs and whether the resulting measurement structure is theoretically defensible. Boateng et al. (2018) similarly emphasised that scale development requires successive stages of item evaluation, dimensionality assessment, and validation, rather than reliance upon a single statistical indicator.

The item-refinement process was an essential part of this evaluation. Rather than retaining the initial 150 items solely based on theoretical relevance or initial reliability estimates, this study used factor analysis and item-level statistics to identify items that required further review. Clark and Watson (1995) note that meticulous item selection must support the intended construct representation.

Internal Consistency of the SCEI Before and After EFA

The reliability analysis pre-EFA indicated that the items within the SCEI demonstrated strong internal consistency. While this finding suggests that items within each scale are generally related, internal consistency alone does not confirm that they adequately represent the intended construct. This distinction is especially pertinent for the SCEI, as workplace competencies involve behavioural manifestations that may be related but are not necessarily interchangeable. Therefore, high reliability coefficients should be interpreted in conjunction with evidence regarding factor structure and conceptual coverage.

Reliability was reassessed post-EFA to determine whether the retained items maintained acceptable internal consistency. The results indicated that satisfactory reliability was generally preserved in the scales, suggesting that the refinement of items did not compromise the reliability of the retained items. Decisions should also be guided by factor loadings, theoretical relevance, and the contribution of each item to the coverage of the intended behavioural indicator of the competency.

Maintaining a balance between statistical and conceptual considerations is essential when refining the SCEI. For instance, Achievement Orientation should reflect the full spectrum of behaviours associated with pursuing performance goals and fulfilling achievement-related responsibilities. Removing items solely to improve the reliability may narrow the operational definition of the competency and reduce its content representation. Boateng et al. (2018) pointed out that scale development requires attention to both the statistical performance of items and the adequacy with which the instrument represents the construct of interest. Thus, the objective of refinement should be to retain items that are both statistically defensible and conceptually meaningful, rather than focusing exclusively on maximising internal consistency or minimising the number of items.

The results for Communication and Listening further emphasise the importance of item-level evaluation. CL7 exhibited a negative item-rest correlation and a KMO value of .210, below the threshold of .60, indicating that the response pattern of this item was inconsistent with the other items and that it was not suitable for factor analysis. Other potential explanations include ambiguous wording or differences in the behaviour being assessed; however, these

possibilities require further examination of the item wording and data before a definitive explanation can be established. Therefore, the decision to exclude CL7 was based on converging item-level evidence rather than its impact on the internal consistency alone.

Factor Structure and Item Refinement Through EFA

Exploratory factor analysis (EFA) yielded information about the internal structure of the SCEI, indicating the extent to which items vary with a single underlying factor. The competencies of Planning and Attention to Detail, Communication and Listening, Initiative and Anticipation, and Team Management and People Development each produced single-factor solutions. These results deliver preliminary evidence that items within these competencies may represent a common underlying dimension. However, this evidence alone is insufficient to confirm unidimensionality; It is also necessary to evaluate factor-retention criteria, the conceptual coherence of the items, and the replicability of the identified structure. The results of factor analysis should be interpreted together with theoretical considerations throughout the development and refinement of psychological measures (Worthington & Whittaker, 2006).

Several competencies produced multiple-factor results, indicating that their behavioural indicators may not be wholly captured by a single factor. This may occur when competencies include behavioural indicators that are similar yet dissimilar. Such cases can result from differences in item wording, overlapping behavioural content, or instability with regard to the sample being studied. However, factor solutions alone cannot clarify the meaning of these dimensions conceptually. A detailed analysis of the behavioural content within each factor is needed to determine whether the observed structures represent meaningful subdimensions or call for further refinement.

Weak factor loadings and cross-loadings significantly affect item selection. Items with weak factor loadings may not have been sufficiently representative of their intended factor, while cross-loadings suggest an item relates to multiple dimensions. These issues require careful review and analysis of item wording, conceptual relevance, and relationships with other behavioural indicators. However, statistical criteria should be applied flexibly, as overlapping items may still give valuable information about the competency being assessed.

The findings stress the significance of balancing the process of refinement and retention of items with the theoretical conceptualisation of the scale. When a competency produces multiple factors under it, decisions regarding item retention, removal, or the consideration of distinct subdimensions should be informed by the interpretation of the factors, the number and quality of the indicators they represent, and their conceptual relevance in the framework. A factor represented by only one or two items does not warrant the creation of a separate subscale without additional investigation. In contrast, retaining all items within a competency solely to maintain its original conceptual definition may hide meaningful differences in the functioning of its behavioural indicators in the competency framework itself. Consequently, item-retention decisions should combine empirical evidence with the intended behavioural scope of each competency, rather than depending solely on factor loadings and item-to-item correlations.

The results should be interpreted while considering the pilot sample of 111 employees from three manufacturing plants only. Although exploratory factor analysis (EFA) was conducted separately for each competency rather than across the full item pool, the stability of the resulting factor solutions may be influenced by sample characteristics and the strength of the observed loadings. Watkins (2018) cautioned against assessing the adequacy of factor analysis based solely on sample size, noting the need to consider the overall characteristics of

the data and factor solution. Therefore, the factor structures identified in this study should be considered provisional and require validation in a larger, independent sample.

Practical Implications for Competency-Based Human Resource Management

The development of the Supervisor Competency Effectiveness Index (SCEI) may have significant implications for competency-based human resource management (HRM) activities, especially for organisations aiming to translate competency frameworks into observable workplace behaviours. Competency modelling offers a structured approach to aligning employee capabilities with organisational requirements and informing HR practices (Campion et al., 2011). By operationalising 15 competencies through behavioural indicators, the SCEI is designed to support more systematic discussions regarding employees' perceived strengths and development needs across manufacturing plants and head-office functions. The practical application of this instrument, however, is contingent upon establishing sufficient psychometric evidence to justify the intended interpretation and use of its scores.

With further validation, the SCEI could inform learning and development (LnD) initiatives by enabling employees and managers to identify specific areas for development. For example, lower self-assessments in Planning and Attention to Detail may prompt discussions concerning work organisation, prioritisation, and monitoring of task completion. These applications could support training needs assessments and individual development planning. However, competency assessments should remain linked to clearly defined organisational requirements rather than serve as standalone indicators of employee effectiveness (Campion et al., 2011).

The organisational relevance of competency assessments is influenced by the responsibilities and opportunities ingrained in different roles. Employees in manufacturing operations, technical functions, supply chain management, and administration may encounter distinct situations that allow for the demonstration of specific competencies. Therefore, variations in self-assessment scores may primarily reflect differences in job responsibilities and opportunities to display particular behaviours, in place of solely indicating disparities in underlying competence. Campion et al. (2011) pointed out the necessity of aligning competency models with relevant work and organisational requirements. Subsequent research should thus investigate whether the SCEI operates equivalently across pertinent employee groups and whether its behavioural indicators are suitable for the intended contexts.

The self-assessment format calls for thoughtful consideration when interpreting the results. Employees' ratings reflect their perceptions of their own behaviours and may be affected by factors such as self-awareness, social desirability, and individual interpretations of rating categories. Consequently, results of self-assessment instruments should not be assumed to be equivalent to any observed workplace behaviour or supervisor evaluations. London and Smither (1995) examined the influence of feedback by coworkers on self-evaluations and performance perceptions, stressing the need to consider self-assessments within a comprehensive feedback framework. Upon validation, the SCEI may be supplemented with supervisor assessments or other relevant sources to achieve a more in-depth understanding of competency-related behaviours. The effectiveness of this approach, however, requires data-driven validation.

Effective implementation would also require definite instructions, interpretation of behavioural indicators, and appropriate confidentiality and feedback procedures. The application of assessment instruments in significant employment decisions requires evidence substantiating their intended use and interpretation (Sackett & Lievens, 2008). Given the preliminary status of the current findings, the SCEI should not be used as the criterion for

major decisions such as recruitment, promotion, performance appraisal, or succession planning.

CONCLUSION

This study developed and evaluated the psychometric properties of the Supervisor Competency Effectiveness Index (SCEI), a competency-based assessment tool created for employees in manufacturing contexts. Informed by an organisational study and a comprehensive literature review, the SCEI consists of 15 competencies encompassing both individual and managerial domains, each operationalised through behaviourally anchored items. Expert review and pilot testing with 111 employees from three manufacturing plants provided the foundation for empirical evaluation. The SCEI is intended to translate broad competency constructs into observable workplace behaviours, thereby facilitating systematic competency assessment. By embedding competency measurement within a manufacturing context, the instrument has the capacity to inform competency-based human resource practices, including employee development, performance management, and identification of developmental needs. Wider application of the SCEI will require further testing with larger and more diverse samples. Subsequent studies should examine its factor structure, reliability, and validity across several organisational settings and employee groups. Such evidence is essential to establish the SCEI as a strong and practically useful instrument for competency assessment.

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APPENDIX A

Table A1

Factor Loadings for Achievement Orientation

	Factor 1	Factor 2	Factor 3	Uniqueness
AO2	0.990			0.094
AO3	0.810			0.140
AO1	0.786			0.229
AO4	0.731			0.288
AO7	0.589		0.436	0.261
AO8	0.391		0.453	0.298
AO5		1.000		-0.002
AO6		0.583		0.481
AO10			0.763	0.267
AO9			0.401	0.516

Note. Applied rotation method is oblimin.

Table A2

Factor Loadings for Analytical Ability

	Factor 1	Factor 2	Factor 3	Uniqueness
AA4	1.029			0.062
AA5	0.756			0.288
AA6	0.734			0.296
AA3	0.576	0.370		0.261
AA7	0.447			0.401
AA2	0.346	0.531		0.254
AA1		0.889		0.271
AA8		0.628		0.302
AA10			1.012	-0.005
AA9			0.845	0.267

Note. Applied rotation method is oblimin.

Table A3

Factor Loadings for Interpersonal Skills

	Factor 1	Factor 2	Uniqueness
IS9	0.932		0.243
IS3	0.925		0.258
IS1	0.831		0.268
IS4	0.764		0.443
IS10	0.702		0.260
IS8	0.638	0.310	0.216
IS7	0.625		0.311
IS2	0.416	0.470	0.328
IS5		0.907	0.245
IS6		0.736	0.214

Note. Applied rotation method is oblimin.

Table A4

Factor Loadings for Planning and Attention to Detail

	Factor 1	Uniqueness
PAD9	0.925	0.144
PAD5	0.887	0.213
PAD1	0.823	0.322
PAD3	0.823	0.323
PAD2	0.823	0.323
PAD7	0.818	0.332
PAD4	0.811	0.343
PAD10	0.793	0.371
PAD8	0.732	0.464
PAD6	0.724	0.475

Note. Applied rotation method is oblimin.

Table A5

Factor Loadings for Communication and Listening

	Factor 1	Uniqueness
CL5	0.883	0.221
CL4	0.861	0.258
CL10	0.842	0.291
CL9	0.828	0.314
CL3	0.800	0.360
CL6	0.792	0.373
CL2	0.696	0.515
CL8	0.680	0.538
CL1	0.590	0.652
	Factor 1	Uniqueness

Note. Applied rotation method is oblimin.

Table A6

Factor Loadings for Creativity and Innovation

	Factor 1	Factor 2	Uniqueness
CI1	1.004		0.111
CI2	0.922		0.215
CI6	0.764		0.308
CI3	0.589		0.462
CI5	0.552	0.362	0.352
CI9	0.533	0.378	0.360
CI4	0.516	0.345	0.427
CI10	0.390	0.524	0.357
CI7		0.998	0.070
CI8		0.555	0.430

Note. Applied rotation method is oblimin.

Table A7

Factor Loadings for Technical Knowledge

	Factor 1	Factor 2	Uniqueness
TK4	0.967		0.237
TK1	0.884		0.214
TK3	0.841		0.248
TK2	0.789		0.309
TK5	0.604		0.495
TK6	0.547	0.399	0.252
TK9	0.532	0.355	0.340
TK8	0.404	0.526	0.279
TK10	0.395	0.537	0.275
TK7		1.028	-0.009

Note. Applied rotation method is oblimin.

Table A8

Factor Loadings for Customer Orientation

	Factor 1	Factor 2	Uniqueness
CO7	0.941		0.178
CO5	0.851		0.295
CO3	0.705		0.381
CO8	0.664		0.341
CO2	0.454	0.418	0.326
CO1	0.319	0.478	0.435
CO9		0.984	0.211
CO10		0.769	0.287
CO4		0.669	0.347
CO6		0.660	0.300

Note. Applied rotation method is oblimin.

Table A9

Factor Loadings for Discipline

	Factor 1	Factor 2	Uniqueness
D1	0.945		0.214
D9	0.850		0.318
D10	0.811		0.424
D3	0.747		0.257
D7	0.747		0.360
D8	0.719		0.399
D2	0.567		0.331
D5		0.950	0.171
D4		0.921	0.095
D6		0.819	0.213

Note. Applied rotation method is oblimin.

Table A10
Factor Loadings for Impact and Influence

	Factor 1	Factor 2	Factor 3	Uniqueness
InI5	0.980			0.163
InI6	0.771			0.294
InI7	0.769			0.339
InI4	0.602			0.334
InI2	0.586		0.498	0.134
InI8	0.440	0.361		0.322
InI9		0.880		0.300
InI10		0.788	-0.338	0.138
InI1		0.583		0.387
InI3		0.457	0.328	0.332

Note. Applied rotation method is oblimin.

Table A11
Factor Loadings for People Leadership

	Factor 1	Factor 2	Uniqueness	
PL4	0.979		0.185	PL4
PL7	0.895		0.190	PL7
PL3	0.673		0.358	PL3
PL9	0.648		0.297	PL9
PL8	0.493	0.381	0.331	PL8
PL10	0.434	0.353	0.458	PL10
PL1	0.324	0.500	0.404	PL1
PL2		0.967	0.173	PL2
PL5		0.750	0.306	PL5
PL6		0.706	0.365	PL6

Note. Applied rotation method is oblimin.

Table A12
Factor Loadings for Initiative and Anticipation

	Factor 1	Uniqueness
IA6	0.845	0.286
IA4	0.840	0.294
IA3	0.840	0.294
IA8	0.825	0.319
IA9	0.822	0.325
IA5	0.818	0.331
IA7	0.812	0.341
IA2	0.781	0.390
IA10	0.761	0.421
IA1	0.744	0.446

Note. Applied rotation method is oblimin.

Table A13
Factor Loadings for Decision Making

	Factor 1	Factor 2	Uniqueness
DM2	0.930		0.279
DM4	0.904		0.309
DM8	0.776		0.195
DM1	0.669		0.380
DM10	0.579		0.361
DM7	0.524	0.385	0.313
DM3	0.488	0.361	0.401
DM9	0.448	0.408	0.393
DM5		0.963	0.065
DM6		0.476	0.505

Note. Applied rotation method is oblimin.

Table A14
Factor Loadings for Team Management and People Development

	Factor 1	Uniqueness
TP5	0.905	0.180
TP8	0.876	0.233
TP6	0.871	0.241
TP9	0.862	0.257
TP1	0.858	0.265
TP7	0.849	0.279
TP10	0.846	0.284
TP4	0.780	0.391
TP2	0.776	0.398
TP3	0.758	0.425

Note. Applied rotation method is oblimin.

Table A15
Factor Loadings for Resource Management

	Factor 1	Factor 2	Uniqueness
RM3	0.941		0.238
RM1	0.897		0.372
RM6	0.883		0.190
RM4	0.828		0.255
RM5	0.718		0.219
RM2	0.664		0.361
RM9	0.650		0.264
RM10	0.463	0.374	0.412
RM7	0.452	0.541	0.172
RM8		0.975	0.024

Note. Applied rotation method is oblimin.