JST&M 9(2025), 20 - 29
DOI: 10.57131/jstm.2025.9.3

Original scientific paper

METHODOLOGICAL FRAMEWORK FOR THE DEVELOPMENT AND MULTI-CRITERION VALIDATION OF THE EFFECTIVE ERGONOMIC LOAD MODEL

Muhamed Herić[1], Edin Cerjaković[1], Alan Topčić[1], Slađan Lovrić[1]

[1] University of Tuzla, Faculty of Mechanical Engineering

ABSTRACT

This paper aims to present a methodological framework for the development and validation of the Effective Ergonomic Load Coefficient (KEEO) model, an approach that seeks to quantify total workload by integrating physical, mental, organizational, and technical and technological factors. Current methods, such as RULA, REBA, OCRA, SWAT, and JCQ, address only individual aspects of work and thus limit insight into the entirety of ergonomic risk. KEEO is based on a multi-criteria integration of methodologies for determining weights and factors that have been identified as determinants of ergonomic workload. Validation includes assessment of the content validity of the questionnaire, analytical boundary checking, sensitivity analysis, and Monte Carlo simulation. The results obtained show stable linear behavior and proportionality between components, suggesting that KEEO can serve as a basis for future integrated ergonomic workload indices. This methodological work is the result of work on a doctoral dissertation on the topic "Multi-functional analysis of effective workplace workload".

Keywords: AHP, ergonomics, KEEO, research methodology, multi-criteria analysis.

Corresponding Author:
Muhamed Herić,
University of Tuzla, Faculty of Mechanical Engineering
Urfeta Vejzagića 4, 75000 Tuzla, B&H
Tel.: +387 35 320 920; fax: +387 35 320 921.
E-mail address: muhamed.heric@untz.ba

1. INTRODUCTION

The assessment of ergonomic workload has traditionally relied on methods that capture only specific aspects of work. Tools such as *RULA*, *REBA,* and *OCRA* primarily evaluate physical and postural demands, whereas *NASA-TLX* represents a subjective benchmark of mental workload and provides a useful point of reference for evaluating comprehensive indices such as *KEEO* [1,2,3,4]. These methods have been standardized and validated; their scope remains limited because they do not take into account the interaction of physical, mental, organizational, and technical factors. In modern work environments, especially within the framework of the Industry 4.0 concept, workload becomes the result of the interaction of man and technology, where physical and mental demands are complemented by organizational and technical complexities. An integrated approach is needed that can simultaneously encompass all these aspects and express them through a single, quantitative indicator.

For this reason, the *KEEO* model (*Coefficient of Effective Ergonomic Load*) was developed, which represents a multifunctional integration of four factors: physical (K_{FIZ}), mental (K_{MEN}), organizational (K_{ORG}), and technical-technological (K_{TEH}). The model allows the unification of different types of ergonomic information into a single index, which allows for an objective comparison of workplaces and the quantification of dominant sources of workload.

1.1. Methodological framework for the development of the KEEO model

The methodological framework defines the conceptual and procedural steps applied in the creation of the *KEEO* model, which begin with the identification of load factors and end with multiple validations of the resulting model. The process includes the integration of existing ergonomic evaluation methods, multi-criteria component weighting, analytical verification of the model, and simulation robustness testing, all to develop an ergonomic model that will take into account all load factors that can occur in the work workspace and will be able to compare ergonomic workloads at workplaces that perform different types of work.

1.2. Identification of load factors

Based on a literature review [5,6,7,8], workload was defined as a function of four basic domains:

- Physical workload (K_{FIZ}): biomechanical, muscular, and postural demands of the task.
- Mental workload (K_{MEN}): cognitive processing, decision-making, attention, and emotional effort.
- Organizational workload (K_{ORG}): time pressure, coordination, communication, and structural organization of work.
- Technical-technological workload (K_{TEH}): interaction with machinery, automation level, maintenance requirements, and technological risks.

This classification follows the holistic ergonomic perspective proposed by [9], in which physical, cognitive, organizational, and technical factors jointly determine the overall ergonomic load.

Within the *KEEO* framework, these domains form the conceptual foundation of the model and serve as analytical dimensions for workload assessment. Each dimension is operationalized through standardized measurement instruments described in the following sections.

1.3. Model structure and formulation

The *KEEO* model (*Coefficient of Effective Ergonomic Load*) is defined as a linear composite function that integrates four key dimensions of workload, Figure 1: physical, mental, organizational, and technical-technological, each weighted according to its relative importance:

$$KEEO_o = w_f \cdot K_{FIZ} + w_m \cdot K_{MEN} + w_o \cdot K_{ORG} + w_t \cdot K_{TEH} \quad (1)$$

where w_i represent the weights of the factors determined through the *Analytical Hierarchy Process* (*AHP*), empirical comparison, or a hybrid combination of both. The weights are normalized such that their sum satisfies the condition:

$$\sum_{i=1}^{4} w_i = 1 \quad (2)$$

Each component *Ki* reflects a specific domain of workload:

- $\boldsymbol{K_{FIZ}}$ physical workload, measured in two complementary ways: $\boldsymbol{K_{FIZobj}}$ objective biomechanical data from ergonomics software simulations (L4/L5 compression, %PC, posture, duration). $\boldsymbol{K_{FIZsubj}}$ subjective physical perception from the *KEEO* questionnaire.
- $\boldsymbol{K_{MEN}}$ mental workload, based on cognitive and emotional demands.

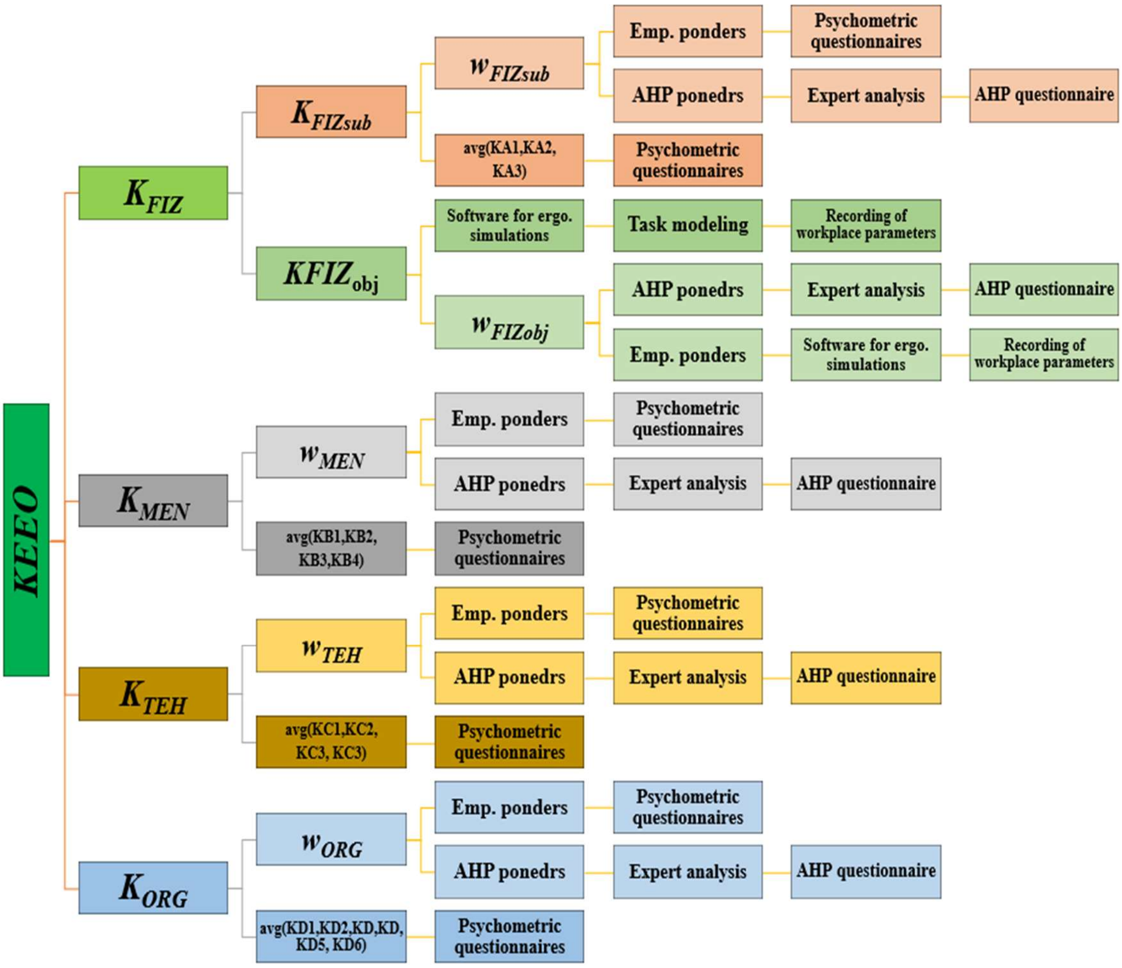

Figure 1. Conceptual framework of the KEEO method

- K_{ORG} organizational workload, related to communication, time pressure, and structural efficiency.
- K_{TEH} technical and technological workload, related to interaction with machines, automation, and maintenance complexity.

All subjective components ($K_{FIZsubj}$, K_{MEN}, K_{ORG}, K_{TEH}) are obtained from standardized Likert-type questionnaires (1-5). For each section (e.g., A1, B2, C3, D1), the mean value of respondents' scores is calculated and then normalized to the interval [0-1] according to:

$$K_i = \frac{\overline{X}_i - 1}{4} \quad (3)$$

where Xi denotes the mean of recoded item scores (after reversing negatively formulated items). This normalization ensures comparability among different factors and allows all components to contribute proportionally to the overall *KEEO* index.

Table 1 shows the normalization principle and scoring of the loads. The same interpretation scale ("Results" and "Meaning" columns) is applied to the final *KEEO* value.

Table 1. The principle of normalization

Rating	Calc.	Results	Meaning
1	(1 - 1)/4	0.00	Minimum load
2	(2 - 1)/4	0.25	Light load
3	(3 - 1)/4	0.50	Intermediate load level
4	(4 - 1)/4	0.75	High load
5	(5 - 1)/4	1.00	Maximum load

Workload is a dynamic rather than static phenomenon, varying with task familiarity, fatigue, and work pace. To account for these temporal effects, the *KEEO* model includes two-time time-related correction factors, the adaptation factor (K_a) and the variation factor (K_v), which adjust the basic index to reflect real fluctuations during the shift:

$$KEEO_d = KEEO_o \times K_a \times K_v \tag{4}$$

The model is designed so that the *KEEO* values are limited in the interval [0,1], which allows interpretation according to the levels of ergonomic risk: 0-0,4 (optimal load), 0,4-0,7 (increased load), and >0,7 (high load).

1.4. Method of weight determination

The weighting system in the *KEEO* model defines the relative contribution of each workload component to the overall ergonomic load index. Three complementary approaches were implemented to ensure both methodological consistency and adaptability to available data.

The **Analytic Hierarchy Process** [10], method was used to determine the relative importance of factors. Evaluation was performed based on pairwise comparisons of factors (*FIZsub, MEN, ORG, TEH*) according to the nine-point Saaty scale. In parallel, the physical workload factor (*FIZobj*) was quantified using ergonomics software biomechanical simulations. Key indicators such as spinal compression force (L5/S1), percentage of muscle use, posture duration, and body symmetry were normalized to a 0-1 scale and subsequently used to calibrate the AHP-derived weight for K_{FIZobj}, ensuring consistency between subjective and simulation-based assessments. The consistency of the pairwise comparison matrix was checked using the coefficients:

$$CI = \frac{\lambda_{max} - n}{n-1}, CR = \frac{CI}{RI} \tag{5}$$

If the values of CR were less than 0.1. Then the weight factors were accepted,

Even when expert comparisons are not available, the same *AHP* principle can be applied analytically to simulate relative factor priorities, preserving the internal logic of the model.

In addition to the *AHP* method, the *KEEO* model also supports an **empirical method** of determining weights, which is used when it is not possible to provide a sufficient number of expert assessments. For each load factor K_{FIZ}, K_{MEN}, K_{ORG}, *and* K_{TEH} sample standard deviation is calculated:

$$\sigma_i = \sqrt{\frac{\sum(K_i - \overline{K_i})^2}{n-1}} \tag{6}$$

In that case, the weights are calculated from the data on the variability of the factors in the sample of workplaces:

$$w_i = \frac{\sigma_i}{\sum \sigma_i} \tag{7}$$

In this formulation, factors that exhibit greater variability across the analyzed sample are interpreted as having a larger influence on the total ergonomic workload, reflecting their dynamic impact within different working environments.

To integrate the structural logic of AHP with the data-driven accuracy of the empirical approach, *KEEO* introduces a **hybrid weighting model** defined as:

$$w_i^{\text{final}} = \alpha \times w_i^{AHP} + (1-\alpha) \times w_i^{emp} \qquad (8)$$

Where 0 ≤ α ≤ 1 represents the weighting coefficient that controls the relative contribution of the analytical and empirical components.

In this way, the *KEEO* weighting system achieves both conceptual consistency and empirical flexibility, ensuring robustness of the final index across different application contexts.

2. KEEO MODEL VALIDATION METHODOLOGY

The validation of the *KEEO* model was conducted through a multi-layered methodological framework encompassing analytical verification of mathematical boundaries and logical consistency, sensitivity analysis to examine the robustness of weighting coefficients, internal reliability testing, and assessment of content (face) validity of the questionnaire. The purpose of this validation framework is to ensure that the model operates consistently within its defined analytical limits, remains stable under variations in input weights, and that the measurement instruments used to operationalize its dimensions adequately capture the intended ergonomic constructs while maintaining external comparability with established assessment methods.

2.1. Content (face) validity of the questionnaire

The first phase of validation refers to the assessment of the content (face) validity of the questionnaires that operationalize individual components of the *KEEO* model (K_{FIZ}, K_{MEN}, K_{ORG}, and K_{TEH}). This type of validity examines whether the items in the questionnaire clearly and intuitively represent the content that is intended to be measured [11,12]. Content validity evaluation was conducted through expert analysis and comparison with standards and relevant instruments.

- K_{FIZ} questionnaire sections are postural, dynamic, repetitive load, drawing on established physical ergonomics frameworks [1,2],
- K_{MEN} questionnaire sections are mental demands, time pressure, responsibility, and stress, and they have a theoretical basis in [4,13],
- K_{ORG} questionnaire sections are work structure, time organization, communication, culture, based on models of organizational ergonomics [5,14],
- K_{TEH} questionnaire sections are technical requirements, automation, *HMI*, and maintenance, supported by literature on technical and systems ergonomics [15,16].
- The analysis showed that all items clearly correspond to their construct and that they encompass the main domains of each factor. This confirmed that the questionnaires are conceptually valid and that they reliably operationalize the factors of the *KEEO* model.

2.2. Analytical verification of the limits and rules of the KEEO model (Edge-Case Test)

The edge-case test represents the first analytical step in the validation process and is used to examine whether the model behaves consistently in limit and extreme cases. The test involves controlled variation of all component inputs K_{FIZ}, K_{MEN}, K_{ORG}, K_{TEH} within the normalized interval [0,1], applied to the basic *KEEO* equation:

$$KEEO_o = w_f \cdot K_{FIZ} + w_m \cdot K_{MEN} + w_o \cdot K_{ORG} + w_t \cdot K_{TEH} \qquad (8)$$

The following limit conditions were systematically tested:

- All input factors=0, *KEEO*=0 (zero workload),

- All input factors=1, *KEEO*=1 (maximum workload),
- Only one factor =1, *KEEO*= w_i,
- Only one factor =0, KEEO decreases linearly by w_i,
- Balanced task (all factors =0.5) KEEO≈0.5.

These analytical scenarios are designed to confirm whether the KEEO model maintains boundedness (0 ≤ KEEO ≤ 1), monotonicity (each component contributes positively), additivity, and proportionality (each factor contributes in accordance with its weight). This test serves as a formal mathematical verification of the *KEEO* formulation before empirical validation is introduced.

2.3. Sensitivity analysis and robustness of weights

The third stage of validation focused on assessing the stability and robustness of the *KEEO* model with respect to changes in weighting coefficients. The purpose of this test was to examine how moderate variations in factor weights (±10%) affect the resulting *KEEO* index and the relative relationships among its components. Sensitivity analysis was performed by systematically varying the weights w_i around their nominal (reference) values within ±10%, while keeping the normalized condition $\sum w_i=1$. For each weight configuration, the *KEEO* index was recalculated under five representative task scenarios:

- Z_1, physical (dominant physical load),
- Z_2, mental (dominant cognitive load),
- Z_3, organizational,
- Z_4, technical, and
- Z_5, balanced scenario (all factors equal).

Each result was compared to the baseline case using the nominal weights, allowing observation of changes in both absolute values and factor order. This procedure represents a numerical robustness test that verifies whether small deviations in weighting produce proportionate and logically consistent changes in the final index.

2.4. Monte Carlo simulation

The Monte Carlo simulation was applied as the final stage of internal validation to assess the numerical stability and robustness of the *KEEO* model under random variations of its component values. A simulation with 10^4 randomized combinations of factor inputs (K_{FIZ}, K_{MEN}, K_{ORG}, K_{TEH}) was performed in Excel, where all component values were uniformly generated within the normalized interval 0-1, while the weighting coefficients remained constant.

The objective of this test was to verify whether the weighted linear structure of the model remains stable and proportional across a large number of stochastic inputs. The following parameters were computed for each component in relation to the overall KEEO index:

- slope of the regression line (βi),
- coefficient of determination (R^2),
- and mean correlation (r) with the *KEEO* value.

This approach tests the model's internal consistency and proportional response to random input variations.

3. Discussion of the methodological approach and the results of validation

The *KEEO* model was developed according to the principles of multifactorial and multicriteria integration, providing a unified approach to ergonomic workload assessment and addressing the limitations of existing, fragmented methods. The methodological framework of the model focuses on maintaining mathematical consistency, numerical stability, and conceptual validity as fundamental conditions for its internal and functional integrity.

Methodologically, the development of *KEEO* follows the analytical and simulation logic often applied in broader engineering contexts, where model stability and parameter interaction are verified through quantitative data analysis and neural-based or system optimization frameworks [17,18,19].

3.1. Advantages of the linear and additive approach

The linear formulation of the *KEEO* model allows for transparency, measurability, and interpretive simplicity. Unlike complex nonlinear models that often make it difficult to analyze the impact of individual factors, the *KEEO* uses an additive structure:

$$KEEO = \sum_{i=1}^{4}(w_i \times K_i) \quad (8)$$

Thus, achieving a clear link between the components and the total index. Such a structure allows for the analysis of the partial contributions of each dimension, the identification of dominant load factors, and the comparability of different jobs. Analytical tests confirmed that the model has monotonic behavior (each component contributes positively to the result) and that the values are always within the limits [0,1], which gives it stability and logical interpretation. Thanks to this form, *KEEO* can be easily implemented in software environments (*Excel*, *MATLAB*, *Python*) and used in simulation analyses.

3.2. Conceptual and content validity of the questionnaire

The content validity assessment confirmed that the items within the *KEEO* component questionnaires are fully consistent with their theoretical foundations and reference instruments. In contrast to conventional tools that address only a single aspect of workload, the *KEEO* framework integrates four interdependent domains: physical, mental, organizational, and technical. This multidimensional structure enables a more comprehensive interpretation of ergonomic risk, particularly in workplaces characterized by advanced automation and digitalization.

Additionally, KEEO can be seen as a cohesive framework that connects traditional ergonomic assessments with the principles of smart work systems and the wider context of Industry 4.0.

3.3. Robustness and stability of the weights

The sensitivity analysis demonstrated that the *KEEO* model maintains numerical stability and structural robustness even under moderate perturbations of the weighting coefficients. The observed deviations in the total *KEEO* index were minimal, typically within ±0.03 for weight variations of ±10%. Across all test scenarios, the order of factor importance remained consistent ($K_{FIZ}>K_{MEN}>K_{ORG}>K_{TEH}$), and the relationship between the factors preserved linear proportionality without nonlinear distortions.

These results confirm that the *KEEO* index is insensitive to small parameter fluctuations, indicating that the model's formulation and aggregation logic are both stable and reliable. Such robustness ensures that the model remains valid even if future empirical or expert adjustments lead to slight modifications of weighting coefficients. This property makes the *KEEO* model particularly suitable for application across diverse industrial and occupational environments, where the specific composition of tasks may vary, but the principle of weighted factor aggregation remains consistent.

3.4. The importance of edge-case testing

The analytical edge-case test confirmed that the *KEEO* model behaves consistently in all predefined limit situations. The results demonstrated that:

- The output of the model remains **strictly bounded** between 0 and 1;
- The index **increases monotonically** with each factor, with no inversion or discontinuity;

- The **sum of weighted contributions** equals the overall result (additivity);
- The **relative impact** of each component corresponds exactly to its weight (proportionality).

The model therefore fulfills the fundamental conditions of **mathematical stability, normalization, and logical consistency**. Each component (K_{FIZ}, K_{MEN}, K_{ORG}, K_{TEH}) shows a proportional and predictable increase in the total value when its own rating is raised, confirming that the model structure correctly represents the additive nature of ergonomic workload.

3.5. Monte Carlo Results

The results of the Monte Carlo simulation confirmed that the *KEEO* model preserves its linear and proportional character across all 10000 simulated cases. The slopes of the regression lines closely matched the **theoretical weights** that were predetermined at the start of the simulation ($\beta_{FIZ} \approx 0.46$, $\beta_{MEN} \approx 0.27$, $\beta_{ORG} \approx 0.17$, $\beta_{TEH} \approx 0.10$), indicating that the model's numerical behavior fully corresponds to the designed weighting structure, Figure 2. The coefficients of determination (R^2=0.67-0.93) confirmed the model's linearity and the absence of multicollinearity among components, while the coefficients of determination for single factors (R^2=0.03-0.65) correspond well with their predefined weighting factors (w_{FIZ}=0.46, w_{MEN}=0.25, w_{ORG}=0.17, w_{TEH}=0.10), indicating a coherent internal balance of the model structure.

The distribution of simulated *KEEO* values exhibited a normal shape with an average of approximately 0.5, confirming the balancedness of the weighting system and the stability of the model under random inputs, Figure 3. These findings validate the internal stability and logical consistency of the *KEEO* formulation, demonstrating that the model remains numerically coherent even when component values vary stochastically. This provides a strong methodological basis for subsequent external validation using real ergonomic data.

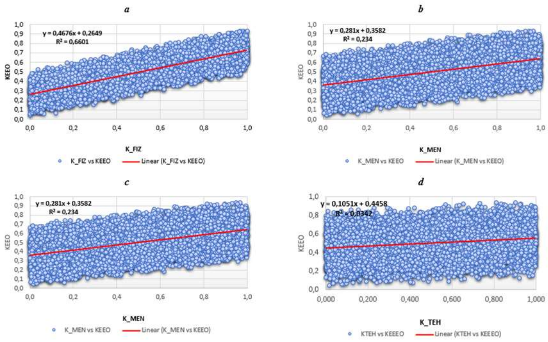

Figure 2. Scatter plots KEEO and it components

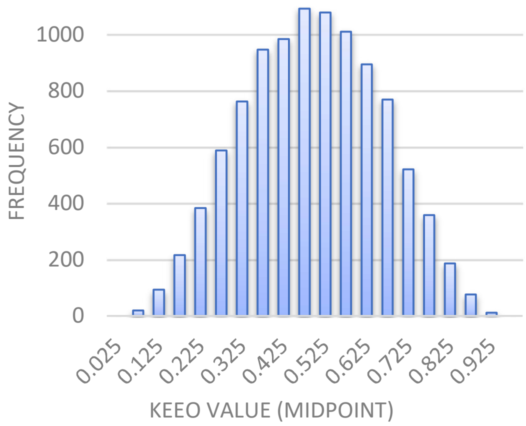

Figure 3. KEEO distribution (rand 0-1, n=10^4).

4. CONCLUSION

This paper presented a methodological framework for the development and validation of the *KEEO* model (Coefficient of Effective *Ergonomic Load*), an integrated system that quantifies total workplace load by combining physical, mental, organizational, and technical-technological factors.

Unlike traditional approaches that assess only isolated aspects of workload, *KEEO* introduces a holistic and analytically verifiable structure, linking subjective perceptions with objective physical data. A key advancement of the current version of the model is the inclusion of the objective physical factor (K_{FIZobj}), obtained from *ergonomics software* biomechanical simulations, which calculate the compression force on the L5/S1 spinal segment, percentage of muscle activation, posture index, and duration of static positions. This component serves as a reference benchmark for the subjective physical perception ($K_{FIZsubj}$) and enables convergent and reliability validation within the same framework.

In that sense, the *KEEO* approach extends these analytical principles beyond the technical domain and adapts them to ergonomic assessment, merging physical and cognitive dimensions into a unified validation structure. Analytical verification confirmed that the model satisfies the fundamental mathematical and logical criteria: boundedness, linearity, monotonic growth, and proportionality of factor contributions. Edge-case testing demonstrated consistent model behavior under extreme input values, while sensitivity analysis indicated that *KEEO* remains stable under ±10% weight variation, confirming its numerical robustness. The Monte Carlo simulation further validated the internal stability of the weighting system and the linear aggregation logic, while the face validity assessment confirmed that the questionnaire structure adequately represents the theoretical constructs of all four workload dimensions.

Methodologically, the *KEEO* framework integrates multi-criteria weighting (*AHP*), empirical and hybrid weighting schemes, and simulation-based stability analysis into a unified validation structure. This combination of analytical and simulation methods enables verification of model behavior even in the absence of experimental data, providing a foundation for early-stage ergonomic model testing and refinement.

Future development of the *KEEO* model will focus on several directions: empirical and psychometric validation, including internal consistency analysis (*Cronbach* α) and convergent comparison with *NASA-TLX* dimensions, standardization of threshold values, defining precise boundaries between optimal, increased, and critical ergonomic load levels based on empirical datasets and extension of the application domain, validating the model in diverse industrial environments such as manufacturing, logistics, healthcare, and information technology.

Conflicts of Interest

The authors declare no conflict of interest.

5. REFERENCES

[1] L. McAtamney and E. N. Corlett, RULA: A survey method for the investigation of work-related upper limb disorders, *Applied Ergonomics*, 4 (1993) 2, pp. 91-99

[2] S. Hignett and L. McAtamney, Rapid Entire Body Assessment (REBA), *Applied Ergonomics*, 31 (2000) 2, pp. 201-205 doi: 10.1016/S0003-6870(99)00039-3

[3] E. Occhipinti, OCRA: a concise index for the assessment of exposure to repetitive movements of the upper limbs, *Ergonomics*, 41 (1998) 9, pp. 1290-1311 doi: 10.1080/001401398186315

[4] S. G. Hart and Lowell E. Staveland, Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research, in *Advances in Psychology*, 52(1988), pp. 139-183. doi: 10.1016/S0166-4115(08)62386-9

[5] R. S. Bridger, *Introduction to ergonomics*, 2. ed. London: Taylor & Francis, 2003

[6] S. Konz and S. Johnson, *Work Design: Occupational Ergonomics*, 1st ed. CRC Press, 2018. doi: 10.1201/9780203733714

[7] International Standard Office, ISO-6385:2016, Ergonomics principles in the design of work systems, 2016

[8] J. Bokrantz, A. Skoogh, C. Berlin, T. Wuest, and J. Stahre, Smart Maintenance: a research agenda for industrial maintenance management, *International Journal of Production Economics*, 224 (2020), p. 107547, doi: 10.1016/j.ijpe.2019.107547

[9] W. S. Marras, *Fundamentals and Assessment Tools for Occupational Ergonomics*, second ed. CRC Press, 2006 doi: 10.1201/9781420003635

[10] R. W. Saaty, The analytic hierarchy process what it is and how it is used, *Mathematical Modelling*, 9 (1987) 3-5, pp. 161-176, 1987 doi: 10.1016/0270-0255(87)90473-8

[11] R. F. DeVelli, S*cale Development: Theory and Applications Applied*, 26 Applied Social Research Methods, ed. by L. Bickman and D. J. Rog, 4th edition, SAGE Publications, Inc., 2017

[12] S. N. Haynes, D. C. S. Richard, and E. S. Kubany, Content validity in psychological assessment: A functional approach to concepts and methods, *Psychological Assessment*, 7(1995) 3, pp. 238-247, doi: 10.1037/1040-3590.7.3.238

[13] R. Karasek, *Healthy work : stress, productivity, and the reconstruction of working life*. New York : Basic Books, 1990. Accessed: Oct. 08, 2025., [Online], Available: http://archive.org/details/healthyworkstres0000kara

[14] T. S. Kristensen, H. Hannerz, A. Høgh, and V. Borg, The Copenhagen Psychosocial Questionnaire a tool for the assessment and improvement of the psychosocial work environment, *Scand J Work Environ Health*, 31, (2005) 6, pp. 438-449, doi: 10.5271/sjweh.948

[15] W. S. Marras and W. Karwowski, Eds., *Interventions, Controls, and Applications in Occupational Ergonomics*, 1st ed. CRC Press, 2006. doi: 10.1201/9781420003642

[16] International Standard Office, ISO-9241-210:2019, Ergonomics of human-system interaction, Part 210: Human-centred design for interactive systems, 2019

[17] S. Lovrić, A. Topčić, E. Cerjaković, The Impact of Different Artificial Neural Network Structures on the Results of Preprocessing 3D Digitization Data, *Teh. vjesn.*, 32(2025) 5 doi: 10.17559/TV-20250131002314

[18] A. Topčić, A. Nurkić, E. Cerjaković, S. Lovrić, and M. Herić, Application of 'soft' three-dimensional printing tools in injection moulding of plastic parts, International scientific conference - ETIKUM 2021, Novi Sad, Serbia, Dec. 2021.

[19] E. Cerjaković, A. Topčić, and I. Veza, Influence of structure of manufacturing system and amount of investment on production costs, *Teh. vjesn.*, 22 (2015) 3, pp. 771-780 doi: 10.17559/TV-20140307103216.