

Segmenting Human Reliability Risks Through Employer Attractiveness: A Clustering Approach in the Military Context

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This study explores human factors and reliability within the Lithuanian Armed Forces by analysing the alignment between employer value propositions and soldiers' expectations. Using five dimensions of employer attractiveness: Interest, Social, Economic, Development, and Application Value, the cluster analysis was applied to segment soldiers based on perceived organizational value. Intention to continue service (ICS), a key indicator of reliability and operational sustainability, was examined across these clusters.

Three distinct clusters emerged through K-means clustering. Cluster 1, with low scores across all value dimensions, showed the lowest ICS ($M = 2.89$), indicating high risk for disengagement and attrition. Cluster 2, scoring highly on all dimensions, demonstrated the strongest commitment ($M = 4.43$), suggesting high reliability and resilience. Cluster 3 reflected moderate perceptions and ICS ($M = 3.65$), marking it as a transitional group requiring attention. Significant differences in ICS across clusters confirmed the relevance of this segmentation for reliability assessment. Both linear and non-linear relationships between cluster membership and ICS highlight the complexity of **motivationally conditioned human reliability risk** dynamics in military contexts. Findings emphasize the importance of economic and developmental support in sustaining engagement. Risks such as communication breakdown, morale decline, and reduced mission readiness are most evident in Cluster 1. Practical implications include targeted counselling, development planning, and recognition strategies to strengthen reliability and organizational effectiveness.

Keywords: Human factors, human reliability, risk profiling, military personnel, employer attractiveness, cluster analysis.

1. Introduction

Human reliability is a critical determinant of operational effectiveness in military organizations, where personnel decisions directly influence mission success and national security. In recent years, scholars have increasingly recognized that human factors such as motivation, engagement, and organizational commitment play a pivotal role in sustaining reliability under demanding conditions (Al-dalahmeh et al. 2018; Andrade et al. 2025). While technical systems have advanced significantly, the human element remains a source of variability and risk, particularly in contexts requiring high resilience and adaptability (Kanapeckaitė et al. 2022; Dekker, 2019). Understanding **motivationally**

conditioned human reliability risk dynamics is essential for mitigating attrition, maintaining morale, and ensuring readiness.

Employer attractiveness has emerged as a key concept in organizational psychology and human resource management, reflecting the perceived value employees associate with their organization (Styvén et al. 2022). Traditionally examined in corporate settings, this construct encompasses dimensions such as economic benefits, developmental opportunities, and social relationships. However, its application in military contexts remains underexplored, despite evidence that soldiers' expectations and perceived organizational support significantly influence retention and reliability (Broesder et al. 2019; Khan et al., 2020). Diverging hypotheses exist

regarding which value dimensions, economic versus developmental, most strongly predict commitment, highlighting the need for empirical segmentation approaches.

This study addresses this gap by investigating how employer attractiveness relates to human reliability risks within the Lithuanian Armed Forces. Conceptually, our approach does not replace classical HRA, it extends it temporally and analytically by treating intention to continue service (ICS) as a leading indicator of reliability degradation that precedes observable errors or unsafe acts. By examining ICS across these clusters, we aim to identify patterns of engagement and potential risk zones. Our findings reveal three distinct clusters with significant differences in ICS, underscoring the complexity of motivational dynamics and their implications for operational sustainability.

2. Theoretical Framework

Human reliability in military organizations is deeply intertwined with psychological and organizational factors that influence soldiers' motivation, engagement, and commitment. Traditional reliability models often emphasize technical systems and procedural safeguards (Reason, 2016; Andrade et al. 2025), yet contemporary research highlights that human factors remain a primary source of variability in high-risk environments (Dekker, 2019). In the military context, where operational success depends on cohesive, resilient personnel, understanding these factors is critical for mitigating risks such as attrition, morale decline, and mission failure.

2.1. Employer Attractiveness as a Predictor of Reliability

Employer attractiveness, defined as the perceived value employees associate with their organization, provides a useful lens for examining motivational dynamics (Ronda et al. 2018; Bendaravičienė & Vitkauskas, 2024). This construct encompasses multiple dimensions, economic rewards, developmental opportunities, social relationships, and meaningful work, that collectively shape organizational commitment. While extensively studied in corporate settings, its relevance to military organizations is underexplored, despite evidence that soldiers' perceptions of

organizational support strongly influence retention and performance (Kumar, 2025; Hood, 2016; Soeters et al., 2014). Diverging hypotheses exist regarding which dimensions exert the strongest influence: some studies emphasize economic incentives as primary drivers of commitment (Woodruff, 2017), while others argue that developmental and social values are more critical for sustaining engagement in high-stress environments (Bekesiene & Smaliukiene, 2022). This theoretical tension underscores the need for empirical segmentation approaches to capture heterogeneity in soldiers' value perceptions.

2.2. Clustering as a Methodological Approach

Cluster analysis is a widely used, person-centered methodology that groups individuals based on multivariate similarity, enabling researchers to reveal heterogeneous profiles that are covered in variable-centered approaches (Pastor et al., 2019). In organizational and psychological research, clustering is particularly valuable for profiling motivational and attitudinal configurations because it treats patterns across variables as meaningful units of analysis rather than isolating single predictors (Morin et al., 2016). This orientation aligns with contemporary calls for person-oriented analyses that capture within-population diversity relevant to engagement, commitment, and reliability outcomes (Morin et al., 2016).

Methodologically, non-model-based clustering such as K-means and model-based approaches offer complementary strengths for uncovering latent subgroups (Pastor et al., 2019). K-means is frequently adopted in applied settings due to its simplicity, scalability, and interpretability, making it suitable for segmenting personnel along multiple value dimensions (Singh et al. 2022). At the same time, recent reviews emphasize that clustering should be embedded within rigorous workflows that include data pre-processing, stability checks, and external validation with theoretically relevant criteria (Pastor & Erbacher, 2019). These practices ensure that emergent profiles reflect substantive structure rather than methodological artefacts.

Within employer attractiveness research, multi-dimensional models typically encompass interest value (intrinsic appeal of work), social value (relational climate), economic value (compensation and security), development value (growth and learning), and application value

(opportunities to apply skills), providing a theoretically grounded basis for segmentation (Berthon et al., 2005). Person-centered profiling of these dimensions helps distinguish distinct value constellations that are hypothesized to associate differentially with retention-related attitudes and behaviours in high-stakes environments (Morin et al., 2016; Soeters et al. 2014). In defence organizations, where reliability hinges on sustained engagement and readiness, such segmentation supports targeted resource allocation and interventions founded on empirically derived patterns of perceived organizational value (Soeters et al., 2014).

By segmenting soldiers according to five dimensions of employer attractiveness: Interest, Social, Economic, Development, and Application Value, this study seeks to uncover patterns that traditional linear models may overlook. Such segmentation aligns with person-centered approaches in organizational research, which argue that aggregated analyses often mask critical differences in motivational profiles (Morin et al., 2016). Understanding these clusters is essential for predicting intention to continue service (ICS), a key indicator of reliability and operational sustainability.

2.3. Linking Intention to Continue Service to Reliability Risks

Intention to continue service (ICS) reflects a soldier's willingness to remain in service **as pre-error conditions, not errors themselves**. Low ICS signals amplified risk for disengagement and attrition, which can lead to communication breakdowns, reduced morale, and compromised mission effectiveness (Bekešienė & Navickienė, 2025). **By examining ICS across clusters, recent study integrates organizational psychology with reliability engineering, offering a nuanced perspective that links to reliability degradation risk, not failure events.** In sum, this theoretical framework positions employer attractiveness as a central determinant of reliability, justifying the use of clustering to reveal motivational heterogeneity.

3. Methodology

This study employs a cross-sectional, person-centered design to examine how perceived employer attractiveness relates to human

reliability risks in a military setting. Grounded in reliability and human factors scholarship, which emphasizes the persistent impact of human variability on system performance (Reason, 2016; Andrade et al. 2025; Dekker, 2019), the design integrates organizational psychology constructs with segmentation methods to reveal heterogeneous motivational profiles relevant to retention and operational readiness (Soeters et al. 2014).

3.1. Participants and Procedure

The study was conducted within the Lithuanian National Defence Volunteer Forces (NDVF), following formal approval from relevant military authorities. Participants were recruited through secure internal communication channels to ensure privacy and compliance with organizational protocols. An invitation containing a unique survey link was distributed to professional service members across multiple NDVF units via the official internal communication system. The survey was administered using a secure online platform (Google Forms) to guarantee standardized, anonymous, and efficient data collection. Participation was entirely voluntary. Respondents were informed about the study's purpose, confidentiality measures, and their right to withdraw at any stage without repercussions. No personally classifiable information was collected, and all procedures adhered to ethical standards for research involving human subjects.

Data collection occurred at the end of January 2025. A total of 307 service members initially responded; however, 31 questionnaires were excluded. Consequently, 276 valid responses were retained for statistical analysis. All participants were actively serving within NDVF structures at the time of the survey, ensuring that responses reflected current perceptions of employer attractiveness. The sample represented a diverse cross-section of professional soldiers, providing robust insights into organizational value perceptions in a military context.

3.2. Employer Attractiveness Assessment

Perceived employer attractiveness was assessed with the EmpAt scale (Berthon, Ewing, & Hah, 2005), which captures both instrumental (e.g., compensation, development resources) and

symbolic (e.g., prestige, social climate, meaningful work) attributes. Five sub dimensions were chosen to evaluate employer attractiveness.

Interest Value (INT). INT reflects the extent to which the organization offers exciting, creative, and challenging work—symbolic characteristics that appeal to soldiers seeking intellectually stimulating and meaningful tasks. Eight items measured INT. Reliability and convergent validity indices were satisfactory ($\alpha = .843$; CR = 0.889; AVE = 0.507).

Social Value (SOC). SOC indexes the quality of interpersonal relationships and the unit's social climate, connecting instrumental and symbolic needs such as harmony, belonging, and emotional well-being. Nine items were used. Internal consistency and construct reliability were high ($\alpha = 0.896$; CR = 0.923; AVE = 0.574).

Economic Value (ECO). ECO focuses on financial rewards, job security, and compensation—core instrumental concerns closely tied to basic needs and long-term security. Four items assessed ECO, yielding strong reliability ($\alpha = 0.853$; CR = 0.901; AVE = 0.695).

Development Value (DEV). DEV represents opportunities for personal growth, training, and career advancement, integrating instrumental resources with symbolic signals of progression and self-improvement. Five items measured DEV with excellent psychometrics ($\alpha = 0.906$; CR = 0.930; AVE = 0.728).

Application Value (APP). APP reflects opportunities to apply skills and make meaningful contributions, emphasizing symbolic value (purpose, self-expression, impact). Six items assessed APP ($\alpha = 0.873$; CR = 0.906; AVE = 0.618).

Intention to Continue Service (ICS) represents a soldier's attitudinal and behavioural commitment to remaining in military service. It was operationalized using a three-item scale designed to capture overall satisfaction and retention-related intentions within the Lithuanian Armed Forces. The items reflect both symbolic and instrumental aspects of employer branding and organizational commitment, aligning with established literature on military retention. Specifically, respondents evaluated statements such as: "The Lithuanian Armed Forces is an attractive employer," "I would recommend military service to others," and "I am satisfied with my service in the Armed Forces." Internal

consistency and construct reliability were high ($\alpha = 0.896$; CR = 0.931; AVE = 0.819).

This scale integrates perceptions of organizational attractiveness with behavioural intentions, providing a holistic measure of reliability and engagement. Conceptual development draws on Lievens (2007). Similar measures have been validated in defence-sector studies, including research on the Belgian Army, confirming their relevance for assessing commitment and sustainability in military contexts. ICS serves as a key indicator of operational reliability, linking employer value perceptions to soldiers' willingness to continue service. In this study, ICS was not used in cluster formation but was analyzed as an external validation criterion to determine whether clusters based on employer attractiveness dimensions differ significantly in retention-related intentions. This approach ensures that segmentation reflects attitudinal profiles while confirming their practical implications for organizational effectiveness and mission readiness.

All EmpAt and ICS items were rated on a 5-point Likert scale (1 = "Completely Disagree" to 5 = "Completely Agree"). Prior to analysis, subscale scores were computed as the mean of constituent items; internal consistency (Cronbach's alpha), composite reliability (CR), and average variance extracted (AVE) were used to evaluate reliability and convergent validity at the construct level. The reported indices exceed conventional thresholds ($\alpha \geq .70$; CR $\geq .70$; AVE $\geq .50$), supporting measurement adequacy for subsequent clustering and criterion validation.

Together, the EmpAt subscales measure provide a multidimensional assessment of how professional soldiers perceive the Lithuanian Armed Forces as an employer capturing the instrumental benefits (economic security, development) and symbolic signals (meaningful work, social climate, opportunity to contribute) that military organizations must balance to sustain engagement and reliability.

3.3. Data Preparation and Clustering Procedure

Prior to conducting the segmentation analysis, all datasets underwent rigorous screening to ensure completeness and accuracy. Checks for missing values, outliers, and distributional irregularities were performed, and user-defined missing values

were treated listwise during subsequent procedures. Univariate distributional properties, including skewness and kurtosis, were examined to confirm normality assumptions. Measurement reliability was assessed using Cronbach’s alpha for each employer attractiveness dimension, Interest, Social, Economic, Development, and Application, while exploratory factor diagnostics such as item–total correlations and inter-factor correlations were evaluated to confirm construct coherence and minimize redundancy (Berthon, et al. 2005).

To ensure comparability across metrics, all clustering inputs were z-standardized (mean = 0, SD = 1) within IBM SPSS 29v. Standardization mitigated scale effects and aligned the procedure with best practices for Euclidean-distance-based clustering of continuous variables (Pastor & Erbacher, 2019). Segmentation was performed using the K-means clustering algorithm in SPSS, selected for its interpretability and efficiency in handling continuous, standardized data (Pastor & Erbacher, 2019). The algorithm iteratively minimized the within-cluster sum of squares (WCSS) by assigning cases to the nearest centroid and updating cluster centers until convergence was achieved. Diagnostics included inspection of iteration history, final cluster centers, and inter-center distances to confirm separation and stability.

The optimal number of clusters (K) was determined through an iterative, triangulated approach. Solutions with varying cluster counts were compared using WCSS trends (elbow method), interpretability of profiles, and centroid stability (Pastor & Erbacher, 2019).

To describe differentiation across clusters, one-way ANOVA was conducted for each input dimension, reporting F-statistics and p-values ($\alpha = 0.05$). These tests were interpreted descriptively, as clustering inherently maximizes between-group differences (Jaeger & Banks, 2023). For external validation, clusters were linked to Intention to Continue Service (ICS) using the same ANOVA framework, confirming the discriminant relevance of segmentation for reliability-related criteria (Soeters et al. 2014). Internal validity was supported by examining inter-center distances and case distributions, yielding a stable three-cluster solution consistent with theoretical expectations.

4. Results

Following the analysis, three clusters were identified based on perceived employer attractiveness, assessed using the EmpAt scale within the ICS framework. Soldiers were classified into three distinct groups: Disengaged, Engaged, and At-Risk/Neutral, through K-means clustering applied to standardized EmpAt dimensions: Interest, Social, Economic, Development, and Application values. The clustering algorithm converged after 11 iterations, indicating stability in the solution. The iteration history presented in Table 1 provides a detailed overview of the clustering process and its progression across successive steps.

Table 1. Iteration History.

Iteration	Change in Cluster Centers		
	1	2	3
1	2,238	1,759	1,853
2	0,774	0,177	0,076
3	0,224	0,031	0,079
4	0,196	0,014	0,121
5	0,091	0,023	0,084
6	0,052	0,023	0,057
7	0,103	0,011	0,072
8	0,040	0,029	0,059
9	0,022	0,039	0,056
10	0,034	0,031	0,040
11	0,000	0,000	0,000

Note: Convergence achieved; cluster centers stabilized.

The ANOVA test identified which variables contributed most to the cluster solution by comparing between-cluster variance to within-cluster variance for each EmpAt dimension using the F-statistic. Conducted analysis confirmed that three clusters were clearly differentiated, and the associated intention to continue service patterns highlight system-level reliability-degradation risk. The ranking of discriminating power showed that *Application* and *Social* values were the most powerful discriminators of cluster membership, with *Development* close behind. *Interest* contributed meaningfully but less so, and *Economic*, while still significant, showed the smallest relative contribution to separating profiles. In practical terms, profiles are differentiated chiefly by the degree to which soldiers can apply their skills in meaningful roles, experience cohesive social climates and leadership, and access credible growth pathways; intrinsic interest and compensation matter, but

comparatively less for partitioning the motivational landscape. By conservative standards (small ≈ 0.01 , medium ≈ 0.06 , large ≈ 0.14 for η^2), all effects are very large. *Application* value alone accounts for $\sim 67\%$ of the variance in standardized scores across clusters, very strong

separation. This pattern demonstrates clear statistical and practical separation across EmpAt dimensions, representing motivationally conditioned human reliability risk. (Table 2).

Table 2. F-statistic and effect sizes.

Variable	Cluster		Error		F	Sig.	Effect η^2
	Mean Square	df	Mean Square	df			
ZINT	77,533	2	0,439	273	176,484	0,000	0.564
ZSOC	89,953	2	0,348	273	258,243	0,000	0.654
ZECON	64,978	2	0,531	273	122,302	0,000	0.473
ZDEV	86,161	2	0,376	273	229,086	0,000	0.627
ZAPP	92,692	2	0,328	273	282,371	0,000	0.674

Effect sizes are measured by η^2 (eta squared).

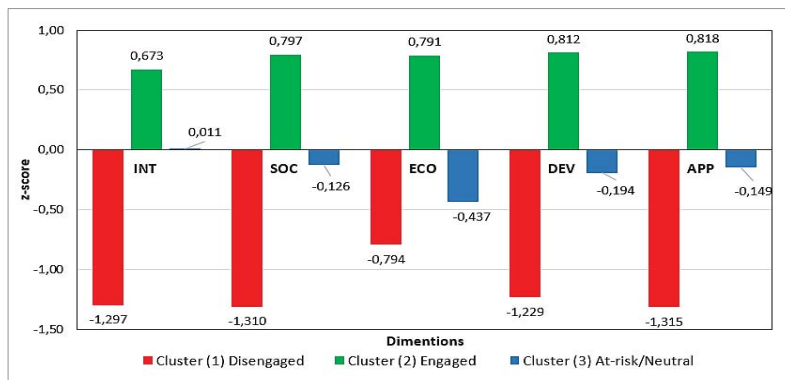


Fig. 1. Grouped bar chart of the final cluster centers (z-scores) by EmpAt dimensions.

The standardized cluster centers (Fig. 1) show a clear gradient of employer attractiveness sensitivities across the three segments. Cluster 2 (“Engaged”) shows uniformly positive z-scores: Application = +0,818; Social = +0,797; Development = +0,812; Interest = +0,673; Economic = +0,791, indicating strong alignment between soldiers’ expectations and organizational offerings. Cluster 1 (“Disengaged”) exhibits consistent negatives: Application = -1,315; Social = -1,310; Development = -1,229; Interest = -1,297; Economic = -0,794, indicating low perceived value across skill use, social climate, growth, and instrumental support. Cluster 3 (“At-risk/Neutral”) values are near the mean or slightly below (Application = -0,149; Social = -0,126; Development = -0,194; Economic = -0,437; Interest $\approx$ +0,011), marking a transitional group with mixed perceptions. The distance matrix confirms separation: the largest gap is

between “Engaged” and “Disengaged” ($C1-C2 = 4,421$), with “At-risk/Neutral” positioned between them ($C1-C3 = 2,382$; $C2-C3 = 2,178$). Collectively, these patterns indicate a robust three-cluster structure, where Application, Social, and Development values most strongly differentiate engagement levels, and Cluster 3 represents the primary target for interventions to shift perceptions upward. Practical implications:

- The Engaged cluster ($N = 116$) represents soldiers with high reliability and commitment. Retention strategies should focus on recognition, leadership opportunities, and transparent career advancement while maintaining fairness to preserve trust.
- The At-risk/Neutral cluster ($N = 99$) is a pivotal group that can shift toward engagement or disengagement. Quick interventions such as improving role-skill

alignment, clarifying development pathways, and mentoring programs are essential to strengthen their connection.

- The Disengaged cluster (N = 61) poses the greatest attrition risk and potential morale challenges. Addressing workload issues, leadership gaps, and unmet development needs through economic support, personalized development plans, and reassignment for better skill fit can help reduce reliability risks and improve operational readiness.

Finally, all effects were large by conventional benchmarks, indicating substantive, not merely statistical, separation across dimensions. Taken together, these patterns align with the premise that even as technical systems advance the human element remains a central source of variability and risk in high-resilience contexts. Understanding these motivationally conditioned human reliability risks is therefore vital for mitigating attrition, sustaining morale, and preserving readiness.

5. Discussion

The present study motivationally conditioned human reliability risk segmented into three profiles: (1) “Disengaged”, (2) “Engaged”, and (3) “At-risk/Neutral”, based on five employer attractiveness (EmpAt) dimensions and examined differences in Intention to Continue Service (ICS). The strong between-cluster differentiation on Application, Social, and Development values aligns with employer branding research showing that attractive organizational attributes jointly shape commitment and retention (Berthon, Ewing, & Hah, 2005). Our findings also echo Lievens (2007), who demonstrated in a defence context that both symbolic (e.g., social climate, pride) and instrumental attributes (e.g., development opportunities, role fit) significantly influence military personnel’s attraction and stay intentions. In our sample, clusters high on these attributes “Engaged” exhibited the most favourable ICS, whereas low-scoring clusters “Disengaged” showed lower ICS, supporting the working hypothesis that perceived value profiles are associated with reliability-related outcomes.

Methodologically, the clear separation among clusters supports the robustness of the segmentation approach (Jaeger & Banks, 2023), while the pre-processing and iterative solution

procedures affirm the suitability of K-means for continuous value dimensions (Pastor & Erbacher, 2019). Substantively, Application emerged as the strongest differentiator, indicating that meaningful skill use is central to engagement; Social (cohesion, leadership climate) and Development (career pathways, training) followed closely, underscoring the role of relational and growth factors in sustaining reliability.

The practical implications are twofold. First, units should prioritize role–skill alignment, transparent development pathways, and climate-building interventions (leader training, mentoring) to move “At-risk/Neutral” soldiers upward and preserve the “Engaged” profile. Second, targeted support for Disengaged clusters, combining material fixes (economic support) with individualized development and reassignment to better skill-fit roles, may prevent attrition and mitigate readiness risks.

In the broader context, these results reinforce the view that motivationally conditioned human reliability and operational sustainability are rooted not only in compensation but in perceived meaningfulness, growth, and social identity within the military. Future research should: (i) incorporate longitudinal designs to test causal pathways from value perceptions to ICS and actual retention; (ii) examine moderators (e.g., rank, specialty, deployment tempo) that may condition the value–ICS link; and (iii) evaluate intervention trials (e.g., role redesign, leadership programs) to quantify effects on cluster transitions and mission readiness. Extending the framework to multinational forces could further clarify how organizational culture shapes the EmpAt–ICS link across defence contexts.

6. Conclusions

This study segmented soldiers into three clusters, “Disengaged”, “At-risk/Neutral” and “Engaged”, based on employer attractiveness dimensions, confirming strong differentiation and stability of the model. Practical implications highlight the need for role–skill alignment, transparent career development pathways, and social climate-building interventions to sustain engagement and reduce reliability risks. Targeted support for Disengaged soldiers, including economic incentives and individualized development plans, can mitigate attrition. These findings emphasize that operational sustainability be determined by

perceived significance, growth, and social identity, not solely compensation. Future research should adopt longitudinal designs, examine moderating factors, and test interventions to validate strategies for improving cluster profiles and mission readiness.

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