**AHP-TOPSIS AND ANOVA METHOD APPROACH IN SOFTWARE DEVELOPMENT CRITERIA SELECTION ACCORDING TO ISO 12207:2017**

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**Abstract:** This study aims to evaluate the effectiveness of combining the Analytical Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods in supporting decision-making for software development activities. The analysis was conducted by comparing evaluation results using these two methods through ANOVA statistical testing to identify significant differences in expert assessment patterns. The findings indicate variations in evaluations, suggesting the need for alignment among experts. Furthermore, the combination of AHP-TOPSIS provides flexibility in determining criteria weights and accuracy in selecting the best alternatives, but still requires a more standardized evaluation guideline to ensure consistency. Based on these findings, the study recommends developing standardized evaluation guidelines and conducting structured discussions among experts before the assessment process to enhance consistency and decision accuracy. For future research, it is proposed to integrate approaches such as the Delphi method or Fuzzy-AHP to better align expert perceptions and expand the respondent pool from various industrial sectors to improve the generalizability of the findings. This research contributes to the development of a more effective and efficient decision-making framework in the context of software development, particularly in enhancing the reliability of multi-criteria evaluations.

**Keywords:** AHP, TOPSIS, ANOVA, ISO 12207:2017

**Abstrak:** Penelitian ini bertujuan untuk mengevaluasi efektivitas kombinasi metode Analytical Hierarchy Process (AHP) dan Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) dalam mendukung pengambilan keputusan pada aktivitas pengembangan perangkat lunak. Analisis dilakukan dengan membandingkan hasil evaluasi menggunakan kedua metode tersebut melalui uji statistik ANOVA, untuk mengidentifikasi adanya perbedaan signifikan dalam pola penilaian oleh para ahli. Hasil penelitian menunjukkan bahwa terdapat variasi dalam penilaian yang mengindikasikan perlunya penyelarasan pandangan antar ahli. Selain itu, kombinasi metode AHP-TOPSIS memberikan fleksibilitas dalam menentukan bobot kriteria serta keakuratan dalam pemilihan alternatif terbaik, namun tetap memerlukan panduan evaluasi yang lebih terstandar untuk memastikan konsistensi. Berdasarkan hasil tersebut, penelitian ini merekomendasikan pengembangan panduan evaluasi terstandar serta pelaksanaan diskusi terarah antar ahli sebelum proses penilaian untuk meningkatkan konsistensi dan akurasi keputusan. Sebagai tindak lanjut, penelitian lanjutan diusulkan untuk mengintegrasikan pendekatan seperti metode Delphi atau Fuzzy-AHP untuk menyelaraskan persepsi ahli lebih baik, sekaligus memperluas cakupan responden dari berbagai sektor industri guna meningkatkan generalisasi temuan. Penelitian ini berkontribusi pada pengembangan kerangka kerja pengambilan keputusan yang lebih efektif dan efisien dalam konteks pengembangan perangkat lunak, khususnya untuk meningkatkan keandalan dalam evaluasi multi-kriteria.

**Kata kunci:** AHP, TOPSIS, ANOVA, ISO 12207:2017

**INTRODUCTION**

The advancement of information technology has driven the increasing demand for high-quality software across various sectors. Software is defined as a set of instructions used to process input and produce output according to the functions and performance expected by users [1]. The software development process includes several key stages: development, testing, manufacturing distribution, training, operations, support, and disposal [2]. To produce high-quality software that meets user needs, a framework is required, encompassing Software Project Tracking and Control, Risk Management, Software Quality Assurance, Technical Reviews, Measurement, Software Configuration Management, Reusability Management, and Work Product Preparation and Production [3].

Standardization in software development has been established by international organizations such as ISO, IEC, and IEEE through standards such as ISO 12207:2017 and ISO 24748-1:2018 [4]. ISO 12207:2017 specifically provides a comprehensive framework covering three main aspects: organizational project-enabling processes, which focus on infrastructure and improvement management; technical management processes, which include documentation, verification, validation, joint review, and issue resolution; and technical processes, which involve acquisition, operation, development, maintenance, and supply [4].

To determine priorities and optimize the implementation of ISO 12207:2017 criteria, a Multi-Criteria Decision Making (MCDM) approach can be used as a systematic decision-making method [5]. MCDM enables the evaluation of alternative solutions in complex problems by considering multiple criteria simultaneously [6]. Common MCDM techniques include the Analytic Hierarchy Process (AHP), Base Criterion Method (BCM), and Best-Worst Method (BWM), which can be integrated with ranking methods such as TOPSIS, MOORA, VIKOR, and PROMETHEE to generate more optimal decisions [7]

The effectiveness of MCDM implementation in software development has been demonstrated through various studies. [8] utilized a combination of Fuzzy AHP and Fuzzy TOPSIS to identify efficient Parameter-Influencing Testing (PIT) in software testing processes. [9] applied the AHP method to evaluate software quality based on ISO 9126 criteria. [10] developed an MCDM-based framework comparing various techniques such as AHP, TOPSIS, and DEMATEL, concluding that a hybrid approach yields more optimal results. [11] combined GIS and AHP methods, validated using Analysis of Variance (ANOVA), to improve decision-making accuracy.

Based on an analysis of previous research and the need for a systematic decision-making framework in software development, this study proposes a hybrid approach combining AHP-TOPSIS with ANOVA validation to select software development criteria based on ISO 12207:2017. This approach is expected to contribute a more structured and validated decision-making framework for implementing ISO 12207:2017 standards in software development.

**METHOD**

This study is quantitative in nature as it involves the collection and analysis of numerical data to test hypotheses. The research employs the Multi-Criteria Decision Making (MCDM) technique by integrating the AHP and TOPSIS methods based on ISO 12207:2017 criteria and activities conducted in software development. The results obtained from the AHP-TOPSIS method are tested using ANOVA to determine whether there are significant differences. The respondents in this study consist of experts and perspectives from the development team in their respective fields, with a total of three experts participating. The research process conducted by the researcher follows these steps:

1. Literature Review – This is the first step in the research, involving the collection and review of relevant literature to establish a strong theoretical foundation and understanding of the research topic. It includes identifying theories, concepts, and previous research findings related to software development, ISO 12207:2017, MCDM techniques (AHP-TOPSIS), and ANOVA.
2. Software Development Activity Points – This stage involves identifying and analyzing the key activities involved in software development. These activity points will serve as the basis for determining relevant aspects in the study.
3. Determining ISO 12207:2017 Criteria – Once the activity points have been identified, the next step is to define the specific criteria that align with the ISO 12207:2017 standard. These criteria will be used for evaluating software processes or products.
4. Multi-Criteria Decision Making (MCDM) Technique – At this stage, a multi-criteria decision-making method is applied to analyze various alternatives based on predefined criteria. This technique aids in structuring complex decisions by considering multiple factors.
5. Integration of AHP and TOPSIS Methods – This step involves integrating two decision-making methods: Analytic Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). AHP is used to determine criterion weights, while TOPSIS evaluates alternatives based on those weights.
6. Determining ISO 12207:2017 Criterion Weights (Questionnaire) – The criterion weights are determined through a questionnaire completed by experts or relevant stakeholders. These weights reflect the importance of each criterion in the context of software development in accordance with ISO 12207:2017, based on the previously identified activity stages.
7. Data Processing – Once the criterion weights have been established and questionnaire data collected, the next step is to process the data for further analysis. This processing may involve statistical calculations or the application of MCDM methods.
8. Determining Alternatives Based on ISO 12207:2017 Criterion Weights Using TOPSIS – Using the TOPSIS method, software development alternatives are evaluated and ranked based on the determined criterion weights.
9. Data Testing Using ANOVA – The results of the alternative selection process are statistically tested using the Analysis of Variance (ANOVA) method to determine whether there are significant differences among the selected alternatives.
10. Research Findings – The final step presents the research results, including key findings from each stage of the study and conclusions drawn based on the analysis.

**RESULT AND DISCUSSION**

This chapter presents the results obtained from a comprehensive analysis of priority determination in software development activities using an integrated approach that combines the Analytical Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), which is further validated through Analysis of Variance (ANOVA). This method is employed to ensure objectivity and reliability in complex decision-making processes within software development. The ISO 12207:2017 framework serves as the foundation, providing a structured international standard for activities and tasks throughout the software lifecycle. This research actively involves the participation of four experts with substantial expertise in various aspects of software development, offering a multi-dimensional perspective on the issues being examined.

Based on the ISO 12207:2017 framework, this study identifies and analyzes twelve sub-criteria as evaluation parameters. The Software Requirements Definition Process serves as the foundational phase, encompassing a comprehensive definition of system requirements. Operation and Implementation provide practical perspectives on software development execution, while Maintenance ensures system sustainability. Stakeholder Needs and Project Planning establish the strategic framework, supported by Measurement and Decision Making for evaluation and decision-making. Project Assessment and Control and Risk Management offer oversight mechanisms, whereas Infrastructure Management and Life Cycle Model Management ensure resource availability and effective lifecycle management.



Figure 1 AHP Weighting Results

On figure 1, the AHP method yields significant priority weights, with the Software Requirements Definition Process receiving the highest weight of 0.169, followed by Implementation (0.101), Operation, and Project Assessment and Control (each 0.095). These results highlight the critical role of software requirements definition and systematic implementation in software development. Infrastructure (0.089) and Risk Management (0.087) occupy mid-range positions, underscoring the importance of infrastructure and risk management. Project Planning (0.051) holds the lowest weight, indicating a relatively lower priority in this analysis.

Based on the findings regarding the weight determination of criteria in ISO 12207:2017 and software development activities using the AHP-TOPSIS method, several key insights emerge that require comprehensive discussion. This research focuses on evaluating eight core activities in software development, correlated with ISO 12207:2017 standards. The analysis process begins with data collection through expert assessments, which are then processed using a combination of Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).

In the initial phase, a matrix weighting was conducted on the eight development activities, which include: Software Project Tracking and Control, Risk Management, Software Quality Assurance, Technical Reviews, Measurement, Software Configuration Management, Reusability Management, Work Product Preparation and Production. The expert assessments collected indicate significant variations in the assigned weights for each correlation between development activities and ISO 12207:2017 sub-criteria. After normalizing the decision matrix and applying AHP weightings, the resulting values reflect the relative importance levels of each activity.



Figure 2 AHP-TOPSIS Results

On Figure 2, the TOPSIS-based preference analysis yields highly compelling findings. Software Configuration Management (SCM) emerges as the highest-priority activity, achieving a TOPSIS preference score of 0.221. This result indicates that SCM plays a crucial role in the overall software development process. SCM is identified as the activity closest to the ideal solution, highlighting the importance of managing and controlling changes in software artifacts. Measurement ranks second with a preference score of 0.363, emphasizing the importance of measurement in development processes. This activity involves collecting, analyzing, and utilizing metric data to support objective decision-making.

Software Project Tracking and Control ranks third with a score of 0.433, underscoring the significance of project monitoring and control in ensuring software development success.

In the mid-priority spectrum, Reusability Management (score 0.478), Risk Management (score 0.529), and Technical Reviews (score 0.600) occupy moderate positions. These rankings indicate that, while not as critical as the top-tier activities, these three functions still play a substantial role in supporting successful software development projects.

Work Product Preparation and Production and Software Quality Assurance, with scores of 0.647 and 0.651, respectively, rank lower. However, it is important to note that these relatively high preference scores suggest that both activities still hold significant value and contribute meaningfully to the overall development process.

The findings of this study provide a quantifiable framework for decision-making in software development project management, particularly in the context of ISO 12207:2017 implementation. The generated rankings and preference scores can serve as strategic guidance for optimizing resource allocation and enhancing the overall efficiency of software development processes.

**CONCLUSION**

Conclusions should be in the form of paragraphs that answer the research objectives. Tells how the researcher’s work can advance current knowledge, does not seem to discuss. Conclusions do not repeat the results that have been displayed in the abstract or only contain the experimental results. Provide a clear scientific justification of the research work and show possible applications and extensions if needed provide suggestions for further research.

To evaluate the consistency of expert assessments in applying the AHP-TOPSIS method, an ANOVA (Analysis of Variance) test was conducted, revealing several key insights. The analysis examined the average criteria ratings provided by four expert respondents (R1-R4) for eight alternative software development activities (A1-A8). The ANOVA test assessed two primary aspects:

#### Table 1 **ANOVA Validation Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source of Variance** | **Degrees of Freedom** | **Sum of Squares** | **Vari-ance** | **F** **Comp.**  | **F Table** |
| Block | 3 | 2.82 | 0.94 | 7.87 | 3.07 |
| Among Columns (Activities) | 7 | 0.52 | 0.07 | 0.63 | 2.49 |
| Residual | 21 | 2.51 | 0.12 |  |  |
| Total | 31 | 5.86 |  |  |  |

On table 1, in the analysis of inter-group variance, the computed F-value of 7.87 is significantly higher than the F-table value of 3.07 at a 0.05 significance level. This finding indicates a substantial difference in assessment patterns among experts. This variation may be attributed to differences in experience backgrounds, professional perspectives, or varying interpretations of evaluation criteria among the experts. Conversely, the inter-column variance analysis results in a computed F-value of 0.63, which is lower than the F-table value of 2.49. This outcome indicates no significant difference in ratings among the software development activity alternatives. This consistency validates the ranking results obtained through the AHP-TOPSIS method, suggesting that the score variations among alternatives reflect stable and reliable assessments.

**CONCLUSION**

This study successfully identifies the priority activities in software development based on the ISO 12207:2017 standard using a combination of the Analytical Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). The analysis results indicate that Software Configuration Management (SCM) holds the highest priority, followed by Measurement and Software Project Tracking and Control. These activities are considered the closest to the ideal solution in supporting an effective software development process. Additionally, the AHP analysis assigns the highest weight to the Software Requirements Definition Process, emphasizing the importance of systematically defining software requirements as the foundational phase of development.

Validation using Analysis of Variance (ANOVA) confirms the consistency of the results, showing no significant differences among the alternative development activities, despite variations in expert assessment patterns. This finding reinforces that the obtained ranking reflects stable and reliable evaluations. These conclusions provide a strategic basis for decision-making in resource allocation and enhancing the effectiveness of software development in alignment with the ISO 12207:2017 framework.

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