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A Fuzzy BWM-MARCOS Decision Model for Social Media Platform Selection in Higher Education Marketing

Edson Yahuda Putra*[1], Jimmy Herawan Moedjahedy[2]
[1,2)]Program Studi Sistem informasi, Fakultas Ilmu Komputer, Universitas Klabat
Email: *[1]eyahuda@unklab.ac.id, [2]jimmy@unklab.ac.id

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Abstrak: *This study addresses the lack of structured, data-driven approaches for selecting social media platforms in higher education marketing, focusing on Universitas Klabat. Although platforms such as Instagram, Facebook, WhatsApp, TikTok, and YouTube reach millions of Generation Z users in Indonesia, decisions about which platforms to prioritize are often intuitive rather than based on measurable criteria. To overcome this, a hybrid fuzzy multi-criteria decision-making model combining Fuzzy-Best Worst Method (Fuzzy-BWM) and Fuzzy-MARCOS is proposed. Three marketing experts evaluated five platforms against five criteria: Engagement, Target Audience, Send/Receive Message, Content Richness, and Cost, using linguistic terms converted into triangular fuzzy numbers. Fuzzy-BWM was used to derive criteria weights with a Consistency Ratio below 0.025; the defuzzified weights show Engagement as the most influential criterion (0.362), followed by Target Audience, Send/Receive Message, and Content Richness (0.182 each), while Cost is least important (0.092). Fuzzy-MARCOS then normalized, weighted, and aggregated platform performances to compute utility scores. The final crisp utilities indicate that Instagram and Facebook are the best platforms (1.2045), followed by WhatsApp (1.0906), with TikTok (0.9778) and YouTube (0.9689) ranking lowest. The model offers a reusable, transparent decision-support tool for university digital marketing.*

Kata Kunci – *Fuzzy-BWM; Fuzzy-MARCOS; Social Media Platform Selection; Higher Education Marketing*

Model Pengambilan Keputusan Berbasis Fuzzy BWM–MARCOS untuk Pemilihan Platform Media Sosial pada Strategi Pemasaran Perguruan Tinggi

Abstract: *Penelitian ini membahas belum adanya pendekatan yang terstruktur dan berbasis data dalam pemilihan platform media sosial untuk pemasaran perguruan tinggi dengan studi kasus di Universitas Klabat. Meskipun platform seperti Instagram, Facebook, WhatsApp, TikTok, dan YouTube menjangkau jutaan pengguna Generasi Z di Indonesia, keputusan mengenai platform yang harus diprioritaskan masih sering didasarkan pada intuisi, bukan pada kriteria yang dapat diukur. Untuk mengatasi permasalahan tersebut, penelitian ini mengusulkan model hibrida fuzzy multi-criteria decision-making yang menggabungkan metode Fuzzy Best Worst Method (Fuzzy-BWM) dan Fuzzy MARCOS. Tiga pakar pemasaran mengevaluasi lima platform berdasarkan lima kriteria, yaitu Engagement, Target Audience, Send/Receive Message, Content Richness, dan Cost, menggunakan istilah linguistik yang dikonversi ke dalam triangular fuzzy numbers. Metode Fuzzy-BWM digunakan untuk menentukan bobot setiap kriteria dengan Consistency Ratio (CR) di bawah 0.025. Hasil defuzzifikasi menunjukkan bahwa Engagement merupakan kriteria yang paling berpengaruh dengan bobot 0.362, diikuti oleh Target Audience, Send/Receive Message, dan Content Richness yang masing-masing memiliki bobot 0.182, sedangkan Cost menjadi kriteria dengan bobot terendah, yaitu 0.092. Selanjutnya, metode Fuzzy-MARCOS digunakan untuk melakukan normalisasi, pembobotan, dan agregasi kinerja setiap platform sehingga diperoleh nilai utilitas. Hasil akhir menunjukkan bahwa Instagram dan Facebook merupakan platform terbaik dengan nilai utilitas 1.2045, diikuti oleh WhatsApp (1.0906), sedangkan TikTok (0.9778) dan YouTube (0.9689) menempati peringkat terendah. Model yang diusulkan memberikan alat bantu pengambilan keputusan yang transparan, sistematis, dan dapat digunakan kembali untuk mendukung strategi pemasaran digital di lingkungan perguruan tinggi*

Keywords – *Fuzzy-BWM; Fuzzy-MARCOS; Pemilihan Platform Media Sosial; Pemasaran Perguruan Tinggi*

1. INTRODUCTION

Digital transformation has reshaped communication and marketing strategies across industries, including higher education institutions. Universities increasingly rely on social media platforms to engage prospective students, disseminate institutional information, strengthen branding, and build community presence in a competitive environment. Global social media usage reached an average of 143 minutes per day in 2024 [1], illustrating its prominence as a communication medium. For Generation Z, social media serves as the primary source of information, with over 90% accessing at least one platform daily [2], [3]. In Indonesia, the potential audience reach is significant. Instagram and TikTok alone account for more than 100 million users each, making them key platforms for digital marketing campaigns targeting youth demographics [4]. As a result, universities must strategically determine which platforms best support their promotional objectives.

Despite its importance, social media selection in many higher education institutions is often intuitive rather than analytical. This challenge is also evident at Universitas Klabat, where platform selection traditionally relies on habits, perceived popularity, or ad-hoc considerations rather than measurable criteria. Findings from a focus group discussion with the institution's marketing division reveal several recurring issues: inconsistent content formats across platforms, varying caption length restrictions, and differences in video duration limits that complicate content production workflows. Furthermore, each platform exhibits distinctive audience behaviors, engagement mechanisms, and content richness capabilities. These factors indicate that selecting a suitable platform requires a systematic, multi-criteria evaluation rather than subjective judgment.

Existing literature offers numerous approaches to evaluating promotional media. Prior works commonly employ AHP [5], Fuzzy AHP–TOPSIS [6], [7], or hybrid MCDM models such as ANP–COPRAS–GRA [8] for media or social platform selection. While these methods are useful, many require extensive pairwise comparisons or assume crisp numerical judgments, which may not reflect real-world uncertainty and linguistic assessments commonly provided by marketing experts. Few studies specifically integrate fuzzy uncertainty with the efficiency of the Best-Worst Method (BWM) and the compromise-solution orientation of MARCOS for platform ranking. Moreover, most prior research focuses on commercial brands, tourism, or product promotion rather than higher education contexts, leaving a methodological and contextual gap for university digital marketing.

To address these limitations, this study proposes an integrated Fuzzy-Best Worst Method (Fuzzy-BWM) and Fuzzy-MARCOS decision model to determine the most suitable social media platforms for marketing at Universitas Klabat. Fuzzy-BWM efficiently derives consistent criteria weights using only two structured comparison vectors (Best-to-Others and Others-to-Worst) while incorporating linguistic uncertainty through triangular fuzzy numbers [9], [10], [11]. Fuzzy-MARCOS is then applied to evaluate alternatives by measuring their proximity to ideal and anti-ideal solutions, enabling robust ranking under multi-criteria environments [12], [13]. This combined framework offers transparency, reduced cognitive load for experts, and mathematically grounded results, making it highly suitable for small marketing teams.

The innovation of this research lies in (1) applying a hybrid Fuzzy-BWM and Fuzzy-MARCOS approach in the context of higher education marketing area with limited prior studies; (2) integrating expert linguistic judgments to handle uncertainty; and (3) producing a reusable decision model validated through prototype implementation and expert assessment. Unlike previous work, this study produces both a methodological contribution and a practical decision-support prototype tailored to real institutional workflows.

2. METODE PENELITIAN

This study employed a quantitative, model-driven research design integrating Fuzzy-Best Worst Method (Fuzzy-BWM) and Fuzzy-MARCOS to identify the most suitable social media platforms for university marketing. The methodological process was carried out chronologically, beginning with problem identification, data acquisition, criteria validation, fuzzy modeling,

computational procedures, and result verification. Each stage was grounded in established MCDM literature to ensure scientific rigor and methodological validity [14][15].

2.1. Research design

The research adopted a hybrid decision-making framework consisting of three major phases:

a) Problem identification and requirement analysis
   Conducted through a Focus Group Discussion (FGD) with the Universitas Klabat marketing division to define issues, platform challenges, and decision requirements.
b) Criteria Weighting Using Fuzzy-BWM
   Determined the relative importance of evaluation criteria through linguistic pairwise comparisons, processed using triangular fuzzy numbers (TFN).
c) Alternative Ranking Using Fuzzy-MARCOS
   Evaluated and ranked social media platforms based on fuzzy-aggregated utility scores relative to the ideal and anti-ideal solutions.

This framework leverages the strengths of BWM, reduced comparison complexity and higher consistency [14][15] and the MARCOS method, which evaluates alternatives by measuring proportional utility relative to boundary solutions [15][16].

2.2. Data acquisition

Data were collected in two stages:

a) Expert Judgment for Criteria Weighting
   Three marketing experts from Universitas Klabat provided linguistic assessments for Best-to-Others (BTO) vector and Others-to-Worst (OTW) vector. These linguistic inputs such as Moderately Important, Very Important, and Equally Important, were converted into TFN values following established fuzzy scales in the literature [3][15].
b) Expert Judgment for Criteria Weighting
   Experts evaluated five platforms (Instagram, Facebook, WhatsApp, TikTok, and YouTube) across five criteria: 1) Engagement, 2) Target Audience, 3) Send/Receive Message, 4) Content Richness, and 5) Cost. Evaluations used fuzzy linguistic terms mapped to TFN matrices, consistent with prior fuzzy MCDM studies [14][15].

2.3. Research procedure

The overall research procedure followed a structured sequence of activities, illustrated in Figure 1, to ensure that the development of the hybrid Fuzzy-BWM–MARCOS model was systematic and scientifically grounded. The process began with problem identification, where the research team conducted discussions with the marketing division of Universitas XYZ to understand the challenges faced in selecting suitable social media platforms. This stage clarified the decision-making context, platform constraints, and the institutional need for an objective evaluation model.

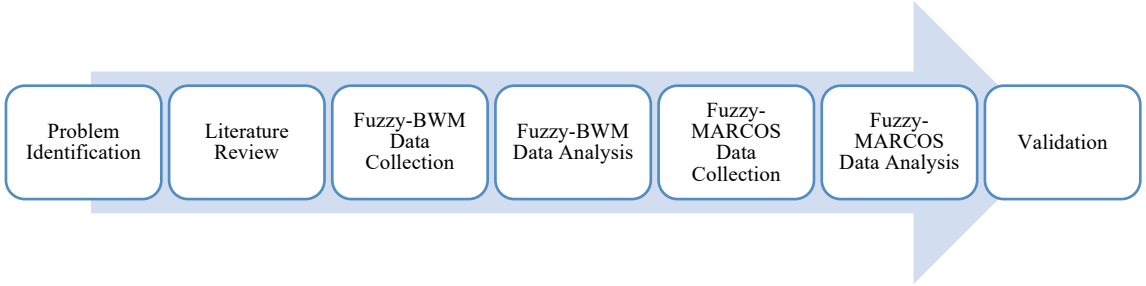

Figure 1. Hybrid Fuzzy-BWM MARCOS Procedure

Following this, a literature review was performed to identify relevant theories, decision-making frameworks, fuzzy logic concepts, and multi-criteria decision-making (MCDM) methods. This review provided the theoretical basis for selecting Fuzzy-BWM for criteria weighting and

Fuzzy-MARCOS for alternative evaluation, while also highlighting methodological gaps in existing studies.

The next stage involved Fuzzy-BWM data collection, where experts provided linguistic comparisons for the Best-to-Others (BTO) and Others-to-Worst (OTW) vectors. These inputs were converted into Triangular Fuzzy Numbers (TFN) and served as the basis for computing fuzzy weights. Subsequently, Fuzzy-BWM data analysis was conducted to solve the optimization model, derive the fuzzy and defuzzified weights, and verify the consistency ratio (CR) to ensure reliability of expert judgments.

The procedure continued with Fuzzy-MARCOS data collection, in which experts evaluated each social media platform using linguistic scales aligned with the previously validated criteria. These fuzzy assessments were organized into a fuzzy decision matrix. This was followed by Fuzzy-MARCOS data analysis, which included fuzzy normalization, construction of the weighted fuzzy matrix, determination of ideal and anti-ideal solutions, computation of utility scores, and final ranking of the platforms based on defuzzified values.

Finally, the process concluded with a validation phase. The resulting rankings and interpretations were presented back to the experts for assessment. Their feedback confirmed the model's accuracy, practicality, and alignment with real-world behavior of social media platforms used in higher education marketing. This validation ensured that the hybrid decision-support model was both theoretically robust and practically relevant.

2.4. Fuzzy-BWM Computation

The Fuzzy-Best Worst Method begins by selecting the Best and Worst criteria. Experts then provided BTO and OTW comparisons using linguistic ratings. Each rating was transformed into its TFN equivalent (l,m,u), forming fuzzy vectors. The optimization model for deriving optimal fuzzy weights is expressed as:

$$\begin{aligned} &\min_{\mathbf{w},\xi} \ \xi \\ &\text{s.t. } |w_B - a_{Bj} w_j| \le \xi, \quad \forall j, \\ &\quad |w_j - a_{jW} w_W| \le \xi, \quad \forall j, \\ &\quad \textstyle\sum_{j=1}^{n} w_j = 1, \quad w_j \ge 0 \ (\forall j). \end{aligned} \tag{1}$$

This formulation follows the fuzzy BWM models proposed in [14], [15], which ensure weight stability and logical consistency. A Consistency Ratio (CR) below 0.025 confirms the reliability of expert input.

2.5. Fuzzy-MARCOZ Computation

After determining the criteria weights using Fuzzy-BWM, the Fuzzy-MARCOS method was applied to evaluate and rank the social media platforms. The process began with fuzzy normalization, where benefit-type criteria were normalized through fuzzy division by the maximum triangular fuzzy number (TFN), while cost-type criteria were normalized using the minimum TFN to ensure proper directional interpretation. The normalized fuzzy decision matrix was then multiplied by the corresponding fuzzy weights to form the weighted matrix. Next, the ideal and anti-ideal solutions were identified by selecting the maximum and minimum fuzzy values across all alternatives, respectively. Based on these reference points, utility coefficients were computed using:

$$K_i^- = \frac{S_i}{S_{A^-}}, \qquad K_i^+ = \frac{S_i}{S_{A^+}} \tag{2}$$

Representing the proportional closeness of each alternative to both boundary solutions. Finally, defuzzification was performed on the utility values to derive final utility scores, from which

the alternatives were ranked. This procedure aligns with established applications of the MARCOS method in multi-criteria decision-making literature [15][16].

2.6. Testing and validation

The model was validated using 1) Consistency Testing (BWM); A CR value < 0.025 ensured that expert comparisons were mathematically consistent, as recommended by prior BWM studies [14][15]. 2) Sensitivity Analysis (Ranking Stability); Small modifications in criteria weights were tested to observe ranking stability. Rankings remained consistent, indicating robustness of the model. 3) Expert Validation; Marketing practitioners evaluated whether model results matched real-world platform performance, confirming practical validity.

3. RESULT AND DISCUSSION

This section presents the outcomes of the hybrid Fuzzy-BWM–MARCOS decision-making model and provides a comprehensive discussion of the findings. The results include criteria weighting, fuzzy evaluation of social media platforms, utility score calculations, and final rankings. All findings are interpreted in relation to the research objectives and supported by expert validation.

3.1. Problem identification

The initial stage involved identifying institutional challenges related to selecting appropriate social media platforms for marketing at Universitas Klabat. Through a Focus Group Discussion (FGD), it was discovered that decisions were based largely on intuition, platform popularity, and convenience rather than structured evaluation. Experts noted specific issues such as differences in caption limits, content formats, video duration constraints, engagement variations, and unequal target demographic coverage across platforms. These concerns confirmed the need for a quantitative multi-criteria decision-making approach.

3.2. Literature review

The literature review identified the core theoretical foundations and empirical findings that informed the selection of criteria and alternatives used in this study. A synthesis of prior research in digital marketing, social media analytics, and multi-criteria decision-making (MCDM) reveals clear justification for both the evaluation dimensions and the social media platforms examined.

A. Selection of criteria

Five criteria were adopted: Engagement, Target Audience, Send/Receive Message, Content Richness, and Cost. These criteria were chosen based on their recurring significance in literature and their relevance to the digital marketing strategies of higher education institutions.

1) Engagement
   Numerous studies emphasize that user engagement, such as likes, shares, comments, and interactions is the strongest predictor of successful digital communication and brand visibility [16], [6]. Platforms with higher engagement potential amplify message reach, make campaigns more interactive, and foster stronger audience relationships. Since the core objective of university marketing is to attract and retain the attention of prospective students, engagement has become the most dominant criterion.
2) Target Audience
   Prior research shows that different platforms cater to distinct demographic segments, such as age, interests, and behavioral patterns [7]. Universities must strategically choose platforms that align with youth demographics, particularly Generation Z, the primary audience for admissions campaigns. High relevance to audience alignment justifies its inclusion as one of the primary criteria.
3) Send/ receive message
   Studies highlight the importance of bidirectional communication in strengthening community trust and responsiveness [8]. Platforms that support direct messaging or quick responses

create more opportunities for personalized engagement. Since universities need channels for inquiries, feedback, and student support, communication capability is essential.

4) Content richness
   Rich media formats: photos, videos, stories, reels, significantly increase information retention and emotional impact [17]. Platforms with diverse content features allow institutions to communicate academic programs more creatively. Universities frequently share promotional visuals, student activities, and academic achievements; thus, content richness directly impacts marketing quality.
5) Cost
   Although social media is generally low-cost, literature acknowledges that content creation, especially videos may require higher production resources [18]. Including cost allows the evaluation to consider resource efficiency and sustainability of long-term campaigns.

These five criteria are repeatedly validated in the literature as essential to digital marketing, and they reflect the practical needs of Universitas Klabat's marketing division, confirmed during the Focus Group Discussion (FGD) process.

B. Selection of alternatives (Social media platforms)
   The alternatives: Instagram, Facebook, WhatsApp, TikTok, and YouTube, were selected based on global usage statistics, platform functionality, and their relevance to Generation Z and the Indonesian context.
   1) Instagram
      Instagram is widely identified as the most effective platform for visual-driven youth engagement [16]. Its high interaction rates, strong visual storytelling features, and massive reach among prospective students justify its inclusion. A dominant platform for higher education branding and recruitment content.
   2) Facebook
      Although older than Instagram, Facebook remains essential due to its wide demographic coverage, flexible content formats, and robust community features [7]. Valuable for reaching parents, alumni, and non-Gen Z audiences, important secondary targets for universities.
   3) WhatsApp
      Indonesia is one of the world's largest WhatsApp user bases [18]. WhatsApp provides fast communication, group channels, and broadcast features, making it ideal for direct inquiries and student-lecturer interactions. Strong communication capability makes it a vital supplementary marketing tool.
   4) Tiktok
      TikTok's short-form videos are highly effective for student engagement and viral content generation [17]. Universities increasingly adopt TikTok to reach younger audiences through creative, trend-based messaging, despite heavier content production demands.
   5) YouTube
      As a long-form video platform, YouTube supports detailed content such as virtual tours, campus life documentaries, and academic showcases [8]. Suitable for deeper storytelling but requires more production resources hence important to evaluate.

3.3. Fuzzy-BWM Data collection

In this stage, expert input was gathered to obtain the linguistic assessments required for the Fuzzy-BWM process. Three experts from Universitas Klabat's Marketing Division were selected due to their direct involvement in managing digital outreach and their familiarity with platform performance [19], [20]. The experts were asked to identify the most important (Best) criterion and the least important (Worst) criterion based on their institutional goals and operational experiences. After identifying Engagement as the Best criterion and Cost as the Worst criterion, each expert completed two comparison vectors: 1) Best-to-Others (BTO); expressing how much more important

the best criterion is relative to each of the remaining criteria. 2) Others-to-Worst (OTW); expressing how much more important each criterion is relative to the Worst criterion.

These comparisons were provided using linguistic terms such as Equally Important, Moderately More Important, Strongly More Important, and Extremely More Important. Each linguistic term was converted into a corresponding Triangular Fuzzy Number (TFN), forming the fuzzy BTO and fuzzy OTW vectors. The use of linguistic scales is critical because experts often express preferences in qualitative terms, and fuzzy logic preserves the uncertainty inherent in such assessments. This approach aligns with established Fuzzy-BWM applications in decision-making scenarios where expert judgment involves vagueness or subjectivity.

By converting expert judgments into TFNs, the study ensured that the subsequent optimization process would capture thorough uncertainty and produce weight that more accurately reflected expert consensus than crisp numerical comparisons. The results are respectively shown in table 1 and 2 below.

Table 1. Linguistic Conversion to TFN for BTO

Linguistic value	l	m	u	**TFN**
Equally important	1	1	1	(1, 1, 1)
Very important	2,5	3	3,5	(2,5, 3, 3,5)
Very important	2,5	3	3,5	(2,5, 3, 3,5)
Very important	2,5	3	3,5	(2,5, 3, 3,5)
Moderately important	1,5	2	2,5	(1,5, 2, 2,5)

Table 2. Linguistic Conversion to TFN for OTW

Linguistic value	l	m	u	**TFN**
Absolutely More Important	4,5	5	5,5	(4,5, 5, 5,5)
Absolutely More Important	4,5	5	5,5	(4,5, 5, 5,5)
Very important	2,5	3	3,5	(2,5, 3, 3,5)
Very important	2,5	3	3,5	(2,5, 3, 3,5)
Equally important	1	1	1	(1, 1, 1)

3.4. Fuzzy-MARCOS Data analysis

The data collection stage for the Fuzzy-MARCOS analysis involved gathering expert evaluations of each alternative: WhatsApp, TikTok, Instagram, Facebook, and YouTube, across the five criteria defined earlier. Experts provided assessments using linguistic scales such as Sangat Baik, Baik, Cukup, Buruk, and Sangat Rendah, which were later converted into Triangular Fuzzy Numbers for computational processing. This linguistic approach enables experts to express qualitative judgments naturally, while fuzzy logic preserves the imprecision inherent in human perception, yielding a more realistic evaluation environment.

The assessments revealed distinct performance patterns among the platforms. WhatsApp received "Good" for communication-centric and moderate scores for engagement-related criteria, reflecting its strong messaging capabilities. TikTok obtained strong engagement ratings but lower scores in content diversity and audience alignment, indicating its effectiveness for viral content yet limitations for broader marketing needs. Instagram demonstrated superior performance, especially in engagement and target audience suitability, consistent with its popularity among younger demographics. Facebook received consistently "Good" ratings in most categories, maintaining its role as a balanced platform. In contrast, YouTube was evaluated as "Poor" in content richness and "Very Low" in cost efficiency due to high production demands. These linguistic ratings formed the foundation of the fuzzy decision matrix, later processed using the MARCOS method to compute

normalized values, utility coefficients, and final platform rankings. The overall results are shown in table 3.

Table 3. Linguistic Evaluation of All Alternatives Across Criteria

Criteria / Alternatives	Engagement	Target Audience	Send/Receive Message	Content Richness	Cost
WhatsApp	Fair	Fair	Good	Good	Fair
TikTok	Good	Fair	Fair	Fair	Very Low
Instagram	Very Good	Good	Good	Fair	Medium
Facebook	Good	Good	Good	Fair	Fair
YouTube	Fair	Fair	Fair	Poor	Very Low

3.5. Fuzzy-BWM Data analysis

The determination of optimal weights began by converting the linguistic assessments from experts into Triangular Fuzzy Numbers (TFN), generating lower (l), middle (m), and upper (u) parameters for each comparison. Using these TFNs, the Fuzzy-BWM optimization model was applied to compute the optimal weights by minimizing the maximum deviation between the derived ratios and the expert preferences. This deviation reflects how closely the optimized weights satisfy the Best-to-Others (BTO) and Others-to-Worst (OTW) comparisons. For each parameter (l,m,u), the model evaluated four constraint residuals (R1-R4), which verify the alignment between the BWM ratio constraints and the resulting weights. This process ensured that the generated weights for each parameter faithfully represented expert preferences. The optimal fuzzy weights obtained from these computations are summarized in Table 4, which forms the foundation for the subsequent defuzzification and MARCOS evaluation.

Table 4. Optimal Weight

Criteria	W_l	W_m	W_u
Engagement	0,318	0,364	0,403
Target Audience	0,193	0,182	0,172
Send/Receive Message	0,193	0,182	0,172
Content Richness	0,193	0,182	0,172
Cost	0,102	0,091	0,082

After obtaining the optimal weights for each TFN parameter, the results showed that Engagement consistently achieved the highest weight across W_l, W_m, and W_u, while Cost consistently received the lowest weight. This indicates that Engagement is structurally the most dominant criterion, regardless of whether experts judgments are interpreted conservatively (l), centrally (m), or optimistically (u). Meanwhile, Target Audience, Send/Receive Message, and Content Richness obtained identical weights across each parameter group, reflecting that experts perceive these three criteria as equally important in the evaluation process. These findings further validate the experts earlier identification of Engagement as the Best criterion and Cost as the Worst criterion.

The final stage of the analysis involved transforming the optimal fuzzy weights into crisp values through the centroid defuzzification method. This method averages the three TFN parameters according to the formula: producing a single crisp weight for each criterion to be used in the Fuzzy-MARCOS evaluation. The defuzzified results are presented in Table 5, which demonstrates the finalized numerical weights used in ranking the social media platforms. As shown, Engagement remains significantly higher than the other criteria, while Target Audience, Send/Receive Message, and Content Richness share equal crisp weights, with Cost remaining the lowest.

Table 5. Defuzzification Weights

Criteria	Crisp Number
Engagement	0,362
Target Audience	0,182
Send/Receive Message	0,182
Content Richness	0,182
Cost	0,092

3.6. Fuzzy-BWM Data analysis

The Fuzzy-MARCOS analysis began with the normalization of the fuzzy decision matrix, ensuring that all performance values were placed on a comparable scale according to the MARCOS normalization rules. For benefit-type criteria, normalization was performed by dividing each triangular fuzzy value by the maximum TFN in its respective column, while for the cost-type criterion, normalization used the inverse operation to ensure lower costs result in higher normalized values. The results of this process are summarized in Table 6, which shows that Instagram and Facebook consistently achieved ideal normalized values in criteria such as Engagement and Target Audience, whereas TikTok and YouTube frequently occupied the lowest normalized levels reflecting weaker relative performance in these areas. WhatsApp often appeared in the middle range, demonstrating moderate strength across several criteria.

Table 6. Normalized Fuzzy Decision Matrix

Alternative	Engagement (l,m,u)	Content Richness (l,m,u)	Cost (l,m,u)	Target Audience (l,m,u)	Send/Receive Message (l,m,u)
WhatsApp	0.714, 0.750, 0.778	1.000, 1.000, 1.000	1.000, 1.000, 1.000	0.714, 0.750, 0.778	1.000, 1.000, 1.000
TikTok	0.429, 0.500, 0.556	0.429, 0.500, 0.556	3.750, 3.000, 2.333	0.429, 0.500, 0.556	0.714, 0.750, 0.778
Instagram	1.000, 1.000, 1.000	0.714, 0.750, 0.778	1.000, 1.000, 1.000	1.000, 1.000, 1.000	1.000, 1.000, 1.000
Facebook	1.000, 1.000, 1.000	0.714, 0.750, 0.778	1.000, 1.000, 1.000	1.000, 1.000, 1.000	1.000, 1.000, 1.000
YouTube	0.429, 0.500, 0.556	0.429, 0.500, 0.556	2.500, 3.000, 3.500	0.429, 0.500, 0.556	0.714, 0.750, 0.778

After normalization, each alternative's normalized TFN values were multiplied by the crisp weights obtained from the Fuzzy-BWM stage. This weighting step ensured that criteria with higher importance (such as Engagement) had greater influence when computing the overall performance scores of each platform. The resulting weighted matrices are illustrated in Table 7, showing that Instagram and Facebook achieved the highest weighted values across multiple criteria, reflecting their strong normalized performance and the high weight of Engagement. WhatsApp performed particularly well in communication-related criteria due to its strong normalized values in Send/Receive Message. Conversely, TikTok and YouTube received lower weighted values in several criteria, especially in Content Richness and Target Audience, which reduced their overall competitiveness in the evaluation model.

Table 7. Weighted Fuzzy Matrix

Alternative	Engagement (l,m,u)	Content Richness (l,m,u)	Cost (l,m,u)	Target Audience (l,m,u)	Send/Receive Message (l,m,u)
WhatsApp	0.259, 0.272, 0.282	0.182, 0.182, 0.182	0.182, 0.182, 0.182	0.130, 0.137, 0.142	0.182, 0.182, 0.182
TikTok	0.155, 0.181, 0.201	0.078, 0.091, 0.101	0.078, 0.091, 0.101	0.078, 0.091, 0.101	0.130, 0.137, 0.142
Instagram	0.362, 0.362, 0.362	0.130, 0.137, 0.142	0.130, 0.137, 0.142	0.182, 0.182, 0.182	0.182, 0.182, 0.182
Facebook	0.362, 0.362, 0.362	0.130, 0.137, 0.142	0.130, 0.137, 0.142	0.182, 0.182, 0.182	0.182, 0.182, 0.182
YouTube	0.155, 0.181, 0.201	0.078, 0.091, 0.101	0.078, 0.091, 0.101	0.078, 0.091, 0.101	0.130, 0.137, 0.142

The next step was computing the total fuzzy score of each alternative by summing the weighted values for all criteria. As shown in Table 8, Instagram and Facebook produced the highest total fuzzy scores across the l, m, and u parameters, reflecting their consistent dominance across nearly all criteria. WhatsApp ranked in the mid-range, driven by its strong messaging capability but limited engagement and content richness. TikTok and YouTube showed weaker overall scores due to their low performance in several weighted criteria, despite some strengths in specific areas such as Engagement (TikTok) or Content Richness (YouTube). These total fuzzy scores were then

compared against the ideal and anti-ideal solutions to compute the utility degrees, which were subsequently transformed into the combined utility values displayed in Table 9.

Table 8. Weighted Fuzzy Matrix

Alternative	l	m	u
WhatsApp	0.8446	0.8640	0.8791
TikTok	0.7861	0.7755	0.7596
Instagram	0.9480	0.9545	0.9596
Facebook	0.9480	0.9545	0.9596
YouTube	0.6711	0.7755	0.8669

Table 9. Combined Utility Values

Alternative	U_l	U_m	U_u
WhatsApp	1.1291	1.0952	1.0475
TikTok	1.0510	0.9830	0.8994
Instagram	1.2674	1.2099	1.1362
Facebook	1.2674	1.2099	1.1362
YouTube	0.8972	0.9830	1.0265

The final step of this analysis involved defuzzifying the combined utility values to obtain the crisp utility score for each alternative. These crisp values, presented in Table 10, provide a definitive ranking of platforms within the Fuzzy-MARCOS framework. Instagram and Facebook achieved the highest crisp utility scores (1.2674), confirming them as the top-performing platforms for marketing purposes. WhatsApp occupies the middle position, while TikTok and YouTube rank the lowest. This outcome aligns consistently with earlier stages of the analysis, reinforcing the robustness of the model.

Table 10. Defuzzified Utility Values

Alternative	Crisp Utility
WhatsApp	1.1291
TikTok	1.0510
Instagram	1.2674
Facebook	1.2674
YouTube	0.8972

4. CONCLUSION

This study addressed the need for a structured approach to selecting social media platforms for higher education marketing by developing a hybrid Fuzzy-BWM and Fuzzy-MARCOS decision model. The method effectively incorporated expert linguistic judgments, allowing uncertainty to be modeled systematically while producing consistent and transparent evaluation results. The findings show that Engagement is the most influential criterion, followed by Target Audience, Send/Receive Message, and Content Richness, with Cost being the least significant. Based on these weights, the Fuzzy-MARCOS analysis revealed that Instagram and Facebook are the most suitable platforms for Universitas Klabat's marketing needs, consistently achieving the highest utility values. WhatsApp serves as a reliable supporting platform, while TikTok and YouTube performed weaker due to production demands and lower alignment with communication and engagement needs. These results were validated by experts, confirming their practical relevance.

The hybrid model contributes both methodologically, by combining two fuzzy MCDM techniques and practically, by providing a reusable and transparent decision-support tool for institutional marketing. Future work may involve expanding the criteria, incorporating real analytic data, or testing the model across different institutions and digital marketing contexts.

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