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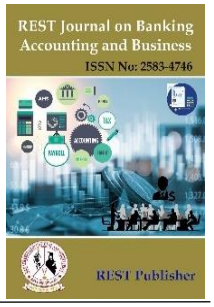

Plithogenic MCDM with LBWA in Selecting Digital Marketing Strategies

***[1]Nivetha Martin, [2]N. Ramila Gandhi, [3]P. Pandiammal**

[1]Arul Anandar College (Autonomous), Karumathur, Madurai, Tamil Nadu, India.

[2]PSNA College of Engineering and Technology (Autonomous), Dindigul, Tamil Nadu, India.

[3]G.T.N Arts College (Autonomous), Dindigul, Tamil Nadu, India.

*Corresponding Author Email: nivetha.martin710@gmail.com

Abstract Digital Marketing is gaining more momentum and it is becoming indispensable in product promotion and sales. The business entities are closely tied with digital marketing mediums to reach customers in large numbers. However, the challenges of choosing the optimal medium of marketing digitally constrains the business endeavours. This research work proposes a decision-making model integrating Plithogenic based contradictions method of ranking with LBWA (Level Based Weighting Assessment) method of finding the criterion weights. This proposed approach of making optimal selection of the mediums of digital marketing is highly efficient in tackling the challenges of product propagation and customer segmentation. The competency of this approach is validated with other Plithogenic integrated methods of criterion weight computation. The newly developed blended method of making decisions facilitates in handling complex decision environments with several criteria. The limitations of this model shall be handled by discussing LBWA with linguistic representations and under the environments of fuzzy and its extended versions.

Keywords: Plithogeny, Contradictions, LBWA, digital marketing mediums, optimal decisions.

1. INTRODUTION

Marketing shall be defined as the set of initiatives or the activities that a company takes to promote the sales of its products. Marketing comprises the analysis of the products through market research and product reach through marketing strategies. Marketing plays a vital role in product development. There are different channels of marketing and digital marketing is one the kind of marketing kind which is highly preferred by the businessmen in this digital era. Digital marketing comprises electronic devices to connect with the customers and to promote the product sales [2]. The online channels, platforms, and technologies are used as mediums to connect and communicate with the customers. Digital marketing strategies often include techniques such as search engine optimization (SEO), content marketing, social media marketing, email marketing, pay-per-click advertising (PPC), and more. The managerial people are constrained in choosing the suitable strategies which are otherwise characterized as marketing mediums. The selection of digital marketing medium is decided based on the several criteria. Few of the significant or the noteworthy criteria that are considered inevitable are compatibility, accessibility, usability, integrity, sustainability, cost, compliance and efficiency. Each strategy of Digital marketing has its own advantages and limitations and this stands as a major challenge for the business decision makers in choosing the optimal medium marketing channel for reaching out their customers through digital portals. Multi-criteria decision-making methods are the ideal choice to resolve this problem of making optimal choices. In general, a decision-making scenario is completely characterized by alternatives, criteria and the nature of the environment. The decision -making methods are primarily grouped into two categories one is to find the optimal criterion weights and the other is to rank the alternatives. The circumstance of deterministic decision making is not possible always as the existence and the interference of uncertainty interludes the process of making decisions. This is the vantage point of the origin of fuzzy and its extended decision-making theory of Plithogeny. Smarandache laid the theoretical formulation of Plithogenic sets. Nivetha and Smarandache [19] developed

Plithogenic contradictions based decision-making model for ranking the alternatives. This new genre of making decision is made more comprehensive by blending with the methods of finding the criterion weights. In this research work the method of LBWA is used in finding the criterion weights. This method based on preferential rankings is used in handling complex relationships and hence it is preferred for this study. The contents of the are paper are organized as follows, Section 2 presents a brief literature on the recent works, section 3 sketches the methodology, section 4 applies to the decision-making problem, section 5 discusses the results and the last section concludes the works.

Literature Review: This section presents the contributions of the researchers in the domains of decision -making with special reference to digital marketing, Plithogenic MCDM and LBWA. Nuseir et al [21] sketched a review on the strategies of digital marketing and its impact over the customers. Dasic et al [7] outlined the opportunities of the digital marketing strategies. The decision -making problem of selecting the suitable marketing strategies is explored recently. Kapustina [14] discussed in criteria selection. Sengul & Eren [27] applied fuzzy Analytic Hierarchy Process (AHP) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is choosing the digital marketing tools. Naz et al [20] developed multi attribute decision-making model to deal with linguistic based decision. From the literature, it is found that the contributions in this respective domain are very limited. Mališa and Pamucar [37] developed the method of LBWA and substantiated the advantages of this new method of finding the criterion weights. This method is widely used to calculate the criterion weights of different entities and few of the significant and recent applications are presented in the Table 1.

TABLE 1. Applications of LBWA

Authors & Year	Method Integrated	Areas of Application
Koruck et al (2023) [15]	Fuzzy combined compromise solution	Network Analysis for Logistic companies
Ogundoyin & Kamil (2023) [23]	Fuzzy Best worst method	Gateway selection in fog-bolstered Internet of Things
Ogel et al (2023) [22]	-------	Retailer selection
Božanić et al (2023) [6]	Multi-attributive border approximation area comparison (MABAC)	Oil spill response strategy selection
Feng et al (2023) [9]	Fuzzy MULTIMOORA	Evaluation of dynamic technological innovation competency
Tesic et al (2023) [31]	BONFERRONI operators	Earthquake Risk Level Assessment
Pamucar & Görçün (2022) [24]	Fuzzy combined compromise solution	Evaluation of the European container ports
Biswas et al (2022) [5]	Fuzzy MULTIMOOSRAL	Evaluation of leanness of MSMEs
Pawlewicz & Cieślak (2022).[25]	-------	Evaluation of Public Participation
Adali et al (2022) [1]	Grey MCDM	Evaluation of smart cities
Demir (2022) [8]	----------	Sustainable green building indicators
Yazdani et al (2022) [35]	-------	Food supplier selection
Gökhan & Cakir (2022) [10]	-------	Theme Park selection
Alkan & Kahraman (2022) [3]	Intuitionistic fuzzy multi-distance-based evaluation for aggregated dynamic decision analysis	Waste Disposal selection
Torkayesh et al (2021) [32]	Best worst method and combined compromise solution	Evaluation of healthcare sectors
Jokić et al (2021) [13]	Fuzzy MABAC	Selection of fire position of mortar units
Biswas et al (2021) [4]	Picture Fuzzy	Social enterprise systems
Hristov et al (2021) [12]	Interval MABAC	Selection of an automatic cannon

Various authors have also explored plithogenic oriented methods across diverse areas of application. Majid et al [17] introduced the Plithogenic Multipolar Fuzzy Hypersoft Set, focusing on dam site selection. Martin et al [19] proposed the Method of Contradictions for logistic supplier selection. Hema et al [11] contributed to decision-making by introducing Plithogenic Interval Valued Neutrosophic Hyper-Soft Sets. Sudha et al [29] introduced MACBETH-MAIRCA Plithogenic for environmental sustainability studies. Tayal et al [30] combined Plithogenic methods with sentiment analysis for ranking products effectively. Wang et al [34] developed Plithogenic

probabilistic linguistic MAGDM & VIKOR for financial risk evaluation. Priyadharshini et al [26] explored plithogenic single valued fuzzy sets in obesity analysis. Yon-Delgado et al [36] contributed to the selection of higher education programs with Neutrosophic Plithogenic AHP. Martin et al [18] also proposed Plithogenic SWARA-TOPSIS for optimizing food processing methods. Sudha et al [28] further expanded the application of plithogenic methods with Plithogenic CRITIC-MAIRCA for ranking feasible livestock feeding stuffs. Ulutaş and Topal [33] introduced Plithogenic PIPRECIA for selecting renewable energy sources. Lastly, Liang et al [16] employed Plithogenic sets in designing an airspace planning scheme. These diverse applications demonstrate the versatility and effectiveness of plithogenic oriented methods across various domains. However, from the aforementioned contributions, the following research gaps are identified

a) Neither Plithogenic based decision making method nor LBWA is applied in the decision-making problem of selecting the marketing strategies
b) The decision- making problem pertaining to the domain of digital marketing is not explored much to the best of our knowledge.
c) Plithogenic integrated LBWA model is not developed so far

These research gaps served as the base for developing a hybrid Plithogenic contradictions-based decision-making model integrated with LBWA.

2. METHODOLOGY

This section presents the steps involved in the LBWA integrated Plithogenic contradictions-based decision-making model. The proposed method works under two phases. In the first phase the method of LBWA is used to determine the criterion weights and in the second phase the Plithogenic contradictions based ranking method is used in ranking.

Phase I: Method of LBWA to find the Criterion Weights

Step 1: Problem Definition and Criteria Selection.
The decision-making problem is well defined and the criteria say C1, C2, …Cn are selected.

Step 2: Framing Level sets of criteria
The most significant criterion is identified say C1. The level sets of criteria say Sk is framed by comparing the significance of other criteria with respect to the chosen significant criterion. The criteria placed in level set Sk is k times or k+1 times of less significance than the chosen criterion.

Step 3: Assigning Significance index
The criteria placed in different level sets are assigned significance index value say I_h. where h cannot exceed the value of r and r = max $\{|S_1|, |S_2|, \dots, |S_k|\}$

Step 4: Calculation of Criterion Influence Function
The criterion influence function f: S → R is defined for every criterion as
$f(C_j) = \frac{r_0}{i*r_0+I_{h_j}}$, here r_0 is the coefficient of elasticity for criterion comparison. j refers to the number of the level set.

Step 5: Finding of the Criterion Weights
The optimal weight of the significant criteria (C1) is determined by

$$w_1 = \frac{1}{1 + f(C_2) + f(C_3) + f(C_4) \dots + f(C_n)}$$

And the other criterion weights say w2, w3...wn are calculated as $w_j = f(C_j) * w_1$

Phase II: Ranking based on Plithogenic Contradictions

Step 6: Formulation of the Contradiction Matrix
The Plithogenic sets are basically a quintuple of the form (P, a, V, d, c) where P is a set, a is an attribute, V is the set of attribute values with respect to an attribute, d is the degree of appurtenance and c is the degree of contradiction. To construct the contradiction matrix, one of the attribute values is assumed to be dominant and pertaining to other values presented in the matrix, the contradiction degree is computed and presented in the matrix form

$$C_D = \begin{bmatrix} c_{D11} & \cdots & c_{D1n} \\ \vdots & \ddots & \vdots \\ c_{Dm1} & \cdots & c_{Dmn} \end{bmatrix}$$

Step 7: Weighted contradiction matrix

The weighted contradiction matrix is determined by multiplying the weight vector with the contradiction matrix.

Step 8: Ranking of the alternatives

The criteria are categorized as benefit and cost and the respective scores are computed with respect to each of the alternatives. The final scores of the alternatives are found using the difference between the criterion score values and the alternatives with maximum score values are given priorities.

3. APPLICATION TO THE SELECTION OF DIGITAL MARKETING STRATEGIES

In this section the proposed method in section 3 is applied in making optimal decisions on the strategies of digital marketing. The decision-making problem comprises five alternatives and eight criteria. The criterion description is presented in Table 2 as follows

TABLE 2. Criterion Description

C.No	Criteria	Description
C1	**Compatibility**	Evaluating how well the chosen digital marketing strategies integrate with existing technologies and platforms.
C2	**Accessibility**	Assessing the ease with which the target audience can reach and interact with the digital marketing channels.
C3	**Usability**	Determining the user-friendliness and navigational ease of the digital marketing platforms.
C4	**Integrity**	Ensuring the trustworthiness, reliability, and authenticity of the digital marketing channels and content.
C5	**Sustainability**	Considering the long-term viability and environmental impact of the chosen digital marketing approaches.
C6	**Cost**	Analyzing the financial implications associated with the implementation and maintenance of the digital marketing strategies.
C7	**Compliance**	Ensuring conformity with legal regulations, industry standards, and ethical principles in digital marketing activities.
C8	**Efficiency**	Measuring the effectiveness and productivity of the digital marketing strategies in achieving desired objectives within allocated resources and timeframes.

Phase I

By Step 1, the aforementioned criteria are selected and, in this case, the criterion C1 is considered to be the most significant among all the criteria.

By Step 2, the level sets are as follows

S1 = {C1, C2, C3, C4}

S2 = {C5, C6, C7}

S3 = {C8}

In this case the value of r = max $\{|S_1|, |S_2|, |S_3|\}$ is 4 and the coefficient of elasticity is 5.

The significance index values of other criteria are assigned as in Step 3.

$I_1 = 0$, $I_2 = 1$, $I_3 = 1$, $I_4 = 2$, $I_5 = I_6 = I_7 = 3$, $I_8 = 4$

The criterion influence function values are tabulated in Table 3 using Step 4.

$f(C_1) = \frac{5}{1.5+0} = 1$ $f(C_2) = \frac{5}{1.5+1} = \frac{5}{6}$ $f(C_3) = \frac{5}{1.5+1} = \frac{5}{6}$ $f(C_4) = \frac{5}{1.5+2} = \frac{5}{7}$

$f(C_5) = \frac{5}{2.5+3} = \frac{5}{13}$ $f(C_6) = \frac{5}{2.5+3} = \frac{5}{13}$ $f(C_7) = \frac{5}{2.5+3} = \frac{5}{13}$ $f(C_8) = \frac{5}{3.5+4} = \frac{5}{19}$

TABLE 3. Criterion Influence Function Values

$f(C_1)$	$f(C_2)$	$f(C_3)$	$f(C_4)$	$f(C_5)$	$f(C_6)$	$f(C_7)$	$f(C_8)$
1	0.83	0.83	0.71	0.38	0.38	0.38	0.26

By step 5, the optimal criterion weight of the significant criteria is determined as

$$w_1 = \frac{1}{1 + 0.83 + 0.83 + 0.71 + 0.38 + 0.38 + 0.38 + 0.26}$$

$$w_1 = 0.21$$

The weights of other criteria are also computed using step 5 and are presented in Table 4

TABLE 4. Criterion Weights

w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8
0.21	0.174	0.174	0.149	0.079	0.079	0.079	0.056

Phase II: The decision-making matrix is framed which comprises five alternatives and eight criteria. The matrix consists of linguistic values (H-High, M-Moderate, L-Low) stating the satisfaction or the fulfilment of the criteria by each of the alternatives.

	C1	C2	C3	C4	C5	C6	C7	C8
M1	H	M	H	M	H	M	H	H
M2	M	L	H	M	H	L	H	H
M3	H	H	M	H	L	H	M	M
M4	H	L	L	H	M	L	M	H
M5	M	L	M	H	H	M	H	L

The criterion C6 is non-benefit or the cost criteria and the other criteria are benefit criteria. The dominant attribute value is L for C6 and H for other criteria. The contradiction degrees say
c (H, H) = 0, c (H, M) = 1/3 c (H, L) = 2/3, c (L, L) = 0, c (L, M) = 1/3
The respective contradiction matrix as described I Step 6 is

	C1	C2	C3	C4	C5	C6	C7	C8
M1	0	1/3	0	1/3	0	1/3	0	0
M2	1/3	2/3	0	1/3	0	0	0	0
M3	0	0	1/3	0	2/3	2/3	1/3	1/3
M4	0	2/3	2/3	0	1/3	0	1/3	0
M5	1/3	2/3	1/3	0	0	1/3	0	2/3

The weighted contradiction matrix as stated in Step 7 is

	C1	C2	C3	C4	C5	C6	C7	C8
M1	0	0.058	0	0.049667	0	0.026333	0	0
M2	0.07	0.058	0	0.049667	0	0	0	0
M3	0	0	0.058	0	0.052667	0.052667	0.026333	0.018667
M4	0	0.116	0.116	0	0.026333	0	0.026333	0
M5	0.07	0.116	0.058	0	0	0.026333	0	0.037333

By step 8, the final Score values of the Marketing mediums are presented in Table 5 under two cases, one with criterion weights obtained in Phase I and other is the case of equal criterion weightage.

TABLE 5. Ranking of the Alternatives

Alternatives	**Score Values**	**Rankings Based on LBWA**	**Score Values**	**Rankings Based on Equal Weightage**
M1	0.081333	5	0.041667	4
M2	0.177667	3	0.125	3
M3	0.103	4	0.125	3
M4	0.284667	1	0.25	1
M5	0.255	2	0.208333	2

4. DISCUSSIONS

Table 5 presents the scores and rankings for five different alternatives (M1, M2, M3, M4, M5) based on two different evaluation methods: LBWA and Equal Criterion Weightage. LBWA reveals that M4 emerges as the top-ranking alternative with the highest score of 0.284667, indicating its superiority over the other options. Following closely, M5 secures the second position with a score of 0.255. Conversely, M3 obtains a score of 0.103, positioning it fourth among the alternatives, while M1 and M2 hold the third and fifth ranks, respectively, with scores of 0.081333 and 0.177667. In contrast, applying the Equal Weightage method maintains M4's lead, as it scores 0.25, securing the first rank. M5 remains in the second position with a score of 0.208333. Both M2 and M3 share the third rank, each scoring 0.125, while M1 trails behind with a score of 0.041667, placing it last among the alternatives. These findings underscore the importance of the chosen evaluation method in determining the rankings of the alternatives and highlight potential variations in outcomes based on the selected methodology.

Inferences

a) The results show some consistency between the two evaluation methods, with M4 consistently ranked the highest and M5 following closely behind in both cases.
b) The LBWA method seems to accentuate the differences between the scores, resulting in more distinct rankings compared to the Equal Weightage method.
c) M1 consistently receives the lowest score and ranking in both evaluation methods, indicating its relatively inferior performance compared to the other alternatives.
d) The differences in scores between alternatives are relatively small, suggesting that the choice between them may depend on other factors not captured by the evaluation criteria.

5. CONCLUSION

This research work proposes a new integrated decision-making model blending the approaches of Plithogenic based contradictions and LBWA method of criterion weight computation. The decision-making problem of selecting digital marketing strategy is addressed in general aspect which could be further investigated with specific choices. This work lays a rudimentary platform for the researchers to explore more on the approach and implications of the decision-making method rather than the choice of marketing strategies. This proposed model shall be further explored by integrating with other MCDM methods to measure the efficacy and competency of the model.

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