CHAPTER II

LITERATURE REVIEW AND THEORETICAL BASIS

2.1 Literature Review

This study proposes a strategic framework for enhancing data quality in Current Research Information Systems (CRIS) through an innovative integration of SWOT analysis and the Best-Worst Method (BWM). The methodology uses SWOT analysis to first methodically identify important external elements (opportunities and weaknesses) and internal factors (strengths and threats) affecting data quality. Subsequently, BWM is applied to objectively prioritize optimal improvement strategies from the identified factors. The analysis revealed two highest-priority interventions: (1) establishing dedicated infrastructure for information documentation and dissemination, and (2) implementing a robust, integrated research database. These strategic solutions demonstrate significant potential for optimizing organizational research data management processes and outcomes (Azeroual et al., 2021).

The article discusses how strategic planning of information systems (IS) involves identifying critical success factors (CSFs) that ensure the effective implementation and operation of mission-critical systems. It emphasizes combining qualitative analysis, like Causal Layered Analysis (CLA), with quantitative methods such as Multi-Criteria Decision-Making (MCDM) to prioritize these factors. This integrated approach helps organizations understand both the underlying causes of issues and the relative importance of each success factor, leading to more aligned and effective IS strategies(Kim, 2022).

The study elucidates that artificial intelligence refers to computer-based systems that can be able of executing tasks generally necessitating human intelligence. In education, especially in math teaching, AI can support personalized learning, provide quick feedback, and create engaging interactive experiences for students, The research uses SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis combined with the BWM (Best-Worst Method) to identify and prioritize

the factors affecting AI's integration into mathematics education(Şahin & Teke, 2025).

The methodology used in this article combines SWOT analysis with the Best-Worst Method (BWM) to evaluate policies or services. SWOT analysis entails recognizing internal strengths and weaknesses, together with external opportunities and threats related to the system being studied. The BWM is a multi-criteria decision-making technique that uses pairwise comparisons to determine the importance of different criteria by identifying the most and least important factors, and then calculating their weights through linear programming. This combination helps provide a clear and quantitative ranking of the most significant factors influencing the development of the service(Stoilova, 2020).

The research highlights that strategic human resource planning involves analyzing internal strengths and weaknesses, as well as external opportunities and threats, using tools like SWOT analysis to identify key factors influencing organizational strategy, It also emphasizes that decision-making methods such as the best-worst method (BWM) help prioritize and evaluate strategies by capturing expert opinions and handling uncertainties with fuzzy logic , Combining these approaches allows organizations to develop effective strategies for human resource management and improve their competitive position(Tabatabaeifar et al., 2022).

This article examines the application of SWOT analysis in assessing the operational viability of cloud-based wireless networks for smart product marketing initiatives. The analytical framework enables enterprises to systematically evaluate both endogenous organizational factors (competitive advantages and limitations) and exogenous market conditions (favorable prospects and potential risks). Through this comprehensive environmental scanning process, businesses can accurately diagnose their market positioning and subsequently formulate data-driven marketing strategies. The methodology facilitates strategic planning by integrating internal capability assessments with external opportunity-threat analyses, thereby optimizing marketing plan development for smart product ecosystems(Lv, 2022).

Enterprise Architecture Framework is a method used to analyze and plan an organization's information systems and technology to align with its goals, SWOT analysis is a tool for identifying internal strengths and weaknesses, as well as external opportunities and threats, to support strategic decision-making, The IT Balanced Scorecard measures IT performance across four areas contribution, user focus, operational efficiency, and future growth to ensure IT supports organizational goals(Wibowo et al., 2018).

The best-worst method (BWM) is a decision-making approach that identifies the most significant and least significant criteria first. Then, it compares these criteria to all other factors to assign importance weights. This process helps produce more accurate and consistent results in prioritizing various options. In this study, BWM was used to evaluate and rank the importance of different information security investments based on both technological and organizational criteria(Hendi Muhammad et al., 2023).

Resilience engineering (RE) is a concept that emphasizes the ability of organizations to adapt and respond effectively to unexpected problems and complex situations. In healthcare settings like operating rooms, RE involves identifying key indicators such as management commitment, teamwork, flexibility, and preparedness to assess safety and performance, To evaluate these indicators, the study uses the Best-Worst Method (BWM) to determine their relative importance, and Data Envelopment Analysis (DEA) to measure the performance of operating rooms based on these factors. This combination of methods helps hospitals develop strategies to improve safety and efficiency by focusing on the most critical resilience indicators(Azizi et al., 2022).

The proposed hybrid approach, called HBWFAD, combines fuzzy Best-Worst Method (FBWM) and Fuzzy Axiomatic Design (FAD) within a hierarchical group decision-making structure to select the optimal product prototype. This method allows decision-makers to evaluate multiple criteria under uncertainty, considering different design aspects such as aesthetics, environmental impact, and functionality, to determine the most suitable prototype among alternatives. It

incorporates expert opinions and expert weighting techniques to manage conflicting criteria and subjective judgments effectively. Additionally, it provides a systematic framework for handling fuzzy and uncertain data, ensuring reliable and consistent decision outcomes. This approach is applicable to various product design scenarios, especially when multiple stakeholders and complex criteria are involved (Ijadi Maghsoodi et al., 2019).

The study utilizes the Best Worst Method (BWM), a decision-making technique that simplifies the criteria weighting process by selecting the most and least important criteria first and then comparing other criteria relative to these choices. This method reduces the number of comparisons needed, making the process more consistent and less complex than other techniques like AHP, Experts assess the importance of different criteria within and across various dimensions such as process feasibility, customer development, and financial status, to determine their weights for effective project prioritization, This approach helps identify the most critical factors for successful Lean Six Sigma project implementation by providing a structured and reliable framework for decision-making(Shukla et al., 2021).

The research methodology used in this study involves a mixed method approach, combining qualitative and quantitative techniques. First, a focus group consisting of experts and practitioners was conducted to identify and categorize the applications of IoT in educational learning. Then, the interval Best-Worst Method (BWM) was employed to weigh and prioritize these applications based on experts' opinions, solving models with specialized software to determine the final weights(Pour et al., 2020).

The Best-Worst Method (BWM) is a decision-making tool used to evaluate multiple criteria more efficiently than conventional approaches such as AHP. Unlike other methods, BWM minimizes the number of comparisons needed by focusing on the most significant (best) and least significant (worst) criteria. Decision-makers then assess all other options against these two reference points using a uniform scale. This streamlined process enhances consistency and reduces

the complexity of decision-making, making it particularly useful in intricate scenarios like choosing international business strategies (Galankashi et al., 2022).

A hybrid framework that combines rough set theory, fuzzy logic, and the best-worst method (BWM) to identify and evaluate user activity-oriented smart service requirements (SSRs). This approach effectively handles both intrapersonal and interpersonal uncertainties during requirement prioritization. The results demonstrated that the method improves the accuracy and objectivity of the evaluation, leading to better support for designing smart product service systems, as shown in the case study of a smart vehicle service system(Chen et al., 2020).

This study employs the Fuzzy Best-Worst Method (BWM) to evaluate and prioritize the key barriers hindering solar energy development in Alborz Province, Iran. By analyzing expert judgments, the method determines the relative importance of each obstacle. The findings reveal that economic factors including high initial investment costs and cheap fossil fuels are the most critical barriers. In contrast, sociocultural factors, such as limited public awareness, have a comparatively lower impact(Mostafaeipour et al., 2021).

The study presents a decision-making framework that integrates fuzzy logic with the Best-Worst Method (BWM) to evaluate and select new product ideas. This hybrid approach enables decision-makers to systematically assess competing criteria under conditions of uncertainty, enhancing selection accuracy. Additionally, the method incorporates group decision-making to aggregate diverse expert opinions, ensuring a more robust and consensus-driven prioritization process(Li et al., 2021).

For optimal industrial robot selection, this study proposes a hybrid decision-making approach that combines the Fuzzy Best-Worst Method (FBWM) and PROMETHEE technique. FBWM uses fuzzy logic to account for decision-makers' uncertainty when determining the weights of evaluation criteria, and PROMETHEE then ranks the available robots according to these weighted criteria. By objectively comparing alternatives, balancing competing demands, and overcoming data

limitations through structured pairwise evaluations and outranking comparisons, the combined methodology systematically handles multiple conflicting factors, including technical specifications, operational requirements, and cost considerations. This enables manufacturers to make well-informed automation investments (Nasrollahi, 2020).

Examining crucial aspects such as formality, clarity, measurability, objectivity, coverage, and consistency is necessary when evaluating strategic planning models. A model's ability to provide comprehensiveness, organizational understanding, and adaptability is determined by these factors taken together. As a sophisticated multi-criteria evaluation tool, the Fuzzy Best-Worst Method (FBWM) addresses the inherent uncertainties in decision-making. Expert linguistic inputs are processed by FBWM, which then allocates weighted values to each criterion, successfully capturing ambiguity and subjective assessments. Moreover, the approach creates fuzzy performance scores for every strategic model by differentiating between high-priority and low-priority factors through pairwise comparisons. Organizations can unbiasedly determine and rank the best planning framework thanks to this methodical approach(Ajripour & Hanne, 2023).

This study adopts an integrated approach utilizing the Fuzzy Delphi Method and Fuzzy Best-Worst Method (FBWM) to systematically evaluate and rank critical factors for cloud service selection. The methodology captures expert judgments through linguistic assessments, which are subsequently converted into triangular fuzzy numbers to effectively handle decision-making uncertainties. The FBWM framework streamlines the evaluation process by focusing on comparisons between the most and least significant criteria, thereby enhancing consistency while minimizing the complexity of traditional pairwise comparisons. The fuzzy preference data undergoes systematic processing to derive precise criterion weights, which are then aggregated and defuzzified to establish a robust ranking of selection factors. This dual-method approach ensures a rigorous, efficient, and comprehensive decision-support mechanism for cloud service evaluation(Salarnezhad & Shoar, 2020).

The fuzzy SWOT analysis is an approach that incorporates fuzzy logic to handle uncertainties and ambiguities in strategic environments. It uses triangular membership functions to represent the degree of importance or certainty of internal and external factors, allowing more realistic and flexible analysis compared to traditional methods, This method also employs techniques such as α-cut planes for defuzzification, which helps to convert fuzzy data into crisp values for decision-making, and combines prioritization tools like TOPSIS with fuzzy logic to rank strategies effectively(Taghavifard et al., 2018).

The article introduces a structured approach to prioritize clashes in building design by considering multiple factors that influence the severity and importance of each conflict. This method involves calculating a score for each clash based on parameters such as the importance of structural and MEP elements, the severity of the clash detected by software, the spatial complexity around the clash, the volume ratio of MEP systems, the functional purpose of each floor, and the number of neighboring elements. These parameters are combined using a formula to rank clashes from most to least critical, helping project teams address high-priority issues first(Bitaraf et al., 2024).

A summary of reviewed literature is sourced from previous studies that serve as references for this research. These references can be seen in Table 2.1.

Table 2. 1 Summary of Reviewed Literature

No	Researcher	Method	Result
1.	Azeroual, O., Ershadi, M. J., Azizi, A., Banihashemi, M., and Edris Abadi, R. (2021) Data Quality Strategy Selection in CRIS: Using a Hybrid Method of SWOT and BMW.	**SWOT** analysis and the Best-Worst Method **(BWM),** a multi-criteria decision-making **(MCDM)** technique, to identify and prioritize strategies for improving data quality in CRIS.	The study found that the most prioritized strategy for improving CRIS data quality is developing a proper space for data recording and dissemination, followed by creating a comprehensive knowledge base. These strategies were ranked using the

			BWM method based on SWOT analysis, emphasizing organizational and environmental factors.
2.	Kim, S. (2022) Critical Success Factors Evaluation by Multi-Criteria Decision-Making: A Strategic Information System Planning and Strategy-As-Practice Perspective.	**SWOT** analysis, causal layered analysis **(CLA)** with a quantitative Multi-Criteria Decision-Making **(MCDM)** model	The study identified and prioritized key CSFs for a next-generation system using qualitative analysis and AHP, providing strategic insights for IS planning.
3.	Şahin, S., and Teke, B. (2025) Artificial Intelligence Integration in Mathematics Education: A SWOT-BWM Analysis	Used a mixed-methods approach combining **SWOT** (Strengths, Weaknesses, Opportunities, Threats) analysis and **BWM** (Best Worst Method).	The study identified key internal and external factors influencing AI in mathematics education and developed strategic recommendations using SWOT and BWM analyses.
4.	Stoilova, (2020) Methodology for assessing intermodal "car on the train" services using SWOT and BWM.	**SWOT** analysis and the Best-Worst Method **(BWM)** for multi-criteria decision-making	The methods identified internal strengths, especially security and travel efficiency, as the most important factors for the "car on the train" service, aiding in decision-making and ranking alternatives
5.	Tabatabaeifar, H., Haghighi, M., and Jafari, S. (2022) Strategic Human Resource Planning in the Export Development Bank of Iran.	Mixed method combining **SWOT** analysis, strategic planning matrices, and the fuzzy Best-Worst Method **(BWM)**	The method revealed that the bank's human resources are in a conservative position internally; therefore, it should adopt aggressive strategies like modern recruitment and talent development to improve its situation

			and align with strategic goals.
6.	Lv, H. (2022) Smart Product Marketing Strategy in a Cloud Service Wireless Network Based on SWOT Analysis.	**SWOT analysis**	Strengths include cost-effectiveness and efficiency; weaknesses are potential misinformation and limited reach. Opportunities in digital marketing help address threats like competition
7.	Wibowo, A., Nugroho, A., and Marbun, P. (2018) Information system planning strategy on higher education institution based on computer: a case study of a STIKOM yos sudarso purwokerto Indonesia.	**SWOT** analysis, **IT** Balanced Scorecard**, and Portfolio** Application Framework**.**	The analysis identified internal strengths and weaknesses, external opportunities and threats, and evaluated IT performance, highlighting areas needing improvement to align with strategic goals.
8.	Muhammad, A. H., Santoso, J. D., and Akbar, A. F. I. J. (2023) Information Security Investment Prioritization Using Best-Worst Method for Small and Medium Enterprises.	Best-Worst Method (**BWM**)	The study identified that network protection is the top technological security measure, and skills and competency improvement is the most important organizational factor. Most security features fall into the second tier, highlighting a balanced investment approach for SMEs
9.	Azizi, F., Tavakkoli-Moghaddam, R., Hamid, M., and Siadat, A. (2022) An Integrated Approach for Evaluating and Improving the Performance of Surgical Theaters with Resilience Engineering.	the Best-Worst Method (**BWM**) for prioritizing indicators, Data Envelopment Analysis (**DEA**) for performance evaluation,	The BWM identified management commitment and learning culture as the most important indicators, while self-organization was the least important
10.	Yousef, et al. (2018) Hybrid Decision-Making Approach for	fuzzy best-worst method **(FBWM)**	The study results indicate that the

	Prototype Selection in Product Design.	and the fuzzy axiomatic design **(FAD)** approach, integrated within a hierarchical group decision-making structure **called** HBWFAD	HBWFAD approach is both valid and accurate for selecting the optimal prototype design. The method effectively incorporates multiple criteria and expert opinions, with its rankings verified through Spearman rank correlation, demonstrating its reliability in decision-making processes
11.	Shukla, V., Swarnakar, V., and Singh, A. R. (2021) Prioritization of Lean Six Sigma project selection criteria using Best Worst Method.	Best Worst Method **(BWM)**	The **BWM** method proved effective, providing consistent and reliable criteria weights, aiding better project prioritization in manufacturing. The results showed process feasibility as the most important dimension, with pull production and customer satisfaction being top criteria for LSS project prioritization.
12.	Jami Pour, M., Hosseinzadeh, M., and Rafiei, K. (2020) Identifying and Prioritizing Applications of IoT in Educational Learning Using Interval BWM	Interval **BWM**	The study identified and prioritized IoT applications in educational learning, with 'providing training opportunities for people with disabilities' rated as the most important, highlighting its significant role in enhancing education through IoT technologies
13.	Galankashi, M. R., Helmi, S. A., Yavari Sabet, S., and	Best-Worst Method (**BWM**)	The study finds that the top international

	Safarkhani, S. (2022) Application of Best-Worst Method (BWM) in Prioritization of International Business Strategies.		business strategies are, in order: international, multi-country, transnational, and global strategies, using BWM for prioritization
14.	Chen, Z., Ming, X., Zhou, T., Chang, Y., and Sun, Z. (2020) Hybrid Framework for Identifying and Evaluating User Activity-Oriented Service Requirements for Smart PSS	Hybrid Rough-Fuzzy Best-Worst Method **(Rough-Fuzzy BWM).**	The rough-fuzzy BWM effectively improves prioritization accuracy of UAO-SSRs by handling uncertainties and providing consistent, objective results, validated through case studies like the smart vehicle service system.
15.	Mostafaeipour, A., Alvandimanesh, M., and Najafi, F. (2021) Prioritization of Barriers to Solar Energy Development Using Fuzzy BWM Method in Iran's Alborz Province	Employed the Fuzzy Best-Worst Method **(Fuzzy BWM)** to identify and prioritize barriers to solar energy development	The study found economic challenges such as low fuel prices, high costs, and risks as the main barriers to solar energy development, while sociocultural factors were less influential.
16.	Li, S.M., Chan, F.T.S., Tsang, Y.P., and Lam, H.Y. (2021) New Product Idea Selection in the Fuzzy Front End of Innovation: A Fuzzy Best-Worst Method and Group Decision-Making Process.	The study uses fuzzy Best-Worst Method **(fuzzy BWM)** combined with group decision-making within a multi-criteria decision-making **(MCDM)**	The study confirms that the fuzzy BWM effectively prioritizes new product ideas, with consistent results across decision makers and validated reliability, aiding strategic NPD decisions
17.	Nasrollahi, M., Ramezani, J., and Sadraei, M. (2020) A FBWM-PROMETHEE Approach for Industrial Robot Selection.	Fuzzy Best-Worst Method **(FBWM)** & PROMETHEE	The study identified six critical criteria for industrial robot selection. The criteria were weighted using FBWM, ensuring reliable importance levels. The

			PROMETHEE method was then applied to rank the robot alternatives.
18.	Ajripour, I., and Hanne, T. (2023) Using the Fuzzy Best Worst Method for Evaluating Strategic Planning Models.	Fuzzy Best-Worst Method **(FBWM),** a multi-criteria decision-making **(MCDM)** technique, to evaluate and prioritize strategic planning models	The results show Wright's strategic planning model is preferred for Iranian manufacturing SMEs due to its practicality and simplicity. Formality and clarity are key evaluation criteria, and the method used confirmed the robustness of the findings
19.	Salarnezhad, A. A. (2020) Identification and Prioritization of Factors Contributing in Cloud Service Selection Using Fuzzy Best-worst Method.	Fuzzy Delphi Method and Fuzzy Best-Worst Multi-Criteria Decision-Making **(FBWM)** to identify and prioritize factors in cloud service selection.	The study identified five primary factors influencing cloud service provider selection: performance, security, data management, personal data protection, and environmental-organizational aspects.
20.	aghavifard, M. T., Amoozad Mahdiraji, H., Alibakhshi, A. M., Zavadskas, E., and Bausys, R. (2018) An Extension of Fuzzy SWOT Analysis: An Application to Information Technolog	fuzzy **SWOT** analysis	Fuzzy SWOT enhances strategy analysis by handling uncertainty and vagueness. It uses fuzzy logic to quantify internal and external factors for better decision-making
21.	Bitaraf, I., Salimpour, A., Elmi, P., and Shirzadi Javid, A. (2024) Improved Building Information Modeling Based Method for Prioritizing Clash Detection in	multi-criteria decision-making **(MCDM)** approach, specifically utilizing the Best-	The study's BIM-based method effectively prioritized clashes, reducing delays and rework by enabling targeted resolution during early

	the Building Construction Design Phase,	Worst Method **(BWM)**	design, using BWM for accurate weighting

2.2 **Theoretical Basis**

2.2.1 IT Strategy in Higher Education

In higher education institutions (HEIs), information technology (IT) strategy refers to the methodical planning, execution, and administration of technological resources in support of institutional objectives. In contrast to corporate IT strategies, HEI IT strategies have to deal with particular issues like tight budgets, the needs of various stakeholders (faculty, students, and administrators), and the increasing demands of data governance, cybersecurity, and digital education(Bianchi & Sousa, 2016).

A clear IT strategy supports more general institutional goals like enhancing research capacity, streamlining administrative procedures, and raising the caliber of instruction. Investing in cloud computing infrastructure, cybersecurity measures, and learning management systems (LMS) are important elements. HEIs must, however, use structured decision-making frameworks that balance qualitative and quantitative assessments in order to prioritize IT initiatives due to resource constraints(Marks & AL-Ali, 2020).

2.2.2 SWOT Analysis as a Strategic Planning Tool

SWOT analysis can be defined as a basic strategy planning framework that helps businesses look at their own strengths alongside with weaknesses as well as the outside factors that affect them. This analytical tool, first conceptualized in the 1960s, has evolved into a widely adopted diagnostic instrument across multiple sectors, including higher education institutional management(Shariatmadari et al., 2013).

The efficacy of SWOT analysis derives from its dual analytical focus, combining internal assessment of organizational resources and competencies (Strengths) with identification of structural limitations and operational gaps

(Weaknesses), complemented by external evaluation of emerging trends and collaborative potentials (Opportunities) alongside competitive pressures and environmental uncertainties (Threats)(Namugenyi et al., 2019).

The SWOT matrix represents a systematic analytical framework that structures environmental scanning into four discrete quadrants: Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T). This two-by-two matrix formulation, building upon early strategic management concepts, provides visual representation of both internal organizational factors (S, W) and external environmental factors (O, T), facilitating comprehensive strategic evaluation(Benzaghta et al., 2021). The SWOT Matrix is depicted in Figure 2.1.

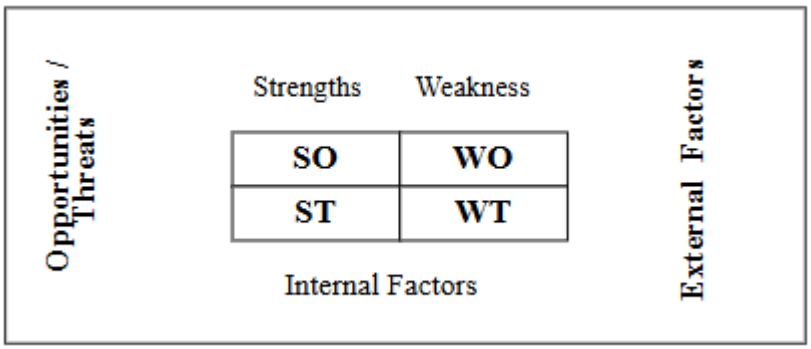

Figure 2.1 The SWOT Matrix

2.2.3 Fuzzy Multi-Criteria Decision Making (MCDM) in IT Management

Fuzzy Multi-Criteria Decision Making (MCDM) represents an advanced analytical approach that incorporates fuzzy set theory to address uncertainty and imprecision in IT management decisions. This methodology extends conventional MCDM techniques by utilizing linguistic variables and membership functions to quantify subjective expert judgments, particularly valuable when evaluating complex IT investments with ambiguous parameters(Kazimieras Zavadskas et al., 2018).

In IT management, fuzzy Multi-Criteria Decision Making (MCDM) serves as a powerful tool for addressing complex challenges across three key domains: strategic technology selection, project prioritization, and risk assessment (Bhole, 2018). The methodology follows a structured four-phase process: initially defining evaluation criteria through fuzzy linguistic scales, followed by alternative assessment via fuzzy pairwise comparisons, subsequent aggregation of fuzzy judgments, and finally defuzzification to derive actionable, crisp priorities(Deng et al., 2011).

2.2.4 The Best-Worst Method (BWM) and Its Fuzzy Extension

The Best–Worst Method (BWM) is an advanced multi-criteria decision-making (MCDM) technique that optimizes pairwise comparisons by identifying only the best (most important) and worst (least important) criteria, significantly reducing the number of required evaluations while improving consistency. Unlike traditional methods such as AHP, which require n(n-1)/2 comparisons for n criteria, BWM achieves robust results with only 2n-3 comparisons, minimizing cognitive load while maximizing reliability(Sadjadi & Karimi, 2018b). The fuzzy extension of BWM incorporates Zadeh's (1965) fuzzy set theory to handle linguistic uncertainty, allowing decision-makers to express judgments using qualitative terms that are subsequently quantified through triangular or trapezoidal fuzzy numbers(Shariatmadari et al., 2013).

The following formula illustrates the core mathematical model of the Best-Worst Method (BWM), used to derive optimal weights based on the decision maker's judgments.

Formula Structure

$$min\ \xi\ = \left\{ \left| \frac{\widetilde{w}_B}{\widetilde{w}_j} - \tilde{a}_{B_j} \right| , \left| \frac{\widetilde{w}_j}{\widetilde{w}_w} - \tilde{a}_{j_w} \right| \right\} \qquad (2.1)$$

Where:

- $\widetilde{w}_B$: Weight of the best (most important) criterion
- $\widetilde{w}_w$: Weight of the worst (least important) criterion

- $\widetilde{w}_j$: Weight of criterion j (any criterion among the set)
- $\tilde{a}_{B_j}$: Preference of best criterion B over criterion j
- $\tilde{a}_{j_w}$: Preference of criterion j over the worst criterion W
- ξ*: The maximum absolute deviation (to be minimized).

2.2.5 Theoretical Integration: SWOT-Fuzzy BWM Hybrid Framework

This hybrid framework combines SWOT analysis with the Fuzzy Best–Worst Method (BWM) to create a more robust decision-making tool for universities. While SWOT helps identify key strengths, weaknesses, opportunities, and threats, it lacks a way to prioritize them objectively(Ghazinoory et al., 2011).By adding Fuzzy BWM, we can assign precise weights to each factor using expert input while accounting for uncertainty turning vague terms like "very important" into measurable data(Mahmoudi et al., 2020).

The result is a clearer, more structured approach to IT strategy planning. Unlike traditional methods, this hybrid model requires fewer comparisons, reduces bias, and provides numerical rankings for better decision-making. Mostly used for universities facing tight budgets, as it helps focus resources on the most critical IT investments(Sahani, 2021). The diagram in Figure 2.2 illustrates the structure of this hybrid framework.

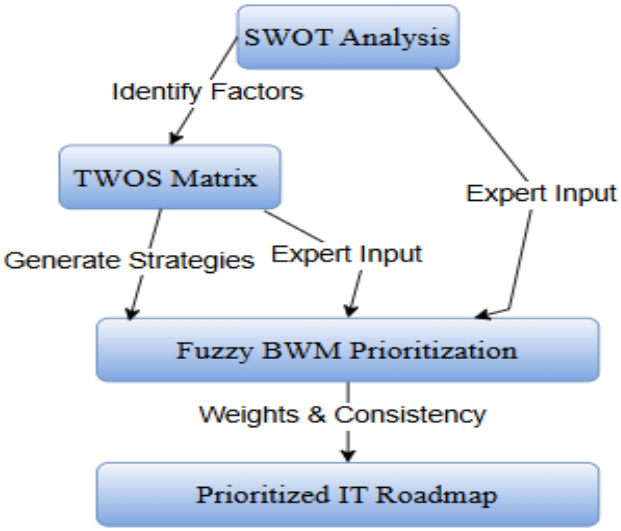

Figure 2. 2 the SWOT - Fuzzy BWM Hybrid Framework

2.2.6 Theoretical justification of using FBWM and Not Other MCDM methods.

In this research we chose the fuzzy best-worth method as our main multi-criteria decision-making (MCDM) tool because it serves the objectives of our research, and moreover, we chose it based on the following reasons:

- **FBWM handles uncertainty better:** Because expert opinions are frequently ambiguous or linguistic in real-world decision situations, precise values in BWM might be rigid. To more naturally convey this ambiguity, FBWM employs fuzzy numbers.
- **FBWM can improve consistency more than BWM:** according to the original FBWM study, which means in some circumstances, the assessments fit the model better.
- **FBWM fits human judgment more realistically:** Meaning it can turn or translate language terms such as "slightly more important" or "equally important" into triangular fuzzy numbers, which is similar to how experts actually think.
- **When data are unclear or incomplete, FBWM is helpful**: According to a recent analysis, FBWM is the most popular extension of BWM for

uncertainty, which makes it appropriate for MCDM problems when precise figures are difficult to supply(Guo & Zhao, 2017).

Oure research uses SWOT–FBWM because SWOT is effective for identifying internal and external strategic factors, but it does not by itself provide objective prioritization. FBWM fills that gap by converting expert linguistic judgments into triangular fuzzy numbers, reducing the burden of pairwise comparisons, and handling uncertainty more realistically than crisp methods such as plain BWM, AHP, or TOPSIS. Our thesis also notes that HEI IT planning involves ambiguous expert opinions, limited resources, and the need for consistent rankings, which makes FBWM a better fit for this context.

A summary of a research comparison of previous studies and my research, and why FBWM instead of BWM. This comparison can be seen in Table 2.2.

Table 2. 2 Research comparison of previous studies vs. this research, of why FBWM instead of BWM

Study	Field / focus	Method	Main contribution	Limitation relative to Our research
Azeroual et al. (2021)	CRIS data quality strategy	SWOT + BWM	Prioritized data-quality strategies in a research-information context	Narrow scope: focused on CRIS only, not holistic HEI IT strategy prioritization.
Wibowo et al. (2018)	Information system planning in higher education	SWOT, IT Balanced Scorecard, Portfolio Application Framework	Assessed IT performance and strategic needs in an HEI	Used SWOT-based planning, but did not use fuzzy weighting to prioritize IT strategies under uncertainty.
Hendi Muhammad et al. (2023)	SME information security investment	BWM	Ranked security investments using BWM	Strong in security prioritization, but not designed for HEI-wide strategic IT planning.

Study	Field / focus	Method	Main contribution	Limitation relative to Our research
Salarnezhad & Shoar (2020)	Cloud service selection	Fuzzy BWM	Used fuzzy judgments to prioritize cloud service factors	Domain is cloud selection, not university IT strategy; no HEI stakeholder alignment.
This research	HEI IT strategy at Semarang University	SWOT + FBWM	Built a university-specific framework to identify and rank IT sub-strategies with fuzzy expert judgments	Extends prior work by combining SWOT-based strategy generation with fuzzy prioritization for a whole HEI context.