

DEVELOPMENT OF AN INTELLIGENT WEB-BASED SWOT ANALYSIS SYSTEM FOR ENHANCING DEVELOPMENT STRATEGIC PLANNING EFFICIENCY

การพัฒนาระบบสารสนเทศอัจฉริยะสำหรับการวิเคราะห์ SWOT
เพื่อเพิ่มประสิทธิภาพการวางแผนยุทธศาสตร์การพัฒนา

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Abstract

This academic article aims to address the persistent limitations of traditional manual SWOT analysis in regional development planning, which is often characterized by time-consuming processes, susceptibility to calculation errors, and a lack of quantitative weighting visualization. Methodology: The study presents the design and development of an "Intelligent SWOT Analysis System," a web-based application that integrates the PESTEL framework for external environmental scanning and the McKinsey 7S framework combined with the 4M model for internal capability assessment. The system architecture features a Client-Side Web Application utilizing an auto-calculation algorithm for weighted scores, real-time strategic position plotting on Cartesian coordinates, and a dynamic TOWS Matrix generation mechanism. A key innovation is the algorithmic filtering of "Critical Factors" (Score > 3.50), which automates the selection of high-impact variables for strategy matching. The implementation results demonstrate that the system successfully transforms abstract qualitative strategic discussions into tangible quantitative visualizations. It streamlines the strategic planning workflow by automating category grouping and providing instant strategy matching guidance. The system significantly reduces the cognitive load on planners and minimizes human error inherent in manual calculation. This innovation serves as a significant tool for regional planners, local administrative organizations, and policy makers. It enables more precise, data-driven, and efficient strategic formulation, shifting the paradigm from subjective opinion-based planning to evidence-based strategy.

Keywords: Regional Development, Strategic Planning, SWOT Analysis, TOWS Matrix
Web-Based Application

Introduction

Strategic planning is crucial for regional development as it enables public organizations to effectively manage change and deliver value to stakeholders (Bryson, 2018). However, the traditional SWOT analysis process (Strengths, Weaknesses, Opportunities, Threats) remains one of the most widely used tools for this purpose. However, the traditional application of SWOT analysis in community and regional planning contexts often faces significant challenges. (Helms, 2010) It is typically a static, manual process that relies heavily on subjective discussions without quantitative weighting. Furthermore, synthesizing these factors into actionable strategies using the TOWS Matrix is often complex and prone to human error, making it difficult for stakeholders to visualize the strategic direction in real-time.

In the context of social sciences and innovation, integrating digital technology into management tools is essential to bridge this gap. This article proposes the development of an "Intelligent SWOT Analysis System." The objective of this article is to present the design, functionality, and application of this web-based tool. It demonstrates how transforming abstract qualitative data into a structured, weighted digital system can significantly enhance the efficiency and precision of strategic planning for regional development.

Theoretical Framework and System Design

To develop an intelligent information system that effectively supports strategic decision-making in regional development, it is insufficient to merely digitize existing manual processes. The system architecture must be rooted in rigorous academic theories to ensure that the output is not only computationally correct but also strategically valid. As stipulated in the guidelines for academic articles, this section lays the foundational knowledge required to understand the system's logic. Consequently, the system design is grounded in a synthesis of four established strategic management frameworks: PESTEL Analysis, the McKinsey 7S Framework combined with the 4M Model, the Logic of Weighted SWOT, and the Dynamic TOWS Matrix.

The Macro-Environmental Scanning: PESTEL Analysis Integration

In the context of regional development, external factors often exert a more significant influence than internal operations. To address this, the system incorporates the PESTEL Analysis framework as the primary engine for "External Analysis" (Opportunities and Threats). This framework serves as a comprehensive checklist that forces planners to look beyond immediate economic concerns and consider the broader ecosystem. (Aguilar, 1967)

Political Factors (P) The system prompts users to evaluate government stability, tax policies, and, crucially for regional development, the allocation of central government budgets and decentralization policies. These factors determine the feasibility of public projects.

Economic Factors (E) This dimension analyzes economic indicators such as local Gross Provincial Product (GPP), inflation rates, interest rates, and unemployment levels. In the developed system, these inputs help assess the economic vitality of the region.

Social Factors (S) Recognizing the importance of demographics, this module focuses on population growth rates, age distribution (e.g., aging society trends), cultural attitudes, and lifestyle changes. For regional planning, understanding the social fabric is vital for designing public services that meet actual community needs.

Technological Factors (T) This includes the level of digital infrastructure, internet penetration, and the rate of technological adoption within the community. The system weighs these factors heavily as they are often catalysts for innovation-driven development.

Environmental Factors (E) Given the global emphasis on sustainability, this factor assesses climate change risks, waste management, and natural resource availability. The system treats these as critical constraints or opportunities for eco-tourism and green agriculture.

Legal Factors (L) Finally, the system incorporates an analysis of regulatory frameworks, labor laws, and zoning regulations, which establish the legal boundaries for any proposed strategy.

By systematically categorizing external inputs through 4M, the system ensures that the "Opportunities" and "Threats" identified are holistic and structurally sound, preventing the oversight of critical non-economic variables (Ginter & Duncan, 1990).

The Micro-Environmental Analysis: Integrating McKinsey 7S and 4M Models

For "Internal Analysis" (Strengths and Weaknesses), the system employs a hybrid approach. While traditional SWOT often lists internal factors haphazardly, this system structures them using the McKinsey 7S Framework supplemented by the 4M Model. This integration ensures a balance between "Hard" and "Soft" elements of the organization or region.

The McKinsey 7S Framework is utilized to analyze the organizational health of the local administrative bodies or development committees:

- Strategy includes clear definition of the region's vision and long-term goals.
- Structure consists of hierarchy and reporting lines within the local organization.
- Systems covers daily procedures and workflows, which the developed system itself aims to improve.
- Shared Values presents core culture and work ethic of the community leaders.
- Style shows leadership style adopted by local administrators.
- Staff includes capabilities and morale of the workforce.
- Skills consists of specific competencies possessed by the organization.

To make this analysis more tangible, particularly for resource allocation, the system overlays the 4M Model: (Barney, 1991)

Man stands for quantitative assessment of human capital (e.g., number of staff, educational levels).

Money is the analysis of fiscal budgets, funding sources, and liquidity.

Material is the evaluation of physical assets, machinery, infrastructure, and land.

Management shows the assessment of administrative efficiency and governance protocols.

This hybrid structure (7S + 4M) allows the system to diagnose internal capabilities with high precision. For instance, a region might have strong "Shared Values" (7S) but lack "Money" (4M), or have abundant "Material" (4M) but poor "Systems" (7S). This granularity is essential for pinpointing the root causes of strengths and weaknesses (Peters & Waterman, 1982).

The Logic of Weighted SWOT: Transitioning from Qualitative to Quantitative

A critical flaw in traditional SWOT analysis is the "flat list" problem, where minor issues are often treated with the same weight as critical strategic drivers. To resolve this, the system incorporates the Logic of Weighted SWOT, transforming the analysis from a purely qualitative brainstorming session into a semi-quantitative assessment.

Where: Weight (0.0 - 1.0): Represents the relative importance of the factor to the overall success of the region. The sum of weights within a category need not equal 1.0 in this flexible model, allowing for independent evaluation, though normalization options are available. Rating (1 - 5): Represents the organization's response capability. For strengths/opportunities, a 5 indicates superior performance/high benefit. For weaknesses/threats, a 5 indicates high vulnerability/severe impact (inverse logic is handled in the visualization layer).

2. กำหนดน้ำหนักความสำคัญ (Weighting)													
วิเคราะห์ภายนอก (O - T)							วิเคราะห์ภายใน (S - W)						
ปัจจัย	นน.(V)	O avg	T avg	VxO	VxT	O-T	ปัจจัย	นน.(V)	S avg	W avg	VxS	VxW	S-W
Policy (นโยบาย)	0.1	3.00	-	0.30	0.00	0.30	Strategy (กลยุทธ์)	0.1	3.00	-	0.30	0.00	0.30
รวมผลลัพธ์ภายนอก: 0.30							รวมผลลัพธ์ภายใน: 0.30						

Figure 1: The Logic of Weighted SWOT

The system aggregates these weighted scores to calculate a "Category Average." This mathematical approach aligns with the concept of the Strategic Factor Analysis Summary (SFAS). By enforcing a weighting mechanism, the system forces planners to prioritize. It filters out "noise"—factors that are discussed but have low impact—and highlights "signals"—factors

that truly drive strategic change. This ensures that the resulting strategies are built upon the most significant pillars of reality, rather than the loudest voices in the meeting room.

The Dynamic TOWS Matrix Logic: Algorithmic Strategy Generation

The final and most advanced component of the theoretical framework is the TOWS Matrix Logic. While SWOT describes the condition, TOWS describes the action. The developed system automates the matching process of the TOWS matrix (Wehrich, 1982) to suggest four distinct categories of strategies:

SO Strategies (Maxi-Max)

Strategies that use Strengths to maximize Opportunities. The system identifies internal assets (e.g., distinct cultural heritage) that can be leveraged to capture external trends (e.g., rising tourism demand). This is an aggressive growth stance.

WO Strategies (Mini-Max)

Strategies that overcome Weaknesses by taking advantage of Opportunities. The system highlights areas where external support (e.g., government grants) can correct internal deficiencies (e.g., lack of infrastructure). This is a developmental or turnaround stance.

ST Strategies (Maxi-Min)

Strategies that use Strengths to minimize Threats. The system suggests ways to use internal resilience (e.g., strong community unity) to defend against external challenges (e.g., economic downturns). This is a diversification or maintenance stance.

WT Strategies (Mini-Min)

Strategies that minimize Weaknesses and avoid Threats. This is a defensive stance, often involving retrenchment or liquidation of non-viable projects.

The "Intelligence" of the system lies in its dynamic filtering. Unlike manual TOWS analysis which attempts to match every factor, the system utilizes the weighted scores calculated in the previous step. It applies a threshold filter (e.g., Factors with Score > 3.50) to populate the matrix only with high-impact factors. This algorithmic approach prevents "Analysis Paralysis"—a state where planners are overwhelmed by too much data—and ensures that the generated strategies are focused, relevant, and actionable.

In summary, this theoretical framework transforms the system from a simple data entry tool into a sophisticated decision-support engine. By rigorously defining the inputs (PESTEL, 7S/4M), processing them through a quantitative logic (Weighted SWOT), and structuring the outputs (TOWS Matrix), the system bridges the gap between complex strategic theory and practical regional application.

2. System Development and Key Features Analysis

The development of the Intelligent SWOT Analysis System was driven by the need to bridge the gap between complex strategic theories and practical, on-the-ground application. The system architecture transforms the theoretical frameworks discussed in Section 2.1 into a

tangible, interactive web-based tool. This section details the technical architecture and the four-step functional logic that constitutes the core "Process Innovation" of this study.

System Architecture and Technology Stack

To ensure accessibility for local administrative officers and regional planners who may operate in areas with limited internet infrastructure, the system was architected as a Client-Side Web Application.

Core Structure Built using HTML5 for semantic structure and JavaScript (ES6+) for the computational logic. This allows the system to process data locally within the user's browser without requiring constant server-side communication, ensuring speed and data privacy.

User Interface (UI) The interface utilizes Tailwind CSS, a utility-first CSS framework. This choice ensures that the system is "Responsive," capable of displaying correctly on various devices, from desktop computers in meeting rooms to tablets used during field surveys.

Innovation in Accessibility Unlike traditional software that requires complex installation, this web-based solution allows for immediate deployment. Planners can simply access the URL, input data, and generate reports instantly, significantly reducing the "Technical Barrier to Entry" for non-expert users.

The screenshot displays two sections of the user interface for data entry:

- Section 1: สภาพแวดล้อมภายนอก (External)**

ปัจจัย (CATEGORY)	รายละเอียด	ประเภท	คะแนน (1-5)	ลบ
Policy (นโยบาย)	ระบุรายละเอียด...	0 (โอกาส)	3	×

+ เพิ่มปัจจัยภายนอก
- Section 2: สภาพแวดล้อมภายใน (Internal)**

ปัจจัย (CATEGORY)	รายละเอียด	ประเภท	คะแนน (1-5)	ลบ
Strategy (กลยุทธ์)	ระบุรายละเอียด...	S (จุดแข็ง)	3	×

+ เพิ่มปัจจัยภายใน

Figure 2: The User Interface (UI) of the System showing the Input Panel and Category Selection

Algorithmic Process and Functional Logic

The system's "Intelligence" is derived from a structured four-step algorithm designed to reduce human error and cognitive load.

Step 1 Structured Input and Categorization One of the primary flaws in manual SWOT analysis is the ambiguity of factors. Participants often confuse "Internal" and "External" factors or list vague statements. The system mitigates this through Controlled Input Fields. Users must select specific categories from a dropdown menu corresponding to the theoretical

frameworks (e.g., Selecting "Economic" under PESTEL or "Staff" under McKinsey 7S). This enforces a mental discipline, ensuring that every factor entered is theoretically categorized before analysis begins. This "Structured Input" method significantly improves the quality of the raw data.

Step 2 The Auto-Weighting Algorithm To transition from qualitative discussion to quantitative analysis, the system employs an Auto-Weighting Algorithm. In a manual setting, calculating weighted scores for dozens of factors is prone to calculation errors.

The algorithm dynamically aggregates these scores in real-time. As users adjust the importance (Weight) or the capability (Rating) of a factor, the system instantly recalculates the sums. This "Real-time Feedback Loop" allows planners to perform sensitivity analysis—seeing how changes in assumptions affect the overall strategic score immediately.

Step 3 Cartesian Strategic Visualization Data visualization is crucial for consensus-building. The system translates the numerical data into a Strategic Position Graph using a Cartesian coordinate system.

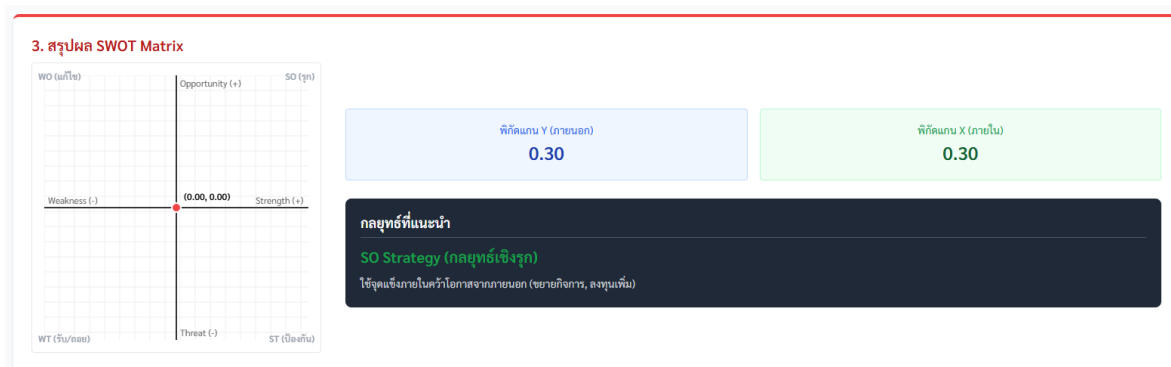


Figure 3: The Strategic Position Graph

By plotting the intersection of these two values, the system visually places the region into one of four strategic quadrants: Aggressive (Star), Turnaround (Question Mark), Diversification (Cash Cow), or Defensive (Dog). This visual output provides "Evidence-Based" confirmation of the region's status, moving the discussion away from subjective feelings to objective data.

Step 4 The "Critical Factor" Filtering and Dynamic TOWS Matrix

The most significant innovation of this system is the Dynamic TOWS Matrix Generation Algorithm. A common cognitive bottleneck in strategic planning is the sheer volume of data; planners struggle to prioritize which Strengths to match with which Opportunities. To solve this, the system applies a "Critical Factor Filtering" logic. The algorithm scans the dataset and retrieves only those factors with a calculated score of >3.50 (on a 5.0 scale).

Logic A score of 3.50 or higher indicates a factor of "High Significance" or "High Performance."

Application The system automatically populates the TOWS Matrix table only with these high-impact factors.

This process reduces "Information Overload." Instead of seeing 50 mixed factors, the planner sees only the top 10 critical factors that truly matter. This allows the strategic formulation process to be focused and high-impact. The system effectively acts as a "Digital Assistant," pre-screening the data so that human planners can focus their cognitive energy on creativity and strategy formulation rather than data sorting.

4. TOWS Matrix Strategy		
Internal / External	Strengths (S)	Weaknesses (W)
Opportunities (O)	SO Strategies (รุก) ใช้จุดแข็ง (S) ควบคู่โอกาส (O)...	WO Strategies (แก้ใ้) ใช้โอกาส (O) เพื่อปิดจุดอ่อน (W)...
Threats (T)	ST Strategies (ป้องกัน) ใช้จุดแข็ง (S) รับมืออุปสรรค (T)...	WT Strategies (รับ/โอน) ลดจุดอ่อน (W) และเลี่ยงอุปสรรค (T)...

Figure 4: The Dynamic TOWS Matrix

By integrating these four steps, the system does not merely record data; it actively processes and structures it, thereby elevating the standard of regional strategic planning from a manual, error-prone task to a sophisticated, data-driven operation.

3. Discussion on Efficiency Enhancement

The development of the Intelligent SWOT Analysis System offers significant implications for strategic management in the public sector. This section discusses the efficiency enhancements observed through the implementation of the system, contrasting the digital approach with traditional manual methodologies, and analyzing its impact on regional development governance.

Transforming Process Efficiency: From Manual to Digital

The most immediate impact of the system is the drastic reduction in processing time and the elimination of calculation errors. In traditional regional planning workshops, the "Manual Process" is often labor-intensive. Facilitators must manually group post-it notes, calculate average scores using calculators, and hand-draw matrices on flip charts. This process is not only slow but also prone to human error, particularly when calculating weighted averages for large datasets.

In contrast, the developed "System Process" operates in real-time. By automating the arithmetic operations (as detailed in the Auto-Weighting Algorithm), the system ensures 100% computational accuracy. This efficiency shifts the focus of the planning session. Instead of spending 80% of the time on data organization and 20% on strategy, planners can now dedicate the majority of their time to interpreting the results and formulating actionable strategies. This shift represents a fundamental improvement in the "Quality of Effort" invested by stakeholders.

Enhancing Objectivity in Regional Governance

A recurring challenge in regional development is the influence of subjectivity and local politics. Strategic decisions are often driven by the loudest voices in the room rather than empirical evidence. The system addresses this by providing "Visual Evidence" through the Cartesian Coordinate Graph and the weighted TOWS Matrix.

The system acts as a neutral arbiter. When stakeholders see the visual position of their region (e.g., falling into the "Defensive" quadrant due to high Threats and Weaknesses), it becomes difficult to argue against the data. This visualization facilitates "Consensus Building." It transforms abstract disagreements into data-driven discussions. Community leaders and policy makers can make quicker, more confident decisions based on the objective visualization of data, moving away from "Gut Feelings" to "Evidence-Based Strategy."

User Experience (UX) and Cognitive Load Reduction

From a social science perspective, a tool is only effective if it is accessible to its users. The target users for this system—local administrative officers and community leaders—are not necessarily data scientists. The system's design successfully lowers the technical barrier to entry.

The innovation of "Critical Factor Filtering" (displaying only factors with Score > 3.50) directly addresses the issue of "Cognitive Load." In complex regional issues, planners are often overwhelmed by information. By automatically filtering out low-impact factors, the system helps users focus their cognitive resources on the critical issues that truly drive development. This feature demonstrates that the system is not just a calculation tool, but a "Decision Support System" (DSS) designed with an understanding of human cognitive limitations. (Power, 2002)

In summary, the Intelligent SWOT Analysis System proves to be superior to traditional methods by enhancing speed, accuracy, objectivity, and usability. It empowers regional planners to navigate the complexities of development strategy with a level of precision and clarity that manual methods cannot achieve.

Conclusion

The development of the Intelligent Web-Based SWOT Analysis System represents a successful convergence of strategic management theory and digital innovation. This study achieved its primary objective of addressing the limitations inherent in traditional manual planning processes. By integrating robust frameworks—PESTEL for external environmental scanning and the McKinsey 7S combined with the 4M model for internal capability assessment—the system ensures that the strategic analysis is both comprehensive and structurally sound.

The significance of this innovation lies in its ability to transform abstract, qualitative strategic discussions into tangible, quantitative visualizations. The implementation of the Auto-Weighting Algorithm and the Cartesian Strategic Position Graph provides regional planners with "Visual Evidence," significantly reducing subjectivity and enhancing the precision of decision-making. Furthermore, the Dynamic TOWS Matrix, with its intelligent filtering of critical factors (Score > 3.50), effectively reduces cognitive load, allowing stakeholders to focus on high-impact strategies rather than getting lost in data administration.

In the context of regional development, this tool empowers local administrative organizations to move towards "Evidence-Based Strategy." It bridges the gap between complex academic theories and practical application, making sophisticated strategic planning accessible to non-technical users.

To further enhance the system's capabilities, future research should consider integrating Artificial Intelligence (AI) and Natural Language Processing (NLP) to automatically suggest strategic keywords based on user input. Additionally, developing a Cloud-Based Database architecture would enable Longitudinal Analysis, allowing organizations to track the evolution of their strategic position over time and assess the long-term effectiveness of the implemented strategies.

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