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A Management Information System Framework Integrating Multi-Objective Integer Programming and Its Application in Product Development Decision-Making

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Abstract: In the midst of increasingly fierce competition in the market, technology companies are facing significant challenges in balancing multiple strategic objectives such as user growth and business revenue with limited research and development (R&D) resources, in order to make the optimal product development decisions. But traditional management information systems (MISs) are unable to provide prospective and guiding support for intelligent decision-making. To address this problem, this paper proposes and validates a decision-making support framework: the Feature Selection Optimization - Multi-Objective 0-1 Integer Programming (FSO-MOIP) model. This framework can quantify the top-level, qualitative strategic orientations of an enterprise into precise weights in the mathematical model, thereby obtaining the optimal product feature combination under given cost constraints. Case analysis shows that this model can generate distinctive optimal decision-making schemes within the budget for different strategies. This study not only clearly reveals the internal structure and cost-effectiveness of the optimal solution, but also presents complex strategic trade-offs to decision makers in the form of an intuitive "Capability Fingerprint".

1. Introduction

With the continuous advancement of technology and raid changes in the market, gaming and technology companies are facing unprecedented opportunities and challenges. Specifically, in the gaming industry, user acquisition, conversion, and retention are key indicators for business success [1,2]; while for technology companies, a balance needs to be struck between feature realization and cost benefit in order to make product development decisions [3]. MIS is an important support tool for enterprise decision-making. Its optimized application is of great significance for enhancing the operational efficiency and business value of enterprises. This paper explores how to enhance the product development decision-making capabilities of gaming and technology companies through the optimization of management information systems, thereby maximizing their business objectives [4-6].

2. Theoretical Basis

2.1 Overview of MIS

MIS provides strong support for enterprise decision-making by integrating various information resources within the enterprise. It features diverse and powerful functions, with its definition covering the entire process from data collection, processing to information output. On the one hand, MIS can efficiently collect and store vast amounts of data generated during business operation processes. Such data encompasses all aspects of enterprise operations including production, sales and finance. On the other hand, MIS possesses strong data processing capability, capable of analyzing and processing the collected data, and converting it to valuation insights for enterprise decision-making [7].

In enterprises, MIS provides comprehensive, accurate and timely information support for the management, enabling the management to make scientific and reasonable decisions on this basis. MIS is capable of, for instance: monitoring the production progress in real time, helping enterprises optimize their workflow and enhance production efficiency in terms of production management; analyzing market trends and consumer demands and providing a basis for enterprises to formulate effective marketing strategies in terms of marketing[8]; realizing automated processing and analysis of financial data, enabling enterprises to better control costs and improve capital usage efficiency in term of financial management[8,9].

2.2 Theory of Data-Driven Decision-Making (DDDM)

DDDM, in essence, is to use data as the basis for decision-making and obtain valuable information from data by collecting, analyzing and interpreting data, thus providing a scientific basis for the decision-making of enterprises [9]. Data permeates the operation process of enterprises, ranging from customer purchasing behavior data to market research data, and production process data to financial data. An in-depth analysis of these informative data enables enterprises to gain a better insight into the market dynamics, customer demands, and their own operational conditions, so that they can make decisions more accurately and effectively [10].

The application of DDDM in enterprises has achieved remarkable results. In many enterprises, data warehouses and data analysis platforms are established to collect and integrate data resources both within and outside the organization. Subsequently, these data are mined and analyzed, using advanced data analysis techniques and tools, to extract valuable information. For example, some e-commerce enterprises can accurately predict users' purchasing needs by analyzing their purchase history and browsing behavior data. This enables them to provide personalized recommendations and targeted marketing, thereby enhancing customer satisfaction and sales performance. Meanwhile, DDDM also help enterprises optimize operational processes and reduce costs within the organization, thereby enhancing their market competitiveness [11].

2.3 Analysis of Business Application Scenarios for Technology Companies

Commercially, technology companies feature prioritized emphasis on technological innovation and rapid response to market demands. These enterprises require continued R&D investment to deliver innovative products and technologies, in order to cater to the changing market demands. Key indicators include Product Development Cycle, Market Share and Customer Satisfaction. The length of product development cycle directly affects the market competitiveness of enterprises. Shorter cycle enables enterprises to launch new products more quickly to seize market. Market share reflects the position and influence of an enterprise in the market. Customer satisfaction is an important indicator for measuring the product and service quality of an enterprise. High customer satisfaction helps enhance customer loyalty and reputation. MIS plays an important role in technology companies, including, facilitating the management of R&D projects, optimizing product development processes, improving product development efficiency and quality, and helping enterprises gain a better insight into the market demand and customer feedbacks, thereby enabling rapid product iteration and innovation and enhancing the commercial value of the enterprises [12].

2.4 Mathematical and Economic Model Basis for Optimizing Decision-Making

In the process of optimizing decision-making, mathematical models enable quantitative analysis and solution of complex decision-making problems by establishing mathematical equations and formulas. Taking cost benefit analysis for example, mathematical models can help obtain the costs and benefits of different decision-making schemes, so as to select the optimal scheme. Additionally, mathematical models are capable of predicating and simulating data, informing enterprises of the possible decisions, thereby providing scientific basis for decision-making [13,14].

3. MIS Decision-Making Support Framework Based on Optimization Model

The previous sections explored the supporting role of MIS in various product development processes, which is mostly process-related and descriptive. In order to upgrade the decision-making process from “empirically driven” mode to “data-driven” and “model-driven” mode, a mathematical optimization model was constructed in this section, with corresponding algorithm and MIS integration framework being designed, to provide quantitative and scientific basis for technology companies to make product development decisions.

3.1 Problem Definition and Mathematical Modeling

In today’s fiercely competitive technology industry, enterprises often face a conflict between limited R&D resources and numerous potential development projects when pursuing product iteration and innovation. Specifically, within a given product development cycle, decision-makers are typically provided with a set of candidate new features, each involving quantifiable resource consumption and having multi-dimensional expected business value. These dimensions of value generally include, among others, improvement in user satisfaction, growth in market share, and direct financial returns. Consequently, the core decision-making optimization problem can be defined as: how to select an optimal feature subset from the candidate feature pool while strictly adhering to the overall resource budget constraint, so as to maximize the comprehensive business value generated by this combination.

From an operations research perspective, this problem can be considered as a typical resource allocation and combination optimization problem. Its discrete decision characteristic of “select/reject” and multiple potentially conflicting optimization objectives (for example, high user satisfaction may not always lead to high profits), make it highly suitable for mathematical modeling and solution through multi-objective 0-1 integer programming. This model can precisely depict this business decision-making scenario and provide a rigorous mathematical framework for obtaining the optimal solution.

3.2 Model Building: The Feature Selection Optimization - Multi-Objective 0-1 Integer Programming (FSO-MOIP) Model

Indexes and Set

Let $I = \{1,2,\ldots,N\}$ be the set of candidate product features, where N denotes the total number of candidate features. Index $i \in I$ denotes the i-th candidate feature.

Model Parameters

These parameters serve as the input for the model and are collected and processed from various business subsystems (such as project management, user survey, market analysis, and financial systems) through the MIS.

c_i: The cost required for developing Feature i (unit: man-day)

s_i: The expected increase in user satisfaction resulting from the development of Feature i (which can be quantified through A/B testing and user survey questionnaires, for example, by measuring the improvement in a 5-point scale score)

m_i: The expected percentage point of market share growth resulting from the development of Feature i (%)

r_i: The expected direct or indirect benefits (such as conversion of new paying users, revenue from value-added services, unit: CNY 10,000) resulting from the development of Feature i.

B: The company's total R&D budget for the development cycle (for example, total available man-days).

Decision-making Variables

x_i: A binary decision-making variable. If the company decides to develop Feature i, then $x_i = 1$; if not, then $x_i = 0$.

Given the multidimensional nature of business value, a multi-objective function is established to simultaneously maximize the value in multiple dimensions:

Maximize User Satisfaction:

$$\text{Maximize} \quad Z_s = \sum_{i=1}^{N} s_i \cdot x_i$$

Maximize Market Share:

$$\text{Maximize} \quad Z_m = \sum_{i=1}^{N} m_i \cdot x_i$$

Maximize Revenue:

$$\text{Maximize} \quad Z_r = \sum_{i=1}^{N} r_i \cdot x_i$$

Constraints

Budget Constraint: The total cost required for all selected features cannot exceed the total budget.

$$\sum_{i=1}^{N} c_i \cdot x_i \leq B$$

Variable Type Constraint: The decision-making variable must be either 0 or 1.

$$x_i \in \{0,1\}, \quad \forall i \in I$$

Dependency Constraint: In practice, certain features may be dependent on each other. For example, the implementation of Feature j must be based on the implementation of Feature k. This can be expressed as:

$$x_j \leq x_k$$

This means that x_j can be 1 only when $x_k = 1$ (the company decides to develop Feature k).

3.3 Algorithm Design

There is no single optimal solution, but rather a set of Pareto optimal solutions to a multi-objective optimization problem. Each Pareto optimal solution represents a different trade-off. To facilitate the practical application by decision makers, a solving algorithm that can transform multi-objective problems into single-objective problems is needed.

Algorithm: Weighted Sum Method

It is the most classic and intuitive method for addressing multi-objective optimization. In this method, multiple objective functions were combined into a composite objective function through "weights".

Introducing weighting parameters:

w_s, w_m, w_r: represent the degrees of importance that the company's strategy attaches to user satisfaction, market share, and revenue (i.e., the strategic weight).

The weights satisfy $w_s + w_m + w_r = 1$, and $w_s, w_m, w_r \geq 0$.

Constructing a single-objective function:

Typically, before weighting, objective function values of different dimensions should be normalized to eliminate the influence of units. Assume that s_i', m_i', r_i' are the normalized parameter values.

$$\text{Maximize} \quad Z = w_s \cdot \left(\sum_{i=1}^{N} s_i{}' \cdot x_i\right) + w_m \cdot \left(\sum_{i=1}^{N} m_i{}' \cdot x_i\right) + w_r \cdot \left(\sum_{i=1}^{N} r_i{}' \cdot x_i\right)$$

Transforming the model:

Through weighted summation, the original model was transformed into a classic 0-1 knapsack problem. This is a standard integer programming problem. Although it is NP-hard, for medium-sized instances, exact optimal solutions can be obtained in a very short time using established commercial or open-source optimization solvers.

3.4 Model Solving

A "Feature Pool" comprising of six candidate product features was set up, with relevant attributes (development cost, expected satisfaction improvement, market share growth and revenue score) being provided by a hypothetical, optimized management information system (MIS). The specific data is shown in the table 1:

Table 1 Attributes of Candidate Feature Pool

	Feature Name	Development Cost (Man-day)	Satisfaction Score	Market Share Score	Revenue Score
Feature A:	One-click Login	15	8	3	2
Feature B:	Data Visualization Report	35	6	7	8
Feature C:	Personalized Theme	20	9	4	3
Feature D:	AI Intelligent Recommendation	50	7	8	9
Feature E:	Multi-User Collaboration Feature	40	5	9	7
Feature F:	Third-Party API Integration	25	4	6	6

Constraint: Assume that the company's total R&D budget for the development cycle is 100 man-days.

Scenario simulation: To test the strategic adaptability of the model, two strategic scenarios with distinct business orientations were set up, which were achieved by adjusting the weighting parameter in the model:

Scenario 1: Prioritizing Growth

In the early stage of development, the company strategy prioritizes user experience improvement, rapid acquisition of users and expansion of market influence. Weight settings: User Satisfaction (w_s) = 0.5, Market Share (w_m) = 0.4, Revenue (w_r) = 0.1.

Scenario 2: Prioritizing Revenue

As the company enters its mature stage, it shifts its strategic focus to commercialization and pursues the maximized return on investment. Weight settings: User Satisfaction (w_s) = 0.1, Market Share (w_m) = 0.3, Revenue (w_r) = 0.6.

4. Analysis of the Optimal Decision-Making Scheme Results

4.1 Optimize Solution Result

The optimal feature development combinations for the two scenarios were yielded by substituting the above data and scenario settings into the FSO-MOIP model and calculating with the optimization solver.

Optimal solution for Scenario 1 (Prioritizing Growth):

Recommended feature combination: {Feature A, Feature C, Feature E, Feature F}, total cost: 15 + 20 + 40 + 25 = 100 man-days (budget utilization rate: 100%)

Expected total scores: User Satisfaction: 26, Market Share: 22, Revenue: 18

Optimal solution for Scenario 2 (Prioritizing Revenue):

Recommended feature combination: {Feature B, Feature E, Feature F}, total cost: 35 + 40 + 25 = 100 man-days (budget utilization rate: 100%)

Expected total scores: User Satisfaction: 15, Market Share: 22, Revenue: 21

As can be seen from the raw results, the model yields two distinctive and quantifiable optimal decision-making schemes based on different strategic weights while satisfying the budget constraints.

4.2 Visualization Analysis

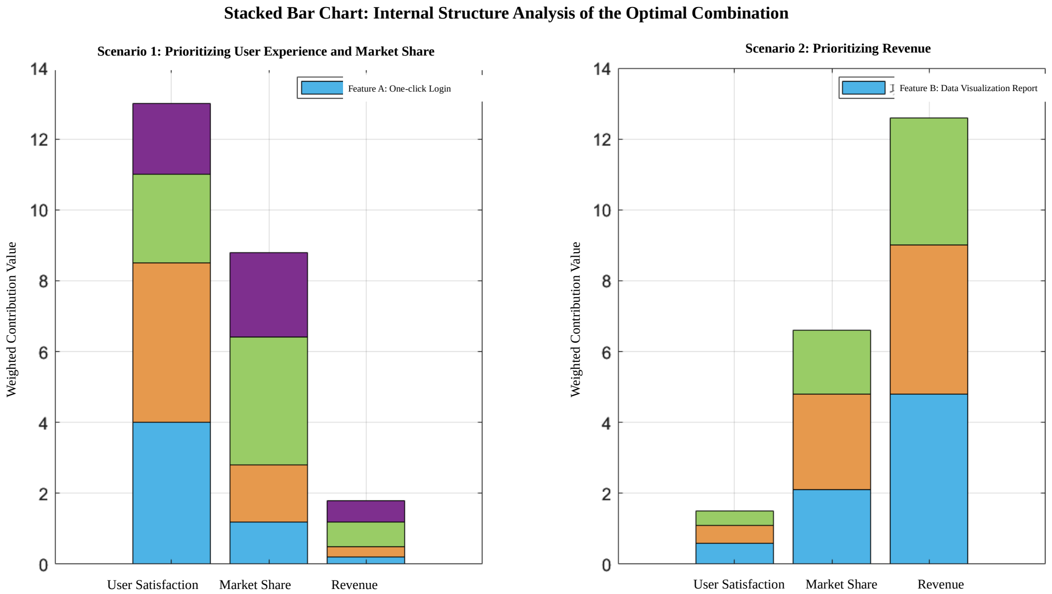

Figure 1 Stacked Bar Chart (Internal Contribution Analysis)

To facilitate an intuitive understanding of the differences between the two optimal solutions and the underlying strategic logic, three complementary visualization charts were used for in-depth analysis.

Figure 1 depicts the internal composition of total scores for all schemes. Scenario 1 exhibits a high user satisfaction score (26 points), which is mainly attributed to the successful incorporation of two efficiency-oriented features characterized by high satisfaction and low cost — Feature A and Feature C. This demonstrates the emphasis of the growth-oriented strategy on rapidly enhancing user reputation. In contrast, the high revenue score (21 points) in Scenario 2 primarily stems from the inclusion of Feature B, a high-revenue-oriented feature. Notably, the inclusion of Feature E and Feature F demonstrates their balanced performance across all indicators. These indicators will be given high development priority regardless of strategic focus shifts.

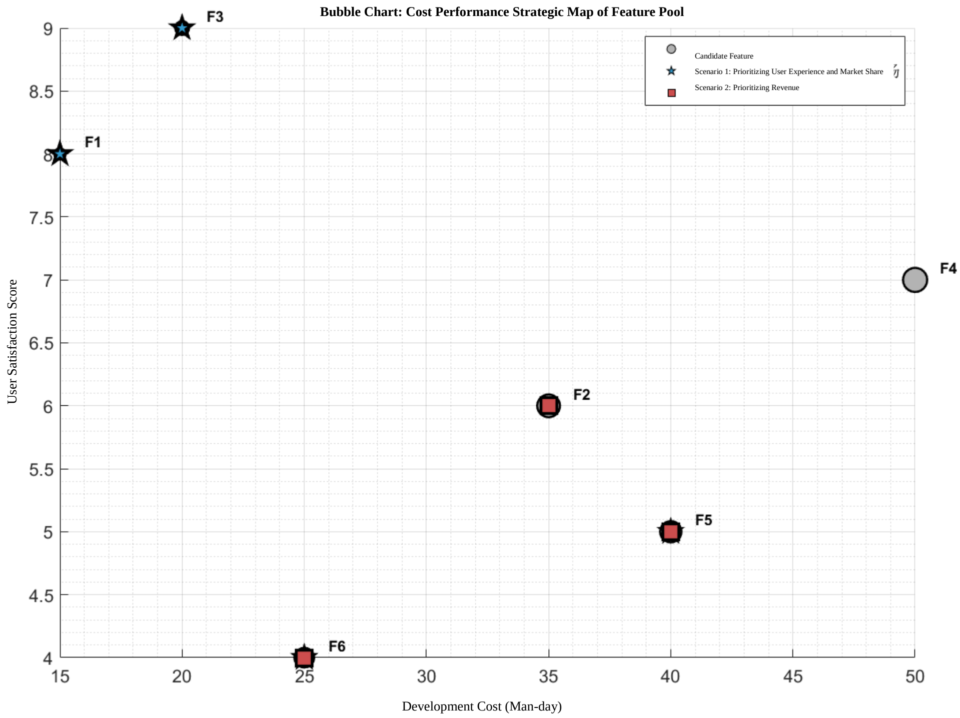

Figure 2 Bubble Chart (Cost Performance Analysis of Feature Pool)

Figure 2 visually presents the cost-benefit distribution of all candidate features. The adoption of Scenario 1, denoted by blue stars, exhibits a trend of concentrating toward the upper-left quadrant characterized by low-cost and high-satisfaction, demonstrating their optimized trade-off between resource efficiency and user value acquisition. By comparison, the adoption of Scenario 2, denoted by red blocks, demonstrates the pursuit of “Big Bubbles” (high revenue), even at the expense of higher development costs. Feature D requires an extremely high cost, about 50 man-days. Considering the high cost of Feature D, including this feature within the expected total budget prevents the formation of a more optimal combination with other features, thus lowering the weighted total value.

Figure 3 provides the top-level strategic portrait of the two solutions. Scenario 1, represented by blue polygon, demonstrates a pronounced “expansion-type” fingerprint with robust saturation in both user satisfaction and market share dimensions, which is in perfect alignment with its strategic objective of “Prioritizing Growth”. Whereas Scenario 2, denoted by red polygon, exhibits a typical profit-oriented fingerprint, characterized by a noticeable spike in “Revenue” and convergence in “User Satisfaction”. Maximizing user experience may compromise direct revenue, and the vice versa.

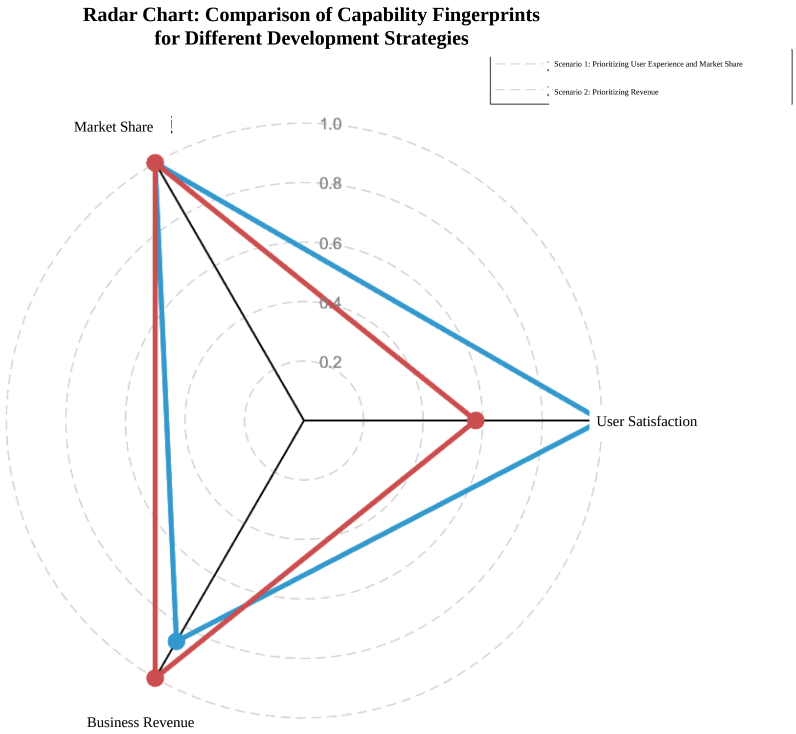

Figure 3 Radar Chart (Strategic Capability Fingerprint)

5. Conclusion

In the paper, a management information system (MIS) decision-making support framework based on multi-objective optimization was constructed and verified through an in-depth analysis of business application scenarios in gaming and technology companies. The core contribution of the study lies in that the Feature Selection Optimization - Multi-Objective 0-1 Integer Programming (FSO-MOIP) model has been proposed and applied, which could mathematically convert the top-level qualitative strategic objectives of enterprises (for example, “Prioritizing Growth” or “Prioritizing Revenue”) into precise and computable weights, thereby providing an optimal and quantifiable solution for product development decision-making under complex resource constraints.

Simulation results show that the proposed framework enables enterprises to identify the optimal feature combinations aligned with their strategic priorities and current development stage. This framework, in combination with multi-perspective visualization tools, not only reveals the composition of the optimal solution, but also presents the complex strategic trade-offs in an intuitive and transparent manner to decision-makers, significantly enhancing the scientificity and explainability of the decision-making process. This marks the shift in the role of management information systems within enterprises — from traditional data recording and report presentation to providing prospective and guiding support for intelligent decision-making.

References

[1] Wang Ping, Li Ting, Zhang Wei. Exploration and Research on the Construction of the Ecosystem of the Micro-Application Open Platform for the Financial Information Systems of Power Grid Companies [J]. Science and Technology & Innovation, 2017(22):3.

[2] Zhang Hongwei, Xu Jianhua, Shi Hongqi, et al. Construction and Implementation of a Digital Management System Based on Information Systems and Business-Finance Integration [C] // 2024 Outstanding Achievements in China

Enterprise Reform and Development (8th) Volume 2. 2025.
[3] Wang Wei. "Data and Coding" Project Design Integrating Real Scenarios - Taking the Development and Application of the Enrollment Information Collection System for First-Grade Primary School Students as an Example [J]. China Information Technology Education, 2024(11):30-34.
[4] Cheng Juming, Li Meilian, Liu Lianfang. Virtual Scene: Management and Its Application in OSG [J]. Control & Automation, 2008.
[5] He Qing. Design and Implementation of Multimedia Information Service System [D]. Beijing University of Posts and Telecommunications, 2011.
[6] Brown, Thomas C. "The concept of value in resource allocation." Land economics 60.3 (1984): 231-246.
[7] Svahnberg, M., Gorschek, T., Feldt, R., Torkar, R., Saleem, S. B., & Shafique, M. U. (2010). A systematic review on strategic release planning models. Information and software technology, 52(3), 237-248.
[8] Ahmed, Farah, et al. "Strengthening the bridge between academic and the industry through the academia-industry collaboration plan design model." Frontiers in Psychology 13 (2022): 875940.
[9] Jantunen, Sami, et al. "The challenge of release planning." 2011 Fifth International Workshop on Software Product Management (IWSPM). IEEE, 2011.
[10] Battleday, Ruairidh M., Joshua C. Peterson, and Thomas L. Griffiths. "From convolutional neural networks to models of higher-level cognition (and back again)." Annals of the New York Academy of Sciences 1505.1 (2021): 55-78.
[11] Jantunen, Sami, and Kari Smolander. "Challenges of knowledge and collaboration in roadmapping." 2006 International Workshop on Software Product Management (IWSPM'06-RE'06 Workshop). IEEE, 2006.
[12] Zorn-Pauli, Gabriele, et al. "Analyzing an industrial strategic release planning process–a case study at Roche diagnostics." Requirements Engineering: Foundation for Software Quality: 19th International Working Conference, REFSQ 2013, Essen, Germany, April 8-11, 2013. Proceedings 19. Springer Berlin Heidelberg, 2013.
[13] Dickson, Sophie R., and Devon LL Polaschek. "Planning to avoid risk or planning for a positive life: The relationship between release plan valence and reoffending." International Journal of Offender Therapy and Comparative Criminology 58.12 (2014): 1431-1448.
[14] Komandla, Vineela. "Crafting a Clear Path: Utilizing Tools and Software for Effective Roadmap Visualization." Global Research Review in Business and Economics [GRRBE] ISSN (Online) (2023): 2454-3217.