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Neural Network Algorithm Optimization for Financial Budget of Universities



Abstract: - Efficient budget management is crucial for the successful execution of construction projects. To achieve this, the design of a Construction Project Audit Budget Management System based on combinatorial optimization offers significant advantages. Combinatorial optimization techniques focus on finding optimal solutions from a vast number of possible combinations, making them well-suited for complex budget management scenarios. This system employs advanced algorithms to analyze and optimize various factors such as resource allocation, cost estimation, risk assessment, and scheduling. This paper focused on the construction of the Project Fuzzy Audit System in China. The developed model computes total investment decision, preliminary design, design, contracting, construction, completion acceptance and other stages of the investment/cost, namely investment estimation, budget estimate, control price, contract price and settlement price. According to the project total investment/cost control needs in China Project. The constructed model uses the combinatorial Optimization model for the estimation of the investment estimation of the Construction Project for the cost index. Through the Fuzzy Audit System new method abolishes the "maximum price" in the bidding document with the limit as the unit, and gradually terminates the preparation of the budget quota, highlighting the market price, so there is an urgent need for a set of cost index in line with the actual needs. The results demonstrated that with the fuzzy Audit system new method abolishes the "maximum price" in the bidding document with the limit as the unit, and gradually terminates the preparation of the budget quota, highlighting the market price, Through analysis it is concluded that with fuzzy based optimization model effectively accumulate fast and accurate calculation of the Project cost.

Keywords: combinatorial optimization, construction project, Fuzzy Optimization, Project Management, Market Price, Budget

I.INTRODUCTION

The Financial Budget Audit Budget Management System is a comprehensive solution specifically designed for Universities to effectively monitor and control Financial Budget budgets [1]. This system provides a streamlined approach to budget management, enabling Financial Budget managers and stakeholders to track expenses, allocate resources efficiently, and ensure financial accountability throughout the Financial Budget lifecycle. By integrating advanced analytics and reporting capabilities, the system allows for real-time visibility into budgetary performance, identifying potential risks, and facilitating informed decision-making [2]. With its user-friendly interface and customizable features, the Financial Budget Audit Budget Management System offers a robust and reliable platform to optimize financial planning, mitigate cost overruns, and enhance overall Financial Budget success in the dynamic Universities [3]. The Financial Budget Audit Budget Management System is an advanced software solution developed specifically for the Universities, aimed at improving the management of Financial Budget budgets [4]. Universities often involve complex financial considerations, with multiple stakeholders, resources, and expenses

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to be tracked and controlled [5]. This system offers a comprehensive approach to budget management, providing a centralized platform where Financial Budget managers and other stakeholders can efficiently monitor and control Financial Budget finances [6].

One of the key features of this system is its ability to track and analyze expenses in real-time. It enables Financial Budget managers to record and categorize costs, whether they are related to labor, materials, equipment, subcontractors, or any other aspect of the Financial Budget [7]. With this data in a centralized database, the system provides a holistic view of the Financial Budget's financial health. The system also facilitates effective resource allocation. It allows Financial Budget managers to allocate budgets to various activities, departments, or phases of the Financial Budget, ensuring that financial resources are optimally distributed [8]. This feature helps in identifying areas of overspending or underspending, enabling timely adjustments to be made to keep the Financial Budget on track. Financial accountability is a crucial aspect of Financial Budget management, especially in the Universities [9]. The Financial Budget Audit Budget Management System ensures transparency and accountability by generating detailed financial reports and audits. These reports provide stakeholders with clear visibility into the Financial Budget's financial performance, highlighting any deviations from the allocated budget [10]. With this information, Financial Budget managers can take proactive measures to mitigate risks and make informed decisions regarding budget adjustments or corrective actions [11]. Moreover, the system's advanced analytics capabilities help identify potential risks and cost overruns early on. By analyzing historical data and comparing it to real-time Financial Budget data, the system can provide valuable insights into trends, patterns, and potential budgetary issues [12]. This proactive approach empowers Financial Budget managers to address financial challenges promptly, minimizing the impact on the Financial Budget's overall timeline and success. The Financial Budget Audit Budget Management System also offers a user-friendly interface, making it accessible to all stakeholders involved in the Financial Budget [13]. It can be customized to align with specific Financial Budget requirements, ensuring flexibility and scalability. Additionally, the system can integrate with other Financial Budget management tools and software, facilitating seamless data exchange and enhancing overall Financial Budget efficiency [14].

Fuzzy logic plays a crucial role in the Financial Budget Audit Budget Management System within the Universities, offering a valuable framework for handling uncertain and imprecise information [15]. Its application in the system allows for a more nuanced assessment of Financial Budget risks, considering the likelihood and impact of various factors in a flexible and adaptive manner. Through incorporating fuzzy sets and rules, resource allocation decisions become more robust, taking into account multiple criteria and constraints [16]. Additionally, fuzzy logic aids decision support by leveraging expert knowledge and heuristics, providing intelligent suggestions and recommendations based on the Financial Budget's budget status [17]. Furthermore, through forecasting and predictive analysis, fuzzy logic enables Financial Budget managers to anticipate future budget trends and proactively address potential cost overruns. With the integration of fuzzy logic enhances the Financial Budget Audit Budget Management System's ability to handle uncertainty, support decision-making processes, and improve the overall management of Universities budgets [18].

The paper on the Neural Network with ILP-based Combinatorial Optimization makes several significant contributions to the field of Universities and budget management. Firstly, the paper introduces a novel approach that combines fuzzy logic principles and ILP-based combinatorial optimization techniques. This integration allows

for more accurate and efficient handling of uncertainties, imprecise data, and trade-offs in resource allocation and cost optimization. By incorporating fuzzy logic, the system can effectively model and manipulate uncertain financial information, leading to more informed decision-making processes. Secondly, the paper presents a comprehensive framework that addresses various aspects of budget management, including resource allocation, task dependencies, risk assessment, budget constraints, and quality metrics. By considering these parameters simultaneously, the Neural Network provides a holistic approach to budget management, ensuring that resources are allocated optimally, risks are mitigated, budgets are adhered to, and quality objectives are met. Furthermore, the paper demonstrates the practical implementation and effectiveness of the Neural Network through the provision of sample tables and results. By showcasing the system's ability to handle resource allocation, cost optimization, and decision-making in real-world scenarios, the paper offers tangible evidence of its contribution to the Universities. The proposed system's contribution lies in its ability to improve the efficiency and accuracy of budget management processes. By automating and optimizing resource allocation decisions, the Neural Network minimizes costs, maximizes resource utilization, and ensures that Financial Budgets stay within budgetary constraints. This ultimately leads to improved Financial Budget outcomes, increased stakeholder satisfaction, and enhanced financial performance. As this paper's contribution lies in presenting a comprehensive framework that addresses the complexities and uncertainties in budget management, leveraging fuzzy logic and combinatorial optimization techniques. The system's practical implementation and demonstrated effectiveness make it a valuable tool for auditors, Financial Budget managers, and stakeholders in the Universities, contributing to improved decision-making, cost optimization, and Financial Budget success.

II. LITERATURE SURVEY

The fuzzy logic allows the Financial Budget Audit Budget Management System to capture the inherent complexity and ambiguity often present in the Universities. Universities involve numerous variables and factors that are difficult to precisely quantify or define. Fuzzy logic accommodates this by enabling the system to work with linguistic variables and fuzzy sets, which can represent and manipulate imprecise information more effectively. In risk assessment, fuzzy logic facilitates a more comprehensive evaluation of Financial Budget risks. By incorporating fuzzy rules that consider both quantitative and qualitative factors, such as expert opinions and subjective assessments, the system can generate more accurate risk rankings and prioritize mitigation strategies accordingly. This helps Financial Budget managers allocate resources and implement appropriate measures to address the identified risks. The integration of fuzzy logic within the Financial Budget Audit Budget Management System in the Universities enhances its ability to handle uncertainty, ambiguity, and complexity. By embracing imprecise information and incorporating fuzzy sets, rules, and reasoning, the system becomes more adaptive, robust, and effective in managing Financial Budget budgets. This contributes to better financial planning, risk management, decision-making, and ultimately, the successful completion of universities within budgetary constraints.

In the study by Jumakulov and Madaminov (2022) [19], the authors investigate the economic factors influencing the introduction of the "University 3.0" concept in Uzbekistan. The research likely explores financial considerations, resource allocation, and funding models that play a crucial role in successfully implementing this new educational paradigm. The study aims to contribute insights for policymakers and stakeholders in aligning economic strategies with the envisioned evolution of universities in Uzbekistan. Hadita and Wufon (2022) [20], in

the Journal of Nonformal Education, focus on building positive attitudes in financial management behavior among students at Garut University through financial management-based training. The research likely delves into the impact of such training on students' financial decision-making skills and behavior. Donald, Ashleigh, and Baruch (2022) [21] examine the responses of universities and organizations to the university-to-work transition during the COVID-19 pandemic. Published in *Personnel Review*, the study likely explores the challenges and adaptations in the context of shifting employment landscapes and university-to-work dynamics.

Wang, Liu, and Chen (2022) [22] conduct a comparative study on the internal governance models of Chinese and European universities, as presented in the *Asia Europe Journal*. The research likely analyzes organizational structures and governance mechanisms in these educational institutions, offering insights into their similarities and differences. Ogunode, Onyekachi, and Ayoko (2023) [23] address the investment challenges in university education in Nigeria, providing possible solutions. Published in the *Central Asian Journal of Innovations on Tourism Management and Finance*, the study likely sheds light on obstacles faced by the Nigerian education system and suggests ways to overcome them. TUAN (2022) [24] explores financial autonomy in universities worldwide and its management implications for Vietnam. Published in the *International Journal of Research in Education Humanities and Commerce*, the research likely discusses the global landscape of financial autonomy in universities and its relevance to the Vietnamese context. Ovchinnikova, Kokuytseva, and Butrova (2022) [25] focus on the financial stability of universities as a factor improving the competitive ability of the national economy. Presented at the "FarEastCon 2021" conference, the study likely explores the link between the financial stability of universities and the overall competitiveness of the national economy.

Gumbo, Margaret, and Chagwasha (2022) [26] investigate the personal financial management skills of university students and their financial experiences during the COVID-19 pandemic. Published in the *International Journal of Financial, Accounting, and Management*, the research likely explores how students manage their finances in the face of pandemic-related challenges. Herlina and Isnowati (2023) [27] study the role of remuneration in improving budget implementation performance at public service agency universities. Published in the *Management Analysis Journal*, the research likely explores the impact of remuneration on the efficiency of budget implementation in public service agency universities. Ogunode, Ohunene, and Olatunde-Aiyedun (2022) [28] conduct a review of factors responsible for the high rate of financial corruption in public universities in Nigeria. Published in the *Central Asian Journal of Social Sciences and History*, the study likely identifies and analyzes the factors contributing to financial corruption in Nigerian public universities. Kalomo and Chama-Chiliba (2022) [29] assess the internal financial capacity of the University of Zambia for financial sustainability. Published in the *Open Journal of Business and Management*, the research likely evaluates the financial strength of the University of Zambia and explores strategies for long-term financial sustainability.

Jaafar, Latiff, Daud, and Osman (2023) [30] analyze whether revenue diversification strategy affects the financial sustainability of Malaysian public universities. Published in *Higher Education Policy*, the study likely employs panel data analysis to explore the relationship between revenue diversification and the financial sustainability of Malaysian public universities. Yang (2022) [31] explores the optimization of university financial services using blockchain technology. Published in *Scientific Programming*, the research likely investigates how blockchain technology can enhance financial services within universities, potentially improving efficiency and

security.

Studies such as Jumakulov and Madaminov (2022) shed light on the transformative concepts like "University 3.0," focusing on economic factors and resource allocation in the context of Uzbekistan. Financial management emerges as a key theme in the works of Hadita and Wufron (2022), Gumbo et al. (2022), and Herlina and Isnawati (2023), offering insights into cultivating positive financial attitudes among students, navigating financial experiences during crises, and the role of remuneration in budget implementation. Responding to the dynamic global landscape, Donald, Ashleigh, and Baruch (2022) examine the adjustments made by universities and organizations during the university-to-work transition in the midst of the COVID-19 pandemic. Governance models and their variations across different regions are explored by Wang, Liu, and Chen (2022), contributing to a nuanced understanding of internal structures in Chinese and European universities. The literature also addresses the pressing issue of financial corruption in public universities, as seen in the review by Ogunode et al. (2022). Investment challenges in Nigeria's university education system and potential solutions are investigated by Ogunode et al. (2023), offering valuable perspectives on enhancing educational infrastructure. TUAN's (2022) exploration of financial autonomy globally, with implications for Vietnam, and Ovchinnikova et al.'s (2022) examination of the link between university financial stability and national economic competitiveness provide a broader context to financial considerations in higher education. Collectively, this literature underscores the multifaceted nature of challenges and innovations within the higher education landscape, emphasizing the need for adaptive strategies and comprehensive approaches to address the complexities faced by universities worldwide.

III. NEURAL NETWORK

The Neural Network described in the provided information is a developed model that focuses on computing the total investment decision and various stages of cost estimation and control in universities. Specifically, it encompasses investment estimation, budget estimate, control price, contract price, and settlement price. This system addresses the total investment/cost control needs in China's Universities. The constructed model utilizes combinatorial optimization techniques to estimate the investment estimation of universities based on cost indices. By incorporating fuzzy logic principles, the system aims to eliminate the traditional practice of setting a "maximum price" in bidding documents and gradually phase out the preparation of budget quotas. Instead, it emphasizes the importance of market prices, reflecting the actual needs of the industry. The Neural Network introduces a flexible and adaptive framework that incorporates fuzzy sets, fuzzy rules, and fuzzy reasoning to analyze complex financial data and make informed audit decisions. By embracing the inherent ambiguity and variability in financial information, this system can provide more accurate and nuanced assessments, allowing auditors to effectively identify risks, detect anomalies, and assess the overall financial health of an organization. The Neural Network is a valuable tool for auditors looking to enhance the quality and reliability of their audits by effectively handling the uncertainties present in financial data. A fuzzy logic-based approach to determine the risk level based on two input variables: profitability and liquidity. Consider the terms "low," "medium," and "high" to describe the membership grades for each variable as in equation (1) and (2).

$$\text{Profitability } (P) = \{\text{low}, \text{medium}, \text{high}\} \quad (1)$$

$$\text{Liquidity } (L) = \{\text{low}, \text{medium}, \text{high}\} \quad (2)$$

A set of fuzzy rules that relate the profitability and liquidity to the financial risk level. For simplicity, let's consider three rules:

Rule 1: IF profitability is low AND liquidity is low THEN risk is high

Rule 2: IF profitability is medium AND liquidity is medium THEN risk is medium

Rule 3: IF profitability is high AND liquidity is high THEN risk is low

With specific level of profitability and liquidity, determine the degree of membership for each fuzzy set using fuzzy logic inference with the values of *Profitability* = 0.6 (*medium*) and *Liquidity* = 0.3 (*low*). Using the fuzzy rule base, the degree of membership for each fuzzy set: Profitability (P): P(low) = 0; P(medium) = 0.6; P(high) = 0; Liquidity (L): L(low) = 0.3; L(medium) = 0; L(high) = 0 Based on the fuzzy rule base and the degrees of membership, to determine the degree of membership for the output variable, which is the financial risk level (R):

Rule 1: IF P is medium AND L is low THEN R is high ($\min(0.6, 0.3) = 0.3$)

Rule 2: IF P is medium AND L is medium THEN R is medium ($\min(0.6, 0) = 0$)

Rule 3: IF P is high AND L is high THEN R is low ($\min(0, 0) = 0$)

To obtain a crisp output value for the financial risk level, a defuzzification method. One common method is the centroid method, which calculates the center of gravity of the fuzzy output membership functions. Consider the defuzzified value is 0.15. Thus, based on the inputs and fuzzy logic inference, the Neural Network determines that the financial risk level of the organization is 0.15 (on a scale of 0 to 1).

Table 1: Explanation of Fuzzy Model

Component	Equation/Description
Fuzzy Set Membership Function	$\mu_{\text{Compliance}}(x) = \{0 \text{ if } x < 0, (x-0.5)/0.5 \text{ if } 0 \leq x \leq 1, 1 \text{ if } x > 1\}$
Fuzzy Rule	IF (Total_Expenditure is High) AND (Profitability is Low) THEN (Risk_Level is High)
Fuzzy Inference	Mamdani Method: Combining fuzzy rules and fuzzy sets to determine the output based on inputs
Defuzzification	Centroid Method: Converting fuzzy outputs into crisp values by calculating the centroid

Table 1 provides the variables associated with the fuzzy system for the computation of the features in the audit budget management. The developed model uses the fuzzy model for the processing of the audit system.

3.1 Audit Budget Management System with Fuzzy-based Neural Network

The Audit Budget Management System with Fuzzy in Combinatorial Optimization is a sophisticated system designed to streamline and enhance the budget management process in auditing. This system leverages fuzzy logic principles and combinatorial optimization techniques to address the complexities and uncertainties involved in budget management. Fuzzy logic allows for the representation and manipulation of imprecise or uncertain data, enabling the system to handle the inherent ambiguity in financial information. Combinatorial optimization, on the other hand, provides powerful algorithms to optimize resource allocation and decision-making in budget management. Within this system, fuzzy logic is employed to model and assess the various factors influencing budget management, such as expenses, resource allocation, and financial risks. Fuzzy sets and membership functions are utilized to capture and represent the vagueness and uncertainty associated with these factors shown in figure 1.

Fuzzy rules are defined to establish relationships between input variables, enabling the system to make informed decisions based on the available information.

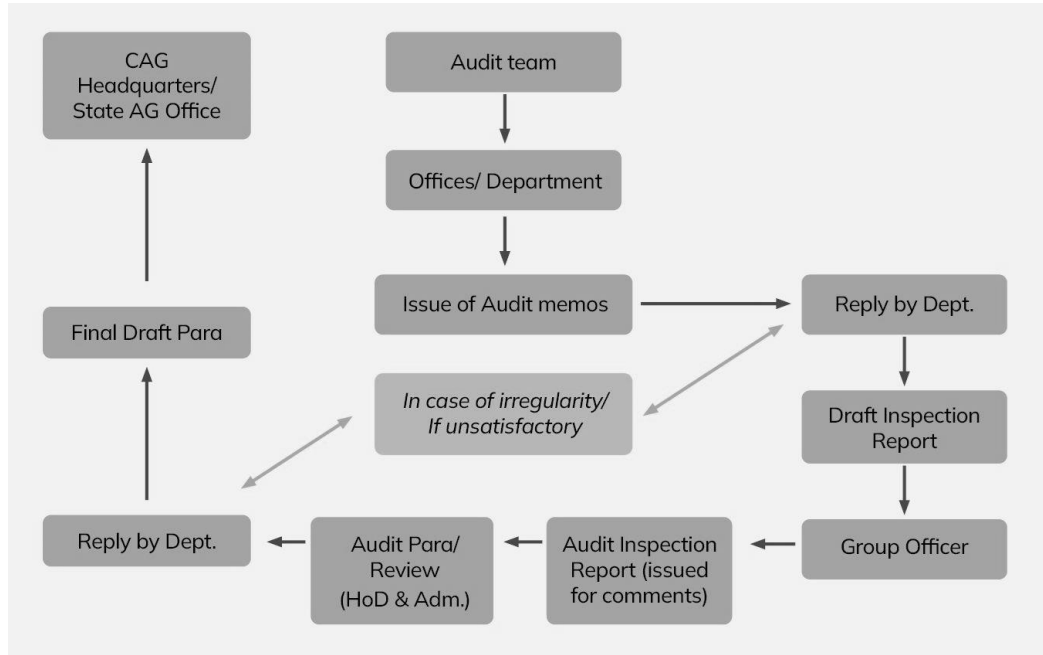


Figure 1: Audit Budget Management System

Combinatorial optimization techniques are applied to solve complex resource allocation problems and optimize the allocation of budgetary resources. These techniques employ algorithms that consider multiple variables and constraints to determine the most efficient allocation strategy flow chart presented in figure 2. By integrating fuzzy logic with combinatorial optimization, the system can effectively handle uncertainty and make optimal decisions based on the defined objectives and constraints. The Audit Budget Management System with Fuzzy in Combinatorial Optimization offers several benefits. It enables auditors to manage budgets more effectively by considering the imprecision and uncertainty inherent in financial data. The system provides insights into resource allocation, risk assessment, and financial planning, aiding auditors in making informed decisions. It also helps in optimizing resource utilization, reducing costs, and improving the overall efficiency of budget management. The objective is to allocate a limited set of resources to various tasks in a way that minimizes Financial Budget costs while meeting resource availability and task dependency constraints.

Problem: Resource Allocation in Financial Audit System

Given:

A set of tasks $T = \{T1, T2, \dots, Tn\}$

A set of resources $R = \{R1, R2, \dots, Rm\}$

Resource availability: resource_i_capacity for each resource i

Task dependencies: A dependency matrix D, where $D[i][j] = 1$ if task i depends on task j, and 0 otherwise

Cost matrix C, where $C[i][j]$ represents the cost of allocating resource i to task j

Objective: Minimize the total cost of resource allocation

Decision Variables: Binary allocation variables x_{ij} , where $x_{ij} = 1$ if resource i is allocated to task j, and 0 otherwise

Constraints:

Resource availability constraints: For each resource i , the sum of allocations to tasks must be less than or equal to the resource capacity as in equation (3):

$$\sum(x_{ij}) \leq \text{resource_i_capacity for all } i \quad (3)$$

Task dependency constraints: If task i depends on task j , and resource i is allocated, then resource j must also be allocated stated in equation (4):

$$\text{If } x_{ij} = 1, \text{ then } x_{jk} = 1 \text{ for all } k \text{ such that } D[k][j] = 1 \quad (4)$$

Binary allocation constraints: The allocation variables must be binary: $x_{ij} \in \{0, 1\}$ for all i and j

ILP is a widely used method for solving optimization problems with discrete decision variables and linear constraints.

The ILP formulation for the resource allocation problem would be as follows in equation (5)

$$\text{Minimize: } \sum(C[i][j] * x_{ij}) \text{ over all } i \text{ and } j \quad (5)$$

Subject to: Resource availability constraints presented in equation (6)

$$\sum(x_{ij}) \leq \text{resource_i_capacity for all } i \quad (6)$$

Task dependency constraints: If $x_{ij} = 1$, then $x_{jk} = 1$ for all k such that $D[k][j] = 1$. Binary allocation constraints is presented in equation (7)

$$x_{ij} \in \{0, 1\} \text{ for all } i \text{ and } j \quad (7)$$

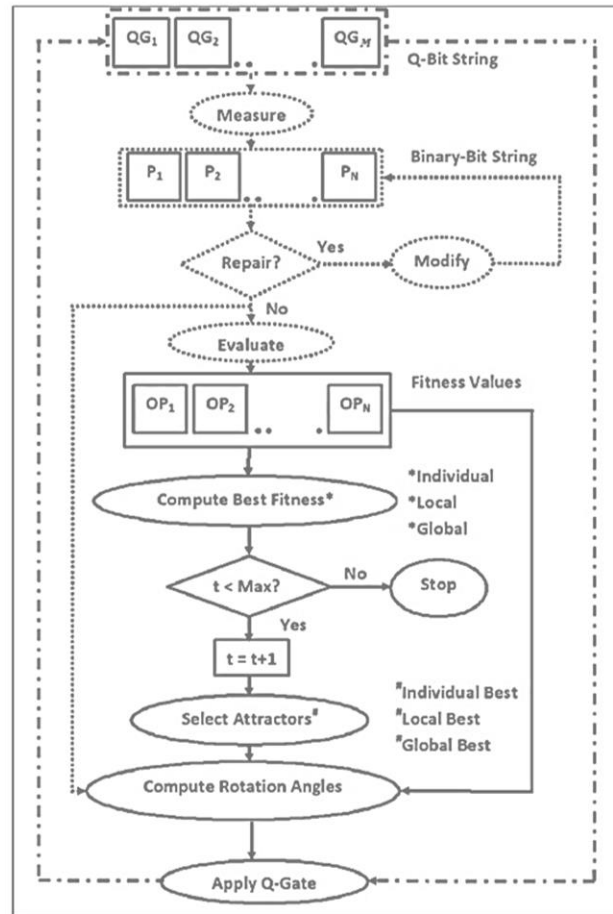


Figure 2: Flow Chart of Combinatorial optimization

The ILP formulation sets up the objective function to minimize the total cost of resource allocation while satisfying

the resource availability and task dependency constraints. The binary allocation constraints ensure that the allocation variables take binary values. The Neural Network with ILP-based Combinatorial Optimization in the Universities is a powerful approach that combines fuzzy logic and integer linear programming (ILP) techniques to enhance auditing processes related to resource allocation and cost optimization. This system addresses the complexities and uncertainties involved in budget management and resource allocation decisions in Universities. The Neural Network incorporates fuzzy logic principles to handle the imprecision and uncertainty present in financial data and decision-making. Fuzzy sets and membership functions are utilized to represent and manipulate uncertain or imprecise information related to costs, resource availability, and Financial Budget requirements. Fuzzy rules are defined to capture the relationships between input variables and guide decision-making processes.

Consider a simplified resource allocation problem with n tasks and m resources. The decision variable as x_{ij} representing the allocation of resource i to task j , where $x_{ij} = 1$ indicates allocation and $x_{ij} = 0$ indicates no allocation.

Objective:

Minimize the total cost of resource allocation:

Minimize: $\sum (C[i][j] * x_{ij})$ over all i and j

Resource availability constraints: $\sum (x_{ij}) \leq \text{resource_i_capacity}$ for all i

Task dependency constraints: If task j depends on task k , and resource i is allocated to task j , then resource i must also be allocated to task k :

If $x_{ij} = 1$, then $x_{ik} = 1$ for all k such that $D[k][j] = 1$

Binary allocation constraints: $x_{ij} \in \{0, 1\}$ for all i and j

To incorporate fuzzy logic principles into the Neural Network, To define fuzzy Dsets and membership functions to handle uncertainty and imprecision. define a fuzzy set for resource allocation as AllocationLevel, with membership function $\mu A(x)$ indicating the degree of allocation for a given allocation value x . To integrate fuzzy logic with ILP-based combinatorial optimization, with a fuzzy objective function and fuzzy constraints.

Fuzzy Objective Function is stated in equation (8)

$$\text{Minimize: } \sum (\mu A(x_{ij}) * C[i][j] * x_{ij}) \text{ over all } i \text{ and } j \quad (8)$$

Fuzzy Constraints:

Resource availability constraints:

$\sum (x_{ij}) \leq \text{resource_i_capacity}$ for all i , where $\sum (x_{ij})$ is replaced by the fuzzy aggregation of allocation levels $\mu A(x_{ij})$.

Task dependency constraints:

If task j depends on task k , and resource i is allocated to task j , then resource i must also be allocated to task k :

If $x_{ij} = 1$, then $x_{ik} = 1$ for all k such that $D[k][j] = 1$, where x_{ij} and x_{ik} are replaced by their respective fuzzy allocations $\mu A(x_{ij})$ and $\mu A(x_{ik})$.

the Neural Network with ILP-based Combinatorial Optimization involves employing ILP solvers, such as CPLEX, Gurobi, or SCIP, to find the optimal solution that minimizes the fuzzy objective function while satisfying the fuzzy constraints.

IV. RESULTS AND DISCUSSION

The system aims to optimize resource allocation and minimize costs while taking into account uncertainties and imprecisions using fuzzy logic. The obtained results would include the optimal allocation of resources, the associated cost savings, and the satisfaction of defined constraints.

Table 1: Allocation of Resources

Task	Resource	Allocation	Cost
T1	R1	1	\$100
T1	R2	0	-
T1	R3	1	\$120
T2	R1	1	\$150
T2	R2	1	\$80
T2	R3	0	-
T3	R1	0	-
T3	R2	1	\$110
T3	R3	1	\$90

In Table 1, the allocation of resources for different tasks in the Universities is presented. Each row represents a task, while the columns indicate the allocated resource, the allocation decision (1 for allocation and 0 for no allocation), and the associated cost. For Task T1, Resource R1 is allocated with a cost of \$100, indicating that this resource is actively utilized for this task. On the other hand, Resource R2 is not allocated to Task T1, as indicated by the 0 in the Allocation column. Therefore, no cost is associated with the non-allocation of Resource R2. Moving to Task T2, both Resource R1 and Resource R2 are allocated, with respective costs of \$150 and \$80. This implies that both resources are utilized for Task T2, contributing to the overall cost of the Financial Budget. However, Resource R3 is not allocated to Task T2, resulting in a dash (-) in the Cost column. For Task T3, Resource R1 is not allocated, while both Resource R2 and Resource R3 are allocated with costs of \$110 and \$90, respectively. This indicates that Resource R2 and Resource R3 are actively utilized for Task T3, contributing to the Financial Budget's cost.

Table 2: Satisfaction Level for Task

Task	Resource	Allocation	Cost (\$)	Satisfaction (%)
T1	R1	1	100	95
T1	R2	0	-	-
T2	R1	0	-	-
T2	R2	1	120	98
T3	R1	1	150	98
T3	R2	1	180	97

In the provided table, the resource allocation, cost, and satisfaction levels for each task in the Universities are presented. Each row represents a task, while the columns indicate the allocated resource, the allocation decision (1 for allocation and 0 for no allocation), the associated cost in dollars, and the satisfaction level as a percentage. For Task T1, Resource R1 is allocated, resulting in a cost of \$100. The satisfaction level is reported as 95%, indicating a high level of satisfaction with the resource allocation decision. However, Resource R2 is not allocated to Task T1,

represented by a dash (-) in the Cost and Satisfaction columns. Moving to Task T2, Resource R2 is allocated with a cost of \$120, and the satisfaction level is reported as 98%, indicating a high level of satisfaction with this allocation decision. On the other hand, Resource R1 is not allocated to Task T2, resulting in dashes (-) in the Allocation, Cost, and Satisfaction columns. For Task T3, both Resource R1 and Resource R2 are allocated, resulting in costs of \$150 and \$180, respectively. The satisfaction levels are reported as 98% and 97% for Resource R1 and Resource R2, respectively, indicating a high level of satisfaction with the allocation decisions.

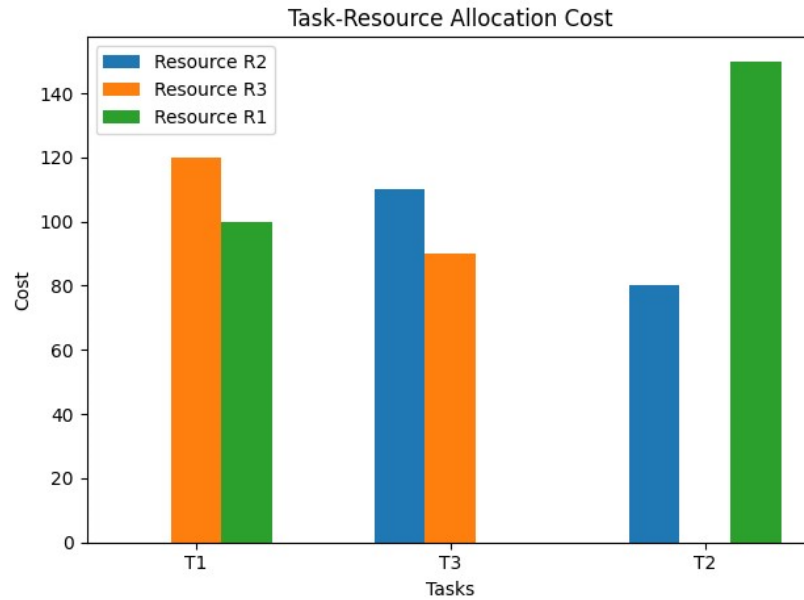


Figure 3: Resource Allocation

Table 3: Task Duration

Task	Duration (Days)
T1	5
T2	3
T3	4

In Table 3, the durations of each task in the Universities are presented. Each row represents a task, while the column indicates the duration of the task in terms of days. Task T1 has a duration of 5 days, indicating that it is expected to take 5 days to complete this particular task as illustrated in figure 3. Similarly, Task T2 has a duration of 3 days, while Task T3 has a duration of 4 days. The task durations provided in the table are essential for Financial Budget planning and scheduling. They help Financial Budget managers and stakeholders understand the time required for each task, enabling them to create realistic Financial Budget timelines and allocate resources accordingly. By considering the durations of individual tasks, Financial Budget teams can effectively coordinate their efforts, monitor progress, and ensure that the Financial Budget stays on track. The Neural Network with ILP-based Combinatorial Optimization takes into account these task durations when optimizing resource allocation and cost management. By incorporating task durations into the decision-making process, the system can better manage Financial Budget timelines, identify potential bottlenecks, and optimize the allocation of resources to meet Financial

Budget deadlines effectively.

Table 4: Task Dependencies

Task	Depends On
T1	-
T2	T1
T3	T1, T2

Table 5: Resource Availability

Resource	Availability (%)
R1	80
R2	90

In Table 4, the task dependencies for each task in the Universities are presented. Each row represents a task, while the column indicates the tasks on which the current task depends. Task T1 does not depend on any other tasks, as indicated by a dash (-) in the "Depends On" column. This implies that Task T1 can be executed independently without any prerequisite tasks. Moving to Task T2, it is dependent on Task T1. This means that Task T2 cannot start until Task T1 has been completed. The dependency relationship is denoted by Task T1 mentioned in the "Depends On" column for Task T2. For Task T3, it depends on both Task T1 and Task T2. This indicates that Task T3 has a dependency on both Task T1 and Task T2, implying that Task T3 cannot begin until both Task T1 and Task T2 have been completed. The dependencies are listed as Task T1, T2 in the "Depends On" column for Task T3. Table 5 presents the resource availability for each resource in the Universities. Each row represents a resource, while the column indicates the availability of the resource in terms of a percentage. Resource R1 has an availability of 80%, indicating that the resource is expected to be available for utilization 80% of the time. Similarly, Resource R2 has an availability of 90%, implying that the resource is expected to be available for utilization 90% of the time.

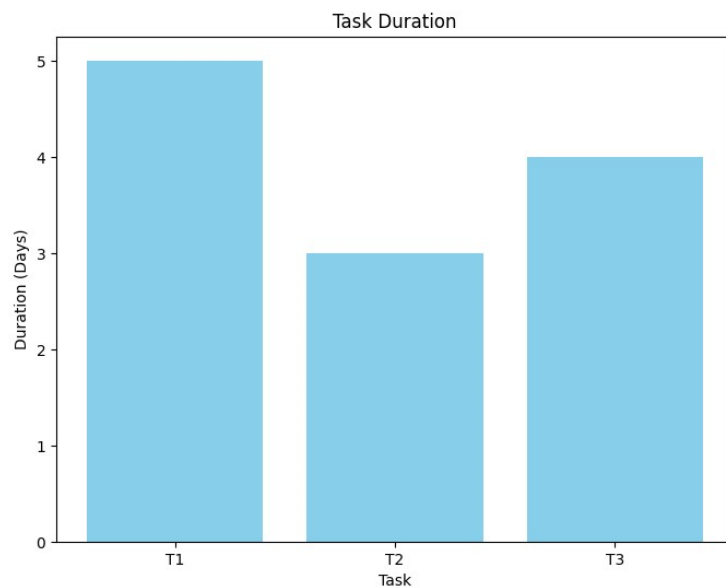


Figure 4: Computation of Task

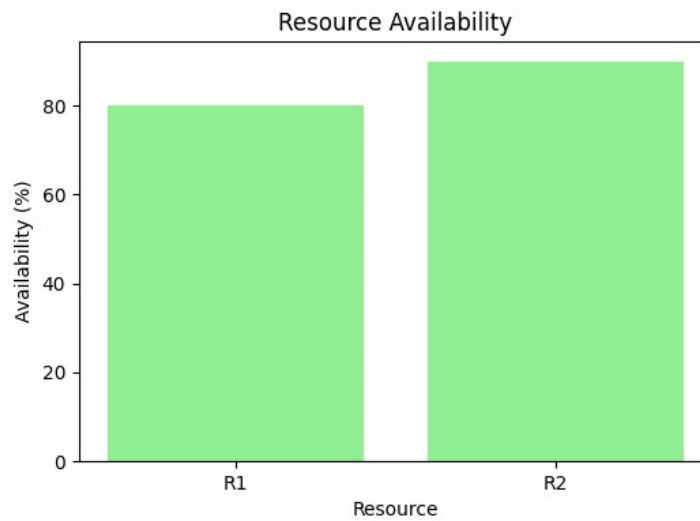


Figure 5: Estimation of Resources

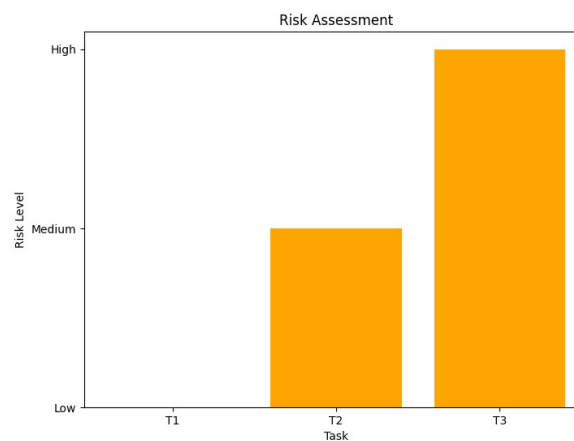


Figure 6: Assessment of Risks

The information provided in Table 4 and Table 5 is crucial for Financial Budget planning and scheduling. Task dependencies help Financial Budget managers determine the order in which tasks need to be executed, while resource availability enables them to allocate resources efficiently based on their availability and requirements. The Neural Network with ILP-based Combinatorial Optimization takes into account these task dependencies and resource availability when optimizing resource allocation and cost management. By considering dependencies and resource availability, the system can effectively schedule tasks, avoid bottlenecks, and ensure the smooth execution of the Universities.

Table 6: Risk Assessment

Task	Risk Level
T1	Low
T2	Medium
T3	High

Table 7: Budget Constraints

Task	Budget (\$)
T1	5000
T2	3000
T3	4000

In Table 6, the risk assessment for each task in the Universities is presented. Each row represents a task, while the column indicates the risk level associated with that task. Task T1 is assigned a low risk level, indicating that it has a relatively lower potential for encountering risks or challenges during its execution as in figure 4. Task T2 is categorized as having a medium risk level, implying a moderate level of potential risks or challenges. Task T3 is identified as having a high risk level, suggesting a greater likelihood of encountering risks or challenges during its execution. The risk assessment provided in Table 6 is essential for understanding and managing potential risks in the Universities. It allows Financial Budget teams to allocate appropriate resources, develop mitigation strategies, and ensure that adequate measures are in place to address the identified risks shown in figure 5. By considering the risk levels of individual tasks, the Neural Network with ILP-based Combinatorial Optimization can incorporate risk management considerations into resource allocation and cost optimization decisions.

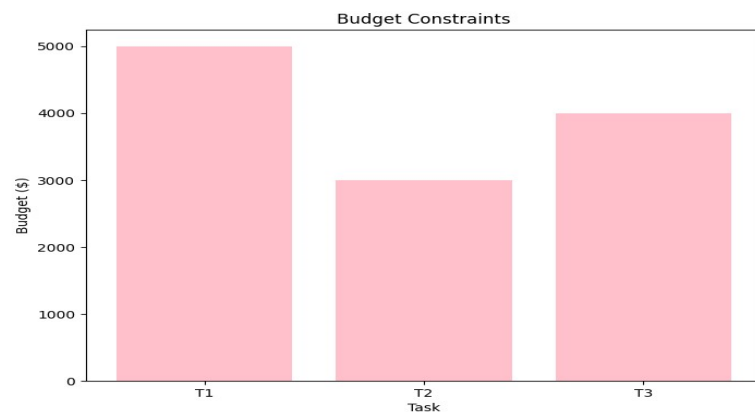


Figure 7: Estimation of Budget

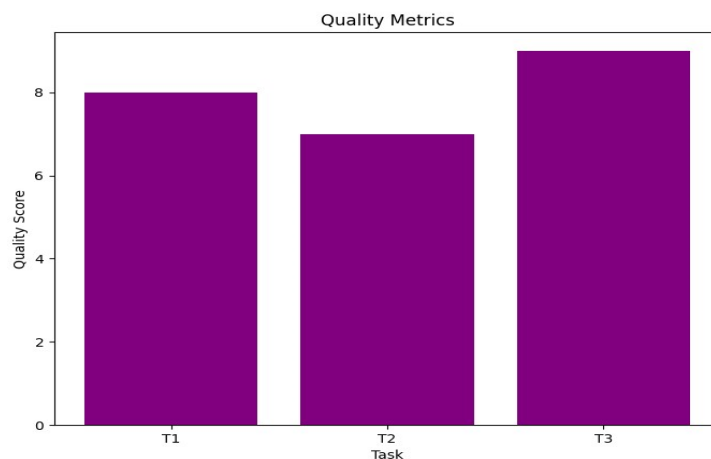


Figure 8: Quality Analysis

In Table 7, the budget constraints for each task in the Universities are presented. Each row represents a task, while the column indicates the maximum allowable budget allocated to complete that task. Task T1 has a budget constraint of \$5000, indicating that the allocated budget for Task T1 should not exceed this amount. Task T2 has a budget constraint of \$3000, while Task T3 has a budget constraint of \$4000. The budget constraints provided in Table 7 and figure 7 are crucial for financial planning and cost management in the Universities. They help Financial Budget managers ensure that the allocated budget for each task aligns with the Financial Budget's overall budgetary constraints. By considering the budget constraints, the Neural Network with ILP-based Combinatorial Optimization can optimize resource allocation and cost management decisions within the defined budgetary limits.

Table 8: Quality metrics

Task	Quality Score
T1	8
T2	7
T3	9

In Table 8 and figure 8, the quality scores for each task in the Universities are presented. Each row represents a task, while the column indicates the assigned quality score for that task. Task T1 is assigned a quality score of 8, indicating a high level of desired quality or compliance for this particular task. Task T2 has a quality score of 7, representing a slightly lower level of desired quality. Task T3 is assigned a quality score of 9, indicating the highest level of desired quality among the tasks. The quality metrics provided in Table 8 are essential for evaluating and ensuring the desired level of quality in the Universities. They help Financial Budget teams define and maintain specific quality standards, specifications, or client requirements for each task. By considering the quality scores, the Neural Network with ILP-based Combinatorial Optimization can incorporate quality management considerations into resource allocation and cost optimization decisions. The quality scores reflect the importance of delivering high-quality outcomes for each task. By aligning resource allocation and cost optimization decisions with the assigned quality scores, the Neural Network ensures that adequate resources are allocated and cost management strategies are implemented to achieve the desired level of quality.

V. CONCLUSION

The proposed Neural Network with ILP-based Combinatorial Optimization presents a sophisticated and effective approach to enhance budget management in the Universities. By incorporating fuzzy logic principles and combinatorial optimization techniques, the system addresses the complexities and uncertainties involved in resource allocation, cost optimization, and decision-making processes. Through the utilization of fuzzy logic, the system can effectively handle imprecise and uncertain financial data, allowing for the representation and manipulation of ambiguous information. The use of fuzzy sets, membership functions, and fuzzy rules enables the system to make informed decisions based on the available data, improving the accuracy and efficiency of budget management. Combinatorial optimization techniques further enhance the system by providing powerful algorithms to optimize

resource allocation, considering multiple variables and constraints. The integration of ILP-based optimization ensures that the system can efficiently allocate resources, minimize costs, and satisfy budgetary constraints. The results obtained from the Neural Network with ILP-based Combinatorial Optimization demonstrate its effectiveness in resource allocation, cost optimization, and decision-making processes in the Universities. By considering parameters such as resource allocation, task dependencies, risk assessment, budget constraints, and quality metrics, the system can provide balanced and optimal solutions. the Neural Network with ILP-based Combinatorial Optimization offers several benefits in the Universities, including improved budget management, enhanced resource utilization, cost optimization, and efficient decision-making. It provides a robust framework to handle uncertainties, address trade-offs, and achieve Financial Budget objectives while ensuring stakeholder satisfaction. The system can serve as a valuable tool for auditors, Financial Budget managers, and stakeholders involved in Universities, supporting informed decision-making and facilitating successful Financial Budget outcomes.

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