

Optimization of Employee Performance and Cost Risk Management using Hungarian Method on MSMEs

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Abstract

Purpose: This research aims to optimize the risk management of employee performance costs in XYZ MSMEs through the application of the Hungarian method and the use of POM QM software.

Methodology/Approach: The study focuses on identifying, measuring, and mitigating risks related to labor cost allocation through the Hungarian method, which is designed to minimize employee performance costs by taking into account differences in abilities, experiences, and skills among employees.

Results/Findings: This study compares manual calculations and POM QM software, confirming that the Hungarian method effectively reduces labor cost risks and improves HR efficiency in XYZ MSMEs. The results show that this method minimizes cost uncertainty and helps mitigate long-term financial risks, making resource management more effective.

Conclusions: The application of the Hungarian method and risk management in XYZ MSMEs effectively optimizes employee assignment, reducing labor cost risks and improving operational efficiency. Utilizing POM QM software further enhances decision-making by simplifying calculations and visualizing optimal solutions for better risk mitigation.

Limitations: This study is limited to the availability of valid data in XYZ MSMEs, the relevance of the Hungarian method and POM QM for other MSMEs, and does not take into account external factors and the required technical expertise.

Contributions: This study offers a practical solution to optimize the risk management of employee performance costs in MSMEs XYZ using the Hungarian and POM QM methods, thereby improving resource allocation and operational efficiency.

Keywords: Cost Optimization, Employee Performance Costs, Hungarian Methods, MSMEs, POM QM.

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1. Introduction

In an increasingly competitive business environment, employee performance management is one of the key factors that determine the success of the organization, especially for Micro, Small, and Medium Enterprises (MSMEs) (Hairudin & Oktaria, 2022; Irawan, 2020). Optimal employee performance not only affects productivity, but also has a direct impact on operational cost efficiency. For MSMEs that often face limited resources, both in terms of finance and labor, cost management related to employee performance is a significant challenge. Managing performance costs effectively is essential to maintain profitability and ensure long-term business continuity (Ompusunggu & Irenetia, 2023). However, many MSMEs have difficulty finding the right method or tool to manage these costs efficiently, especially when faced with various variables that affect employee performance, such as wages, bonuses, and training costs (Riniwati, 2016). Thus, a performance management approach is needed that can maximize employee productivity while minimizing costs to maintain business competitiveness.

Micro, Small, and Medium Enterprises (MSMEs) have a very important role in Indonesia's economy, especially in creating jobs and contributing to economic growth (Vinatra, 2023). However, MSMEs often face various challenges, one of which is effective and efficient management of labor costs (Sofyan, 2017). Poor management can pose financial risks that have an impact on business stability (Siswanto, 2021). The risk of unpredictable and uncontrolled labor costs can lead to the inability of MSMEs to compete in an increasingly competitive market (Yusup, 2024).

One of the main problems faced by MSMEs in employee performance management is the high costs that must be incurred, both in the form of wages, bonuses, and training and development costs. If these costs are not managed properly, MSMEs can experience increased financial risks that can affect their business continuity (Riniwati, 2016). Therefore, the right methods are needed to optimize the allocation of human resources and reduce the risk of uncontrolled performance costs.

Risk management in managing labor costs is very important for business continuity, especially in reducing uncertainty and mitigating the negative impact of inefficient labor costs (Wibowo, 2022). These risks arise when labor costs are not properly managed, including suboptimal allocation of employees, inefficient assignments, and differences in employee abilities, experience, and skills that are not properly accounted for (Sajjad et al., 2020). To face this challenge, it is necessary to implement appropriate risk mitigation strategies.

One of the effective methods in optimizing the allocation of labor resources is the Hungarian method. This method assists companies, including MSMEs, in minimizing the risk of labor costs by ensuring that employee assignments are carried out optimally. By using this method, companies can reduce labor costs by assigning employees based on their efficiency and performance towards specific tasks. In addition, the use of POM QM software allows for more accurate and fast calculations, thus assisting management in making the right decisions regarding employee allocation.

In this case, the Hungarian method emerged as one of the approaches that can help MSMEs in optimizing employee performance cost risk management. This method allows organizations to determine the optimal allocation of tasks or projects to employees, taking into account capability and cost efficiency. This method is well-known in assignment problem-solving that involves selecting the best employees for each task with the lowest cost in mind, making it highly relevant for use in the context of employee performance management.

One of the main advantages of the Hungarian method is its ability to handle complex assignment problems in a simple and efficient manner. For MSMEs, which often do not have a large human resource management team or sophisticated analysis tools, this method can be a practical solution. Using a simple yet powerful algorithm, the Hungarian method allows MSMEs to maximize employee performance while minimizing costs incurred.

This study addresses critical challenges faced by MSMEs in managing employee performance costs within a competitive market. Effective resource allocation is vital for MSMEs, which often operate with limited financial and human resources. Inefficient labor cost management can lead to financial risks, reducing competitiveness. By applying the Hungarian method through POM QM software, this research offers a practical solution for optimizing workforce assignments, reducing overhead costs, and enhancing profitability. The findings aim to provide MSME managers with a structured approach to risk management, enabling data-driven decisions that support operational efficiency and long-term business sustainability.

This study aims to analyze how the application of the Hungarian method and the use of POM QM software can help in optimizing the management of labor cost risk in XYZ MSMEs. Thus, it is hoped that this research will contribute to efforts to reduce financial risks and improve the operational efficiency of MSMEs.

2. Literature review and hypothesis development

2.1 Risk Management

Risk management is a systematic process for identifying, analyzing, and controlling risks that can hinder the achievement of organizational goals. In the context of labor cost management, risks can be in the form of an inability to allocate labor efficiently, which has the potential to incur higher costs than they should and affect the company's financial stability (Hubbard, 2020). Effective risk management helps organizations, including MSMEs, to deal with uncertainty and minimize the negative impact of operational risks (Hillson & Murray-Webster, 2017).

Risk management is the process of identifying, analyzing, evaluating, controlling, and mitigating risks that have the potential to affect the achievement of organizational goals. This process involves identifying relevant risks, analyzing their probabilities and impacts, and implementing mitigation measures to minimize the negative effects of these risks (Hubbard, 2020). In the context of MSMEs, risk management is becoming increasingly important because the inability to handle certain risks, such as financial or operational risks, can have a direct impact on business sustainability. Here is the Risk Management Formula:

$$\text{Risk} = \text{Likelihood}_{\text{value}} \times \text{Consequence}_{\text{value}}$$

2.2 Hungarian Method

The Hungarian method is an algorithm designed to solve assignment problems by finding optimal solutions in allocating tasks to workers or other resources. This assignment problem is often related to cost optimization, where organizations aim to assign workers to specific tasks at the lowest possible cost, or with the highest efficiency (Hillier & Lieberman, 2015).

The assignment problem is formally defined in a linear program where there are a number of tasks and workers (or resources) that must be allocated. In this problem, each worker has a different ability to complete a particular task, which is expressed in varying costs or times. The main goal of the Hungarian method is to minimize the total cost or maximize the benefits of the assignment (Kurnia & Suseno, 2021).

2.3 Steps of the Hungarian Method

The Hungarian method works through several main steps as follows: The first is Compiling the Assignment Table, assignments are organized in the form of a table with rows representing tasks and columns representing workers (Agbo & Egbunike, 2024). Each element in this table indicates the cost or benefit of assigning a worker to a particular task. Second is Row and Column Reduction, for minimization cases, each element in the table is reduced by the smallest element in the row or column in question. This reduction creates a new matrix of opportunities, which makes it easier to find the optimal solution. Third is Determination of the Initial Solution, after reduction, the Hungarian method tries to find the optimal assignment by checking if each row and column has at least one zero value. If there is a viable solution (a qualified solution), the next step is to draw the lines that pass through the zero elements in the matrix. Fourth is Assignment Optimization, if the initial solution is not optimal, additional steps are taken to reduce the elements that are not crossed by the line and adjust the values in the table. This process is repeated until an optimal solution is reached, where each task is allocated to workers at a minimum cost (Haryanti et al., 2019).

2.4 Advantages of the Hungarian Method

The Hungarian method has several advantages, including: Efficiency: This method is designed to provide optimal solutions quickly, especially on assignment problems involving a comparable number of tasks and workers. Simple: Although it is based on linear program theory, this algorithm is relatively easy to implement, even for complex problems. Flexible: This method can be applied to a variety of problems, both to minimize costs and maximize the benefits of assignments (Maulina & Jatnika, 2019).

2.5 Application of the Hungarian Method in Labor Cost Risk Management

In the context of risk management, the Hungarian method can be used to optimize employee assignments to minimize labor costs, which are often a source of financial risk for MSMEs. By using this method, organizations can ensure that their human resources are used in the most efficient way, thereby reducing the risk of cost waste and increasing productivity (Kurnia & Suseno, 2021). The application of the Hungarian method not only reduces labor costs directly but also assists organizations

in mitigating risks related to human resource management, such as inefficiencies and excessive spending. With this optimization, MSMEs can achieve better financial stability in the long term.

2.6 POM QM for Assignment Optimization with the Hungarian Method

POM QM (Quantitative Methods for Windows) software is a tool designed to solve a variety of quantitative problems, including assignment optimization using Hungarian methods. The use of POM QM allows organizations to resolve assignment issues more quickly and accurately. In the context of labor cost risk management, POM QM helps in visualizing assignment scenarios and selecting the most optimal solution to minimize the associated costs and risks (Wirum, 2017).

2.7 Program Operations Management – Quantitative Methods for Windows (POM QM for Windows)

The Operations Management – Quantitative Methods for Windows (POM QM for Windows) program is a software designed to assist decision-making in operational management using a quantitative approach. POM QM was first developed by Professor Howard J. Weiss in 1996 and has become one of the commonly used tools in the field of operations and operational research, including to solve problems of assignment, forecasting, simulation, and other optimization (Weiss, 2021).

2.8 Features of POM QM

POM QM offers a variety of modules that include quantitative methods for decision-making, including Linear Programming, Transportation Model, and Assignment Model modules. This software is very helpful in solving resource allocation problems that require a mathematical approach and complex calculations. Some of the advantages of POM QM include: Ease of Use, there's POM QM is designed with a user-friendly interface that makes it easy for users to enter data and perform calculations, even for those who do not have a strong computer background (Haryanti et al., 2019). Accuracy, the POM QM produces accurate and fast calculations, especially in problems involving many variables or complex conditions, such as the assignment of employees within an organization. Simulation and Visualization, the POM QM allows users to simulate various scenarios in resource allocation or work assignments, as well as display results in the form of tables and graphs that facilitate interpretation (Wirum, 2017).

2.9 Application of POM QM in Assignment Optimization with the Hungarian Method

In the application of the Hungarian method for assignment optimization, POM QM plays an important role because it is able to simplify complex calculation processes. The Hungarian method in POM QM is implemented through the Assignment Model module, which allows users to enter data related to the cost or efficiency of employee assignments to specific tasks (Udodiugwu, 2024). Once the data is entered, the software automatically calculates the optimal solution based on the Hungarian algorithm. The use of POM QM for labor assignment is very relevant in the context of risk management, especially in minimizing labor costs. With the help of POM QM, organizations can test different workforce assignment scenarios and choose solutions that result in the lowest costs and reduce the risk of cost wastage. This is very important for MSMEs that must operate with limited budgets and efficient resources (Siregar & Tanjung, 2020).

2.10 Benefits of POM QM for Risk Management

The use of POM QM in risk management provides significant benefits, including: Better Decision Making: POM QM allows organizations to make decisions based on more accurate and quantitative data, reducing the likelihood of errors or wastes in resource allocation. Operational Efficiency: With the optimization provided by POM QM, organizations can maximize the use of human resources by placing them on the most suitable tasks, which in turn reduces the risk of inefficiencies. Cost Savings: By minimizing assignment costs, organizations can reduce financial risk and improve overall profitability (Haryanti et al., 2019).

3. Research Methods

3.1 Research object

In this article, the object of the study is employees at MSME XYZ which starts from November to December 2023.

3.2 Data Types and Data Sources

The type of data used in this study is primary data. The data taken from MSMEs is in the form of data on the number of employees, especially the production part, the type of work, operating costs, and the time to complete the work. The data source used in this study is sourced from XYZ MSMEs.

3.3 Data Collection Techniques

The first step is observation, the researcher saw and observed directly the objects in Joko Moro MSMEs. The second step is interview, the researcher conducted a questions and answers process to MSME XYZ employees to get information about several employee numbers and costs in the MSMEs. After that researcher Documenting information and data collection related to XYZ MSME employees. Literature studies is the last step, in the literature study, the researcher uses previous research to be used as a reference in this study.

4. Results and Discussion

Our study was conducted in MSME XYZ and we conducted an interview with an employee named Mr. Oji as a cashier at MSME XYZ we asked about the number of employees in MSME Joko and the costs associated with the employee Chicken Pecak & Seafood Restaurant Joko Moro, Katamso is a restaurant located in North Sumatra Province precisely on Jl. Brigjend Katamso No. 309-323 Sei Mati, Medan Maimun, Medan.

This restaurant sells various types of food/drinks such as. This place offers a variety of delicious and delicious dishes at affordable prices. This restaurant also provides various categories of culinary types such as: goring, grill, padang sauce, vegetables, and drinks. An MSME in the culinary sector has 4 different jobs to be completed by 4 employees. The cost of assigning an employee to different jobs is different because the nature of the work is different. Each employee has a different level of skills, work experience and training. So that the cost of completing the same work by different employees is also different.

Table 1. Work assignment using the Hungarian method

Employee	I	II	III	IV
Saparudin	150	200	180	220
Apin	140	160	210	170
Oji	250	200	230	200
Khoir	170	180	180	160

Source: Data Processing (2024)

From the assignment problem above in the Tabel 1, it is seen that if you want to determine the performance cost of the employee who is required to determine the cost received, then the type of problem is in the form of minimization. It is also known that workers as sources who will receive costs there are 4 employees who will get different costs and 4 types of work which are their duties this shows rows = columns so that the rows and columns are balanced, as follows:

Table 2. Reduction

Employee	I	II	III	IV
Saparudin	0	50	30	70
Apin	0	20	70	30
Oji	50	0	30	0
Khoir	10	0	20	0

Source: Data Processing (2024)

The steps taken to solve the problem are as follows: Based on table 2 select the smallest cost per row and subtract all costs with the smallest cost per row so as to produce a reduced cost matrix /matrix.

Tabel 3. Total opportunity cost matrix

Employee	I	II	III	IV
Saparudin	0	50	10	70
Apin	0	20	50	30
Oji	50	0	10	0
Khoir	10	0	0	0

Source: Data Processing (2024)

Based on the results of the step 2 table, select the smallest cost for each column to reduce all costs in those columns. In the example above, it is only done in column III because all other columns already have elements with a value of zero (0). If the second step has yielded at least one zero value in each column, then the third step can be omitted. The following is a matrix of total opportunity cost, where each row and column has at least one zero value.

Table 4. Search for the lowest value of each column

Employee	I	II	III	IV
Saparudin	0	50	10	70
Apin	0	20	50	30
Oji	50	0	10	0
Khoir	10	0	0	0

Source: Data Processing (2024)

4.1 Forming the optimal assignment

The practical procedure for conducting an optimization test is to draw a minimum number of horizontal and/or vertical lines to cover all zero-valued elements in the total opportunity cost matrix. If the number of lines is equal to the number of rows/columns, then the assignment is optimal. If not, it must be revised.

Table 5. Results of table revision reduction

Employee	I	II	III	IV
Saparudin	0	40	0	60
Apin	0	10	40	20
Oji	60	0	10	0
Khoir	20	20	0	0

Source: Data Processing (2024)

To revise the total opportunity cost, select the smallest number that is not covered (crossed) by the line. (in the example above = 10). Subtract the number that the line does not cross by the smallest number (10). Add the number at the intersection of the line with the smallest number.

Table 6. Assignment Table

Assignment	Cost
Saparudin - III	180
Apin - I	140
Oji - II	200
Khoir - IV	160
	680

Source: Data Processing (2024)

Then the results of the calculation will be compared with the calculation via the POM QM application to find out whether the results remain the same or not. The second calculation of the analysis of the problem of optimizing work cost assignment using the Hungarian method in XYZ MSMEs case of Minimization using the POM QM application version 5, the following are the stages: Open the POM QM application then select the Module > Assessment menu.

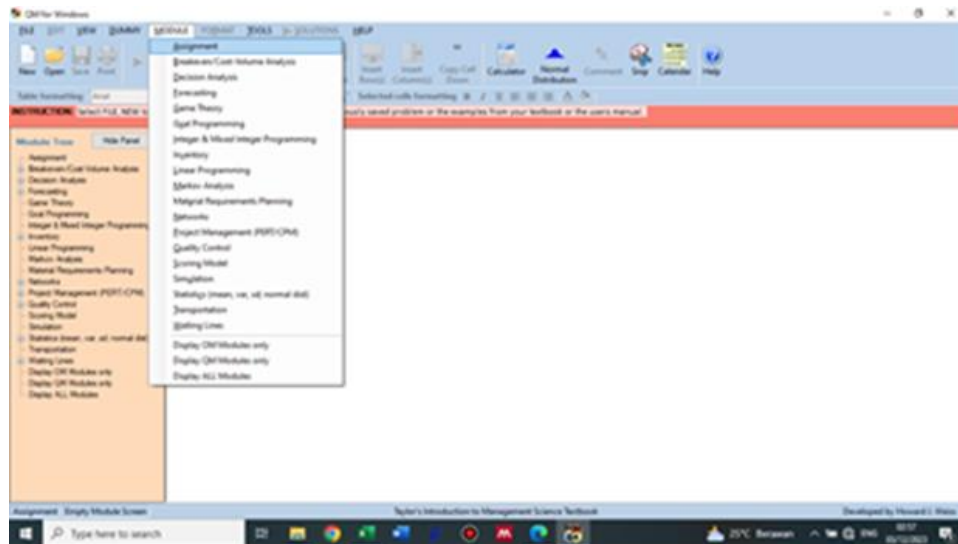


Figure 1. Create an assignment module
Source: Data Processing (2024)

The first steps are create a new file by selecting the File menu and then selecting New.

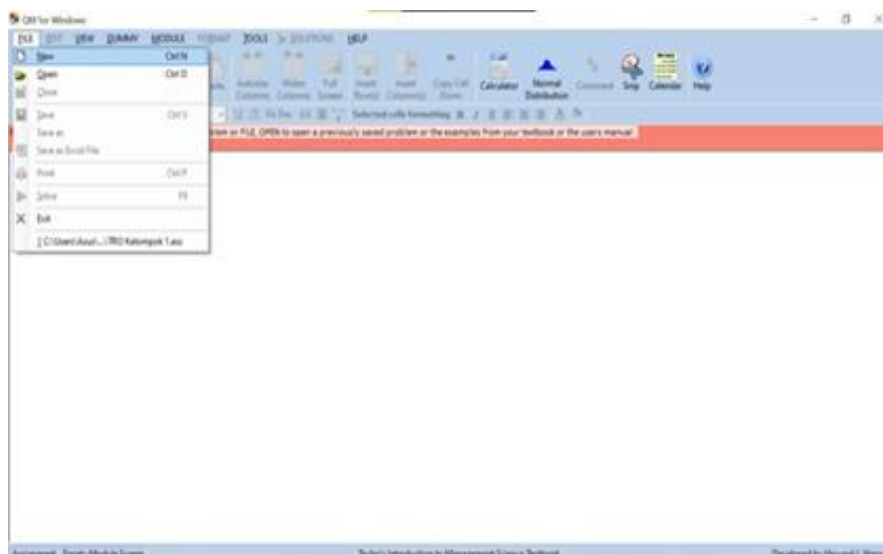


Figure 2. Create a new file
Source: Data Processing (2024)

The second steps are fill in the title column according to the title of the discussion, specify the number of rows and columns, select the case study to be taken, and select the type of row and column naming.

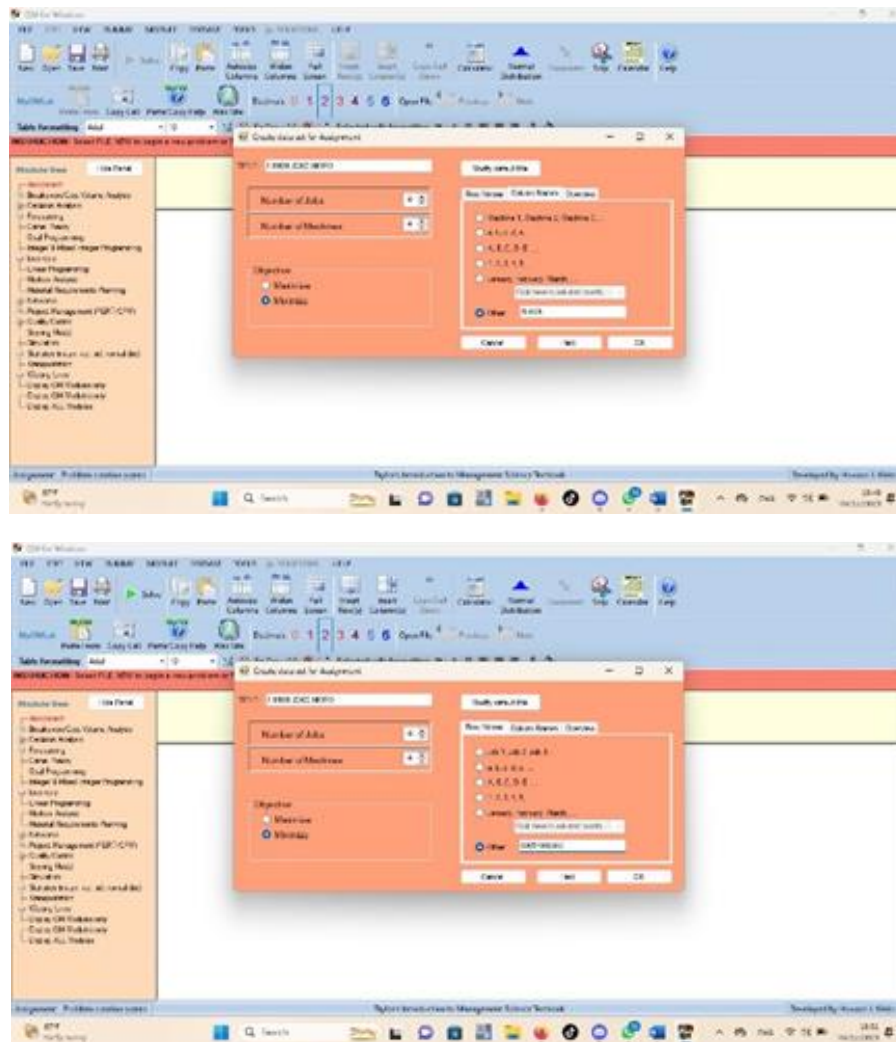


Figure 3. Setting up a table
Source: Data Processing (2024)

The third steps is fill in the table with the predetermined data and Click the Solve button to process the calculation.

	Machine 1	Machine 2	Machine 3	Machine 4
Job 1	150	200	180	220
Job 2	140	190	210	170
Job 3	250	200	210	180
Job 4	170	190	190	160

Figure 4. Processing Data
Source: Data Processing (2024)

Fourth steps is the results of the calculation of the Optimal Solution Value with a score of 680 are obtained as follows:

The top screenshot shows the initial cost matrix for the assignment problem:

	UJAYA 1	UJAYA 2	UJAYA 3	UJAYA 4
KARYAWAN 1		40		60
KARYAWAN 2		10	40	20
KARYAWAN 3	50		10	
KARYAWAN 4	20	20		

The bottom screenshot shows the optimal assignment solution with a total cost of 680:

	Assigned to	Cost
KARYAWAN 1	UJAYA 3	100
KARYAWAN 2	UJAYA 2	10
KARYAWAN 3	UJAYA 4	10
KARYAWAN 4	UJAYA 1	20
Total		680

Figure 5. Results Table
Source: Data Processing (2024)

Overall, the application of the Hungarian Method to MSMEs XYZ was obtained by the Minimization method with the application of existing employee performance costs.

4.2 Level of Risk Management Risk

Tabel 6. Level of Risk Management Risk

Risk	Likelihood	Consequence	Risk Level
Employee Expense 1	3	4	12
Employee Expenses 2	4	3	12
Employee Cost 3	2	5	10
Employee Expenses 4	5	2	10

Source: Data Handler

4.3 Heat Map

Form the result here is the Heat Map that authors made.

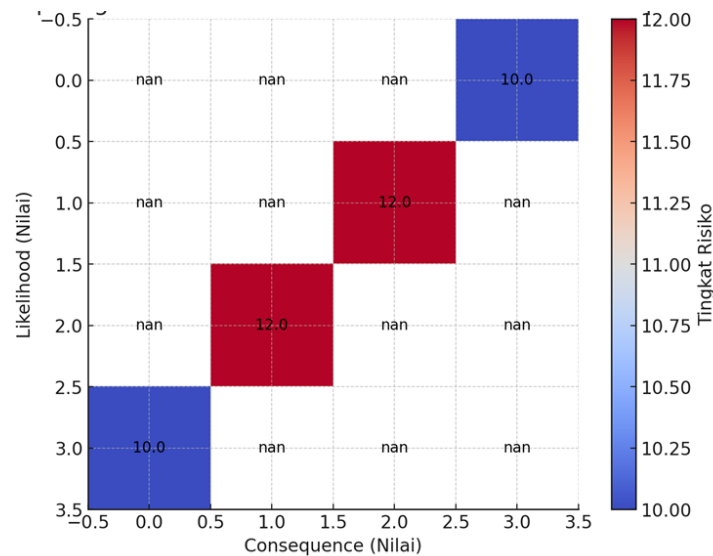


Figure 6. Risk Level Heatmap by Likelihood and Consequence
Source: Data Processing (2024)

5. Conclusion

In managing labor cost risk in XYZ MSMEs, the main challenge lies in the inefficiency of human resource allocation which has the potential to significantly increase operational costs. Through a systematic risk management approach, these risks can be better identified, measured, and managed. Using the Hungarian method for employee assignment has proven to be an effective strategy in minimizing costs and optimizing task allocation.

In this study, manual calculations and the help of POM QM software provide consistent results, namely optimization of total employee performance costs. The Hungarian method successfully reduces the risk of labor costs by providing the most efficient assignment solution. In addition, the application of risk management, by multiplying the Likelihood and Consequence values, produces numbers that can be used to map the existing risks. Through this analysis, risks with a high level of likelihood and consequence can be identified as the top priority for mitigation.

Visualization through heatmaps further clarifies risk areas that need special attention. The heat colours that appear on the heatmap indicate significant risk areas, where management must focus actions to mitigate potential impacts. By reducing these risks, XYZ MSMEs can improve efficiency and reduce potential cost waste that can occur in the future. In addition, the benefits of using POM QM as a quantitative tool are very felt in decision-making. The software not only simplifies the calculation process, but also provides a clearer visualization of the most optimal assignment options. This supports a faster and more accurate risk mitigation process, thereby improving overall operational efficiency.

Overall, the application of the Hungarian method and risk management calculations provide significant results in the management of labor costs in MSMEs XYZ. This strategy can be used by other MSMEs in facing similar challenges, where efficiency in human resource allocation is the key to operational success and financial sustainability.

Suggestion

The suggestion from the authors for the next study is, it's could explore the integration of the Hungarian method with other optimization techniques, such as machine learning, to enhance decision-making in labor cost management. Additionally, investigating the long-term impact of risk management strategies on MSME financial sustainability would provide valuable insights. Further research could also focus on real-time data applications to improve the adaptability and accuracy of workforce allocation.

Limitations And Further Studies

One limitation of this study is that it focuses solely on labor cost optimization without considering other operational factors such as employee satisfaction and skill development. Further research could explore the integration of qualitative aspects, such as worker motivation, into the Hungarian method for a more holistic approach. Additionally, future studies may expand on the use of advanced AI-based optimization techniques to enhance decision-making in dynamic MSME environments.

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