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Application of the Hungarian Algorithm for Workforce Task Optimization in Mobile Device Repair Operations

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ABSTRACT *– An imbalance in task assignments within a business unit can decrease efficiency and extend job completion time. To address this issue, an optimization approach is required to allocate tasks effectively and minimize total working time. This study analyzes the application of the Hungarian Method to optimize employee assignments at Konter Bintang Sorong, aiming to achieve the most efficient mobile phone repair time. A quantitative approach was employed using the Hungarian algorithm implemented through POM-QM for Windows version 5. Data were collected through observation, interviews, and documentation related to repair durations for each task type. The findings show that the Hungarian Method produced the most efficient task allocation: employee Willi repaired connectors in 25 minutes, Aksa handled software issues in 60 minutes, and Fadli repaired LCD components in 10 minutes. These results indicate that the Hungarian Method effectively reduces average repair time and increases the number of devices serviced within a given period. Thus, it serves as an effective optimization tool for improving task distribution, operational efficiency, and customer satisfaction.*

Keywords *- Hungarian Method, Optimization, Task Assignment*

Penerapan Algoritma Hungarian untuk Optimasi Penugasan Tenaga Kerja pada Operasional Perbaikan Perangkat Seluler

ABSTRAK *– Ketidakseimbangan dalam pembagian tugas di suatu unit usaha dapat menurunkan efisiensi dan memperpanjang waktu penyelesaian pekerjaan. Untuk mengatasi permasalahan tersebut, diperlukan pendekatan optimasi yang mampu mengalokasikan tugas secara efektif guna meminimalkan total waktu kerja. Penelitian ini menganalisis penerapan Metode Hungarian untuk mengoptimalkan penugasan karyawan pada Konter Bintang Sorong dengan tujuan mencapai waktu perbaikan handphone yang paling efisien. Pendekatan kuantitatif digunakan dengan menerapkan algoritma Hungarian melalui perangkat lunak POM-QM for Windows versi 5. Data penelitian dikumpulkan melalui observasi, wawancara, dan dokumentasi terkait durasi perbaikan untuk setiap jenis pekerjaan. Hasil penelitian menunjukkan bahwa penerapan Metode Hungarian menghasilkan alokasi tugas yang paling efisien, yaitu karyawan Willi menangani perbaikan konektor dalam 25 menit, Aksa menangani perbaikan perangkat lunak dalam 60 menit, dan Fadli memperbaiki komponen LCD dalam 10 menit. Temuan ini menunjukkan bahwa Metode Hungarian efektif dalam mengurangi rata-rata waktu perbaikan serta meningkatkan jumlah perangkat yang dapat diselesaikan dalam jangka waktu tertentu. Dengan demikian, metode ini dapat dijadikan sebagai alat optimasi yang efektif untuk meningkatkan distribusi tugas, efisiensi operasional, dan kepuasan pelanggan.*

Keywords *- Metode Hungarian, Optimasi, Penugasan Tugas*

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1. INTRODUCTION

The rapid advancement of Information Technology (IT) has become an integral part of modern human life. The utilization of technology today extends beyond communication and industrial sectors, encompassing workforce management aimed at achieving optimal efficiency and productivity [1], [2], [3], [4], [5], [6], [7], [8]. One crucial application of technology in business operations is the optimization of labor time to enhance productivity and customer satisfaction. In this context, Operations Research (OR) plays a vital role as a scientific approach to decision-making related to the optimal allocation of resources [9], [10], [11], [12], [13], [14], [15], [16], [17]. OR is a discipline that employs mathematical models and quantitative analysis techniques to derive optimal solutions to various problems, particularly those concerning efficiency, effectiveness, and workforce productivity.

Small-scale service enterprises, particularly in the field of electronic device maintenance, often encounter challenges in achieving operational efficiency due to ineffective task allocation and time management. Despite the growing reliance on mobile phone repair services in developing regions, limited research has been conducted on optimizing technician task assignments to reduce service completion time. Konter Bintang Sorong, a mobile phone repair enterprise based in Sorong City, Southwest Papua, exemplifies this issue. The business experiences uneven workload distribution among technicians, resulting in prolonged repair durations and inconsistent service quality. While such inefficiencies are common in micro-scale repair businesses, they are rarely addressed using quantitative optimization approaches. Previous studies have primarily focused on manufacturing or large-scale industrial applications of task optimization, leaving a gap in the empirical implementation of mathematical optimization models—such as the Hungarian Method—in small service-based enterprises. This research, therefore, aims to address that gap by applying an operations research approach to improve task assignment efficiency and minimize total repair time in the context of a local mobile phone repair service.

One of the most effective techniques to address this issue is the Hungarian Method, a mathematical algorithm in OR designed to solve assignment problems. The Hungarian Method was first introduced by Harold Kuhn in 1955, based on concepts derived from the work of Dénes Kőnig and Jenő Egerváry in graph theory [18], [19], [20]. This algorithm operates by transforming rows and columns in a cost matrix to produce a single zero element in each row and column, thereby determining the most efficient combination of task assignments. Applying this method enables the identification of optimal task distribution among employees, with the objective of minimizing total job completion time and improving operational efficiency [9], [18], [21], [22], [23], [24], [25].

The collaboration between the Hungarian Method and information technology is implemented through the POM-QM for Windows version 5 application. Developed by Howard J. Weiss, this software is designed to facilitate quantitative analysis and address mathematical problems in OR, production management, and operational strategy. POM-QM for Windows allows users to perform complex computational processes efficiently and accurately. In this study, the software is utilized to apply the Hungarian algorithm in determining the optimal allocation of employee repair tasks at Konter Bintang Sorong. This technological integration supports a systematic analytical process that produces optimal solutions for minimizing mobile phone repair time.

Based on this background, the present study aims to analyze the implementation of the Hungarian Method in optimizing employee task assignments at Konter Bintang Sorong, with the goal of achieving efficient task distribution and minimizing mobile phone repair time. By applying this method through the POM-QM for Windows platform, the study is expected to contribute to improving operational efficiency, workforce productivity, and overall customer satisfaction within the organization.

2. LITERATURE REVIEW

Recent literature reaffirms the Hungarian Method's enduring relevance for assignment and workforce-allocation problems while also documenting methodological enhancements and diverse applications across service and logistics domains. Several empirical studies and case applications from 2018–2025 demonstrate that the Hungarian algorithm remains a practical, polynomial-time approach for producing optimal one-to-one assignments when the objective is to minimize cost or time. In large-scale and domain-specific settings, researchers have successfully adapted or hybridized the Hungarian algorithm to address problem variants and dynamic requirements, indicating both robustness and

extensibility of the method [26].

Methodological advances reported in the past five years include algorithmic refinements and hybrid frameworks that combine Hungarian-based matching with complementary optimization or machine-learning components to handle multi-index assignment, stochasticity, or large-data workflows. Such developments aim to preserve the Hungarian Method's optimality guarantee while improving computational efficiency or accommodating additional practical constraints (e.g., multi-site assignments, varying task weights) [18], [19], [20], [27]. These works provide conceptual and computational precedents for applying the Hungarian approach in contexts where operational complexity or data volume is nontrivial [28].

Applied studies in service-oriented sectors show that implementing the Hungarian Method via decision-support software consistently yields reproducible and implementable optimal allocations. Case reports and software-assisted studies indicate that packages such as POM-QM (and similar quantitative-methods tools) effectively operationalize the Hungarian algorithm, enabling practitioners to transform empirical time/cost matrices into implementable schedules or assignments with minimal manual computation [29], [30], [31], [32], [33], [34], [35], [36]. The literature thus supports the combined use of rigorous analytical procedure and software tools for validation and deployment in small and medium service enterprises [37].

Finally, contemporary applications—ranging from delivery assignment and remote-sensing task scheduling to workforce allocation in production and service firms—illustrate the Hungarian Method's adaptability and impact on operational performance metrics (e.g., reduced total processing time, increased throughput). These empirical outcomes justify its selection for optimizing mobile-phone repair assignments at Konter Bintang Sorong and motivate using POM-QM for computational validation.

3. RESEARCH METHOD

This study was conducted through several systematic stages to ensure methodological rigor and analytical accuracy (see Figure 1). The research was carried out at Konter Bintang Sorong, located in Ruko Irian Bhakti, Jalan Sam Ratulangi No. 5, Kampung Baru, Sorong City, over a two-month period from August to September 2025. This time frame was selected to enable comprehensive observation, data collection, and analysis related to the optimization of employee task assignments using the Hungarian Method.

The data collection process employed three complementary techniques—observation, interview, and documentation—to ensure the validity and reliability of the findings. Direct observation was conducted from August 6 to August 8, 2025, to examine the workflow, distribution of repair tasks, and duration of each technician's activities during the mobile phone repair process. In addition, an in-depth interview was conducted with one of the technicians, Mr. Willi George, to obtain detailed information regarding average repair time and the factors influencing task efficiency. The documentation process supported both the observation and interview phases by providing visual and written records of the repair procedures, ensuring data triangulation and enhancing the credibility of the research findings.

In the data analysis stage, all collected data were categorized according to the estimated repair time for each employee. The analysis focused on comparing task assignments using the Hungarian Method integrated with the POM-QM for Windows version 5 software. This analytical approach facilitated the identification of the most efficient allocation of repair tasks by minimizing the total repair time and maximizing overall operational efficiency. The data were processed and analyzed through the Hungarian algorithm within the software to determine the optimal distribution of tasks among employees. The results were then interpreted to formulate conclusions and recommendations aimed at improving task management strategies and operational performance at Konter Bintang Sorong.

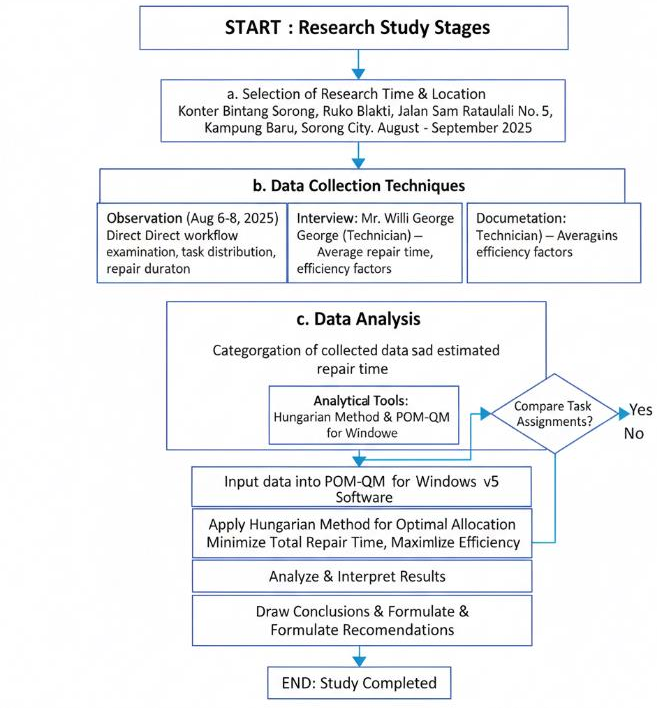

Figure 1. Research Flowchart

4. RESULTS AND DISCUSSION

Each employee has distinct tasks and varying completion times; therefore, a systematic calculation is required to determine the most optimal assignment configuration. The results of the observation are presented in Table 1, which illustrates the assignment of employees to specific repair tasks. There are three employees and three types of work analyzed in this study. Employee Willi performs tasks related to connector repairs with an estimated completion time of 25 minutes, software or mobile program repairs requiring 90 minutes, and LCD repairs taking approximately 30 minutes. Employee Aksa handles connector repairs in 25 minutes, mobile program repairs in 60 minutes, and LCD repairs in 25 minutes. Meanwhile, employee Fadli completes connector repairs in 30 minutes, mobile program repairs in 45 minutes, and LCD repairs in 10 minutes.

These observations provide the initial data matrix required for the application of the Hungarian Method, which aims to determine the most efficient task assignment among employees. By analyzing this matrix using the POM-QM for Windows software, the research seeks to identify the optimal combination of employee-task allocations that minimizes total repair time and enhances overall operational efficiency at Konter Bintang Sorong.

Table 1. Employee Assignment Observation Results

Job	Processing Time (Minute)		
Employee	Connector	Program HP	LCD
Willi	25	90	30
Aksa	25	60	25
Fadli	30	45	10

Based on Tabel 1, the systematic steps undertaken to obtain the optimal solution are outlined as follows.

Step 1. Formulating the Cost Matrix (Table 1)

The initial step involves constructing a cost matrix that represents the estimated time (in minutes) required by each employee to complete each type of repair task. In this study, the cost matrix was developed based on the observed repair times of three employees (Willi, Aksa, and Fadli) for three different tasks (connector repair, program repair, and LCD repair). The primary objective is to minimize the total completion time across all assignments.

Step 2. Row Reduction (Table 2)

Each row of the cost matrix is examined, and the smallest value within that row is subtracted from all elements in the same row. This step ensures that every row contains at least one zero element, simplifying the identification of potential optimal assignments.

Table 2. Row Reduction Results

Job	Processing Time (Minute)		
Employee	Connector	Program HP	LCD
Willi	(25 - **25**) = 0	(90 – **25**) = 65	(30 – **25**) = 5
Aksa	(25 - **25**) = 0	(60 – **25**) = 35	(25 – **25**) = 0
Fadli	(30 – **10**) = 20	(45 – **10**) = 35	(10 – **10**) = 0

Step 3. Column Reduction (Table 3)

Following row reduction, the same process is applied to each column. The smallest value in each column is subtracted from all elements within that column, ensuring that each column also contains at least one zero element.

Table 3. Column Reduction Results

Job	Processing Time (Minute)		
Employee	Connector	Program HP	LCD
Willi	0	(65 – **35** = 30)	5
Aksa	0	(35 – **35** = 0)	0
Fadli	20	(35 – **35** = 0)	0

Step 4. Assignment of Zero Elements (Tabel 4)

A preliminary assignment is made by selecting zeros in the matrix such that no two selected zeros appear in the same row or column. This represents an initial feasible solution. If the number of assignments equals the number of employees (or tasks), the optimal solution has been found.

Table 4. Assignment of Zero Elements Results

Job	Processing Time (Minute)		
Employee	Connector	Program HP	LCD
Willi	0	30	5
Aksa	~~0~~	~~0~~	~~0~~
Fadli	~~20~~	~~0~~	~~0~~

Step 5. Optimization Check and Matrix Adjustment

If the number of feasible assignments is less than the total number of employees or tasks, further adjustment is necessary. The smallest uncovered element in the matrix is identified and subtracted from all uncovered elements while being added to elements at the intersections of covered rows and columns. This process creates additional zeros and improves the feasibility of the solution. Within the context of this study, Step 5 was deemed unnecessary, as an acceptable and feasible solution was already achieved during Step 4 of the procedure.

Step 6. Final Assignment and Optimal Solution

After adjustment, the new matrix is re-evaluated until a full set of assignments can be made. The final matrix provides the optimal assignment configuration, minimizing total repair time. Using the Hungarian Method through POM-QM for Windows version 5, the optimal combination of

employee-task assignments is determined for Konter Bintang Sorong. This enables efficient distribution of workload, reduces total repair duration, and enhances operational performance.

Table 5. Final Assignment and Optimal Solution

Employee	Job	Processing Time (Minute)
Willi	Connector	25
Aksa	Program HP	60
Fadli	LCD	10
Total		**95**

The results obtained from the application of the Hungarian Method, as presented in Table 5, indicate that the optimization process successfully produced the most efficient assignment configuration among employees. Specifically, employee Willi was assigned to the connector repair task with a working time of 25 minutes, employee Aksa was allocated to the mobile phone software repair task with a completion time of 60 minutes, and employee Fadli was assigned to the LCD repair task, which required only 10 minutes. The overall total working time of 95 minutes demonstrates that the Hungarian Method effectively minimized the total processing duration across all tasks.

This finding reinforces the strength of the Hungarian Method as a reliable optimization approach in operational research, particularly in solving assignment problems where time efficiency and resource allocation are critical. By systematically reducing redundant task overlaps and assigning each employee to the most suitable job based on their efficiency levels, the method ensures that labor resources are utilized optimally.

Moreover, the integration of the POM-QM for Windows software facilitated the computational process, allowing the assignment matrix to be analyzed more accurately and efficiently. The combination of the Hungarian algorithm and decision-support software not only streamlined the optimization process but also provided a transparent framework for evaluating the results.

In conclusion, the optimized allocation derived from this study demonstrates that the Hungarian Method can significantly enhance operational performance at Konter Bintang Sorong by minimizing repair time and improving workflow efficiency. This approach can serve as a model for similar small and medium-scale service enterprises aiming to increase productivity through systematic task optimization.

Following are the integration steps using POM-QM for Windows software:

Step 1. Open the POM-QM for Windows software and select the Module Tree Assignment option. A dialog box titled Create Data Set for Assignment will appear. In this form, enter the title "Konter Bintang Sorong", specify the Number of Jobs as 3, and the Number of Machines as 3. For the Objective option, select Minimize, and then click the OK button to proceed. This process is illustrated in Figure 2.

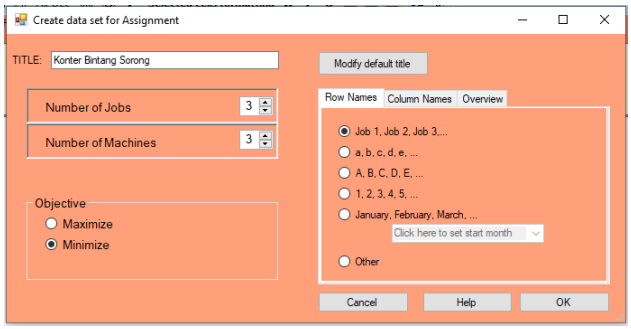

Figure 2. Form Create data set for Assignment

Step 2. Input the data based on the values presented in Table 1 into the designated fields of the application. The resulting data entry interface and configuration are shown in Figure 3.

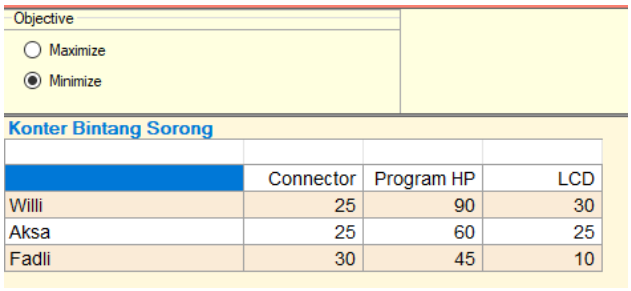

Figure 3. Data entry and configuration interface

Step 3. Click the Solve button to execute the optimization process and generate the task assignment results, as displayed in Figure 4.

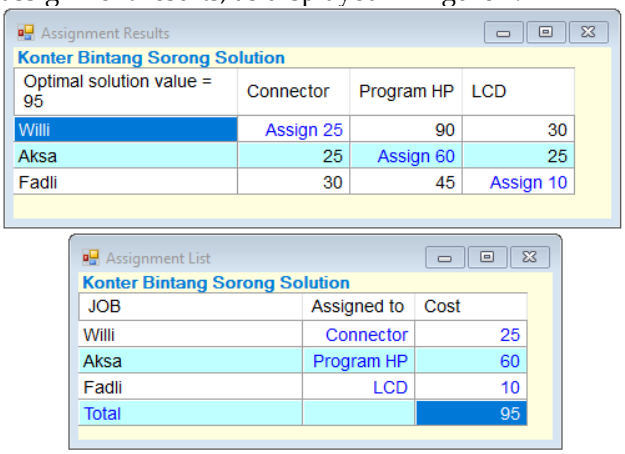

Figure 4. Assignment result interface

To ensure the accuracy and validity of the optimization process, a verification stage was conducted by comparing the results of the manual computation using the Hungarian Method with the outcomes generated by the POM-QM for Windows

software. The validation aimed to confirm whether both approaches produced consistent and reliable task assignments. The analysis revealed that the results were entirely consistent, with no differences observed between the manual and software-based calculations. This indicates that the POM-QM for Windows software effectively implements the Hungarian algorithm with precision equivalent to the manual computation process.

The consistency between the two methods further validates the robustness of the Hungarian Method as an optimization tool in minimizing total task completion time and ensuring efficient resource allocation. Additionally, this verification strengthens the credibility of the research findings, as the results have been confirmed through both analytical and computational approaches. Consequently, the derived solution can be confidently applied within the operational framework of Konter Bintang Sorong to enhance workflow efficiency, optimize employee performance, and improve overall service quality.

The findings of this study have significant implications for operational management, particularly in the context of small and medium-scale service enterprises such as Konter Bintang Sorong. The successful application of the Hungarian Method demonstrates that systematic task optimization can substantially improve efficiency in employee assignments and reduce total processing time. By integrating mathematical optimization techniques with decision-support tools such as POM-QM for Windows, organizations can achieve data-driven decision-making that enhances productivity, minimizes operational bottlenecks, and improves overall service delivery.

From a managerial perspective, the adoption of the Hungarian Method provides a practical framework for assigning tasks based on employee performance metrics, ensuring that each worker is allocated to the task where they are most effective. This approach fosters a more balanced workload distribution, which in turn contributes to higher job satisfaction and customer service quality.

5. CONCLUSION

The findings of this study demonstrate that the application of the Hungarian Method offers an effective and systematic approach for optimizing task assignments within the operational framework of Konter Bintang Sorong. By utilizing this method, the allocation of repair tasks among employees was optimized to achieve the minimum total completion time of 95 minutes, with each employee assigned to the task most aligned with their efficiency level—Willi to connector repair, Aksa to software repair, and Fadli to LCD repair—resulting in a balanced workload and enhanced productivity. The integration of the Hungarian algorithm with the *POM-QM for Windows* software played a crucial role in facilitating computational accuracy and streamlining the optimization process, thereby supporting data-driven decision-making and providing a robust analytical framework for evaluating employee performance. Overall, the study confirms that the Hungarian Method significantly reduces average repair time, improves resource utilization, and enhances operational efficiency in service-based enterprises. Consequently, this approach can serve as a practical decision-support model for similar businesses seeking to improve performance and customer satisfaction through efficient task allocation. Future research should extend the analytical framework by incorporating additional variables such as employee skill levels, workload variability, and task complexity. Furthermore, integrating the Hungarian Method with advanced optimization or artificial intelligence techniques could enhance predictive accuracy and broaden its applicability across diverse operational contexts.

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