

# Assignment of Motor Mechanics at the Tire Palace Using the Hungarian Method and Testing Software Quality Management (QM)

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**Abstract:** Measurement of working time (time study) is basically an attempt to determine the placement of mechanical work from the length of work time required by a mechanic to complete a job. This study aims to place the optimal mechanical work in the context of service operational time efficiency and obtain optimal time savings that can be achieved by mechanics in working on motorcycle servicing so as to maximize income using the Hungarian Method. The purpose of this research is to optimize employee assignments by looking at the mechanical working time. The problems that occur at ISTANA BAN are the ineffectiveness of the work process time and the swelling of operational costs, especially in the work of Matic Kaburator, Injection Matic, Injection Duck, Kaburator Duck and Sport with 5 workers. The results of the Assignment Application with the Hungarian Method and Software Quality Management (QM) Testing, Evan mechanics serviced the Duck Kaburator motorbike with a service time of 25 minutes, Minus mechanic serviced the Injection Duck motorbike with a service time of 24 minutes, Hermon mechanic serviced the Sport motorbike with a service time of 27 minutes, mechanic Anton servicing the Matic Injection motorbike with a service time of 25 minutes, mechanic Zola servicing the Matic Kaburator motorbike with a service time of 26 minutes. After analyzing the possibilities, it can be concluded that all mechanics can service each type of motor if the assigned mechanic has worked on the specified type of motor. By minimizing mechanical service time, it will have an impact on Tire Zone revenue because the number of motorbikes being serviced is increasing. Total Tire Zone revenue can be increased from pre-implementation revenue using the Hungarian Method.

**Keywords:** Assignment, Hungarian, Quality Management, Mechanics

## INTRODUCTION

Motorcycles are one of the most widely used vehicles by the community, both from the lower, middle, and upper classes (Tarmizi, 2018). The selection is based on the buying price of motorbikes which are getting cheaper and affordable by the community (Pratama Afrianto, 2021). ISTANA BAN is a place to replace motorcycle spare parts, especially tires and motorcycle service services. The motorbike has several types of motorbikes, namely Sport motorbikes, Matic motorbikes and Duck motorbikes. For each type of motor, it is divided into two, namely motors that still use a blurator and those that already use the injection system (Afizah, 2017).

Wages are one of the things that encourage or motivate employees to work or fully serve the company (Lavinia, 2018). Wages are often also called salaries or vice versa, but the two designations have slight differences. With the categorization of permanent employees and contract employees in a company (Imbaruddin, 2020), then there is a difference in the compensation payment system between salaries and wages. The definition of difference between salary and wages can be seen as follows (Butar, 2021), Wages are defined as rewards for workers who do menial work and rely more on physical strength and the amount is usually set on a daily, unit or piece basis. Another opinion about wages which defines that, wages are given on the basis of daily performance (Lukman, 2022), usually this practice is found in factories. Wages are sometimes also based on units of product produced (Astuti, 2017).

ISTANA BAN serves consumers in selling spare parts and servicing motorcycles. The service facility is provided as one of the manifestations of Istana Ban's caring attitude to satisfy its customers. The number of

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customers of Istana Ban makes the need for service even higher. Meanwhile, the number of mechanics who handle servicing at Motorcycle repair shops is limited. With the limited number of mechanics who service motorbikes, the placement of the right mechanic according to his expertise is very necessary in order to get an optimal placement (Robiul, 2019), so that in the placement process it can be calculated based on the total time of the mechanic in doing the assigned work (Muhamad, 2022). Currently, every mechanic tends to complete motor service work at different speeds. As a result, the number of motors that are serviced by each mechanic varies each month. Therefore, in this case it is necessary to measure working time, because the measurement of working time (time study) is basically an attempt to determine the placement of mechanical work from the length of work time required by a mechanic to complete a job.

This study aims to measure the optimal service time and mechanical placement based on the minimum processing time using the Hungarian method. This research will produce mechanical grouping in working on the type of motor with a minimum time and obtain income/income data from the results of the application of the Hungarian method (Hidayat R, 2019).

Measurement of working time (time study) is basically an attempt to determine the placement of mechanical work from the length of work time required by a mechanic to complete a job. (Syafiq Hilmi MZ, 2019). This study aims to place the optimal mechanical work in the context of service operational time efficiency and to obtain optimal time savings that can be achieved by mechanics in doing motorcycle servicing so as to maximize revenue using the Hungarian Method.

The Hungarian method is one of the algorithms used to solve assignment problems, this method was discovered and published by Harold Kuhn in 1955. (Mardiani, 2020). The Hungarian algorithm has two solutions, namely a minimal solution and a maximum solution. In addition, the Hungarian algorithm uses simple calculations so that it is easier to understand and apply in life. The Hungarian method is a method that modifies the rows and columns in the effectiveness matrix until a single zero component appears in each row or column that can be selected as an assignment allocation. The purpose of this research is to apply the Hungarian method in optimization of the mechanical assignment of ISTANA BAN.

ISTANA BAN is a company engaged in the sale of tires and motorcycle service. In carrying out the service process there are obstacles to mechanical performance, namely the incompatibility of the placement of mechanics in carrying out the work being handled. The purpose of this research is to obtain the appropriate assignment based on the expertise or ability of mechanics in carrying out service activities, using data from research on service processes and performance obtained at ISTANA BAN. The method used in this research is the Hungarian method which is a work assignment problem solving technique. Based on the calculations that have been carried out, with QM for Windows it is concluded that this method can minimize costs and optimize performance.

## LITERATURE REVIEW

Previous research that discussed the assignment problem with the application of the Hungarian method, as follows:

- 1 This study aims to place the optimal mechanical work in the context of service operational time efficiency and to obtain optimal time savings that can be achieved by mechanics in working on motorcycle services so that they can maximize revenue using the Hungarian Method. The chosen variable is the number of mechanics 7 people which are denoted by MK1 (Wayan), MK2 (Frendyk), MK3 (Moh.Ikram), MK4 (Sudirman), MK5 (Arif), MK6 (Dimas), MK7 (Moh.Irsal) and 5 types of vehicles which are denoted JM1 (Matic Kaburator), JM2 (Matic Injection), JM3 (Injection Duck), JM4 (Caburator Duck) and JM5 (Sport). (Afizah, 2017).
2. Penelitian penyelesaian menjahit pakaian pada Grand Sony Tailor yaitu 39 jam, dimana terjadi efisiensi waktu sebanyak 4 jam jika dibandingkan waktu penyelesaian sebelum menggunakan metode Hungarin yaitu selama 43 jam. adapun untuk biaya produksi yang dikeluarkan perusahaan melihat dari penempatan tugas karyawan dengan waktu penyelesaian optimum yaitu Rp 4.925.500,00 dengan keuntungan perusahaan Rp 1.624.750,00 dalam menyelesaikan 10 jenis pakaian (Ibnas, 2018)..
3. This research was conducted on MSME bread makers who have not optimized the problem of employee assignment and distribution processes. This research is expected to increase the company's competition. Then the researcher uses the Penalty method to allocate employees in order to obtain optimal results and the Networking method to solve distribution problems. The data obtained from the observations will be tested according to the method used (Riki Ramadan, 2021).

Based on 3 previous studies, it becomes the author's reference to apply the Hungarian method to the assignment of employees to the Ban Palace so that optimal working time is obtained.

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## METHOD

Metode yang digunakan dalam penelitian ini adalah metode Hungarian dimana dengan metode ini dilakukan penerapan penugasan kinerja karena adanya ketidaksesuaian penempatan pekerjaan pada masing-masing mekanik. The method that is said to be optimal is the method that has a greater value indicating the optimal amount of time (Riskiono, 2020).

Data collection techniques are carried out to obtain the information needed in order to achieve the research objectives, then the following types of data are used::

1. Is the result of direct observation or observation. The results of these observations are in the form of data on 5 workers who serve customers, and data on the time of workers in carrying out each task. Less effective work processes.
2. Mechanical work based on 5 types of motors with 5 workers working on Assignment Problems Assignment problems are problems regarding individual arrangements to carry out tasks, so that time to serve customers can be minimized.

Some things that must be learned in solving assignment problems are: number of workers (m), number of jobs to be completed (n), assignment of workers to a job (Xij), allocation parameter assigned (Cij) = 1 If worker i is assigned = 0 If worker i is not assigned Metode Hungarian adalah metode yang memodifikasi baris dan kolom dalam matriks efektivitas hingga komponen nol tunggal muncul di setiap baris atau kolom yang dapat dipilih sebagai alokasi penugasan.

Assignment is a method that can be used for modes of transportation where workers are to be assigned to each activity. And can be defined as (i,j =1,2,3,4,5). Some things that must be learned in solving assignment problems are: number of workers (m), number of jobs to be completed (n), assignment of workers to a job (Xij), assigned allocation parameters (Cij).

Xij= If worker i is assigned to one of the machines.

Xij= 0 If worker i is not assigned to any machine.

The mathematical model in this case is based on the constraint function obtained and then entered into the assignment table. In general, the assignment problem can be written with the following formula (Husniati, 2017):

Optimize Z :

$$\sum_{i=1}^m \quad \sum_{j=1}^n \quad (1)$$

With obstacles:

$$\sum_{i=1}^m ij = 1 ; j = 1,2, \dots, m \quad (2)$$

$$\sum_{j=1}^n ij = 1 ; i = 1,2, \dots, n \quad (3)$$

Information:

Z : The objective function is to find the optimal value (maximum or minimum).

N : Number of tasks to be completed.

Xij : Assignment from source (worker) i to destination (task) j.

Cij : Parameter allocation from source i to destination j

The Hungarian method is a method that modifies the rows and columns in the effectiveness matrix until a single zero component appears in each row or column that can be selected as an assignment allocation. The Hungarian method is usually used to solve minimal assignment problems (Mardiani, 2020):

Step 1: Find the minimum element in each row of the max cost matrix. Construct a new matrix by subtracting from each minimum costs in the row. For this new matrix, find the minimum cost in each column. Construct a new matrix (called the reduced cost matrix) by subtracting from each minimum costs in its column.

Step 2: Draw the minimum number of lines (horizontal, vertical, or both) required to cover all zeros in the reduced cost matrix. If m lines are required, then the optimal solution is available among the zeros included in the matrix. If it takes less than the m line, then proceed to step 3.

Step 3: Find the smallest nonzero element (call its value k) in the low-cost matrix opened by the lines taken in step 2. Now subtract k from each non-find element from the low-cost matrix and add k for each element covered by the two lines. Go back to step 2.

Testing With POM QM Software is a software designed to perform calculations needed by management to make decisions in the field of production and marketing (Putri, 2017). This software was designed by Howard J. Weiss in 1996 to help production managers, especially in preparing forecasts and budgets for the production of raw materials into finished or semi-finished products in the manufacturing process.

## RESULT

This research was conducted at the Ban Palace in Jakarta. Istana Ban, apart from selling spare parts, also serves periodic light motorcycle services. Istana Ban serves periodic light services for each different type of

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motorcycle, both motorcycles that use a blurator or those that already use injection. The types of motorbikes available are Matic Kaburator, Matic Injection, Duck Injection, Duck Kaburator and Sport. As for the mechanics assigned to service the motorbike, there are 5 people, namely Evan, Minus, Hermon, Anton and Zola.

The steps in determining the assignment of an employee:

1. Menyusun tabel waktu pekerjaan sesuai dengan data yang telah didapatkan. Berikut ini dilakukan pengolahan data dengan metode Hungarian untuk menentukan penugasan pada Istana Ban sebagai berikut:

Table 1. Employee Assignment

Mechanical Name	Motor Type				
	Matic Carburetor	Matic Injection	Injection Duck	Carburetor Duck	Sport
Evan	30	39	37	25	41
Minus	28	40	24	43	40
Hermon	29	30	41	43	27
Anton	27	25	40	45	32
Zola	26	25	32	35	30

In Table 1, the periodic light service time required by each mechanic to complete each job, in minutes. It is also known that 5 employees as assigned resources will be allocated to 5 jobs which are job assignments.

1. Determine the smallest value in each row.

Tabel 2. Menentukan Nilai Terkecil

Mechanical Name	Motor Type				
	Matic Carburetor	Matic Injection	Injection Duck	Carburetor Duck	Sport
Evan	30	39	37	25	41
Minus	28	40	24	43	40
Hermon	29	30	41	43	27
Anton	27	25	40	45	32
Zola	26	25	32	35	30

In Table 2. Determine the smallest values in each row with the details being the first row the smallest value 25, the second row the smallest value 24, the third row the smallest value 27, the fourth row the smallest value 25 and the fifth row the smallest value 25.

2. Subtracts the value in each row by the smallest value in each row

Table 3. Results of the Smallest Value Reduction

Mechanical Name	Motor Type				
	Matic Carburetor	Matic Injection	Injection Duck	Carburetor Duck	Sport
Evan	5	14	12	0	16
Minus	4	16	0	19	16
Hermon	2	3	14	16	0
Anton	2	0	15	20	7
Zola	1	0	7	10	5

In Table 3. The results of the reduction of the smallest value of each row. To reduce the time value for each row, with the smallest value from Table 2, it is obtained according to the row in the second table, with the details being the first row (30-25= 5, 39-25=14, 37-25=12, 25-25=0, 41-25=16) , second line(28-24=4, 40-24=16, 24-24=0, 43-24=19, 40-24=16), third line (29-27= 2, 30-27=3, 41-27=14, 43-27=16, 27-27= 0), fourth row (27-25=2, 25-25=0, 40-25=15, 45 -25=20, 32-25=7), fifth row (26-25= 1, 25-25=0, 32-25=7, 35-25=10, 30-25=5).

3. If there is still a column that does not have the number 0, then iterate again by determining the smallest value in that column.

\*name of corresponding author



Tabel 4. Hasil Pengurangan Kolom

Mechanical Name	Motor Type				
	Matic Carburetor	Matic Injection	Injection Duck	Carburetor or Duck	Sport
Evan	4	14	12	0	16
Minus	3	16	0	19	16
Hermon	1	3	14	16	0
Anton	1	0	15	20	7
Zola	0	0	7	10	5

In Table 4. The results of the subtraction of column values by determining the smallest value of the column, based on Table 3, which is in the first column (5-1=4, 4-1=3, 2-1=1, 2-1=1,

4. Create assignment lines on rows and columns that contain the number 0.

Table 5. Line of Assignment

Mechanical Name	Motor Type				
	Matic Carburetor	Matic Injection	Injection Duck	Carburetor Duck	Sport
Evan	<del>4</del>	<del>14</del>	<del>12</del>	<del>0</del>	<del>16</del>
Minus	<del>3</del>	<del>16</del>	<del>0</del>	<del>19</del>	<del>16</del>
Hermon	<del>1</del>	<del>3</del>	<del>14</del>	<del>16</del>	<del>0</del>
Anton	<del>1</del>	<del>0</del>	<del>15</del>	<del>20</del>	<del>7</del>
Zola	<del>0</del>	<del>0</del>	<del>7</del>	<del>10</del>	<del>5</del>

In Table 5, there are already zero values in each different row and column, so the optimal time value results have been obtained.

Table 6. Optimal Cost Results

Mechanical Name	Motor Type	Time ( Minutes)
Evan	Carburetor Duck	25
Minus	Injection Duck	24
Hermon	Sport	27
Anton	Matic Injection	25
Zola	Matic Carburetor	26

Based on table 6, the optimal assignment by the mechanic assigned to service the motor is:

- a. mechanic Evan serviced the Duck Kaburator motorbike with a service time of 25 minutes,
- b. Minus mechanics service the Injection Duck motorbike with a service time of 24 minutes,
- c. Hermon mechanics service a Sport motorbike with a service time of 27 minutes,
- d. Anton's mechanic serviced the Matic Injection motorbike with a service time of 25 minutes,
- e. Zola's mechanic serviced the Matic Kaburator motorbike with a service time of 26 minutes.

### Testing With POM QM Software

The test is carried out to determine whether the employee assignment input is valid or invalid. The test is carried out using the POM QM application for windows. The initial steps for calculating the Hungarian method using QM for Windows are as follows:

1. Run QM Program For Windows V.5

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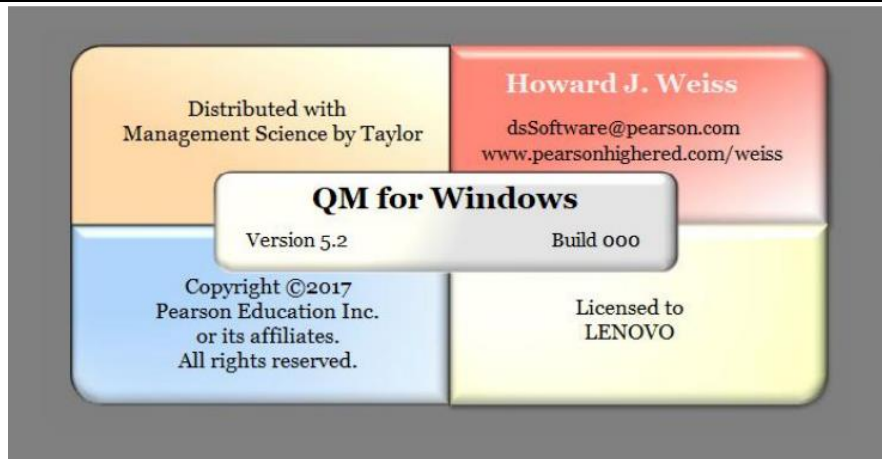


Figure 1. Display QM for Windows

In Figure 1, the Process of Running the QM software, with the results of the Initial Quick Start Instruction display.

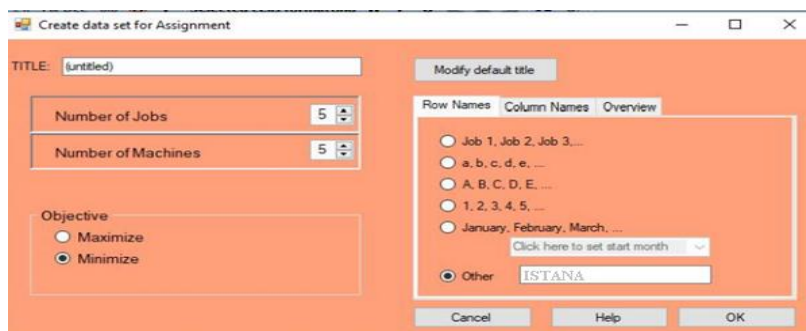


Figure 2. Tree . Module

In figure 2. Select the Module to determine the Number of Jobs and Number of employees, based on the data of 5 Jobs and 5 employees.

Objective	Comment																																				
<input type="radio"/> Maximize <input checked="" type="radio"/> Minimize	yada yada																																				
<b>1000</b>																																					
	<table border="1"> <thead> <tr> <th></th> <th>Matic Kab...</th> <th>Matic Injeksi</th> <th>Bebek Injeks</th> <th>Bebek Kab...</th> <th>Sport</th> </tr> </thead> <tbody> <tr> <td>Evan</td> <td>30</td> <td>39</td> <td>37</td> <td>25</td> <td>41</td> </tr> <tr> <td>Minus</td> <td>28</td> <td>40</td> <td>24</td> <td>43</td> <td>40</td> </tr> <tr> <td>Hermon</td> <td>29</td> <td>30</td> <td>41</td> <td>43</td> <td>27</td> </tr> <tr> <td>Anton</td> <td>27</td> <td>25</td> <td>40</td> <td>45</td> <td>32</td> </tr> <tr> <td>Zola</td> <td>26</td> <td>25</td> <td>32</td> <td>35</td> <td>30</td> </tr> </tbody> </table>		Matic Kab...	Matic Injeksi	Bebek Injeks	Bebek Kab...	Sport	Evan	30	39	37	25	41	Minus	28	40	24	43	40	Hermon	29	30	41	43	27	Anton	27	25	40	45	32	Zola	26	25	32	35	30
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Figure 3. Display of Input Data

In Figure 3, type the numbers of the time data for distribution activities in the cells provided. Then click the solve button located on the top right to see the solution results. From the create data table that has been filled in, click ok so that the image above appears.

\*name of corresponding author



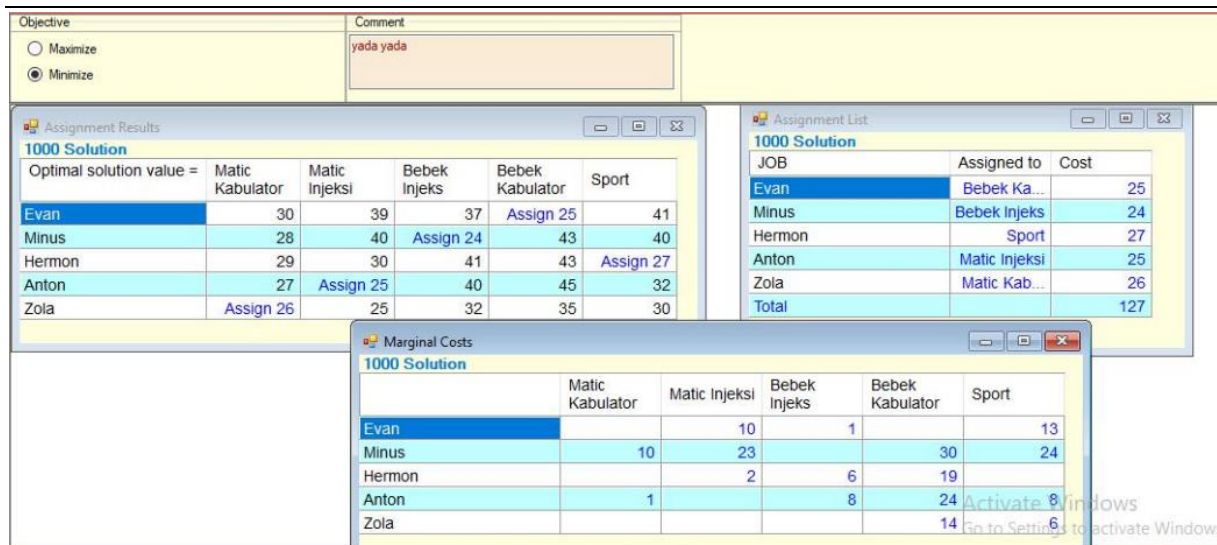


Figure 4. Display Display column RHS (Right Hand Side)

In Figure 4, based on data processing in the Hungarian method, assignments have been obtained according to the work, so the total time is 127 minutes.

### DISCUSSIONS

After applying the Hungarian method and testing the QM software, the average time for each group of mechanics to complete each type of motor assigned was 126 minutes, the mechanical group only needed the Matic Kaburator motor time, 26 minutes, for the Matic Injection motor type, 25 minutes, for the Duck Injection motorcycle, 24 minutes, for the Duck Kaburator motorcycle type it is 25 minutes and for the sport motorbike type it is only 27 minutes. when compared with the previous calculation without using the Hungarian method by issuing an average service time of 160 minutes. Based on the application of the Hungarian method, it is effective in determining an assignment and placement of workers so that they can work more effectively on a better and optimal service process. After getting the mechanical assignment grouping using the Hungarian Method in servicing the TIRE PALACE, it can be assumed that the possibilities that occur are:

- First possibility analysis If the number of the same type of motor comes to perform periodic minor servicing more than the number of mechanics that have been assigned then another mechanic can be assigned
- Second probability analysis If the number of the same type of motor comes to perform periodic light servicing more than the number of mechanics that have been assigned and the mechanic assigned based on the first probability analysis is also working on the same type of motor then another mechanic is assigned.

### CONCLUSION

Based on the results of the discussion, it can be concluded that the assignment of optimal results by the mechanic assigned to service the motorbike, namely mechanic Evan servicing the Duck Kaburator motorbike with a service time of 25 minutes, mechanic Minus servicing the Duck Injection motorbike with a service time of 24 minutes, mechanic Hermon servicing the Sport motorbike with service time of 27 minutes, mechanic Anton servicing the Matic Injection motorcycle with a service time of 25 minutes, mechanic Zola servicing the Matic Kaburator motorcycle with a service time of 26 minutes. After analyzing the possibilities, it can be concluded that all mechanics can service each type of motor if the assigned mechanic has worked on the specified type of motor. By minimizing mechanical service time, it will have an impact on Tire Zone revenue because the number of motorbikes being serviced is increasing. Total Tire Zone revenue can be increased from pre-implementation revenue using the Hungarian Method.

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