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# Optimal Utilization for the Technicians in Automotive Service Station Using the Assignment Technique

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**Abstract** Customer satisfaction is one of the most important factors that determine the success of any automotive service station. Yet gaining customer satisfaction is directly related to the repair time, as repair time is considered one of the parameters that has a direct effect on customer satisfaction. Therefore, this research will focus on reducing the repair time for automotive service stations by scheduling the repair job orders then assigning tasks to the technicians. The proposed model, after making some modifications to the general assignment model to become suitable for solving the assigned problem of technicians' repair job orders, is used to minimize the total repair time in the automotive service station. The results show that using this technique is a powerful tool to minimize the repair time which leads to not only gaining customer satisfaction but also increasing the total income for the automotive service station.

**Keywords** Assignment**,** Schedule Time, Optimal Utilization, Optimization, Repair Time

## Introduction

No one can deny that the operations research science plays an important role in finding the optimal or efficient solutions for practical problems in our life. There are many researchers that proposed solutions for many practical problems by using the operations research techniques such as Khalil [1-2] who suggested a solution to save the fuel consumption for a public transport company and Khalil *et al* [3] who offered a solution for reducing the noise of the traffic in some places by using the operations research technique. Therefore, most of researchers use the operations research science in solving many practical problems in different fields. On the other hand, there are many fields of application that show the potentials of researchers in the field of scientific research to solve the problem of scheduling time. For example, Chaudhry [4] carried out a research about minimizing flow time for the worker assignment problem in identical parallel machine models, using Genetic Algorithm (GA). This article suggested an approach to genetic algorithms to minimize the cumulative flow time of a set of tasks for equivalent parallel machines and system assignment for the worker. For another example, Zhang *et al* [5] conducted an experimental research on the implementation of Ant Colony Optimization technique for job shop scheduling problem (JSSP), using Ant Colony System (ACS) to optimize the JSSP. The numerical experiments of ACS were implemented in a small JSSP and the performance of ACS was discussed. The results showed that the ACS of the optimal ways improved the problem of job shop scheduling. In addition, Abbas *et al* [6] carried out Scheduling job shop – A case study through measured time and motion time and operation time were as total processing time, the jobs were scheduled on the basis of priority. In addition, Abbas *et al* [6] carried out a case study about Scheduling job shop in which setup time and operating time are measured through time and motion as total processing time for a variety of products with different manufacturing

processes. Different tasks are allocated to the workers on the basis of due dates, and the jobs are scheduled based on priority. Considering the calculated processing time, the times are estimated for the processing of some new jobs and an algorithm is proposed and validated for the efficient use of the available machines. Moreover, Vieira, Hans *et al* [7] presented a literature review about operations research for resource planning and -use in radiotherapy. The literature review was performed in six repositories spanning various fields, from the scientific to the technical field. From 2000 to 2015, articles included in the study were published in peer reviewed journals. Data extraction covered the research topic, the OR methods used in the analysis, the degree of implementation according to a six-stage model and the (potential) effect of the findings in practice. Of the 33 papers included in the study, 18 discussed patient scheduling issues (including 12 focused on scheduling patients on linear accelerators), 8 centered on strategic decision making, 5 focused on resource capacity planning and 2 focused on patient prioritization.
Also, Po-Chieng Hu [8] carried out further study of minimizing total flow time for the worker assignment scheduling problem in the identical parallel-machine models. It was used to schedule a sub-task and a shorter processing time. The performance was measured to reach conclusions by using different values of w (number of workers) that results showed its efficiency to minimize the total flow time. Currently, we find that there is a problem in scheduling technicians in automotive service stations that leads to many delays of automotive inside the station, causing customer dissatisfaction. Therefore, this paper suggests a proposed model to technicians scheduling for minimizing the repair time of cars inside the station, to increase the customer satisfaction and the total income of the station, through maximizing the utilization of technicians.

## 2. Methodology

There are several models to represent the assignment problem (AP) according to their applications. Some examples of these models will then be displayed and the general state of the assignment problem will also be presented in this research to use it.

### 2.1. The Classic Assignment Model (CAM)

The assignment model (AM) is considered as a linear programming branch, it usually means: n jobs require n people, one person for one job, supposing the time to complete a functional person $j$ is $c_{ij}$. The question is how to customize for reducing the whole time to complete $n$ jobs.

**Mathematical Model of CAM:**

$$\left.\begin{aligned} & Min\ z = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}\, x_{ij} \\ & \text{Subject to:} \\ & \sum_{i=1}^{n} x_{ij} = 1 \qquad j = 1,2,..,n \\ & \sum_{j=1}^{n} x_{ij} = 1 \qquad i = 1,2,\dots,n \\ & x_{ij} = 0\ or\ 1 \end{aligned}\right\} \quad (1)$$

Where $x_{ij}$ =1 if the machine $i$ is assigned to job $j$, 0 if not, and $c_{ij}$ is the cost of assigning machine $i$ to job $j$. The first set constraint ensures that each job is assigned to only a machine and the second set constraint ensures that each machine is assigned to a job.

### 2.2 The General Assignment Model (GAM)

The most of the classical assignment model (CAM)that allows a machine to be assigned to multiple jobs is the generalized assignment model (GAM). The assumption in this model (GAM) is, as in the CAM, but each job will be assigned to one machine. It allows for the possibility that a machine may be assigned more than one job, while recognizing how much of a machine capacity to do those jobs each one. Thus the GAM is an example of a one-to-many assignment models that recognizes capacity limits. Recognizing that a job may use only part of a machine capacity (GAM) rather than all of it as in (CAM), leads to the following model

$$\min \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij}\, x_{ij}$$

Subject to

$$\sum_{i=1}^{m} x_{ij} = 1 \qquad j = 1,2, \dots n$$

$$\sum_{j=1}^{n} a_{ij} x_{ij} = b_i \qquad i = 1,2, \dots, m \qquad (2)$$

$$x_{ij} = 0 \text{ or } 1$$

Where $x_{ij}$ =1 if the machine $i$ is assigned to job $j$, 0 if not, and $c_{ij}$ is the cost of assigning machine $i$ to job $j$.$a_{ij}$ is the amount of machine $i$'s capacity used if that machine is assigned to job $j$, and $b_i$ is the available capacity of machine $i$. The first constraint ensures that each job is assigned to only a machine and the second constraint ensures that the set of jobs assigned to a machine do not exceed its capacity.

### 2.3 The Proposed Mathematical Assignment Model (PMAM)

According to the model proposed in this paper which is shown in Fig 1., the objective of the paper is to reduce the repair time of the automotive in service stations in order to maximize the utilization of working time, and improve the productivity and efficiency of labors and as a result increase the level of customer satisfaction. The customer satisfaction will be reflected in the increase of the service station income.

$$Min \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{l} t_{jk}^{i}\, x_{jk}^{i}$$

Subject to

$$\sum_{j=1}^{m} x_{jk}^{l} = 1 \qquad i = 1,2, \dots, n \;\&\; k = 1,2, \dots, l \qquad (3)$$

$$\sum_{i=1}^{n} \sum_{k=1}^{l} t_{jk}^{i}\, x_{jk}^{i} \le T_j\, j = 1,2, \dots, m$$

$$x_{jk}^{i} = 0 \text{ or } 1$$

Where $x_{jk}^{i}$ = 1if the labor $j$ is assigned to job $k$ for vehicle i

$t_{jk}^{i}$ is the time of assigning labor $j$ to job $k$ for vehicle i

$T_j$ is the available time of labor $j$'s

The first set constraints ensure that the any job must be finished by only one labor. The second set constraints ensure that any labor can perform more than one job without exceeding the available time for him. Where $x_{jk}^{i}$ =1 if the vehicle i is assigned to technician j for job k, 0 if not,

| labor | jobs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | . | . | $l$ |
| 1 | $t_{11}^{m}$ | $t_{12}^{m}$ | $t_{13}^{m}$ | . | . | $t_{1l}^{m}$ |
| 2 | $t_{21}^{m}$ | $t_{22}^{m}$ | $t_{23}^{m}$ | . | . | $t_{2l}^{m}$ |
| . | . | . | . | . | . | . |

| labor | jobs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | . | . | $l$ |
| 1 | $t_{11}^{2}$ | $t_{12}^{2}$ | $t_{13}^{2}$ | . | . | $t_{1l}^{2}$ |
| 2 | $t_{21}^{2}$ | $t_{22}^{2}$ | $t_{23}^{2}$ | . | . | $t_{2l}^{2}$ |
| . | . | . | . | . | . | . |

| labor | jobs | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | . | . | $l$ |
| 1 | $t_{11}^{1}$ | $t_{12}^{1}$ | $t_{13}^{1}$ | . | . | $t_{1l}^{1}$ |
| 2 | $t_{21}^{1}$ | $t_{22}^{1}$ | $t_{23}^{1}$ | . | . | $t_{2l}^{1}$ |
| . | . | . | . | . | . | . |

*Figure 1: Time table for labors according to the required job for each vehicle*

By simplifying the proposal mathematical model shown in equation (3) to save many constraints by collection all required jobs in any vehicle in one constraint in each vehicle. Then the proposal Mathematical model will become as the following

$$\left.\begin{aligned} & Min \sum_{i=1}^{n}\sum_{j=1}^{m} t_{ij}\, x_{ij} \\ & \text{Subject to} \\ & \sum_{j=1}^{m} \mathrm{x_{ij}} = 1 \qquad i = 1,2,\dots,n \\ & \sum_{i=1}^{n} t_{ij}\, \mathrm{x_{ij}} \le T_j\, j = 1,2,\dots,m \\ & \mathrm{x_{ij}} = 0 \text{ or } 1 \end{aligned}\right\} \quad (4)$$

Where: $x_{ij} = 1$if the vehicle$i$ is assigned to technician $j$

$t_{ij}$ is the time of assigning to vehicle $i$ for technician $j$.

$T_j$ is the available time of technician $j$'s

The first set constraints ensure that the any required jobs for any vehicle must be finished by one technician only. The second set constraints ensure that any technician can perform for more than a vehicle where do not exceed available time for him. $x_{ij}$ =1 if the vehicle $i$ is assigned to technician $j$, 0 if not.

## 3. Application

The proposed simplify mathematical model will be applied to one of the automotive service stations to study its Usefulness in term of reducing the repair time in the service centers. The selected automotive service station in this paper is working by booking system so that no vehicle is accepted without pre-booking. This means that the service station knows in advance the required size for the man-hour on the next day. Therefore, this option has been used to schedule the required work to be carried out to maximize the service station efficiency by distributing the vehicles between technicians according to their efficiency in the required jobs per each vehicle. So the distribution will be according to the required repair time for each technician.

### 4. Collected Data

In this paper, we will take part of the data to check the efficiency of the proposed model. So, we will choose data about one type of vehicles that will enter the service station in the next day and it can generalized after that. The day will be randomly selected and the data will be collected as the following/as shown. Table 1 represents the operations time for each technician as the selected operation form the booking list can be summarized to 11 operations required in this day for vehicles. The number of technicians are 8 technicians and their distribution is illustrated in Table 2 with total repair time 3125 min for all technicians.

Table 3 reflects the required operations for each vehicle where the number of vehicles is 19 vehicles. From Table 4 to Table 11, these tables represent the time required to complete the required work for each technician. Table 12 represents the names of the selected operations for the vehicles through this day, and Table 13 shows the workshop capacity in the selected day.

**Table 1:** Operations Time for Different Technicians by (minutes)

| Operation / Tech | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 100 | 75 | 85 | 120 | 110 | 175 | 125 | 115 | 95 | 110 | 120 |
| B | 90 | 65 | 90 | 140 | 120 | 140 | 130 | 110 | 90 | 110 | 130 |
| C | 85 | 80 | 90 | 150 | 125 | 130 | 145 | 100 | 90 | 105 | 125 |
| D | 90 | 75 | 85 | 125 | 115 | 150 | 155 | 125 | 85 | 120 | 135 |
| E | 90 | 60 | 90 | 130 | 110 | 130 | 145 | 100 | 95 | 95 | 125 |
| F | 95 | 65 | 85 | 120 | 125 | 140 | 130 | 110 | 95 | 100 | 120 |
| G | 90 | 65 | 90 | 140 | 120 | 140 | 130 | 110 | 90 | 110 | 130 |
| H | 95 | 65 | 85 | 120 | 125 | 140 | 130 | 110 | 95 | 100 | 120 |

**Table 2:** The Required Operations for the Existence vehicles in the Service Station in This Day

| Operation / Vehicle | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | x | x | |
| 2 | | | x | | | | | | | | x |
| 3 | | | | | x | x | | | | | |
| 4 | | | x | | | | | | | x | |
| 5 | | x | x | | | | | | | | |
| 6 | x | | | | x | | | | | | |
| 7 | | | | | | | x | | | | |
| 8 | | | | | x | | | | | | |
| 9 | | x | | | | | | x | | | |
| 10 | | | | | | | x | | | | |
| 11 | | | | x | | | | | | | |
| 12 | | | | | x | | | | | | |
| 13 | x | | | | | | | | x | | |
| 14 | | | x | | | | | | | | |
| 15 | | | | x | | | | | | | |
| 16 | | | | | | | x | | | | |
| 17 | | x | | | | | | x | | | |
| 18 | | | x | | | | | | x | | |
| 19 | | | | | | x | | | | | |

**Table 3:** The Actual Distributions for technicians on the vehicles

| Vehicle / Tech. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | x | x | | | | | | | | | | | | | | | | | |
| B | | | x | x | | | | | | | | | | | | | | | |
| C | | | | | x | x | | | | | | | | | | | | | |
| D | | | | | | | x | x | x | | | | | | | | | | |
| E | | | | | | | | | | x | x | x | | | | | | | |
| F | | | | | | | | | | | | | x | x | x | | | | |
| G | | | | | | | | | | | | | | | | x | x | | |
| H | | | | | | | | | | | | | | | | | | x | x |

**Table 4:** The needed time for complete the required works for Technician No. 1

| Operation / Vehicle | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total operation time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 95 | 110 | | 205 |
| 2 | | | 85 | | | | | | | | 120 | 205 |
| 3 | | | | | 110 | 175 | | | | | | 285 |
| 4 | | | 85 | | | | | | | 110 | | 195 |
| 5 | | 75 | 85 | | | | | | | | | 160 |
| 6 | 100 | | | | 110 | | | | | | | 210 |
| 7 | | | | | | | 175 | | | | | 175 |
| 8 | | | | | 110 | | | | | | | 110 |
| 9 | | 75 | | | | | | 115 | | | | 190 |
| 10 | | | | | | | 175 | | | | | 175 |
| 11 | | | | 120 | | | | | | | | 120 |
| 12 | | | | | 110 | | | | | | | 110 |
| 13 | 100 | | | | | | | | 95 | | | 195 |
| 14 | | | 85 | | | | | | | | | 85 |
| 15 | | | | 120 | | | | | | | | 120 |
| 16 | | | | | | | 175 | | | | | 175 |
| 17 | | 75 | | | | | | 115 | | | | 190 |
| 18 | | | 85 | | | | | | 95 | | | 180 |
| 19 | | | | | | 175 | | | | | | 175 |

**Table 5:** The needed time for complete the required works for Technician No. 2

| Operation / Vehicle | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total operation time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 90 | 110 | | 200 |
| 2 | | | 90 | | | | | | | | 130 | 220 |
| 3 | | | | | 120 | 140 | | | | | | 260 |
| 4 | | | 90 | | | | | | | 110 | | 200 |
| 5 | | 65 | 90 | | | | | | | | | 155 |
| 6 | 90 | | | | 120 | | | | | | | 210 |
| 7 | | | | | | | 130 | | | | | 130 |
| 8 | | | | | 120 | | | | | | | 120 |
| 9 | | 65 | | | | | | 110 | | | | 175 |
| 10 | | | | | | | 130 | | | | | 130 |
| 11 | | | | 140 | | | | | | | | 140 |
| 12 | | | | | 120 | | | | | | | 120 |
| 13 | 90 | | | | | | | | 90 | | | 180 |
| 14 | | | 90 | | | | | | | | | 90 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | | | | 140 | | | | | | | | 140 |
| 16 | | | | | | | 130 | | | | | 130 |
| 17 | | 65 | | | | | | 110 | | | | 175 |
| 18 | | | 90 | | | | | | 90 | | | 180 |
| 19 | | | | | | 140 | | | | | | 140 |

**Table 6:** The needed time for complete the required works for Technician No. 3

| Operation / Vehicle | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total operation time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 90 | 105 | | 195 |
| 2 | | | 90 | | | | | | | | 125 | 215 |
| 3 | | | | | 125 | 130 | | | | | | 255 |
| 4 | | | 90 | | | | | | | 105 | | 195 |
| 5 | | 80 | 90 | | | | | | | | | 170 |
| 6 | 85 | | | | 125 | | | | | | | 210 |
| 7 | | | | | | | 145 | | | | | 145 |
| 8 | | | | | 125 | | | | | | | 125 |
| 9 | | 80 | | | | | | 100 | | | | 180 |
| 10 | | | | | | | 145 | | | | | 145 |
| 11 | | | | 150 | | | | | | | | 150 |
| 12 | | | | | 125 | | | | | | | 125 |
| 13 | 85 | | | | | | | | 90 | | | 175 |
| 14 | | | 90 | | | | | | | | | 90 |
| 15 | | | | 150 | | | | | | | | 150 |
| 16 | | | | | | | 145 | | | | | 145 |
| 17 | | 80 | | | | | | 100 | | | | 180 |
| 18 | | | 90 | | | | | | 90 | | | 180 |
| 19 | | | | | | 130 | | | | | | 130 |

**Table 7:** The needed time for complete the required works for Technician No. 4

| Operation / Vehicle | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total operation time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 85 | 120 | | 205 |
| 2 | | | 85 | | | | | | | | 135 | 220 |
| 3 | | | | | 115 | 150 | | | | | | 265 |
| 4 | | | 85 | | | | | | | 120 | | 205 |
| 5 | | 75 | 85 | | | | | | | | | 160 |
| 6 | 90 | | | | 115 | | | | | | | 205 |
| 7 | | | | | | | 155 | | | | | 155 |
| 8 | | | | | 115 | | | | | | | 115 |
| 9 | | 75 | | | | | | 125 | | | | 200 |
| 10 | | | | | | | 155 | | | | | 155 |
| 11 | | | | 125 | | | | | | | | 125 |
| 12 | | | | | 115 | | | | | | | 115 |
| 13 | 90 | | | | | | | | 85 | | | 175 |
| 14 | | | 85 | | | | | | | | | 85 |
| 15 | | | | 125 | | | | | | | | 125 |
| 16 | | | | | | | 155 | | | | | 155 |
| 17 | | 75 | | | | | | 125 | | | | 200 |
| 18 | | | 85 | | | | | | 85 | | | 170 |
| 19 | | | | | | 150 | | | | | | 150 |

**Table 8:** The needed time for complete the required works for Technician No. 5

| Vehicle \ Operation | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total operation time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 95 | 95 | | 190 |
| 2 | | | 90 | | | | | | | | 125 | 215 |
| 3 | | | | | 110 | 130 | | | | | | 240 |
| 4 | | | 90 | | | | | | | 95 | | 185 |
| 5 | | 60 | 90 | | | | | | | | | 150 |
| 6 | 90 | | | | 110 | | | | | | | 200 |
| 7 | | | | | | | 145 | | | | | 145 |
| 8 | | | | | 110 | | | | | | | 110 |
| 9 | | 60 | | | | | | 100 | | | | 160 |
| 10 | | | | | | | 145 | | | | | 145 |
| 11 | | | | 130 | | | | | | | | 130 |
| 12 | | | | | 110 | | | | | | | 110 |
| 13 | 90 | | | | | | | | 95 | | | 185 |
| 14 | | | 90 | | | | | | | | | 90 |
| 15 | | | | 130 | | | | | | | | 130 |
| 16 | | | | | | | 145 | | | | | 145 |
| 17 | | 60 | | | | | | 100 | | | | 160 |
| 18 | | | 90 | | | | | | 95 | | | 185 |
| 19 | | | | | | 130 | | | | | | 130 |

**Table 9:** The needed time for complete the required worksfor Technician No. 6

| Vehicle \ Operation | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total operation time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 95 | 100 | | 195 |
| 2 | | | 85 | | | | | | | | 120 | 205 |
| 3 | | | | | 125 | 140 | | | | | | 265 |
| 4 | | | 85 | | | | | | | 100 | | 185 |
| 5 | | 65 | 85 | | | | | | | | | 150 |
| 6 | 95 | | | | 125 | | | | | | | 220 |
| 7 | | | | | | | 130 | | | | | 130 |
| 8 | | | | | 125 | | | | | | | 125 |
| 9 | | 65 | | | | | | 110 | | | | 175 |
| 10 | | | | | | | 130 | | | | | 130 |
| 11 | | | | 120 | | | | | | | | 120 |
| 12 | | | | | 125 | | | | | | | 125 |
| 13 | 95 | | | | | | | | 95 | | | 190 |
| 14 | | | 85 | | | | | | | | | 85 |
| 15 | | | | 120 | | | | | | | | 120 |
| 16 | | | | | | | 130 | | | | | 130 |
| 17 | | 65 | | | | | | 110 | | | | 175 |
| 18 | | | 85 | | | | | | | 95 | | 180 |
| 19 | | | | | | 140 | | | | | | 140 |

**Table 10:** The needed time for complete the required works for Technician No. 7

| Vehicle \ Operation | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total operation time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 90 | 110 | | 200 |
| 2 | | | 90 | | | | | | | | 130 | 220 |
| 3 | | | | | 120 | 140 | | | | | | 260 |
| 4 | | | 90 | | | | | | | 110 | | 200 |
| 5 | | 65 | 90 | | | | | | | | | 155 |
| 6 | 90 | | | | 120 | | | | | | | 210 |
| 7 | | | | | | | 130 | | | | | 130 |
| 8 | | | | | 120 | | | | | | | 120 |
| 9 | | 65 | | | | | | 110 | | | | 175 |
| 10 | | | | | | | 130 | | | | | 130 |
| 11 | | | | 140 | | | | | | | | 140 |
| 12 | | | | | 120 | | | | | | | 120 |
| 13 | 90 | | | | | | | | 90 | | | 180 |
| 14 | | | 90 | | | | | | | | | 90 |
| 15 | | | | 140 | | | | | | | | 140 |
| 16 | | | | | | | 130 | | | | | 130 |
| 17 | | 65 | | | | | | 110 | | | | 175 |
| 18 | | | 90 | | | | | | 90 | | | 180 |
| 19 | | | | | | 140 | | | | | | 140 |

**Table 11:** The needed time for complete the required works for Technician No. 8

| Vehicle \ Operation | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total operation time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 95 | 100 | | 195 |
| 2 | | | 85 | | | | | | | | 120 | 205 |
| 3 | | | | | 125 | 140 | | | | | | 265 |
| 4 | | | 85 | | | | | | | 100 | | 185 |
| 5 | | 65 | 85 | | | | | | | | | 150 |
| 6 | 95 | | | | 125 | | | | | | | 220 |
| 7 | | | | | | | 130 | | | | | 130 |
| 8 | | | | | 125 | | | | | | | 125 |
| 9 | | 65 | | | | | | 110 | | | | 175 |
| 10 | | | | | | | 130 | | | | | 130 |
| 11 | | | | 120 | | | | | | | | 120 |
| 12 | | | | | 125 | | | | | | | 125 |
| 13 | 95 | | | | | | | | 95 | | | 190 |
| 14 | | | 85 | | | | | | | | | 85 |
| 15 | | | | 120 | | | | | | | | 120 |
| 16 | | | | | | | 130 | | | | | 130 |
| 17 | | 65 | | | | | | 110 | | | | 175 |
| 18 | | | 85 | | | | | | | 95 | | 180 |
| 19 | | | | | | 140 | | | | | | 140 |

**Table 12:** Names of the selected operations

| Oper. No. | Operation Description |
|---|---|
| 1 | Alternator belt replace |
| 2 | Front brake pads R & I |
| 3 | Rear brake pads R &I |
| 4 | clutch removed+ reinstalled |
| 5 | complete service |
| 6 | coolant pump R & I |
| 7 | Power steering replace |
| 8 | Front disc brake replace |
| 9 | Normal service |
| 10 | Front damper R & I |
| 11 | Rear damper R & I |

**Table 13:** Workshop Capacity

| | |
|---|---|
| m | 19 automotive |
| n | 8 Technicians |
| l | 11 operations |

$$Min \sum_{i=1}^{19} \sum_{j=1}^{8} t_{ij} x_{ij}$$

Subject to

$$\sum_{j=1}^{8} \mathrm{x_{ij}} = 1 \qquad i = 1,2, \ldots ,19$$

$$\sum_{i=1}^{19} t_{ij} \mathrm{x_{ij}} \leq T_j j = 1,2, \ldots ,8$$

$$\mathrm{x_{ij}} = 0 \text{ or } 1 \qquad (5)$$

By using lingo software, the optimal distribution shown in Table 14, where the total repair time becomes 2925 min instead of 3125 min. that means, the total repair time reduced by 7% approximately. Form the solution of the assignment, it was found that the technician No. 7 way not distributed in the scheduling plan that means can this technician can be used him in another job in this period to improve the technician utilization and increasing the total income.

**Table 14:** Optimal distribution for technicians on the vehicles

| Vehicle<br>Tech. No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | x | | | x | x | | x | | | | | |
| 2 | | | | | | | x | | | x | | | | | | x | | | |
| 3 | | | x | | | | | | | | | | | | | | | x | |
| 4 | | | | | | x | | | | | | | x | | | | | | |
| 5 | | | | | | | | | x | | | | | | | | x | | x |
| 6 | | | | x | x | | | | | | | | | | x | | | | |
| 7 | | | | | | | | | | | | | | | | | | | |
| 8 | x | x | | | | | | | | | | | | | | | | | |

## 5. Conclusion

By using the proposed mathematical assignment model on a service station in a random day, the labor utilization is improved by 7% approximately and the optimal distribution illustrate that we can find a new time for our labors by saving the repair time by redistribution them, and this time can be used in a new jobs that reflect increasing the total income to the service station. In the final, we can say that the using the proposed modeling in service station consider as a powerful tool for maximize the labor utilization and will improve the labor efficiency also.

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