Lecture Notes in Mechanical Engineering

Muhammed Nafis Osman Zahid · Radhiyah Abd. Aziz · Ahmad Razlan Yusoff · Nafrizuan Mat Yahya · Fazilah Abdul Aziz · Mohd Yazid Abu *Editors*

# iMEC-APCOMS 2019

## Proceedings of the 4th International Manufacturing Engineering Conference and The 5th Asia Pacific Conference on Manufacturing Systems

iMEC-APCOMS 2019
A joint conference of
4th International Manufacturing Engineering Conference
5th Asia-Pacific Conference on Manufacturing Systems

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# Foreword

For the third time, the 4th International Manufacturing Engineering Conference (iMEC) 2019 is co-organized with 5th Asia-Pacific Conference on Manufacturing System (APCOMS) 2019, owned by Fakulti Teknologi Industri, Institut Teknologi Bandung (ITB), Indonesia. Starting from 2019, the collaboration has been extended to the other institutions including Universiti Teknikal Malaysia Melaka (UTEM), Malaysia and Universitas Sebelas Maret, Indonesia. This extended collaboration aims to intensify knowledge sharing and experiences between higher learning institutions in Malaysia and Republic of Indonesia.

We are immensely pleased to welcome all delegates and distinguished guests to the iMEC-APCOMS 2019, held in the heart of Putrajaya, Malaysia. The conference aims to bring the researchers, academicians, scientists, students, engineers and practitioners around the world to present their latest findings, ideas, development and applications in manufacturing engineering and other related areas. With rapid advancements in manufacturing engineering that currently gearing towards Industry 4.0, iMEC provides an excellent avenue for the community to keep pace with the changes. In 2019, the conference theme is "Intelligent Engineering & Sustainable Development" which reflects to the acceleration of knowledge and technology in global manufacturing. In addition to three keynote speeches, there are 93 papers will be presented in 13 technical sessions. The papers published in these proceedings have underwent an intense peer review from the member of Technical Review Committee. The accepted submissions were categorized based on the conference topics which related to manufacturing systems, manufacturing processes, manufacturing automation and materials.

We are honoured to collaborate with respective institutions to make this conference a grand success. A sincere thanks to all members of the Organizing Committee for their infinite contribution. Not forgetting to all sponsors—Atomic Solutions, Crest, FESTO and others—for their kind gesture and continuous support.

Further, we would like to extend our appreciation to all authors for participation and high-quality contribution to the proceedings. Last but not least, we are grateful to publisher support especially to Dr. Christoph Baumann and Ms. Megana Dinesh. We hope this book will escalate the knowledge sharing and resources in the field of manufacturing engineering.

August 2019

Muhammed Nafis Osman Zahid
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# Manufacturing Systems

# Formulation of Marketing Strategies in Expedition Services Company with SWOT and QSPM Methods

Nanang Alamsyah(✉), Arina Luthfini Lubis, and Dede Hamdi

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**Abstract.** This research was conducted to determine what strategies the company should do in increasing project load. The company engaged in export and import expedition services has problems with unstable project load, especially in export projects in the past two years. The stages of research are divided into 3 stages: (1) input stage using Internal Factor Evaluation (IFE) Matrix and External Factor Evaluation (EFE) Matrix, (2) matching stage using Internal-External (IE) Matrix, the Strategic Position and Action Evaluation (SPACE) Matrix & the Strength-Weakness-Opportunity-Threat (SWOT) Matrix, (3) decision stage using the Quantitative Strategic Planning Matrix (QSPM) Matrix. In addition, the Analytic Hierarchy Process (AHP) method is used for weighting variables at the input stage. Based on the input stage, there are 8 key questions external factors and 12 key questions internal factors. From IE & SPACE Matrix, it shows the current position of the company in a conservative profile where the strategy that must be carried out is hold and maintain. The results of the SWOT matrix analysis are alternative strategies that are raised based on the comparison between S-O, S-T, W-O, and W-T. Then the QSPM matrix analysis will compare the value of interests between existing strategies and alternative strategies produced by the SWOT matrix. It is show that the proposed weighted strategy value of 6.27 while the existing strategic weighting is 5.56. Based on the results of the analysis, the things that must be done by the company are improving the internal relations, expanding marketing network, and adjusting prices.

**Keywords:** Strategic management · Strategy formulation · Expedition services company

## 1 Introduction

One of the processes in manufacturing is the distribution of goods through the supply chain. An expedition company in 2020 the vision, mission and goals for the future were first announced in the 2015 strategy and recently focused and re-emphasized in "Strategy 2020: Focus, Connect, Grow." A strategy that is simple but not mediocre. Built on three pillars of Focus, Connect, and Develop, this strategy sets out a clear plan for the coming years with ambitious but achievable goals. It is a global logistics


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company with a position that right in the developing world market. The company remains focused on the logistics sector as the core of our business while continuing to contribute to a better world, which we call "Undergoing Responsibility." But based on the data and information the authors receive has a lack of stability in marketing, especially in the export section that is not stuck, the following are Project-Load data for 2 years, namely 2016 and 2017 (Table 1 and Fig. 1).

**Table 1.** Project load

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 36 | 28 | 36 | 33 | 28 | 23 | 13 | 24 | 19 | 30 | 22 | 12 | 25.33 |
| 2017 | 13 | 10 | 12 | 20 | 18 | 17 | 13 | 28 | 8 | 18 | 34 | 16 | 17.25 |

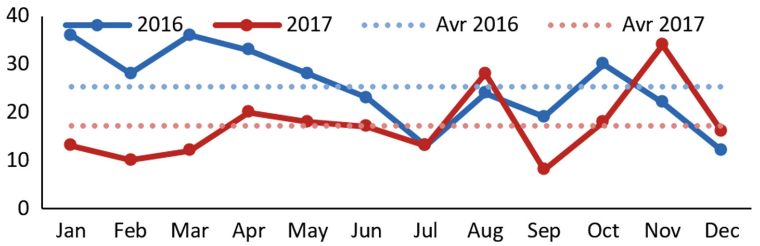


**Fig. 1.** Project-load fluctuation

Therefore, we need to know how to determine a good strategy for the company to stabilize and improve the company's project load, is to make observations on the internal and external parties of the company. Then do data processing with the SWOT and QSPM methods.

## 2 Research Methodology

The stages of research that have been carried out begin with the identification of problems through observation. Then proceed with identifying internal and external factors that affect the company through interviews with the head of the company's branch. Factors, both internal and external, that have been identified are given scores based on questionnaires that have been filled by customers and branch heads and given weights using the calculation of Analytical Hierarchy Process (AHP) [2]. With these scores and weights, we can create an IFE & EFE matrix, so that we can find out the scores of Strength (S), Weakness (W), Opportunity (O), and Threat (T). The IE and SPACE matrix can inform us of the position of the company in what quadrant. Each quadrant has a different strategy recommendation. The SWOT matrix helps us in choosing strategies that are in accordance with the comparison between SO, ST, WO, and WT. The QSPM matrix serves to find out whether the strategy we are proposing is better than the existing strategy [3] (Figs. 2 and 3).

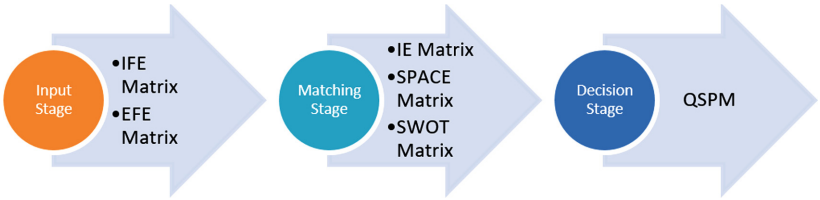


**Fig. 2.** Strategy-formulation analytical framework [1]

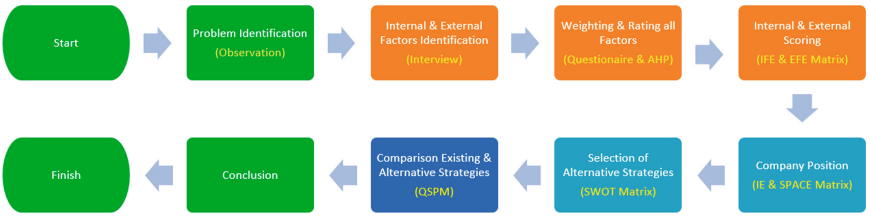


**Fig. 3.** Stages of research

## 3 Finding and Discussion

See Tables 2, 3, 4, 5, 6 and 7 and Figs. 4 and 5.

**Table 2.** Key questions internal & external factors

| No. | Item description | Forces |
|---|---|---|
| I1 | More than ever emphasize low price and value versus rivals | Marketing |
| I2 | More than ever emphasize how the product/service will make your life better | Marketing |
| I3 | Does the firm have good relations with its investors and stockholders? | Finance |
| I4 | Are the firm's financial managers experienced and will trained? | Finance |
| I5 | Is the firm's debt situation excellent? | Finance |
| I6 | Are facilities, equipment, machinery, and offices in good condition? | Operation |
| I7 | Are facilities, resources, and markets strategically located? | Operation |
| I8 | Is communication between R&D and other organizational units effective? | R&D* |
| I9 | Is there a chief information officer or director of information systems positions in the firm? | MIS** |
| I10 | Do managers from all functional areas of the firm contribute input to the information system? | MIS |
| I11 | Are strategists of the firm familiar with the information systems of rival firms? | MIS |
| I12 | Is the firm's information system continually being improved in content and user-friendliness? | MIS |
| E1 | Worker productivity levels | Economic |
| E2 | Value of dollar in world markets | Economic |
| E3 | Tax rates | Economic |
| E4 | Attitudes toward work | Social |
| E5 | Ethical concerns | Social |
| E6 | Attitudes toward product quality | Social |
| E7 | Attitudes toward customer service | Social |
| E8 | Import – Export regulations | Political |

Note: *R&D: Research and Development; **MIS: Management Information System

**Table 3.** Pairwise comparisons of IFE

| No. | I1 | I2 | I3 | I4 | I5 | I6 | I7 | I8 | I9 | I10 | I11 | I12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I1 | **1.00** | 0.20 | 0.33 | 0.25 | 0.16 | 0.50 | 0.14 | 0.33 | 0.12 | 0.20 | 0.20 | 0.25 |
| I2 | 5.00 | **1.00** | 1.66 | 1.25 | 0.83 | 2.50 | 0.71 | 1.66 | 0.62 | 1.00 | 1.00 | 1.25 |
| I3 | 3.00 | 0.60 | **1.00** | 0.75 | 0.50 | 1.50 | 0.42 | 1.00 | 0.37 | 0.60 | 0.60 | 0.75 |
| I4 | 4.00 | 0.80 | 1.33 | **1.00** | 0.66 | 2.00 | 0.57 | 1.33 | 0.50 | 0.80 | 0.80 | 1.00 |
| I5 | 6.00 | 1.20 | 2.00 | 1.50 | **1.00** | 3.00 | 0.85 | 2.00 | 0.75 | 1.20 | 1.20 | 1.50 |
| I6 | 2.00 | 0.40 | 0.66 | 0.50 | 0.33 | **1.00** | 0.28 | 0.66 | 0.25 | 0.40 | 0.40 | 0.50 |
| I7 | 7.00 | 1.40 | 2.33 | 1.75 | 1.16 | 3.50 | **1.00** | 2.33 | 0.87 | 1.40 | 1.40 | 1.75 |
| I8 | 3.00 | 0.60 | 1.00 | 0.75 | 0.50 | 1.50 | 0.42 | **1.00** | 0.37 | 0.60 | 0.60 | 0.75 |
| I9 | 8.00 | 1.60 | 2.66 | 2.00 | 1.33 | 4.00 | 1.14 | 2.66 | **1.00** | 1.60 | 1.60 | 2.00 |
| I10 | 5.00 | 1.00 | 1.66 | 1.25 | 0.83 | 2.50 | 0.71 | 1.66 | 0.62 | **1.00** | 1.00 | 1.25 |
| I11 | 5.00 | 1.00 | 1.66 | 1.25 | 0.83 | 2.50 | 0.71 | 1.66 | 0.62 | 1.00 | **1.00** | 1.25 |
| I12 | 4.00 | 0.80 | 1.33 | 1.00 | 0.66 | 2.00 | 0.57 | 1.33 | 0.50 | 0.80 | 0.80 | **1.00** |
| Sum | 53.00 | 10.60 | 17.66 | 13.25 | 8.83 | 26.50 | 7.57 | 17.66 | 6.62 | 10.60 | 10.60 | 13.25 |

**Table 4.** Pairwise comparisons of EFE

| No. | E1 | E2 | E3 | E4 | E5 | E6 | E7 | E8 |
|---|---|---|---|---|---|---|---|---|
| E1 | **1.00** | 0.20 | 0.20 | 0.20 | 3.00 | 3.00 | 0.25 | 5.00 |
| E2 | 5.00 | **1.00** | 1.00 | 1.00 | 1.67 | 1.67 | 1.25 | 1.00 |
| E3 | 5.00 | 1.00 | **1.00** | 1.00 | 1.67 | 1.67 | 1.25 | 1.00 |
| E4 | 5.00 | 1.00 | 1.00 | **1.00** | 1.67 | 1.67 | 1.25 | 1.00 |
| E5 | 0.33 | 0.60 | 0.60 | 0.60 | **1.00** | 1.00 | 0.75 | 0.60 |
| E6 | 0.33 | 0.60 | 0.60 | 0.60 | 1.00 | **1.00** | 0.75 | 0.60 |
| E7 | 4.00 | 0.80 | 0.80 | 0.80 | 1.33 | 1.33 | **1.00** | 0.80 |
| E8 | 0.20 | 1.00 | 1.00 | 1.00 | 1.67 | 1.67 | 1.25 | **1.00** |
| Sum | 20.87 | 6.20 | 6.20 | 6.20 | 13.00 | 13.00 | 7.75 | 11.00 |

**Table 5.** IFE & EFE matrix

| Key internal factors | Weight | Rating | Weighted score | Key external factors | Weight | Rating | Weighted score |
|---|---|---|---|---|---|---|---|
| Strengths | | | | Opportunities | | | |
| I1 | 0.02 | 3 | 0.06 | E1 | 0.13 | 3 | 0.41 |
| I4 | 0.09 | 3 | 0.28 | E4 | 0.15 | 3 | 0.46 |
| I6 | 0.06 | 3 | 0.17 | E6 | 0.15 | 3 | 0.46 |
| I8 | 0.08 | 3 | 0.23 | E7 | 0.15 | 3 | 0.46 |
| I10 | 0.11 | 3 | 0.34 | | | | **1.8** |
| I11 | 0.04 | 3 | 0.11 | | | | |
| | | | **1.19** | | | | |
| Weaknesses | | | | Threats | | | |
| I2 | 0.13 | 2 | 0.26 | E2 | 0.08 | 2 | 0.15 |
| I3 | 0.06 | 2 | 0.11 | E3 | 0.08 | 2 | 0.15 |
| I5 | 0.15 | 2 | 0.3 | E5 | 0.12 | 2 | 0.25 |
| I7 | 0.09 | 2 | 0.19 | E8 | 0.13 | 2 | 0.25 |
| I9 | 0.09 | 2 | 0.19 | | | | **0.8** |
| I12 | 0.08 | 2 | 0.15 | | | | |
| | | | **1.21** | | | | |
| Total | **1** | | **2.4** | Total | **1** | | **2.6** |

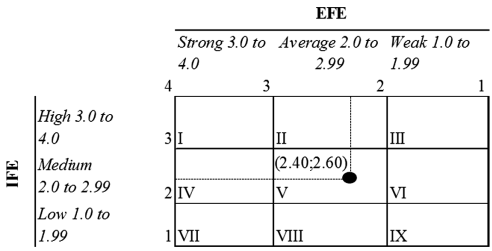


**Fig. 4.** IE matrix

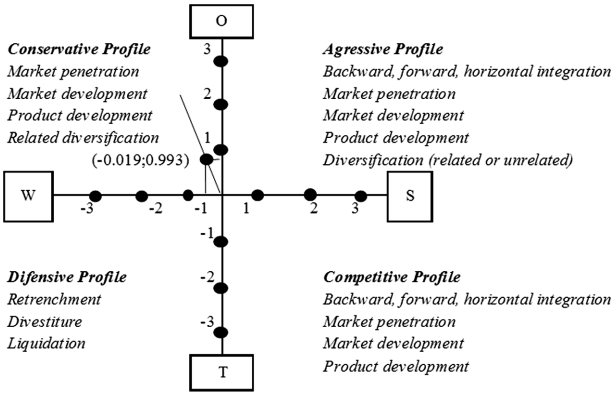


**Fig. 5.** SPACE matrix

**Table 6.** SWOT matrix

| | Strength | Weakness |
|---|---|---|
| Opportunities | **SO strategies**<br>All notifications let post and distribute to all department by system information of there (S5, O1)<br>Expand market and coming to customer for do cooperations (S3, S4, O2, O3, O4) | **WO strategies**<br>Increasing the company information systems (W5, W6, O2)<br>Repair relationships with the cooperations (W2, O2)<br>Do calculation price on the input, process, output for repair debt situation (W3, O3, O4) |
| Threats | **ST Strategies**<br>Create the ethical rule for employee toward work (S4, T3)<br>Do changed price for get more profit toward service import & export (S2, T4) | **WT Strategies**<br>Determine BEP price of service/product to minimize the loss value of dollar in world markets (W5, T1, T4) |

**Table 7.** QSPM matrix

| Key factors | Strategic alternative | | | | |
|---|---|---|---|---|---|
| | Weight | Focus | | Company repair | |
| | | Connected | | Expand market | |
| | | Evolved | | Change price | |
| | | AS | TAS | AS | TAS |
| *Opportunities* | | | | | |
| *E1* | 0.14 | 3 | 0.41 | 4 | 0.55 |
| *E4* | 0.15 | 2 | 0.31 | 4 | 0.62 |
| *E6* | 0.15 | 3 | 0.46 | 3 | 0.46 |
| *E7* | 0.15 | 3 | 0.46 | 3 | 0.46 |
| *Threats* | | | | | |
| *E2* | 0.08 | 3 | 0.23 | 4 | 0.31 |
| *E3* | 0.08 | 2 | 0.15 | 3 | 0.23 |
| *E5* | 0.12 | 3 | 0.37 | 3 | 0.37 |
| *E8* | 0.13 | 3 | 0.38 | 3 | 0.38 |
| | **1.00** | | | | |
| *Strength* | | | | | |
| I1 | 0.02 | 2 | 0.04 | 2 | 0.04 |
| I4 | 0.09 | 4 | 0.38 | 4 | 0.38 |
| I6 | 0.06 | 3 | 0.17 | 3 | 0.17 |
| I8 | 0.08 | 2 | 0.15 | 2 | 0.15 |
| I10 | 0.11 | 2 | 0.23 | 2 | 0.23 |
| I11 | 0.04 | 2 | 0.08 | 1 | 0.04 |
| *Weakness* | | | | | |
| I2 | 0.13 | 3 | 0.40 | 3 | 0.40 |
| I3 | 0.06 | 3 | 0.17 | 3 | 0.17 |
| I5 | 0.15 | 2 | 0.30 | 3 | 0.45 |
| I7 | 0.09 | 3 | 0.28 | 3 | 0.28 |
| I9 | 0.09 | 4 | 0.38 | 4 | 0.38 |
| I12 | 0.08 | 3 | 0.23 | 3 | 0.23 |
| *Total* | **1.00** | **55** | **5.56** | **60** | **6.27** |

## 4 Conclusion

Based on the input stage, there are 8 key questions external factors and 12 key questions internal factors. From IE & SPACE Matrix, it shows the current position of the company in a conservative profile where the strategy that must be carried out is hold and maintain. The results of the SWOT matrix analysis are alternative strategies that are raised based on the comparison between S-O, S-T, W-O, and W-T. Then the QSPM matrix analysis will compare the value of interests between existing strategies and alternative strategies produced by the SWOT matrix. It is show that the proposed weighted strategy value of 6.27 while the existing strategic weighting is 5.56. Based on

the results of the analysis, the things that must be done by the company are improving the internal relations, expanding marketing network, and adjusting prices.

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# Optimization of CNG Multi-depot Distribution to Determine Model Routes and GTM Totals Using Tabu Search and Differential Evolution Methods

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**Abstract.** Fuel Gas Filling Station Sadikun Bekasi and Fuel Gas Filling Station Sadikun Sukabumi multi-depots have 30 consumers of distribution area such as Bogor, Tangerang, and Cilegon. They distribute Compressed Natural Gas (CNG) to industrial consumers by using a trailer-based Gas Transport Module (GTM). The CNG purchase agreement between the provider of CNG to consumers who will fulfill the request per day without time limitation (time windows) and the distribution frequency set by the company. To optimize the distribution of CNG in this research is conducted using Tabu Search (TS) and the Different Evolution (DE) Methods. Meanwhile, TS Method has reducing total distribution costs as Rp 45.294.844, the reducing of mileage distribution as 1532, 3 km, and the route of distribution is reduced. Starting from 17-trips to 6-trips as the offer route of distribution using 6 GTM. It affects increasing the utility value of GTM as 22.70%. DE Method has reduced total distribution costs as Rp 36.571.190, the reducing of mileage distribution as 1.441,7 km, and the route of distribution is reduced. Starting from 17-trips to 8-trips as the offer route of distribution using 8 GTM. It affects increasing the utility value of GTM as 29.95%. This study shows that Tabu Search (TS) Method is more reliable.

**Keywords:** Compressed Natural Gas · Tabu Search · Differential Evolution

## 1 Introduction

Today, the largest contribution of gas utilization is industrial sector reached 44% of totals and will increase in 2050 to 69%. In the industrial sector, natural gas is not only consumed to fuel, but also as raw material. By 2050, the power generation sector, commercial, and transportation of each section of gas utilization are 26%, 13% and 1%. At the same time, the part of household sector is below 1% [1]. To satisfy the demand of industrial gas needs which to increase annually, then the perpetrators of the natural gas business needs to expand the infrastructure of pipelines, increase the optimization value of the production process and supply chain from upstream to downstream in order to the availability of gas supply awake in various regions, price stability, and timeliness of the distribution of precision so that the cycle of industrial production in Indonesia continues to perform well.


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The study focuses on multi-depot of Fuel Gas Filling Station Sadikun Bekasi and Sukabumi which are 30 consumer distribution areas such as Bogor, Tangerang, and Cilegon. The distribution of Compressed Natural Gas (CNG) to industrial consumers uses a trailer-based Gas Transport Module (GTM) that is specifically used for the transport of gas. The Gas Sales Purchase Agreement between the CNG provider to consumers who will perform the request of CNG per day without a time limit (time windows) and the distribution frequency set by the company depot. The Problem in research is related to quantity different in each point, charge, the limited capacity of fleet limited fleet, the distance, those who to traffic congestion. The distribution still uses the one-on-one. To minimize the total cost of distribution made the determination of the route and the number of the distribution of CNG optimal industry to reduce fixed cost and variable cost are conducted by using Tabu Search (TS) and the Different Evolution (DE) algorithm of The Vehicle Routing Problem with Times Window (VRPTW).

## 2 Literature Review

### 2.1 Tabu Search (TS)

Tabu Search is a method that is incorporated in a class called meta-heuristics. TS method has proven successful in solving problems related to the combinatorial optimization problems. The basis of TS meta-heuristic is to use aggressive strategies escort to cut local search procedure to carry out exploration in the solution set in order to avoid being stuck in local optima. When local optima encountered, an aggressive strategy to move to the best solution in every neighbor even if it resulted in a decrease in the value of interest.

### 2.2 Different Evolution (DE)

Differential Evolution algorithm is not much different from other Evolutionary algorithms. DE uses vectors that represent all of candidate solutions which its search technique performed simultaneously on a number of solutions called the population. Initial population (zero generation) is formed by generating a random number, while the next population is the result of the evolution of vectors that have been through the stages of reproduction, mutation, recombination and selection. Each individual is defined as a D-dimensional vector in which the vectors are denoted as $x_{i.g}$ which is a member of the population in g-generation. Population denoted as Px comprising the vectors are Np dimension where Np is the population size.

### 2.3 The Vehicle Routing Problem with Times Window (VRPTW)

VRP with time windows (VRPTW) is the development of CVRP which has a capacity constraint applied and each i-consumer associated with interval $[a_i, b_i]$ called time window. The instant time when the vehicle leaves the depot, travel time TIJ, for each

notation (i, j) € A (or te notation for e € E) and the addition of the service time for each i-consumer have been determined [2].

Service to customers should be initiated which is associated in the time window and the vehicle must stop at customer locations are for the time instant. Sometimes, in the case of an earlier arrival at the location of the i-consumer, vehicles are generally allowed to wait until the instant time $a_i$, i.e. until the service begins.

## 3 Research Methodology

The data used in the research is the historical data in 2015 regarding the distribution of CNG from CNG provider company depot to various consumer depots which have a demand regardless of time of delivery (time windows). Here is a secondary data that is required in this study.

(a) Fleet data used
(b) Data of distribution costs (fixed cost and variable cost)
(c) The number of CNG by consumer demand
(d) Data of mileage of the vehicle from the depot to the consumer
(e) Data of matrix consumer depot locations

Overall the data processed by designing mathematical models and algorithms VRPTW translated into programming language Matlab R2015b (ver.7.9.0) by entering the objective function and constraints are predetermined.

**Constraint**

Q = The number of transported for customers *j*
*j* Point = 1, 2, 3, …., 32
$d_{ij}$ = The distance from *i* to *j*
$FC_l$ = Fixed costs vehicles
$VC_l$ = Variable costs vehicles

**Variable**

$$X_{ijk} = \begin{cases} 1\ (i \text{ point connected to } j \text{ point on the day to } k) \\ 0\ \text{No} \end{cases}$$

$$Y_k = \begin{cases} \text{Vehicle used} \\ 0\ \text{No} \end{cases}$$