Original Research

Development of Make or Buy Decision on Polyethylene Terephthalate Preform Plastic Bottles in Addis Ababa MOHA Soft Drink Company

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Abstract
The purpose of the study is to develop a make-or-buy decision on polyethylene terephthalate (PET) preform of plastic bottles for the sake of minimizing the company expense. However, the study was focused on the summit MOHA soft drink industry PET preform purchasing price status. The study aimed to address the impact of the demand-supply gap on PET preform prices, particularly affecting companies reliant on preforms. It focused on conducting a cost analysis to assess the feasibility of replacing merchant-supplied PET preforms with in-house injection machines, along with outlining viable investment strategies for PET preform production. The study utilized cost-benefit and linear regression analyses to evaluate the economic feasibility of this approach. The findings revealed that replacing merchant-supplied PET preforms with an in-house injection machine is a highly effective strategy for reducing procurement costs. The company achieved significant annual savings of 91,705,969.30 birr through this approach. This underscores the economic advantage of producing PET preform plastic bottles internally, rather than purchasing them from external suppliers.

Keywords- PET preform, Cost-benefit, and linear regression analysis

INTRODUCTION

In the dynamic landscape of modern business operations, the strategic decision-making process of whether to make or buy products is a critical element that can significantly impact a company's competitiveness and profitability. This decision becomes even more crucial in industries such as the beverage sector, where packaging plays a pivotal role in product quality, branding, and customer perception.

Summit MOHA Soft Drink Share Company is producing Pepsi Cola, Miranda orange, 7 up, and Miranda Tonic however Polyethylene Terephthalate (PET) preforms plastic bottles are the main facility in soft drink industries. The company has invested in high expenses to obtain the PET from suppliers not only this but also it cannot be obtained in the right place and at the right time. This, reduced the company's productivity since equipment costs have been the major factor in the company's growth [1]. The main types of PET preform used in the company are the quantity of P-018 (0.5 litter preform), the quantity of P-023 (1 litter preform), and the quantity of P-022 (1.5 litter preform). Although, perform plastic bottles are manufactured from

polyethylene terephthalate to take the advantage of lightweight, ease of handling, and longer shelf life of packaged goods [2]. Furthermore, an injection machine is used to produce PET preform.

The market for PET products is expected to develop at a compound annual growth rate (CAGR) of 5.31 percent from 2017 to 2022, reaching USD 23.35 billion, according to research by [3]. From 2017 to 2022, the market is projected to increase in volume by a CAGR of 4.1 percent, reaching 552.64 billion units. PET preforms are unfinished PET bottles with variously sized necks. The evolution of carbonated soft drinks has raised time to time due to this the demand for PET bottles have increased. As a result, the demand for PET bottles in 2015 enhanced from 19,077 to 41,127 tons. While as record data shows since 2020 the required bottle for soft drink products had 85,479 tons [4]. This trend indicates that the consumption of PET bottles is strictly increased so making the PET perform using an injection machine in the company is reduces the demand and supplier gaps. The main objectives of the study are, to calculate the costs associated with establishing and running a PET factory for MOHA soft drink, to assess the feasibility of the study using economic analysis tools and to develop solution whether it is more cost-effective for the host company to produce or purchase PET preforms.

The article delves into the intricacies of the make or buys decision-making process within the context of MOHA Soft Drink Company's operations. It explores the various factors influencing this decision, such as cost considerations, quality control, supply chain dynamics, and strategic alignment with the company's core objectives. By examining the development of MOHA Soft Drink Company's approach to the make or buy decision regarding PET preform plastic bottles, this article aims to provide valuable insights and lessons for other companies facing similar strategic dilemmas.

LITERATURE REVIEW

As [5] studied the advantages of injection moulding machines over electric and hydraulic moulding machines include superior accuracy and precision, higher efficiency leading to cost-effectiveness, ability to work with a wide material variety, and lower scrap rates. However, disadvantages of injection moulding machines compared to their electric and hydraulic counterparts include the need for a high initial investment, operational complexity resulting in tooling costs, potential material waste, and environmental impact considerations.

The make or buy decision is a strategic choice that companies often face when determining whether to produce a component in-house or outsource it to external suppliers. This decision is particularly relevant in industries such as the beverage sector, where the production of PET preform plastic bottles plays a crucial role. However, make or buy decision involves evaluating the costs and benefits of producing a component in-house versus outsourcing it to external suppliers. Several factors influence this decision, including production capacity, cost considerations, quality control, and strategic alignment with the company's core competencies [6]. Recent studies have further emphasized the importance of the make or buy decision in the context of the beverage industry. For example, a study by [7] analysed the make or buys decision for PET preform plastic bottles in a beverage company and found that investing in in-house production led to significant cost savings and improved quality control.

In conclusion, the make or buy decision for PET preform plastic bottles at MOHA Soft Drink Company requires a thorough analysis of various factors, including cost, quality control, and strategic alignment. By using economic evaluation tools and considering recent research findings, the company can make a decision that enhances its efficiency and competitiveness in the market.

METHODS

The study has followed both qualitative and quantitative research methods. Qualitative information has been used to conduct engineering analysis and raw material needed while quantitative analysis was to evaluate economic analysis and overall PET perform manufacturing cost [8]. To develop PET perform plastic bottle make or buy decisions collect the company’s previous PET bottle purchase price data, injection machine costs, and forecast the future PET preform demand to know how much PET preform bottle will be needed using a linear regression model. Then, decide the right decision using a cost-benefit ratio and engineering economic analysis. Therefore, the study reduces transportation, and production cost, create job opportunity, and removes the supplier and demand gap. Finally, the aim of the study is to make a cost analysis in the replacement of merchant-supplied PET preform with injection machine on summit MOHA soft drink Company.

I. Linear regression Model

The demand for PET preform in the company is forecasted to determine the amount of PET preform consumption. However, to analyse the future PET preform using the equation as shown in Eq. (1).

$$Y = a + bX \quad (1)$$

Where Y and X are dependent and independent variables for PET preform respectively. Furthermore, a, and b are the y-intersection and slope of the regression line. Y-intercept and the slope of a regression line as shown in Eq. (2) and (3) respectively.

$$a = \frac{\sum x2 \sum y - \sum x \sum xy}{n \sum x2 - (\sum x)2} \quad (2)$$

$$b = \frac{n \sum xy - \sum x \sum y}{n \sum x2 - (\sum x)2} \quad (3)$$

II. Selection of the plant site

Right plant site selection has a significant factor for investment analysis. Thus, the chemical and physical properties of the land play an important role in the selection of location. Although, the site selection process can be investigated by the availability of land, accessibility of facilities, water, and power availability. As a result, considering the above factors selecting available free from in the company compound seemed a feasible location to produce PET preform.

MANUFACTURING COST

Detail production cost of injection machine is shown below.

I. Injection Machine Cost

PET preforms plastic bottle production using an injection machine. Chose Ningbo sonly injection machine due to production capacity, quality, and price consideration [9]. Machine manufacturing cost is shown in Table I.

TABLE I.
INJECTION MACHINE COST SPECIFICATIONS

No	Name	Specification	Production capacity	Quantity	Unit price	Total cost in ETB
1	438T injection machine	Model-HY-1280	720kg per hour	1-set	2,314,293.72	2,314,293.72
2	Perform mould	500ml, 11, 1.51 48 cavity	6092.16 kg per hour	2-set	567,657.6	1,135,315.2
	Auxiliaries	Hopper dryer	100 kg per hour	1-set	94,609.6	94,609.6
3		Vacuum hopper	50 Litres	1-set	118,262	118,262
		Water chillier	500 KW	1-set	141,914.4	141,914.4
		Total				3,813,846.37
		Total cost after tax of 17%				4,462,200.25

II. Installation and Training Cost (ITC)

Ningbo sonly machine industry will dispatch two engineers to MOHA soft drink Company for machine installation and give training. However, it requires 13 days for proper installation and training [9]. Therefore, installation and training costs as shown in Eq. (4).

$$ITC = 2 \times 3784.36 \frac{birr}{day} \times 13\ days = 98{,}393.36\ birr \quad (4)$$

III. Raw Material Cost

The machine is able to produce 17,500 PET-preform plastic bottles per hour. But, due to technical and operational problems, it works with 96% efficiency. The company worked annually 248 days. Raw material cost is shown in Eq. (5).

$$17{,}500 \times 0.96 \times 24\ hours \times 248\ days = 82{,}280{,}448\ preform\ per\ year \quad (5)$$

Therefore, the machine has the capacity of making 82,280,448 preform a year, but according to the procurement data of MOHA for the past, the 3 years forecast the next year using simple linear regression to identify the amount of raw material needed.

IV. Linear Regression

The data is a time series so the independent variable is the time period and the dependent variable is the company demand for PET preform as shown in Eq. (1). Let Y1= quantity of P-018 (0.5 litter preform),Y2= quantity of P-023 (1 litter preform), Y3= quantity of P-022 (1.5 litter preform), a1= y-axis intersection for P-018 (0.5 litter preform), a2= y-axis intersection for P-023 (1 litter preform), a3= y-axis intersection for P-022 (1.5 litter preform) b1= slope of regression line for P-018 (0.5 litter preform),b2= slope of regression line for P-023 (1 litter preform) and b3= slope of regression line for P-022 (1.5 litter preform). The linear regression PET preform demand forecast as shown in Table II.

TABLE II.
LINEAR REGRESSION VARIABLES FROM THE COMPANY DATA

X	Y1	Y2	Y3	X^2	XY1	XY2	XY3
1	30,439,584	8,862,912	5,998,258	1	30,439,584	8,862,912	5,998,258
2	27,363,168	11,306,112	2,403,648	4	54,726,336	22,612,224	4,807,296
3	48,083,532	11,906,544	8,057,952	9	144,250,596	35,719,632	24,173,856
∑X=6	∑y1=105,886,284	∑y2=32,075,568	∑y3=16,459,858	$\sum x^2$=14	∑xy1=229,416,516	∑xy1=67,194,768	∑xy1=34,979,410

Therefore, use Eq. (2), (3) for y-intercept and slope respectively.

$$a_1 = \frac{14(105886284) - 6(229416516)}{3(14) - (6)2} = 17{,}606{,}480$$

$$a_2 = \frac{14(32075768) - 6(67194768)}{3(14) - (6)2} = 7{,}648{,}224$$

$$a_3 = \frac{14(16459858) - 6(34979410)}{3(14) - (6)2} = 3{,}426{,}924.98$$

$$b_1 = \frac{3(229416516) - 6(105886284)}{3(14) - (6)2} = 8{,}844{,}474$$

$$b_2 = \frac{3(67194768) - 6(32075568)}{3(14) - (6)2} = 1{,}521{,}816$$

$$b_3 = \frac{3(34979410) - 6(16459858)}{3(14) - (6)2} = 1{,}029{,}847$$

After evaluating the y-intercept and slope find each type of PET to perform a demand forecast for the next four years using Eq. (1).

$Y1 = 17{,}606{,}480 + 8{,}844{,}474X \ \ therefore\ Y1(4) = 17{,}606{,}480 + 8{,}844{,}474 \times 4 = 52{,}984{,}376\ units$

$Y2 = 7{,}648{,}224 + 1{,}521{,}816X\ therefore\ Y2\ (4) = 7{,}648{,}224 + 1{,}521{,}816\ \times 4 = 13{,}735{,}488\ units$

$Y3 = 3{,}426{,}924.98 + 1{,}029{,}847.01X\ threfore\ Y3\ (4) = 3{,}426{,}924.98 + 1{,}029{,}847.01\ \times 4 = 7{,}546{,}313.02\ units.$

As a result, a single 0.5-liter preform requires 25 grams of PET resin [10]. Therefore, according to the forecast the company needs 52,984,376 units of a preform for 0.5-litter bottles and this consumes 1,324,609,400g of PET resin. However, a single 1-litter preform consumes 37.2 g of PET resin [11]. Therefore, it needs 13,735,488 unit preform requires 510,960,153.6g PET resin. Moreover, for 1.5 litter requires 324,491,459.86g. Finally, the total amount of PET resin needed for annual production is 2,160,061,013.46g/2,160.06T. The required raw material for the production of preforms polyethylene terephthalate resin costs around (34,059birr) 720 U.S. dollars per metric ton. The tax and price of the PET resin according to [13]. Total PET resin cost with tax is as shown in Table III.

TABLE III.
PET RESIN VALUE AND TAX

HS code	Production description	Importer name	Country of origin	Country consignment	Net weight	Value ETB	Total tax ETB
391111000	PET resin	MOHA soft drink	China	China	2,160.06T	73,569, 224	17,509,475.3
Total annual raw material cost after tax = 91,078,699.3 birr							

V. Labor Cost

The machine is fully automated due for this reason there is no need for too many workers. However, for two shifts only two are workers required to operate the machine and control the technical and operational problems. For one operator paid 4,600birrr therefore annually paid 111,400 birrs for labour.

VI. Power Consumption Cost

The machine work with a hydraulics system and electric power; due to this reason petroleum-based fluid and electricity are needed although for chilling the preform and cleaning the internal part of the machine water is required. The machine consumes 0.208 kwh/kg of electricity, 0.043m3/kg of water, and 0.0021L/kg of petroleum. Therefore, the annual power consumption cost (APCC) is;

$$APCC = \left(0.208\frac{kwh}{kg} \times 2{,}160{,}060kg \times \frac{3.2466birr}{kwh}\right) + \left(\frac{0.043m^3}{kg} \times 2{,}160{,}060kg \times \frac{6.20birr}{m^3}\right) + \left(\frac{0.0021L}{kg} \times 2{,}160{,}060kg \times \frac{24.7birr}{L}\right) = 2{,}146{,}588.2birr$$

VII. Transportation cost

A standard 20-foot container can accommodate around 28 tons which means to ship 2,160.06 tons of PET resin overseas, need about 77containers. Furthermore, shipping a full container overseas from Ningbo port to Djibouti port's current cost is

4,837dollars although to transport the machine and raw material from Djibouti port to Addis Ababa is 350birr per quintal. Therefore, the total transportation cost for raw material and injection machines is 25,446,225.331birr. As a result, the total manufacturing cost is the summation of machinery, raw material, power; installation, labour, and transportation cost to manufacture PET preform plastic bottles in the company invest 123,342,506.44birrr for total manufacturing cost.

VIII. Straight-line depreciation cost

As [14] showed that the cost of an injection machine is 4,462,200.25birr and the salvage value of the machine is 1,007,575.2 birr. The depreciation value of the injection machine is shown in Eq. (6).

$$Dt = \frac{B-S}{N} \tag{6}$$

Where Dt is the annual depreciation

N is the number of years in depreciation

B is the cost of the asset made ready for use

S is estimated salvage value after depreciation

Therefore, the annual depreciation value for every five years is calculated using Eq. (6)

$$Dt = \frac{4{,}462{,}200.25 - 1{,}007{,}575.2}{5} = 690{,}925.01\ birr$$

COST TO MAKE ANALYSIS

Total variable cost per unit = material cost + other expense$= (1.226\ birr + 0.372\ birr) \times (52{,}984{,}376\ units + 13{,}735{,}488\ units) = 118{,}677{,}350.85\ birr$. Total cost is the summation of fixed, variable, and depreciation costs as a result the value is shown below.

$$TC = 110{,}400 + 4{,}462{,}200.25 + 98{,}393.36 + 118{,}677{,}350.85 + 690{,}925.01 = 124{,}033{,}431.41\ birr$$

BUYING COST ANALYSIS

A company has an extra capacity that can be used to produce a PET preform which has been buying (p-018, p-022, and p-023) for (2.55, 3.95, and 3.70) birr per unit respectively. If the company makes the preform, it will incur raw materials cost of 1.226 birrs per unit and other expenses of cost 0.372 birrs per unit. The annual fixed cost associated with human resources, machines, and installation is 110,400, 4,462,200.25, and 98,393.36 birrs respectively. However, demand over the next year is estimated at 52,984,376units of p-018, 13,735,488 units of p-023, and 7,546,313.02 units of p-022. Therefore, the total cost to buy PET preform plastic bottles for each type is;

$$cost\ of\ buying = (2.55\ birr \times 52{,}984{,}376\ units) + (3.95\ birr \times 7{,}546{,}313\ units) + (3.70\ birr \times 13{,}735{,}488\ units) = 215{,}739{,}400.75\ birr$$

RESULTS AND DISCUSSION

The feasibility study conducted for the establishment of a PET preform plant aimed to evaluate the make or buy decision. It was found that there were no significant technical obstacles to implementing this concept. An empty room within the MOH plant was chosen as the installation site for the machinery due to the presence of necessary utilities and zero land cost. The selection of the 438T injection machine was based on its cost-effectiveness and high efficiency [15]. The analysis revealed that the production cost of PET preform bottles amounted to 124,033,431.41 birr, whereas the cost of purchasing PET preforms would have been 215,739,400.75 birr. This indicates a substantial annual cost saving of 91,705,969.30 birr by opting to produce the preforms in-house [16]. In conclusion, the decision to manufacture PET preform bottles internally has proven to be advantageous in terms of cost savings and is expected to enhance the company's efficiency and effectiveness. This strategic move not only reduces procurement costs but also offers greater control over the production process, ensuring consistent quality and timely delivery of preform bottles.

CONCLUSIONS

In conclusion, the make or buy decision regarding PET preform plastic bottles at MOHA Soft Drink Company in Addis Ababa represents a significant strategic move toward enhancing operational efficiency and cost-effectiveness. The study underscored

the importance of weighing the costs and benefits of in-house production versus outsourcing. Through a detailed cost analysis and the use of economic evaluation tools, it was determined that establishing an in-house PET preform plant would yield substantial cost savings. This decision, coupled with replacing merchant-supplied preforms with an on-site injection machine, not only reduced procurement costs but also promised a quick return on investment. The study also emphasized the significance of considering factors like production capacity, quality control, and strategic alignment. By carefully evaluating these aspects, MOHA Soft Drink Company made an informed decision aligned with its long-term strategic goals. Overall, this development is expected to positively impact the company's operations, enhancing efficiency, reducing costs, and maintaining a competitive edge in the beverage industry.

Nomenclatures

PET	Polyethylene terephthalate
ETB	Ethiopia Birr
ITC	Installation and training cost
APCC	Annual power consumption cost
Dt	Annual depreciation cost
TC	Total cost
KW	Kilowatts

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