TRIPLE BOTTOM LINE SUSTAINIBILITY ANALYSIS OF A SUPPLY CHAIN

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Abstract. Sustainability is increasingly becoming the ultimate goal of companies in the last decades. However, measuring the degree of sustainability can be difficult. John Elkington introduced an accounting framework, called the triple bottom line (TBL) which went beyond the traditional measures of profit, return on investment, and shareholder value to include environmental and social dimensions. However, the three dimensions of performance (social, environmental, and financial) do not have a common unit of measure. One way is to monetize all dimension of the TBL, including social welfare or environment damage. Another solution is to calculate the TBL in terms of an index. A critical issue is the potential metric for inclusion in a TBL calculation. In this paper we use a scoring method from 1 to 5 scale for very bad, bad, moderate, good and very good to evaluate the sustainability of the supply chain of an oil and gas company specifically delivering gasoline from drilling point through a refinery to a gas station. At each chain the appropriate metrics are identified for economic, environmental, and social performances. The scores are given by benchmarking against the overall performance of the company. It was found that the environmental performance of the supply chain is the lowest which means that the company needs to re-evaluate its waste processing practices.

Keywords: Triple Bottom line, Sustainability, Supply Chain

1. INTRODUCTION

In the last decades, the term sustainability has increasingly become one of the most important aspects of business practices all over the word. The term sustainability refers to social, environmental, and economic sustainability. Sustainable Supply Chain Management (SSCM) has the objective to help organizations achieve its economic, environment and societal goals (Das, 2015). Referring to Vachon and Mao (2008) and Seuring and Müller (2008), Das remarked that there is a positive relationship between social sustainability and supply chain strength in terms of fair wages and human rights. He found that proactive organizations who voluntarily implemented SSCM seem to have derived benefits in terms of environmental performance, operations performance and also community-centered social performance.

Yogi (2016) in reference to Hutchins and Sutherland (2008) stated that economic, social and environmental dimensions, also known as the Triple Bottom Line (TBL) approach are recognized as the three pillars of sustainability. These pillars are not only integrated with the operations of an individual company but also with the network of suppliers, producers, distributors, and customers which mainly constitute the supply chain system.

In this paper a case study was conducted on Petroliam Nasional Berhad or PETRONAS. PETRONAS was established in 1974. PETRONAS is one of the largest oil and gas corporations in the world and is placed 68 in the Fortune 500 companies. PETRONAS diversifies its core business into two streams, upstream and downstream. The upstream operations start with the extraction of crude oil and the gathering of natural gas across 23 countries in the world. In this study the upstream is focused on the Sarawak production facilities operated by PETRONAS. The downstream operation starts with the liquefaction of natural gas that will be sold to other countries and processing the natural gas for the power, residential and industrial sector. Crude oil processing starts with refining the oil into several end products such as diesel, gasoline, jet fuel and lubricants which are then distributed to the end consumer through a transportation network. This study evaluates the PSR-1 and PSR-2 refineries in Melaka which process 270,000 barrels of crude oil per day. The aim of this paper is to analyze the supply chain of PETRONAS companies by using the Triple Bottom Line approach.

2. TRIPLE BOTTOM LINE

Elkington (1997) introduced the triple bottom line concept as an accounting framework for measuring and reporting corporate performance against the three dimensions of performance which are economic, social, and environmental. This framework establishes the principles by which a company should operate focusing on the total effect of their actions. The triple bottom line approach measures the sustainability performance of the company as depicted in Figure 1. Dutta (2011) remarked that TBL report reflects a more comprehensive mechanism that integrates the traditional financial information along with non-financial information, which can help the firm in enhancing economic value addition, besides putting it on a firm financial footing. The idea behind the TBL paradigm is that a corporation’s ultimate success or health can and should be measured not just by the traditional financial bottom line, but also by its social/ethical and environmental performance (Norman and MacDonald, 2003).

2.1 ECONOMIC MEASURES

The economic variable of TBL framework refers to the impact of the organization’s business practices on the economic system (Elkington, 1997). It pertains to the capability of the economy as one of the subsystems of sustainability to survive and evolve into the future in order to support future generation (Spangenberg, 2005). It could look at income or expenditure, taxes, business climate and business diversity factors.

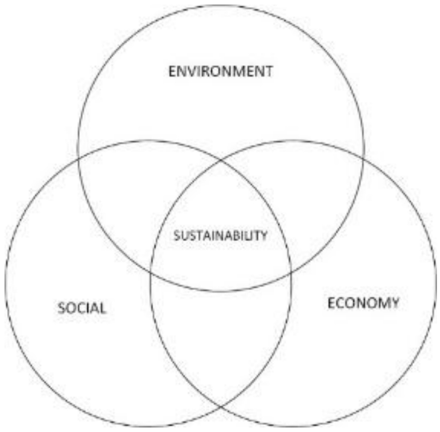

Figure 1: Diagrammatic illustration of triple bottom line.

2.2 ENVIROMENTAL MEASURES

The environment variable of TBL refers to actions that do not compromise the environmental resources of the future generation for today needs. It pertains to the efficient use of energy resources, reducing greenhouse gas emissions and minimizing the ecological footprint, etc. (Goel, 2010).

2.3 SOCIAL MEASURES

The social variable of TBL refers to conducting beneficial and fair business practices to labor, human capital, and to the community (Elkington, 1997).

3. METHODOLOGY

The study was divided into 3 sectors which are production and lifting site for oil extraction, refinery for processing, and gas station as retailer engaging directly with costumer. The performance or output of selected PETRONAS chain in each dimension is compared with the overall performance of the company. For upstream, the production and lifting facilities in Sarawak was selected, whilst for downstream, the Melaka Refineries was selected followed by petrol filling stations in Petaling Jaya. The method of assessment is explained in the following sections. To assess the petrol filling stations, Google Streetview was used to find the number of PETRONAS petrol filling stations in Petaling Jaya.

In this study, the subjective indexing method was used to score the performance from 1 to 5, as follows:

1. Very bad
2. Bad
3. Moderate
4. Good
5. Very good

4. CALCULATION AND ANALYSIS

The calculation and analysis utilized data from various sources.

4.1 ENVIRONMENTAL MEASUREMENT

The GHG Emission and energy used for production

Table 1: Environmental assessment of Petronas Sarawak – Melaka – Petaling Jaya chain

Chain	Criteria		Benchmark		Score
	Var.	Value/day	Value/day	Var.	
A	X1	5,964.2	789,397.3 (WRI, 2012)	Y1	4
	X2	6,065.8	419,381 (MEIH, n.d.)	Y2	4
B	X3	16,165.98	789,397.3 (WRI, 2012)	Y1	3
	X4	26,271.92	419,381 (MEIH, n.d.)	Y2	1
C	X5	18.92	60.794 (WRI, 2012)	Y3	2
	X6	0.2295	237,634.36 (MEIH, n.d.)	Y4	4

A = Production and Lifting,
B = Refineries,
C = Petrol Filling Station,
X1 = Greenhouse Gas Emission of production process (tCO_2e),
X2 = Energy consumption of production process (MWh),
X3 = Greenhouse Gas Emission to refine crude oil (tCO_2e),
X4 = Energy consumption to refine crude oil (MWh)
X5 = Gasoline Vaporization Emission (t),
X6 = Energy Used with respect to number of Fuel Dispenser (MWh),
Y1 = Malaysia GHG Emission for Energy Sector (tCO_2e),
Y2 = Malaysia Energy Consumption for Industry (MWh),
Y3 = Malaysia GHG Emission for Fugitive Emission Sector (tCO_2e),
Y4 = Malaysia Energy Consumption for Residential and Commercial Building (MWh)

activities in Sarawak was calculated using OPGEE v1.1. The crude oil production of PETRONAS in 2014 is 494,000 bbl (Petronas, 2015), thus the crude oil produced in Sarawak accounts for 26% of the national oil production (Bernama, 2015). This means that the crude oil production of Sarawak is 128,440 bbl. The calculated GHG Emission and energy used on oil production process is then compared with the total GHG emission of Malaysia for the energy sector and the total Malaysia energy consumption for Industry respectively. It was found that the production activities in Sarawak only contribute up to 0.75% of gas emission in Malaysia and 1.44% of energy consumption for industry in Malaysia and are considered low.

For refineries, the average GHG emission to refine 1 barrel of oil was calculated. The average of CO_2 emissions to process 1 bbl of crude oil is 132 pound (CBE, 2011). Thus, the energy needed to process 1 barrel of crude oil gained by comparing the annual energy consumption with the number of oil produced is 0.0945 MWh (ITP, 2006) and the processing gain of Malaysian refineries is 2.95% (EIA, n.d.). In this study, the result of GHG emission is compared with the total GHG emission of Malaysia for the energy sector and the result of energy consumption is compared with the total Malaysia energy consumption for Industry. It was found that crude refining activities contribute up to 2.7% of gas emission in Malaysia for energy sector and the energy consumption contributes to 6.2% of energy consumption in Malaysia for industry. This can be considered quite high for just the 2 facilities in the whole Malaysia.

For petrol filling stations, the gasoline vaporization and energy used to run the fuel dispensers are calculated. This gasoline vaporization is calculated by multiplying the number of population in Petaling Jaya which is 1,782,375 (Department of Statistic Malaysia, 2010) with the number of refined petroleum consumption per capita in Malaysia which is 3.649 liters/day (CIA, 2016) and divided by the rate of gasoline loss in petrol stations which is 0.316% (Yan, 2008). This results in vaporization of 18.92 tons/day. For energy consumption, the power needed to run the fuel dispensers was calculated. The estimated power to run each fuel dispenser is 0.75 KW based on the standard specification of a Wayne dispenser with 4 nozzles operating 3 hours a day. It was calculated that gasoline vaporization contributes to 0.031% of the total GHG emission for fugitive emission sector in Malaysia which is not good because there are lots of districts in Malaysia and if combined, it will give significant amount of gasoline vaporization. The energy calculated to run the fuel dispensers in Petaling Jaya contributes to 0.000097% of the whole energy demand for Residential and Commercial Building in Malaysia which is good because the number is quite small.

4.2 SOCIAL MEASUREMENT

The social performance measurement for production and lifting, is based on the average income in PETRONAS compared to the Growth Domestic Product Per Capita in Malaysia. The average income per person in the production and lifting section specifically the drilling engineer is 44% higher than most people in Malaysia with the growth domestic product Per Capita (GDP) of Malaysian being 42.636 Ringgit Malaysia in 2014 (World Bank, 2015). The standard package of benefit and work balance are also compared to the Malaysian regulatory of Employment act 1955. The standard specifies that the company should provide the employee with insurance, off day and good work balance (Ministry of Human Resource Malaysia, 2012). PETRONAS companies have already provided several benefits such as, insurance, vacation policy, educational and death compensation. In terms of work, it was reported that working in PETRONAS companies is quite satisfying in terms of work balance and culture. The work balance indicator includes the working hour of employee and flexibility of working.

Table 2: Social assessment of Petronas Sarawak – Melaka – Petaling Jaya chain

Chain	Criteria		Benchmark		Score
	Var.	Value/year	Value/year	Var..	
A	X7	61.416	42.636	Y5	5
	X8	P1, P2, P3	P1, P2, P3	Y6	4
B	X7	52.596	42.636	Y5	4
	X8	P1, P2, P3	P1, P2, P3	Y6	4
C	X7	12.000	42.636	Y5	2
	X8	P1, P2, P3	P1, P2, P3	Y6	3

P1 = Benefit, P2 = Compensation, P3 = Work life
A = Production and Lifting,
B = Refineries,
C = Petrol Filling Station,
X7 = Average income per person (RM),
X8 = Standard package benefit and work balance,
Y5 = Average income per people in country (RM),
Y6 = Malaysian regulatory on labor: Employment act 1955

In the refineries, the average income per person specifically the process engineer is 24% higher than the Growth Domestic Product per capita.

The average income per person working in the petrol filling stations in PETRONAS company is compared with the Growth Domestic Product Per Capita in Malaysia. It was found that the average income per person in the retailer sector or petrol station specifically the operator of the fuel dispenser, is 71% lower than of the growth domestic product Per Capita (GDP) of 42.636 Ringgit Malaysia in 2014Despite having a lower income the operator receives the standard minimum wage in Malaysia as specified by the Ministry of Human Resource (Ministry of Human Resource Malaysia, 2011). In terms of standard package of benefit and work balance, the operator is provided with adequate life insurance and Health Safety Environment protection. The minimum coverage for employee's is through the Social Security Organization (SOSCO) in accordance with employee's social security act 1969 (Attorney General Chamber of Malaysia, 2006). Although the coverage is lesser for an engineer than an operator but the work balance in downstream is quite satisfactory.

4.3 ECONOMIC MEASUREMENT

The economic aspect of production and lifting in Sarawak is based on the crude oil sales and the cost of electricity. The crude oil sales in Sarawak are calculated based on the average Dated Brent crude price in 2014 which is RM 323.73/bbl (Petronas, 2014). The crude production volume of PETRONAS in 2014 is 494,000 bbl/day (Petronas, 2015). The crude oil production in Sarawak is equal to 26% of the Malaysia crude oil production (Bernama, 2015) which means that the production of crude oil in Sarawak is 128,000 bbl. The

Table 3: Economic assessment of Petronas Sarawak – Melaka – Petaling Jaya chain

Chain	Criteria		Benchmark		Score
	Var.	Value/day	Value/day	Var.	
A	X9	41,579,881.2	159,907,800	Y7	4
	X10	2,074,503.6	143,428,302	Y8	4
B	X11	87,407,100	178,051,500	Y9	3
	X12	8,984,996	143,428,302	Y8	1
C	X13	14,950,740	400,000,000	Y10	2
	X14	103	106,697,827	Y11	4

A = Production and Lifting,
B = Refineries,
C = Petrol Filling Station,
X9 = Sales of crude oil (RM),
X10 = Electricity cost of crude production process (RM),
X11 = Sales of refined petroleum product (RM),
X12 = Electricity cost to refine crude oil (RM),
X13 = Sales of fuel product (RM),
X14 = Electricity cost to run the fuel dispenser (RM),
Y7 = Malaysia sales of crude oil (RM),
Y8 = Electricity cost of Malaysia energy consumption for energy sector
Y9 = Malaysia sales of petroleum product
Y10 = Malaysia sales of refined petroleum product
Y11 = Electricity cost of Malaysia energy consumption for residential and commercial building

maximum crude oil sales in Sarawak is RM 41,579,881.2/day which is relatively high compared to the PETRONAS maximum crude oil sales in Malaysia which is RM 159,907,800/day.

The electricity cost is calculated based on the energy used in producing oil using OPGEE v1.1 and was found to be 6,065.8 MWh/day compared to the total energy consumption of Malaysia which was 419,381 MWh/day (MEIH, n.d.). The average price of electricity for industry is RM 0.342/kwh (MEIH, 2015).

For the refineries, the economic aspect is based on the maximum sales of crude oil and petroleum product and electricity cost needed. The PETRONAS Melaka refinery complex is compared with PETRONAS total refining capacity of about 550,000 bbl/day. PETRONAS Melaka refinery complex has two refining trains which is PSR-1 and PSR-2 with different capacity process. The total capacity of PETRONAS Melaka refinery complex is 270,000 bbl/day (Petronas, 2014). The maximum crude oil and petroleum product sales are then calculated based on the average Dated Brent crude oil price in 2014 which is the PETRONAS Group's main crude oil benchmark price of USD 99/bbl or RM 323.73/bbl (Petronas, 2014). The total energy consumption in the refinery is 26,271.92 MWh. The energy needed to process 1 barrel of crude oil is calculated and compared with the annual energy consumption with the number of oil produced is 0.0945 MWh (ITP, 2006) The processing gain of Malaysian refineries is 2.95% (EIA, n.d.). This is compared with the total energy consumption of Malaysia which is 419,381 MWh/day (MEIH, n.d.).

For petrol filling stations, the sales of refined petroleum product and electricity cost is calculated. The refined petroleum product consumption per capita in Malaysia is 3.649 liters/day (CIA, 2016). To get the sales estimation of refined petroleum product in Petaling Jaya, the refined petroleum product consumption per capita with population in Petaling Jaya of 1,782,375 people (Department of Statistic Malaysia, 2010) is calculated. The average Malaysia gasoline price is RM 2.30/liter (Astro Awani, 2014) so the total sales is RM 14,950,740 and this is compared with the total Malaysia sales which is RM 400,000,000 (Petronas, 2014). The electricity cost is calculated based on the commercial price of RM 0.449/kwh (MEIH, 2015). The energy consumption in the gas stations are calculated based on the power needed to run the fuel dispenser and compared to Malaysia Energy Consumption for Residential and Commercial Building which is 237,634.36 MWh (MEIH, n.d.).

4.4 SCORING

This study found that the environmental aspect in PETRONAS obtained the lowest score compared to the other triple bottom line aspect such as economy and social. Environmental contributes the lowest score due to high greenhouse emission and energy consumption produced in the chain process.

The greenhouse emission produced in production and lifting process is relatively low compared to the Malaysia GHG Emission for Energy Sector. The Gasoline Vaporization Emission in petrol filling station chain has massive influence in the environmental scoring. Economy aspect is determined by the sales of crude oil and Petroleum product and its electricity cost needed in the process. The electricity cost in refinery process has the biggest influence because of the high cost needed. The social aspect gets a high score due to high standard package benefit and work balance offered by PETRONAS.

Table 4: Total score of triple bottom line assessment of Petronas Sarawak – Melaka – Petaling Jaya chain

Chain	Score		
	Economy	Environmental	Social
A	8	8	9
B	6	4	8
C	6	6	5
Total	20	18	22

5. CONCLUSION AND RECOMMENDATION

This study evaluates the sustainability of the supply chain of an oil and gas company from lifting, refinery until the gas station. This study found that the environmental aspect is the biggest issue. The environmental aspect must be monitored in the upcoming years. Nevertheless, the company has done well to reduce waste and emission, to achieve a sustainable supply chain the company needs to evaluate the drilling and lifting site, refinery process and waste treatment to reduce the greenhouse emission. Secondly the company should evaluate its gas stations because vaporizing benzene contributes significantly to gas emission globally.

This study has shown that the method used to evaluate performance of the three dimensions of TBL can yield reasonable measurement of the supply chain. The method is based on scoring of the performance of each chain by benchmarking it against the overall performance of the company. The evaluation can be done using existing data. Further study need to done to improve the scoring method.

LIMITATIONS

This study has some limitations: first, the data on the wages of the employees and detail of benefits from company in social aspect, therefore researcher uses hypothetical method to perform analysis. Second, the way to measure the electricity cost. This study estimated the energy used instead of actual electricity consumption to calculate the electricity cost.

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