IFAMA 2020 CASE STUDY WORKSHOP SERIES

Improving Decision-Making through Material Flow Cost Accounting: The Case of VietGreen Bottled Mineral Water Company

'I was concerned about the corporate performance in the next coming years. The company was facing some considerable challenges to accomplish its economic and environmental goals. 2018 was a daunting year for VietGreen since we were forced to make totally unprecedented decisions over the past ten years.'

(Minh Le, Chief Executive Officer)

1. Introduction

In 2014, the Vietnamese government passed the Law on Environmental Protection[1]. Two years later, a new regulation on Environmental Protection Fee for Industrial Wastewater[2] was signed to encourage Vietnamese enterprises in sustainable development. As VietGreen did not own a wastewater treatment system, the regulation was creating pressure on VietGreen. If the company would succeed in attaining higher standards for the treatment of industrial wastewater, the environmental fees for VietGreen would be lower.

In 2017, the Ministry of Industry and Trade signed a decision[3] to increase the price of electricity, making the price of bottled mineral water higher. The company strove to find a solution to save production costs. Ly Pham, the accounting manager, was worried about the financial position of the company if there would be a continuing increase in the price of electric energy.

The appearance of new regulations confronted VietGreen with economic and environmental considerations. Minh Le decided to arrange some roundtable meetings in order to ascertain what the company should improve, thereby achieving high efficiencies in future investments.

2. The industry

In the middle of the 16th century, the bottled water industry first began in Europe. Consumption of bottled water has been on the rise due to considerations of health, safety, purity, taste, and convenience. In 2017, global bottled water consumption reached nearly 100,000 millions gallons.

[1] 55/2014/QH13 – Law on Environmental Protection
[2] 154/2016/NĐ-CP – Regulation on Environmental Protection Fee for Industrial Wastewater
[3] 4495/QĐ-BCT – Decision on the Electricity Price

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It experienced a dramatic increase throughout the world, especially in China, the United States, Indonesia, and India. It is noted that China led the market in bottled water consumption, with the equivalent of more than 25,000 millions gallons in 2017 (see **Table 1**). Average per capita bottled water consumption of all countries was 13.2 gallons. Mexico, Thailand, and Italy had the biggest per capita consumption rates of 67.2 gallons, 57.5 gallons, and 48.2 gallons, respectively (see **Table 2**).

As compared with other countries, the bottled water consumption of Vietnam was not high, at 320.04 millions gallons (1,211.5 millions liters) in 2017. The average per capita consumption saw a slight increase, from 3.09 gallons (11.7 liters) in 2016 to 3.41 gallons (12.9 liters) in 2017 (see **Table 3**). Leaders of the bottled water market in Vietnam were international companies (Suntory PepsiCo Vietnam Beverage, La Vie and Coca-Cola Beverages Vietnam) which accounted for two thirds of off-trade value sales. In particular, Suntory PepsiCo Vietnam Beverage continued to lead bottled water in both carbonated and still bottled water[4].

According to the European Federation of Bottled Water (EFBW)[5] which is an non-profit international trade association, with its membership of national associations and bottled water companies across Europe, bottled waters are divided into three types including natural mineral water, spring water, and bottled drinking water. Natural mineral water has a distinctive mineral composition which depends on the water source and each brand. This composition includes a wide variety of minerals such as calcium, fluoride, magnesium, and nitrate. The amount of minerals dissolved in water is indicated as total dissolved solids (TDS) (milligrams per liter-mg/l or parts per million-ppm). According to the International Bottled Water Association (IBWA)[6], mineral water is water which contains not less than 250 ppm TDS. Moreover, it is distinguished from other types of bottled water 'by its constant level and relative proportions of mineral and trace elements at the point of emergence from the source. No minerals can be added to this product'.

3. The company and production process

In 2008, VietGreen Mineral Water Company was established by Mai Tran, a business owner and an environmental engineer. Six months later, the bottling plant was built in the South of Vietnam where the source of mineral water had been found. The company invested over one million USD in purchasing manufacturing equipment and building this factory with an area of 3,500 square meters. In early 2010, the company officially began to operate the production process. Still mineral water was bottled in one size (0.5 liters) and was distributed to the big cities of Vietnam such as Hanoi, Da Nang and Ho Chi Minh City. The production of bottled mineral water strictly obeyed both international standards (e.g., ISO 9001:2015) and national standards (e.g., QCVN 09:2015/BTNMT[7]). Most direct laborers of all steps of production are the local residents. VietGreen's production process includes three main steps (water filtering, bottle filling and cap

[4] https://www.euromonitor.com/bottled-water-in-vietnam/report
[5] https://www.efbw.org/index.php?id=40
[6] https://www.bottledwater.org/types/bottled-water
[7] QCVN 09:2015/BTNMT – National Technical Regulation on Ground Water Quality

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closing, labelling and packaging), and a supportive process (bottle and cap cleaning). Each step includes inputs and ouputs as described in the following:

Step 1: Water filtering

The raw mineral water is directly transported through stainless steel pipes into the factory. The information about received water in storage tanks is monitored on a daily basis. Then the process of filtering sand, activated carbon and micron is completed to remove suspended matter, color, odor, smell and micron particles from the water. After that a water softener is used to reduce water hardness before the process of disinfection by an ultra-violet system. Auxiliaries, which are necessary materials to support filtration and disinfection, are controlled on a monthly basis. There is a small amount of wastewater and normal solid waste at this stage.

Step 2: Bottle filling and cap closing

The large room is highly sanitary to ensure the safe process of bottle filling and cap closing. Firstly, clean empty bottles are automatically moved from the cleaning system to the bottle filling system. Next, the nozzles pour the filtered mineral water into the bottles held by grippers. Then clean bottle caps from the cleaning system, which uses chemicals and groundwater to ensure the hygiene and safety of empty bottles and caps, are transported and pressed onto the filled bottles. Finally, the quality of filled and capped bottles is checked by the manufacturing workers before being labelled and packaged.

Step 3: Labelling and packaging

Each bottle is labelled with sufficient information about the company and its mineral ingredients. A steam system is used to heat shrink wrap and label the bottles. On the cap of each bottle, the exact date of bottling is printed. Most of the waste from the labelling and packaging step are printing ink boxes (toxic solid waste) and packages of shrink wrap and sticky tape (normal solid waste). All finished bottles are finally packed into cartons to prepare for shipment to the domestic market.

At the end of 2017, Mai Tran, a trustworthy and ambitious owner, established a new vision, new strategic objectives and new core values for the company. The new vision was created: ‘VietGreen becomes the best mineral water brand in Vietnam in 2025 and will be one of top 30 mineral water brands in the world by 2030’. Based on this vision, the new strategic objectives were made in different perspectives such as developing new products with a diversity of bottle size and taste, implementing continuous improvement, and achieving sustainable growth. In order to accomplish the above goals, the new core values were emphasized: ‘integrity, responsibility and diversity’.

In 2018, VietGreen was challenged by meeting new environmental regulations and achieving the company’s major objectives. At that time, Minh Le, the Chief Executive Officer (CEO) of VietGreen, attended a workshop organized by the Vietnam Productivity Institute in which a trainer introduced a new concept, called Material Flow Cost Accounting (MFCA). It is ‘one of the major tools for environmental management accounting and promotes increased transparency of material use practices through the development of a material flow model that traces and quantifies the flows

and stocks of materials within an organization in physical and monetary units'[8]. During the one-day workshop, some case studies were used to provide practical evidence of the benefits of MFCA. After this workshop, Minh Le thought that the approach could be a potential for helping VietGreen to identify losses and to increase the continuous improvement of economic and environmental performance. Therefore, he made a decision to establish a project team to explore the potential of MFCA for enhanced eco-efficiency and achieving the company's long-term goals. As a leader of the project, he needed to select members of the team in order to economize on production costs. Before roundtable meetings were organized and detailed actions were taken, he required managers to provide some constructive information. Some suggestions and feedback were:

Lan Nguyen (Purchasing Department Manager):

'We should look for new suppliers to save material costs. We also should update our new payment policy within 30 days, instead of 31-60 days, in order to negotiate a better price.'

Tai Pham (Environment Department Manager):

'I was considering solutions to reduce the large number of wastewater and craps at the bottle filling and cap closing stage. I was worried about the increasing amount of wastewater and toxic solid water at the stage of bottle and cap cleaning.'

Ha Bui (Utility Department Manager):

'The production process wasted a large amount of electricity. It took much time for me to monitor and provide usage rate of each process, including the three main production steps and the supportive process – bottle and cap cleaning.'

Linh Nguyen (Sales and Marketing Department Manager):

'The company sold 94,650,000 mineral water bottles to the domestic market in 2017. We should have more budgets for running our new marketing strategy with the new slogan – Making the environment cleaner, making people healthier, and making life better.'

4. Material and energy flow accounting

After the MFCA team was established (see **Table 4**), selected managers of the project group were invited to a first meeting. At 8:00 am, Mr. Minh made an opening presentation regarding the importance of the MFCA approach and the meeting agenda. After that, he began to explain the reasons why the company should adopt the new approach:

'I participated in a workshop organized by the Vietnam Productivity Institute which introduced a new management approach to me, material and energy flow accounting. I think that this approach is completely compatible with the company's long-term objectives. Thank you so much for your suggestions and feedback that you sent to me last week. They show that there are many problems which took place and should be addressed. Today, I would like to listen to your presentations in more detail. Then, we will analyze together the

[8] ISO 14051:2011 - Environmental Management - Material Flow Cost Accounting - General Framework

usefulness of material and energy flow accounting for improving the company's production process.'

To continue, Mr. Long, a production manager with over twenty years of experience, was invited to report on the company's manufacturing position in the year 2017. He stated that:

'Our production was very good. We always ensure the quantity of products due to manufacturing activities with continuous capacity - 24 hours per day. In 2017, direct laborers worked 316 days. We monitored the quality of mineral water on a daily basis to meet customer's high standards. With each manufacturing period (eight hours), we allocated a number of direct laborers as follows: four laborers working at the stage of water filtering, six laborers working at the stage of bottle filling and cap closing, two laborers working at the stage of bottle and cap cleaning and seven laborers working at the stage of labelling and packaging in order to produce final products.'

Next, Mr. Bao, who was responsible for managing the warehouse, presented the stock out report (see **Table 5**). He highlighted that all goods were strictly checked and controlled at three warehouses including the first warehouse for storing final products, the second warehouse for storing empty bottles, caps and auxiliaries and the third warehouse for storing chemicals. He provided further information about the quantity of inventory, which were 1,340,400 final bottles at the beginning of year 2017 and 290,400 final bottles at the end of year 2017. In addition, there were 100,152,000 empty bottles and 93,600,000 bottle caps which were transported to the process of bottle and cap cleaning and were cleaned in 2017. The weight of each empty bottle was 19 grams and the weight of each bottle cap was 1.8 grams. To understand clearer the usage of electric energy and water, a report was carefully prepared by Ms. Ha who was responsible for the activities of the utility department. According to her evaluation, the consumption of electricity, water, and steam was quite stable and well controlled. The company used electricity with low tension <6KV within the production process (see **Table 6**).

After that, Mr. Tai from the environment department, a young and new engineer, presented some challenging pressures concerning waste. He showed that there were a number of craps released after the production process and the pollution volume in wastewater (see **Table 7 and 8**). He emphasized that a detailed report about managing solid waste and wastewater was sent to the Department of Natural Resources and Environment of Province quarterly.

At 11:00 am, in line with their presentations, discussion parts took place.

Mr. Tai (Environment Department Manager):

'According to my calculation, there was 30,177 m^3 wastewater arising from all production processes with the amount of 8,193 m^3; 7,625 m3; 6,815 m^3; 7,544 m^3 for the first, second, third, and last quarter, respectively. I was concerned about the company's wastewater.'

Mr. Linh (Sales and Marketing Department Manager):

'I think that we should concentrate on the marketing strategy to increase profits and expand new markets. Customers drink mineral water because it is good for their health. They do not care about wastewater. Our wastewater has met the basic conditions to be released into the

environment. We should not waste time discussing environmental problems. He looked at Mr. Tai and concluded: you are only a new employee of the company.'

Mr. Long (Production Department Manager):

***'**You are right, Mr. Linh. Environmental problems do not become serious as Mr. Tai said. I have been engaged with the company from its establishment days. I know clearly what we did in the past. The manufacturing process were well-controlled and efficient. We attempted to save expenses for the company. If the company wants to address the wastewater problem, we could invest a new system of wastewater treatment. This is very simple.'*

Ms. Ly (Accounting Department Manager):

'I completely disagree with Mr. Long. Production costs increased roughly 10 % in 2017 as compared with in 2016. This led to a decrease in profits over the last year. I do not think that it is simple to make a new budget for investing in wastewater treatment. Furthermore, if the new strategy of the company is implemented, marketing costs and costs for designing new products might continue to increase.'

Mr. Tai (Environment Department Manager):

'I think that we should focus on environmental concerns if the company's strategy is to develop sustainably. Every quarter, polluted emissions within industrial wastewater of the company were measured and reported with the Level B Quality by a reliable service. Although our wastewater meets regulatory requirements to release into the environment, we should aim to improve the quality of it and reduce the level of pollution. I was considering the higher standard (Level A Quality) of wastewater[9] proposed by the Ministry of Natural Resources and Environment. Accordingly, the value (mg/l) of COD (Chemical oxygen demand), Pb (Lead), and Cd (Cadmium) are 75, 0.1, and 0.05, respectively'.

The atmosphere of the meeting became fairly strained when there were controversial ideas from heads of departments. However, it was 12 o'clock. According to the agenda of the meeting, it took about 60 minutes to have lunch and people came back at 13 o'clock.

After lunch, Mr. Minh (CEO) started to share his thoughts:

'Our task today is to analyze material and energy flows related to our production process. As far as I know, this analysis will help us to identify inefficiencies and the causes of such inefficiencies. Instead of arguing whether a marketing strategy or a wastewater treatment system investment is better for us, let's first consult our flowchart and start filling in physical information into input/output tables' (see **Table 9**).

[9] QCVN 40:2011/BTNMT - National Technical Regulation on Industrial Wastewater

5. Material and energy cost accounting

In 2010, the Vietnamese government signed the Law on Economic and Efficient Use of Energy[10]. Drawing on this law, the reduction of energy loss and environmental waste was highlighted. In the same year, the Law on Environmental Protection Tax[11] was passed and the Decision on National Green Growth Strategy for the period 2011-2020, Vision to 2050[12], was also approved in Vietnam. All of these regulations have played a major role in encouraging environmentally friendly production and consumption patterns.

In line with the above institutional changes, there were some considerable changes in the price of electricity and water which made a large impact on Vietnamese producers. No exception, VietGreen was under pressure from such increases. To understand precisely the position of costs arising from the production process over the year 2017, the second meeting was organized, thereby determining the actual material and energy losses through calculating by using the MFCA approach.

Based on the Decisions on Electricity Price proposed by the Vietnamese Ministry of Industry and Trade[13], Ms. Ly (Accounting Department Manager) summarized and prepared a detailed report (see **Table 10**). In addition, an explanation of calculating water costs was presented at this meeting. Water costs were the amount of natural resource taxes which the company must pay for the government due to using water resources (see **Table 11**). Further information was added that the price of steam was at USD 0.053/kg in 2017.

In 2014, Vietnam continued to demonstrate a huge interest in building up the green economy by launching the Law on Environmental Protection[14]. As a result, a new regulation[15] on environmental protection fees for exploiting minerals was publicly announced in 2016 to related manufacturers. With regard to this regulation, mineral water experienced an increase in input costs. It is noted that VietGreen had to spend additional money which was 0.132 USD for one m^3 mineral water exploited from national water resources.

In 2015, the Vietnamese government passed a regulation[16] on solid waste management including both toxic solid waste and normal solid waste. Compliant with the regulation, the company proposed helpful guidelines about how to collect, categorize, and transport all industrial solid waste to safe areas. They were clearly labeled and were recorded according to each manufacturing process. According to information from the accounting department, the cost of toxic solid waste was USD 0.696/kg in 2017. In addition, there was a commercial contract between the company and the waste service company on a yearly basis in which the company received income from selling craps and normal solid waste at the same price of USD 0.040/kg.

[10] 50/2010/QH12 – Law on Economical and Efficient Use of Energy
[11] 57/2010/QH12 – Law on Environmental Protection Tax
[12] 1393/QĐ-TTg – Decision on National Green Growth Strategy for the period 2011-2020, Vision to 2050
[13] http://www.moit.gov.vn/
[14] 55/2014/QH13 – Law on Environmental Protection
[15] 164/NĐ-CP – Regulation on Environmental Protection Fee for Exploiting Mineral
[16] 38/2015/NĐ-CP – Regulation on Solid Waste Management

Wastewater become one of noticeable concerns throughout the world due to its negative impacts on the environment. It is noted that the vast majority of industrial wastewater has been discharged into nature without being treated, affecting areas such as lakes, rivers, and oceans. As a result, such untreated wastewater may seriously influence people's health as well as the quality of natural water sources. In 2017, wastewater became the main theme of World Water Day, focusing on reducing, treating, and reusing wastewater in order to tackle the urgent water crisis. This focus has been emphasized in the goal 6.3 of the 17 Sustainable Development Goals[17].

Similarly, wastewater in Vietnam has confronted many alarming risks. According to the Vietnamese Ministry of Resource and Environment, each year there are approximately nine thousand Vietnamese people die due to using contaminated water consisting of toxic and polluted ingredients. In addition, natural water has been considerably damaged due to a lack of untreated industrial wastewater control. For example, Formosa caused a massive environmental disaster for marine life in Vietnam in 2016 since the company illegally discharged toxic waste into the ocean through drainage pipes. This discharge led to a large number of dead fish along the coast of provinces in the middle of Vietnam such as Ha Tinh, Quang Binh, Hue, and Quang Tri.

In 2016, a new regulation on Environmental Protection Fees for industrial wastewater[18] was also promulgated. From this, the Environmental Department was responsible for quarterly reporting on Environmental Protection Fees. The arising fees of the company include a fixed fee (66.079 USD per year) and a variable fee depending on total wastewater and the amount of sum parameter in wastewater analysis (see **Table 12**).

Over many years, the company has created valuable working opportunities for local residents. For instance, nearly 95% of manufacturing workers were employed from the available human resources of the province. Their salary was paid on a working-hour basis. At the meeting, Chi Ly (Human Resource Manager) stated that:

> *'In 2017, the total of number of employees and managers of the company was 270 people. There were 74% male employees and 26 % female employees. To ensure monitoring of the quality of mineral water, from the beginning of its establishment, the company employed qualified engineers who had a wealth of knowledge about mechanics, chemicals and the functioning ability of filtering systems. Their salary was higher than that of other workers who were responsible for the process of bottle filling and cap closing, bottle and cap cleaning, and labelling and packaging* (see **Table 13**).'

Currently, the company purchases PET bottles and caps from local suppliers. There are two different types of price based on payment time. She showed that the price of PET bottles is USD 0.053 per empty bottle if the payment is implemented within 31-60 days. Nonetheless, if the payment is implemented in fewer than 30 days, the price is USD 0.046 per empty bottle. Additionally, she provided further information associated with the accepted price of some materials and auxiliaries (see **Table 14**).

[17] https://www.sdg6monitoring.org/indicators/target-63/

[18] 154/2016/NĐ-CP – Regulation on Environmental Protection Fee for Industrial Wastewater

The meeting lasted for over three hours. Afterwards, all necessary information for calculation was provided. Although Ms. Ly had over ten years working experience in accounting, it was the first time that she applied an MFCA approach to calculating production costs. Indeed, it was a challenging task for her to identify both product and non-product costs. She was considering allocating electricity and labor costs at the rate of 60% for the bottle filling step and 40% for the cap closing step. Moreover, she provided additional information at the stage of bottle filling that the consumption of electricity and usage of direct labor to create craps was equal to the consumption of electricity and usage of direct labor to create wastewater. She needed to report detailed costs and identify actual losses in terms of the new approach. Meanwhile, the project team was expecting to receive relevant financial results. Based on these, they would consider potential proposals to improve the company's performance.

6. Investment appraisal

After the process of material and energy flow analysis as well as the calculation of related costs by using the MFCA approach, the project team was faced with the considerable challenge of allocating funds among a range of compelling investment projects. To make final decisions, the third meeting was properly organized to entertain three proposals which were proposed by the Environment Department and Production Department.

At the beginning of the meeting, Mr. Minh emphasized VietGreen's new vision and new strategic objectives again. He was expecting that new investments which were decided by most of the managers could make a promising future for the company. He said that:

> *'As you know, in early February 2018, we replaced a system of producing steam from fossil fuels by directly purchasing steam from a reliable local supplier. Indeed, this replacement helped the company to make not only a great deal of cost savings but also a positive impact on the environment due to using a source of clean and efficient energy. This was true when the company was pursuing both economic and environmental performance. However, our funds and resources are limited and we must spend a lot on budgets for new product introduction and market expansion; therefore, we should attentively rank the proposals.'*

To provide a clearer picture about the company's capital budget for a five-year period (2018-2022), Mr. Minh posited a spending limit on capital projects of only USD 220,000 for each year. Up to date, the company has successfully conducted two projects with a total amount of USD 148,942. He also added major information:

> *'The actual results of previous projects made a good contribution to the company's economic performance. I am expecting the final decision on three potential proposals which were proposed by the Environment Department and Production Department. Nonetheless, I would like to highlight that economic performance should be prioritized. The company needs money to exist and operate. I suggest that the discount rate of the company would be 10%.'*

Before three proposals were presented in detail, Ms. Lan argued that:

> *'According to my opinion, investing in PET bottle production could make challenging potentials for the company because we have little knowledge and experience about this new perspective. Why do we need to invest in the new system whereas we could easily purchase*

PET bottles from local suppliers? If the price of the PET bottle is high, two options should be considered: seek a new supplier or change the company's payment policy. We should simplify the process rather than add the new process.'

Three following proposals were presented at the meeting:

Proposal 1: A new system for wastewater treatment

The Vietnamese government has made enormous efforts to improve the quality of wastewater by passing the National Technical Regulation on Industrial Wastewater in 2011, and the new regulation on Environmental Protection Fee for industrial wastewater in 2016. Along with enforcing such regulations, some workshops were purposely organized to seek practical solutions for safe processing, reusing wastewater, and protecting sustainable water sources.

In late November 2017, Mr. Tai attended one important workshop in which modern technologies for wastewater treatment in the world were introduced. During this workshop, he also received some informal information from an expert that there would be a dramatic increase in environmental protection fees in the next years. Then, he continued to strive for understanding and analysis of popular solutions of wastewater treatment.

After that, he discussed the issue with employees within the Environment Department. After considering some major factors, they found an experienced service supplier which could help the company to address the high rate of COD, Pb, and Cd in the company's wastewater. At the meeting, he explained the operation process of the wastewater treatment system. After that, he reported estimated costs (see **Table 15**), and showed environmental results for wastewater if a new treatment system would be equipped (see **Table 16**). It is clear that the quality of wastewater would be improved, and the sludge would meet the standard of the National Technical Regulation on Hazardous Thresholds for Sludge from Water Treatment Process[19].

Proposal 2: A new process for producing PET bottles

PET plastic is the main packaging material used for mineral water due to its safety and convenience. Nonetheless, PET bottle cost has accounted for a large amount of production costs. Therefore, bottled mineral water manufacturers have made many efforts to reduce the weight of plastic bottles. For example, in 2009, Nestle Waters launched a new version of its Eco-Shape PET bottle with the reduction of bottle weight from 12.5 grams to 9.5 grams which delivered a saving of 80 million pounds annually for the corporation[20]. According to the International Bottled Water Association (IBWA), the average PET bottled water container weighed 18.9 grams in 2000 and 12.7 grams in 2008. There was a dramatic decrease in the weight of each PET bottle leading to saving more than 1.3 billion pounds of PET plastic[21].

[19] QCVN 50:2013/BTNMT – The standard of the National Technical Regulation on Hazardous Thresholds for Sludge from Water Treatment Process

[20] https://www.beveragedaily.com/Article/2009/12/17/Nestle-launches-lightweight-PET-bottle

[21] https://www.bottledwater.org/news/weight-pet-bottled-water-containers-has-decreased-326-over-past-eight-years

In line with VietGreen's new strategy, the Production Department made an innovative plan to achieve its goal for plastic reduction. This goal could be accomplished by purchasing and equipping a new system for producing PET bottles. Mr. Long expected that the weight of PET plastic would be reduced to 10 grams if the new system was invested in. In addition, he described in detail the process of manufacturing PET bottles. To provide useful information for the proposal, he collaborated with the manager of the Accounting Department to calculate potential costs. As a result, he showed that the estimated cost of one PET bottle would be USD 0.039. With this proposal, the company would strictly manage the quality of bottles and would become active in its manufacturing activities. However, the company would spend about USD 110,132.159 on purchasing as well as installing machines.

Proposal 3: A new system for the bottle filling process

Along with the PET bottle proposal, the Production Department recommended an efficient solution to address the problem associated with the bottle filling process. The old system, which wasted much time, water, electricity, and labor hours due to breakdown, could be sold in the first year of this project at the price of USD 5,286.344. The new system would be set up to suit the company's various requirements, for example, the ability of flexible filling from 250ml to 5l bottles. It could strictly control input, output, bottle size, and system speed through a modern controller program and easily integrate with the cap closing process. In addition, wastewater and craps would be completely solved.

Before presenting investment costs (see **Table 17**), Mr. Long emphasized that:

> *'We searched for information and requested quotations from famous filling machine suppliers in Europe. Finally, we discussed and agreed to choose the supplier from Italy due to cost efficiency, productivity, quality assurance, and low maintenance. I think that we should invest in the new system since it would be compatible with the company's new strategy. If market demands increase, we need to assure the provision of mineral water in time, with a high quality. Please look forward with long-term thinking instead of short-term thinking.'*

Members of the project team were expected to express their opinions on three investment options. Before making a decision, Mr. Minh hoped that a payback would be two years. Although all three proposals were presented, balancing the economic and environmental performance posed a totally daunting challenge for managers due to its huge impacts on the future of the company. At 5:00 pm, they would need to make an official decision about which proposal(s) the company would invest in:

1. Construction of a new system for wastewater treatment, or;
2. Development of a new process for producing PET bottles, or;
3. Acquisition of a new system for the bottle filling process.

Supplementary material

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Table 1. Global bottled water market consumption by country in 2012 and 2017

Rank	Countries	2012 (millions of gallons)	2017 (millions of gallons)	CAGR[1] (2012/2017)
1	China	14,579.9	25,468.9	11.8%
2	United States	9,711.4	13,710.5	7.1%
3	Mexico	7,516.3	8,682.9	2.9%
4	Indonesia	4,966.4	8,158.2	10.4%
5	Brazil	4,611.9	5,794.5	4.7%
6	India	3,623.6	5,759.0	9.7%
7	Thailand	3,135.4	3,966.3	4.8%
8	Germany	3,024.1	3,131.5	0.7%
9	Italy	2,904.8	2,917.5	0.1%
10	France	2,287.9	2,445.7	1.3%
	Top 10 Subtotal	**56,361.7**	**80,034.9**	**7.3%**
	World Total	**72,894.5**	**99,555.6**	**6.4%**

[1] CAGR - Compound annual growth rate

Source: Rodwan, J.G. 2018. Bottled Water. 2017 Staying Strong. *Bottled Water Reporter Jul/Aug 2018*: 18.

Table 2. Global bottled water market per capita consumption in 2012 and 2017

Rank	Countries	2012 (gallons per capita)	2017 (gallons per capita)
1	Mexico	62.2	67.2
2	Thailand	46.9	57.5
3	Italy	47.7	48.2
4	United States	30.9	42.1
5	Germany	36.6	37.9
6	France	35.8	36.4
7	Belgium-Luxembourg	34.6	35.1
8	United Arab Emirates	25.3	33.9
9	Spain	30.9	32.6
10	Indonesia	20.1	30.9
	World Average	**10.3**	**13.2**

Source: Rodwan, J.G. 2018. Bottled Water. 2017 Staying Strong. *Bottled Water Reporter Jul/Aug 2018*: 20.

Table 3. Total and per capita bottled water consumption in Vietnam 2012-2017

Year	Total bottled water consumption (millions of liters)	Per capita bottled water consumption (liters)
2012	732.6	8.1
2013	808.3	8.9
2014	893.5	9.8
2015	989.2	10.7
2016	1,095.8	11.7
2017	1,211.5	12.9

Source: www.statista.com

Table 4. MFCA application project team

No.	Name	Gender	Department/Position
1	Minh Le	Male	Chief Executive Officer
2	Bao Tran	Male	Warehouse
3	Ha Bui	Female	Utility Department
4	Lan Nguyen	Female	Purchasing Department
5	Linh Nguyen	Male	Sales and Marketing Department
6	Long Hoang	Male	Production Department
7	Ly Pham	Female	Accounting Department
8	Tai Pham	Male	Environment Department

Table 5. The stock out report of chemicals, labelling and packaging materials, auxiliaries in 2017

Name	Amount	Unit
Chemicals	34,000	liter
Printing ink	47	bottle
Shrink wrap	3,950	roll
Label	93,600,000	label
Sticky tape	5,280	roll
Cartons	3,900,000	box
Auxiliaries	173,160	kg

Table 6. The consumption of electric energy, water and steam in 2017

Name	Amount	Unit
Electric energy - Water filtering	256,336	kWh
Electric energy - Bottle filling and cap closing	420,165	kWh
Electric energy - Bottle and cap cleaning	128,168	kWh
Electric energy – Labelling and packaging	303,253	kWh
Raw mineral water	56,351,000	liter
Ground water	20,592,000	liter
Steam	915,680	kg

Table 7. The report of wastewater and solid waste in 2017

Name	Amount	Unit
Wastewater - Water filtering	1,127	m^3
Wastewater - Bottle and cap cleaning	20,626	m^3
Toxic solid waste - Bottle and cap cleaning	1,373	kg
Toxic solid waste - Labelling and packaging	7	kg
Normal solid waste - Water filtering	208	kg
Normal solid waste - Labelling and packaging	408	kg
Craps	6,552,000	bottle

Table 8. The report of the pollution volume within $1m^3$ wastewater in 2017

Name	Quarter 1	Quarter 2	Quarter 3	Quarter 4
COD (Chemical oxygen demand)	86 mg/l	85 mg/l	78 mg/l	89 mg/l
TSS (Total suspended solids)	45 mg/l	52 mg/l	48 mg/l	51 mg/l
Hg (Mercury)	0.003 mg/l	0.005 mg/l	0.005 mg/l	0.004 mg/l
Pb (Lead)	0.2 mg/l	0.15 mg/l	0.25 mg/l	0.2 mg/l
As (Arsenic)	0.03 mg/l	0.04 mg/l	0.05 mg/l	0.045 mg/l
Cd (Cadmium)	0.054 mg/l	0.04 mg/l	0.05 mg/l	0.045 mg/l
BOD (Biochemical oxygen demand)	26 mg/l	28 mg/l	27.5 mg/l	28.9 mg/l
P (Phosphorus)	3.54 mg/l	3.69 mg/l	3.85 mg/l	3.7 mg/l

Table 9. Input/output table

INPUT				**OUTPUT**			
Item	Unit	Data source	Amount	Item	Unit	Data source	Amount

Table 10. Average electricity price (Unit: USD/kWh)

Electricity consumption	2010	2017
Electric tension > 110 kV	0.046	0.072
Electric tension 22 KV-110 kV	0.048	0.074
Electric tension 6 KV-22 KV	0.050	0.077
Electric tension < 6 kV	0.052	0.080

Table 11. Natural resource tax (Unit: USD/m^3)

Types of water	2017
Raw mineral water	7.2687
Groundwater	0.0176

Table 12. Variable Environmental Protection fee as for wastewater (Unit: USD/kg)

Parameter in wastewater	2017
COD (Chemical oxygen demand)	0.088
TSS (Total suspended solids)	0.106
Hg (Mercury)	881.057
Pb (Lead)	44.053
As (Arsenic)	88.106
Cd (Cadmium)	88.106
BOD (Biochemical oxygen demand)	-

Table 13. Direct labor salary in 2017

Step	Salary (USD/hour)
Water filtering	1.322
Bottle filling and cap closing	1.101
Bottle and cap cleaning	0.881
Labelling and packaging	0.881

Table 14. Price of purchased materials and auxiliaries in 2017

Materials and auxiliaries	Price
Bottle cap (USD/cap)	0.005
Chemicals (USD /m^3)	3.921
Printing ink (USD/bottle)	82.256
Shrink wrap (USD/roll)	15.198
Label (USD/label)	0.002
Sticky tape (USD/roll)	3.789
Carton box (USD/box)	0.148
Auxiliaries (USD/kg)	0.714

Table 15. Estimated costs if a new wastewater treatment system would be equipped

Types of cost	Amount (USD)
Chemical	1,367.225
Electric energy	2,522.432
Direct labor	3,171.806
Sludge	723.877
Equipment investment	6,607.930

Table 16. Environmental results if a new wastewater treatment system would be equipped

Emissions within 1m^3 wastewater	Amount (mg/l)
COD (Chemical oxygen demand)	5
TSS (Total suspended solids)	5
Hg (Mercury)	0.00003
Pb (Lead)	0.0006
As (Arsenic)	0.0003
Cd (Cadmium)	0.0003
BOD (Biochemical oxygen demand)	18
P (Phosphorus)	0.17

Table 17. Estimated investment costs for a new system for bottle filling process

Types of cost	Amount (USD)
Purchasing new system	82,819.383
Estimated energy and labor cost savings	3,348.018