Soft Drink Supply Chain Sustainability in Kuwait

Kawthar Fadhlullah[a]; Souad Alothman[b]; Fayi Malallah[c]; Daniah Albahouh[d]; Fay AlSanae[e]; Abdullah S. Karaman[f]

College of Engineering and Technology
American University of the Middle East,
Kuwait
[a] 43892@aum.edu.kw ;[b] 41027@aum.edu.kw
[c] 44912@aum.edu.kw;[d] 42892@aum.edu.kw
[e] 42891@aum.edu.kw;[f] Abdullah.Karaman@aum.edu.kw

Abstract

This study discusses the soft drink supply chain sustainability, which includes the production of carbonated soft drinks made from carbonated water, flavors, and sweetened with a non-nutritive sweetener or sugar, their packaging, storage, and distribution. The study targeted three soft drink companies in Kuwait, to successfully identify sustainability problems relating to the three pillars of sustainability in the companies' supply chains. We used the identification of the problem; analysis; design; evaluation of alternatives; and implementation approach in the project design. To identify the sustainability problems in these companies, a list of questions and an analytical hierarchy process (AHP) questionnaire were sent to them. The answers to the questions/and the AHP questionnaire revealed a packaging and water waste problem. As a solution methodology, we first implemented benchmarking to identify industry best practices in the soft drink industry. As a solution to the water waste problem, after conducting a feasibility analysis, reverse osmosis (RO; as compared to ultrafiltration) was chosen as the best sustainable water recycling method; as it has a longer life span than ultrafiltration. As a solution to the packaging problem, when analyzing between rPET and PlantBottle, rPET was chosen because it is less costly. Moreover, a simulation of RO was conducted using Arena software for a real-life illustration. Lastly, to illustrate the benefit of the sustainability initiatives, a multiple regression model was built by collecting data from the Refinitiv database. The regression results showed that there is a U-shaped relationship between the firm value and environmental sustainability performance.

Keywords
Soft drink supply chains, Sustainability, Reverse osmosis, rPET, SDG.

1. Introduction
Supply chain activities involve the sourcing of products from raw materials and semi-finished parts, all the way to the assembly and production, then, packaging, storage, and distribution to the stores, and finally delivering to customers. Sustainability is defined as satisfying the needs of the present without compromising the future generation's ability to satisfy their needs. In this respect, it applies to both manufacturing and service supply chains as well as applies to a broad spectrum of different industries. As part of the bigger Consumer Non-Cyclicals economic sector, soft drink companies do the most environmental damage in the food and beverage industry (Lau 2022), and this comes down to two main reasons. The first reason is that the packaging of many soft drinks is not recyclable. Even if it is, consumers find it difficult to recycle them. For example, when visiting a beach, you can instantly spot many different soft drink bottles and cans that have been littered, and that surely isn't doing any good to the environment. The second reason that soft drink companies are damaging to the environment, is due to the water waste that comes from manufacturing soft drinks. Water isn't just used to create the drink that gets consumed, it is also used and wasted in huge amounts in the cleaning processes, and other processes.

To correctly identify the problem, we visited some soft drink companies in Kuwait to understand their sustainability issues. We asked each one of the three companies about their sustainable practices through a questionnaire: an AHP survey and a list of questions. The answers are collected and analyzed. We noticed that all three companies have sustainability issues regarding packaging and water treatment.Kuwait relies solely on desalination as a water retrieval technique. However, with its rapid population growth, per capita water consumption is increasing. As reported by

Water Challenges in Kuwait (2020), freshwater demand in Kuwait is expected to increase from 722 MCM/year to 3,036 MCM/year by 2025. Additionally, after speaking with one of the soft drink companies, they do not have any water treatment technique to reuse or treat used water, meaning it all goes to waste. Our approach is to research and suggest a popular water treatment technique that is used by other international soft drink companies.

1.1 Objectives

Here are the objectives of our study:

1 Reviewing Kuwait's soft drink supply chain concerning the sustainability issues
2 Satisfying the United Nations Goal 6: Clean Water and Sanitation (United Nations, 2015).
2.1.1 Goal 6.3: Reduce water waste by 50% by 2030
3 Satisfying United Nations Goal 12: Responsible Consumption and Production (United Nations, 2015).
3.1.1 Goal 12.5: Reduce waste generation by preventing, reusing, reducing, and recycling
3.1.2 Goal 12.6: Encourage companies to adopt and report sustainable practices
4 Finding out how to optimize Kuwait's soft drink supply chain. (in terms of "sustainability")
5 Using benchmarking and Industrial Engineering methodologies to create a long-range plan for Kuwait's soft drink manufacturing companies to practice sustainability in their supply chain
6 Simulating a sustainable water treatment technique by using ARENA Software to suggest to all local soft drink manufacturing companies in Kuwait
7 Studying the benefits of sustainability to firm value

In the next sections, we conducted a literature review to gain more background information about our research topic. Later on, we will discuss the research methods used in this study. After that, our results will be mentioned and discussed. Finally, we will summarize our research in the conclusion by also mentioning the plans of this research paper and the fulfilled objectives.

2. Literature Review

The supply chain is getting more interest in the literature in recent years and is considered one of the most productive displace (Laengle et al. 2017). Moreover, the sustainable supply chain has been investigated in the context of supply chain management. Sustainability has three pillars. These include economics, which is concerned with the growth of the economy and finding new jobs for the people. Second is the environment, which is the maintenance of sustainable resources and clean production including using clean energy and reducing emissions. The third pillar of sustainability is the social aspects including maintaining social identity (Martins and Pato 2019) and observing human rights. The general supply chain consists of suppliers, manufacturers, distributors, and retailers. From the firm viewpoint, the operations related to the supplier are the evaluation, selection of suppliers, and procurement. Whereas in the manufacturer itself, the main operations are related to the design, development, manufacturing, scheduling, warehousing, inventory management, and outsourcing. The main operations of retails are transportation and marketing (Stohler et al. 2018).

The increase in demand and competition leads the development of supply chains to the next step of innovation and sustainability (Laengle et al. 2017). The sustainable supply chain is one of the most active fields in research. A sustainable supply chain means how to design a chain of suppliers and the operation of the organizations sustainably. These operations start from the acquiring of raw materials and the supplier selection and evaluation to the last retail center, including the production activities, distribution, and storage. Sustainability will be associated with all these stages, in the form of selecting the best practices that fulfill the three pillars of sustainability. These pillars are environmental, economic, and social aspects (Martins and Pato 2019). According to the producer's perspective, the operations related to the supplier are the evaluation, selection, and procurement. These operations are followed by the operation of production and inventory and distribution (Stohler et al. 2018).

Zhong et al. (2017) investigates 192 different articles about food supply chain management (SCM) from the literature from the years 1993-2017, a total of 24 years, and categorized them according to hierarchical organizations. There are four aspects that are investigated: data collection, the structure of the supply chain, decision-making models, and implementations. Any implementations in food SCM come from top-of-the-line technologies that are used to face issues in the industry. Noticeable improvements have been made in the food SCM cycle after using a special information technology system. In addition, Big Data Analytics can be used to help food companies make the correct decisions by using the correct data input for their daily operations. This can be used to make the food supply chain the most sustainable it can be. Big Data Analytics helps organizations figure out the status of the produced food, get industrial feedback, as well as create an up-to-date stat report. Based on the 192 articles, Big Data Analytics and Internet-of-Things will be used to transform the food supply chain industry in the future, and new implementations will be facilitated as well as new technologies that can be customized to be made user-friendly.

Sustainability has always been investigated in the field of soft drinks. The supply chain of the Coca-Cola company has been investigated in the literature. The research is considering the supply chain in Coca-Cola and its relation to the branding (Jones and Comfort, 2018). The research considers the main sustainability operations of Coca-Cola as expressed on the company's website. Using the materials disclosed by the company, the authors tried to find the relationship between sustainability and branding. These results reveal many findings regarding the company's responsibility toward the environment and society. These actions toward sustainability have a relation with the Coca-Cola brand as the authors stated. Another research in this field is discussing the use of artificial intelligence in the field of sustainability in the food and drinks supply chains (Olan et al. 2021).

The increasing demand for food and drinks leads to the global trading of these products. Global trade required huge attention regarding designing and optimizing a sustainable supply chain. In this case, there will be multi suppliers, manufacturers, and distributors. Consequently, the competition is more especially around scarce resources. Then sourcing sustainable resources is of strategic importance. So, the use of modern technologies such as artificial intelligence is crucial for success and completion. The collaborative approaches in sustainable supply chains are proven their success in achieving strategic goals. However, collaboration should be evaluated to better choose the partners. In this regard, Singh et al. (2018) published an article to evaluate the partner in the field of the food supply chain. The study aims to evaluate the dependency on partners' performance. The authors design a supply chain model measurement and prove the positive relationship between the evolution of partners and the performance of the supply chain.

The best example to investigate in the field of soft drinks supply chain sustainability is the Coca-Cola case. Coca-Cola has been investigated more than once by the researchers in literature. One of the important references is a master thesis conducted by Chmielarska (2019). This study has investigated the experience of Coca-Cola in sustainability. The article presented the methods that the company followed to handle sustainability issues. And provide a managerial concept that can be applied in similar organizations. Sustainability is associated with all stages of the product life cycle, starting from designing a sustainable product that maintains the environment and saves resources. In this regard, Chen et al. (2018) presented a multi-criteria model to evaluate the design of supply chains and production systems. The authors considered the economic issues in the design stage of the product life cycle and the influences of emissions.

Emissions can be due to the production process activities and due to the usage of the final products. Also, in the context of no complete data for the evolution the usage of uncertainty techniques is very important. One of the sustainability approaches is the closed-loop supply chain system. In this system scrap or waste should be utilized. Fathollahi-Fard et al. (2020) designed a sustainable closed-loop supply chain system for the water supply chain and wastewater collection system. The collection system is the place and activities associated with the collection of waste for further processing. The processing includes the evolution of waste source and feasibility of use in addition to the economic and manufacturing feasibility. Generally, the collection systems of waste material are associated with a big uncertainty. This uncertainty is in the form of the expected amounts of waste material and the processing time for the new activities associated with the collection and processing of waste.

3. Methods

The methods used in this research were through five steps: identification, analysis, design, evaluation of alternatives, and implementation. We first started by identifying the sustainability problems. Next, research was conducted on some sustainability initiatives to use in benchmarking. After that, a feasibility analysis was done to compare alternative solutions for the two sustainability problems. The risks and trade-offs of each initiative were analyzed. We also created a simulation to mimic a real-life water treatment method to test the solution of water treatment. Next, a regression model was created to see the benefits of sustainability initiatives. Finally, the chosen initiatives were suggested and implemented.

In Figure 1, we present a flowchart to show exactly what specific steps we followed. The flowchart below illustrates the steps we have taken to achieve our project design.

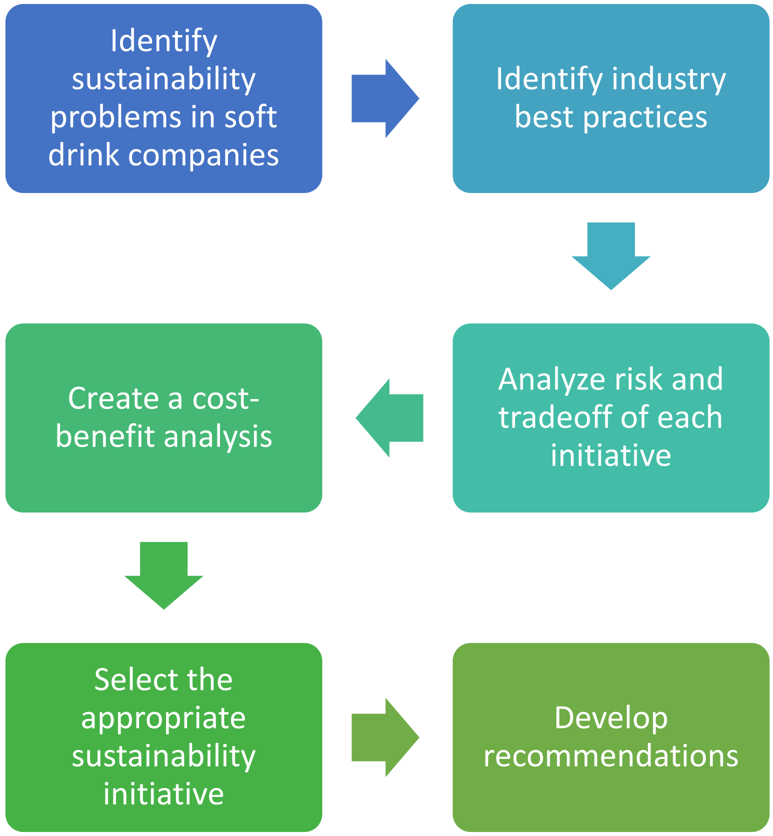

Figure 1. The Design Approach

4. Data Collection

We collected data to understand the sustainability problems, by submitting questions and the AHP surveys to three different soft drink companies in Kuwait. According to their responses, we were able to gather the data we needed and identified the problems. The design is based on an in-depth study of the sustainability of the soft drink supply chain. To investigate exactly what our sustainability problems are, we sent out a list of questions to the three companies. From the companies' answers, we noticed packaging and water treatment problems as the biggest sustainability issues. This list of questions helped us to conclude the identification phase of our project, where we collected data to identify the problems at hand. The AHP surveys were tested for consistency. Also, the survey asks the companies to rank the importance of each sustainability dimension, as well as their sub-pillars.

5. Results and Discussion

In this section, we present our results.

5.1 Questionnaire Analysis

We check the consistency of the answers for the AHP questionnaires given to us by the companies. The questionnaire asks the companies to rank the importance of each sustainability dimension, as well as their pillars. We first started by merging all surveys into one. After that, we created two matrices in MS Excel for the Environmental dimensions and the Social dimensions. Table 1 shows the results of AHP Environmental pillar dimensions. The criteria weights in Table 1 showed that the soft drink companies believe Resource Use to be the most important dimension in the environmental pillar of sustainability, and Innovation is the least important.

Table 1. AHP Environmental Pillar

Merged	Resource Use	Emissions	Innovation	Criteria Weights	Weighted sum	WSV
Resource Use	0.60	0.66	0.55	0.60	1.81	3.0141

Emissions	0.21	0.23	0.25	0.23	0.68	3.0055
Innovation	0.19	0.16	0.17	0.17	0.52	3.0039
					Average	**3.0078**

$\lambda\max = \frac{3.0141 + 3.0055 + 3.0039}{3} = 3.0078$; CI $= \frac{\lambda\max - n}{n-1} = \frac{3.0078-3}{3-1} = 0.0039$; CI = 0 indicates perfect consistency; Compute the Ratio CI/RI: CI/RI = 0.0039/0.58 (from tables) = 0.0068; Degree of consistency is satisfactory if CI/RI < 0.10 (Akman and Karaman 2022).

Also, Table 2 shows AHP Social Pillar Dimensions. The criteria weights in Table 2 show that the soft drink companies believe that Community is the most important dimension in the social pillar of sustainability, followed by Human Rights, then Product Responsibility, and finally Workforce.

Table 2. AHP Social Pillar

Merged	Community	Human Rights	Workforce	Product responsibility	Criteria Weights	Weighted sum	WSV
Community	0.3	0.36	0.3	0.25	0.30	1.2	4.03531
Human Rights	0.21	0.25	0.3	0.25	0.25	1.01	4.03133
Workforce	0.21	0.18	0.21	0.25	0.21	0.85	4.02491
Product responsibility	0.28	0.24	0.2	0.24	0.24	0.96	4.02887
						Average	4.03011

$\lambda\max = \frac{4.03531 + 4.03133 + 4.02491 + 4.02887}{4} = 4.03011$; CI $= \frac{\lambda\max - n}{n-1} = \frac{4.03011-4}{4-1} = 0.0100$; CI = 0 indicates perfect consistency; Compute the Ratio CI/RI: CI/RI = 0.0100/0. 0.90 (from tables) = 0.91; Degree of consistency is satisfactory if CI/RI < 0.10.

5.2 Sustainability Scores and Firm Value Nexus

In this section, we studied the relationship between firm value and sustainability scores using the Environmental, Social, and Governance (ESG) scores as proxies for sustainability performance. We collected all the variables from Refinitiv (aka Thomson Reuters) database. Refinitiv database houses both company financial data and corporate governance characteristics. The data belongs to the Beverages industry worldwide for the period 2011-2021. This is cross-country data collected from 28 different countries. As a proxy for firm value, we use Tobin's Q ratio. It is calculated as the company's market capitalization and total liabilities scaled by total assets. The ESG score, Environmental, Social, and Governance pillar scores, and their sub-pillar scores are directly used from the Refinitiv database. In addition, by following prior studies in the literature (Karaman et al. 2020; Fernandes et al. 2022; Kuzey et al. 2022), we also collected company financials and corporate governance characteristics. The corporate characteristics include *CSR_Sustainability_Committee* (takes a value of 1 if the committee exists, and 0 otherwise), *Board_Size* (number of board members in the board of trustees), *Board_Gender_DiversityPercent* (percent of female board members in the board of trustees), *CEO_Chairman_Duality* (indicating whether the same person is the CEO and the chair of the board of trustees), and *Non_Executive_Board_Members* (percent of independent board members in the board of trustees). The corporate financials include *FirmSize* (natural logarithm of total assets), *ROA* (earnings before interest and taxes scaled by total assets), *Leverage* (total liabilities divided by total assets), and *Free_Float_Percent* (percent of shares circulating freely in the stock market). The descriptive statistics of the variables are presented in Table 3.

Table 3. Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Tobin's Q Ratio	642	2.776	2.613	0.533	27.662
ESG	642	44.121	22.874	0.776	93.572
Environmental_Pillar	642	42.227	28.506	0	97.942

Social_Pillar	642	43.120	25.657	0.807	94.191
Governance_Pillar	642	48.343	24.099	0.400	96.434
Resource_Use	642	43.497	31.887	0	99.438
Emissions	642	45.319	31.372	0	99.438
Environmental_Innovation	642	28.736	32.237	0	95.588
Workforce	642	50.364	28.563	0.521	99.495
Human_Rights	642	32.550	33.098	0	96.154
Community	642	49.560	28.716	0	99.479
Product_Responsibility	642	45.361	30.924	0	99.194
CSR_Sustainability_Committee	567	0.732	0.443	0	1
Board_Size	642	11.358	4.268	1	33
Board_Gender_DiversityPercent	642	15.130	13.155	0	63.636
CEO_Chairman_Duality	642	0.287	0.453	0	1
Non_Executive_Board_Members	642	72.007	20.302	0	100
FirmSize	642	22.256	1.627	14.611	26.271
ROA	642	0.104	0.085	-0.307	0.552
Leverage	642	0.532	0.170	0.132	0.979
Free_Float_Percent	641	62.148	28.596	0.421	100

We also looked at Pearson's correlation between the variables. These are presented in Table 4.

Table 4. Correlation Coefficients

No	Variable	1	2	3	4	5	6	7	8	9	10
1	Tobin's Q Ratio	1									
2	ESG	-0.26*	1								
3	Environmental_Pillar	-0.27*	0.91*	1							
4	Social_Pillar	-0.24*	0.95*	0.84*	1						
5	Governance_Pillar	-0.15*	0.67*	0.44*	0.48*	1					
6	Resource_Use	-0.26*	0.87*	0.94*	0.84*	0.37*	1				
7	Emissions	-0.24*	0.83*	0.93*	0.73*	0.42*	0.79*	1			
8	Environmental_Innovation	-0.18*	0.62*	0.65*	0.56*	0.38*	0.50*	0.54*	1		
9	Workforce	-0.19*	0.86*	0.84*	0.86*	0.43*	0.84*	0.78*	0.45*	1	
10	Human_Rights	-0.17*	0.82*	0.71*	0.89*	0.40*	0.72*	0.59*	0.50*	0.70*	1
11	Community	-0.13*	0.72*	0.61*	0.79*	0.32*	0.63*	0.50*	0.45*	0.63*	0.66*
12	Product_Responsibility	-0.28*	0.74*	0.64*	0.77*	0.43*	0.61*	0.57*	0.44*	0.58*	0.49*
13	CSR_Sustainability_Committee	-0.17*	0.59*	0.58*	0.52*	0.41*	0.54*	0.56*	0.31*	0.52*	0.42*
14	Board_Size	-0.19*	0.29*	0.30*	0.30*	0.08*	0.33*	0.24*	0.13*	0.28*	0.26*
15	Board_Gender_DiversityPercent	-0.03	0.40*	0.37*	0.40*	0.22*	0.41*	0.29*	0.25*	0.36*	0.40*
16	CEO_Chairman_Duality	0.07	-0.03	-0.02	-0.03	-0.04	-0.06	0.01	0.02	-0.08*	-0.01
17	Non_Executive_Board_Members	-0.01	0.31*	0.23*	0.34*	0.21*	0.31*	0.16*	0.03	0.32*	0.41*
18	FirmSize	-0.34*	0.54*	0.55*	0.51*	0.28*	0.51*	0.51*	0.42*	0.47*	0.47*
19	ROA	0.60*	-0.14*	-0.13*	-0.12*	-0.11*	-0.12*	-0.14*	-0.06	-0.11*	-0.05
20	Leverage	-0.30*	0.40*	0.35*	0.42*	0.18*	0.36*	0.27*	0.32*	0.30*	0.36*

21	Free_Float_Percent	-0.16*	0.30*	0.24*	0.26*	0.32*	0.22*	0.20*	0.24*	0.15*	0.18*

No	Variable	11	12	13	14	15	16	17	18	19	20	21
11	Community	1										
12	Product_Responsibility	0.46*	1									
13	CSR_Sustainability_Committee	0.39*	0.38*	1								
14	Board_Size	0.20*	0.25*	0.22*	1							
15	Board_Gender_DiversityPercent	0.35*	0.23*	0.19*	0.05	1						
16	CEO_Chairman_Duality	-0.01	-0.01	-0.09*	0.03	0.09*	1					
17	Non_Executive_Board_Members	0.37*	0.02	0.11*	0.26*	0.32*	-0.05	1				
18	FirmSize	0.40*	0.36*	0.33*	0.34*	0.19*	0.11*	0.16*	1			
19	ROA	-0.06	-0.18*	-0.11*	-0.12*	0.01	0.12*	0.03	-0.16*	1		
20	Leverage	0.41*	0.35*	0.20*	0.07	0.22*	0.02	0.08*	0.38*	-0.27*	1	
21	Free_Float_Percent	0.19*	0.31*	0.16*	0.13*	0.24*	0.21*	-0.02	0.13*	-0.06	0.18*	1

We studied the following linear regression models:

Model 1
In this model, the ESG score and other control variables have been investigated to see their effects on Tobin's Q ratio. To examine this effect a multiple regression model has been developed. The results of the regression model are presented in Column 1 of Table 5. Overall, the regression model is significant as shown by the value of significance of *F*-stat and its *p*-value which is equal to zero, and it's significant because it's less than 0.05. The significant coefficients are those associated with *CEO_Chairman_Duality* (+), *ROA* (+), and *Free_Float_Percent* (-). The *ESG* score is not significant. This indicates that the ESG score in this model does not affect Tobin's Q ratio. Lastly, the value of the intercept is positive and significant since its *p*-value is equal to zero (< 0.05).

Models 2 to 4
In these models, the Environmental pillar score, Social pillar score, and Governance pillar score are entered into the regression model separately. The results of the regression analysis are presented in Columns 2-4 of Table 5. The results show that the Environmental pillar score is significant at a 10% level (weak significance). Hence, the Environmental pillar score has a weak negative effect on Tobin's Q ratio.

Models 5 and 6
In these models, the sub-pillars of the Environmental and Social pillar scores are entered into the regression model separately. The results of the regression analysis are presented in Columns 5-6 of Table 5. The results indicate that the Environmental sub-pillars and Social sub-pillars have no association with Tobin's Q ratio.

Table 5. Sustainability and Firm Value Nexus by Studying Linear Relationships

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Tobin's Q Ratio is the dependent variable					
ESG	-0.0044 (-0.77)					
Environmental_Pillar		-0.0073* (-1.70)				
Social_Pillar			-0.0019 (-0.39)			
Governance_Pillar				0.00072		

				(0.18)		
Resource_Use					-0.0060 (-1.21)	
Emissions					-0.0025 (-0.53)	
Environmental_Innovation					0.0021 (0.68)	
Workforce						0.00049 (0.10)
Human_Rights						-0.00052 (-0.13)
Community						0.0054 (1.30)
Product_Responsibility						-0.0050 (-1.41)
CSR_Sustainability_Committee	0.095 (0.41)	0.19 (0.84)	0.040 (0.19)	-0.0057 (-0.03)	0.20 (0.90)	-0.0018 (-0.01)
Board_Size	-0.012 (-0.58)	-0.0097 (-0.46)	-0.012 (-0.57)	-0.013 (-0.59)	-0.0068 (-0.31)	-0.0071 (-0.33)
Board_Gender_DiversityPercent	0.0082 (1.15)	0.0098 (1.37)	0.0077 (1.07)	0.0071 (1.01)	0.010 (1.39)	0.0069 (0.95)
CEO_Chairman_Duality	0.41** (2.18)	0.40** (2.13)	0.42** (2.22)	0.42** (2.28)	0.38** (2.02)	0.41** (2.19)
Non_Executive_Board_Members	0.0067 (1.48)	0.0064 (1.47)	0.0063 (1.39)	0.0057 (1.27)	0.0074* (1.66)	0.0029 (0.59)
FirmSize	-0.40*** (-6.23)	-0.38*** (-5.82)	-0.41*** (-6.53)	-0.42*** (-6.91)	-0.38*** (-5.91)	-0.42*** (-6.61)
ROA	14.7*** (14.32)	14.8*** (14.41)	14.7*** (14.24)	14.7*** (14.27)	14.7*** (14.19)	14.5*** (13.95)
Leverage	-0.60 (-1.07)	-0.60 (-1.08)	-0.61 (-1.07)	-0.67 (-1.20)	-0.63 (-1.12)	-0.72 (-1.24)
Free_Float_Percent	-0.010*** (-3.39)	-0.011*** (-3.49)	-0.011*** (-3.53)	-0.011*** (-3.47)	-0.011*** (-3.58)	-0.010*** (-3.24)

Constant	10.7***	10.1***	10.9***	11.1***	10.3***	11.2***
	(8.05)	(7.64)	(8.29)	(9.08)	(7.65)	(8.37)
N	566	566	566	566	566	566
Adj. R^2	0.416	0.419	0.416	0.416	0.418	0.416
F-stat	41.326	41.729	41.249	41.229	34.825	31.995
p-value	0.000	0.000	0.000	0.000	0.000	0.000

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Nonlinear regression analysis
Due to the unsatisfactory results with linear models, we also studied the following non-linear relationships. We included the square of the ESG scores to study any U-shaped or inverted U-shape relationships. We rerun all the regression analyses for Models 1 to 6. The results of the regression models are presented in Table 6. The result shows that the overall regression models are significant as shown by the value of significant *p*-value (<.01). In Column 1 of Table 6, the ESG score coefficient shows a weak (<.10) negative effect on Tobin's Q ratio. In Column 2 of Table 6, the Environmental pillar score has a U-shape relationship with Tobin's Q ratio (the Environmental pillar score has a negative relationship and the square of the Environmental pillar score has a positive relationship). Finally, the Social, Governance scores and sib-pillars of Environmental and Social scores have no relationship with Tobin's Q ratio (except for the weak negative product responsibility score).

Table 6. Sustainability and Firm Value Nexus by Studying Non-Linear Relationships

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Tobin's Q Ratio is the dependent variable					
ESG	-0.029*					
	(-1.69)					
ESG^2	0.00026					
	(1.53)					
Environmental_Pillar		-0.030**				
		(-2.30)				
Environmental_Pillar^2		0.00024*				
		(1.84)				
Social_Pillar			-0.014			
			(-0.97)			
Social_Pillar^2			0.00013			
			(0.90)			
Governance_Pillar				0.0056		
				(0.37)		
Governance_Pillar^2				-0.000048		
				(-0.33)		
Resource_Use					-0.024	
					(-1.60)	

Resource_Use^2					0.00016 (1.27)	
Emissions					-0.0021 (-0.14)	
Emissions^2					0.0000082 (0.06)	
Environmental_Innovation					0.0091 (0.94)	
Environmental_Innovation^2					-0.000080 (-0.72)	
Workforce						0.014 (0.96)
Workforce^2						-0.00013 (-0.98)
Human_Rights						-0.0051 (-0.49)
Human_Rights^2						0.000067 (0.60)
Community						-0.0020 (-0.16)
Community^2						0.000068 (0.59)
Product_Responsibility						-0.019* (-1.80)
Product_Responsibility^2						0.00015 (1.42)
CSR_Sustainability_Committee	0.18 (0.77)	0.30 (1.29)	0.075 (0.34)	-0.019 (-0.09)	0.31 (1.29)	-0.018 (-0.08)
Board_Size	-0.012 (-0.56)	-0.0068 (-0.32)	-0.012 (-0.58)	-0.013 (-0.62)	-0.0077 (-0.35)	-0.013 (-0.59)
Board_Gender_DiversityPercent	0.0083 (1.16)	0.0091 (1.27)	0.0078 (1.08)	0.0073 (1.03)	0.010 (1.43)	0.0068 (0.94)
CEO_Chairman_Duality	0.37*	0.33*	0.41**	0.44**	0.33*	0.44**

	(1.96)	(1.76)	(2.19)	(2.30)	(1.68)	(2.29)
Non_Executive_ Board_Members	0.0065	0.0071	0.0060	0.0055	0.0077*	0.0033
	(1.46)	(1.63)	(1.33)	(1.22)	(1.72)	(0.66)
FirmSize	-0.40***	-0.36***	-0.41***	-0.42***	-0.38***	-0.43***
	(-6.24)	(-5.60)	(-6.56)	(-6.83)	(-5.70)	(-6.71)
ROA	14.6***	14.8***	14.6***	14.7***	14.7***	14.4***
	(14.13)	(14.47)	(14.09)	(14.25)	(14.04)	(13.73)
Leverage	-0.70	-0.73	-0.64	-0.65	-0.69	-0.67
	(-1.24)	(-1.31)	(-1.11)	(-1.17)	(-1.22)	(-1.13)
Free_Float_Percent	-0.010***	-0.010***	-0.011***	-0.011***	-0.011***	-0.0098***
	(-3.32)	(-3.31)	(-3.51)	(-3.48)	(-3.62)	(-3.13)
Constant	11.1***	10.1***	11.1***	10.9***	10.4***	11.5***
	(8.20)	(7.63)	(8.28)	(8.54)	(7.60)	(8.37)
N	566	566	566	566	566	566
Adj. R^2	0.418	0.421	0.416	0.415	0.418	0.415
F-stat	37.871	38.409	37.559	37.431	28.050	24.617
p-value	0.000	0.000	0.000	0.000	0.000	0.000

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In the linear multiple regression models, after we have several different models, we see that all the results in the multiple linear regression show that there is no relationship between the dependent variable and the independent variables (except a weak negative link with the Environmental pillar score). Then, when we started with the multiple nonlinear regression, it shows that there is no relationship between the dependent and independent except for the Environmental pillar. We got the curvilinear results by taking the square of the Environmental pillar and adding it to the other independent variables. After getting the results, we can see the coefficient in the environmental pillar has a negative value. On the other hand, the square environmental pillar has a positive value, and both together the Environmental pillar and its square give a curvilinear relationship. The U-shaped link will first show that the effect of Environmental initiatives first decreases firm value (since they are costly) up to a point, and then it starts increasing the firm value. This means the firms need to continue with the Environmental initiatives by following up with the results and this will have a long-term effect on the firm value.

5.3 Proposed Improvements

To have the intended effect on the performance of the system, we need to think creatively about process changes as well as additional activities to take part in during the Improve phase. In this context, we proposed the improvement of the packaging process using plant materials, known as Plant bottles. Plant-Bottle is an initiative introduced by Coca-Cola, and it is a fully recyclable plastic bottle that is partially made from sugar cane plants (Coca-Cola,2021). Plant Bottle is a good choice for a solution as it reduces carbon dioxide emissions by 30%. Figure 2 below shows the flowchart of how Plant Bottles are made.

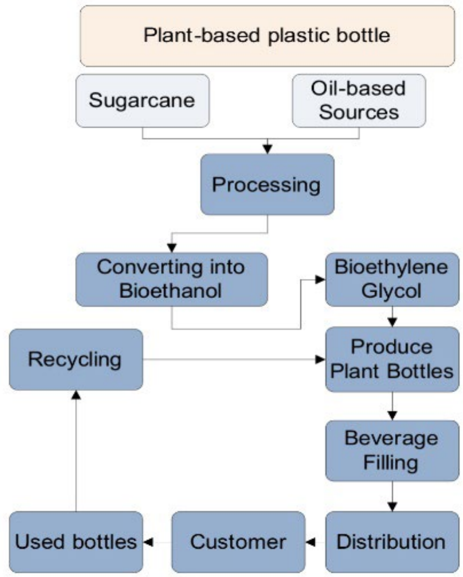

Figure 2. Suggested Packaging Solution

Figure 2 illustrates the bottles being produced from plant-based plastic material. These materials are normally produced from oil-based and sugarcane sources. Then it undergoes different processing steps to produce the bioethanol material which is further processed to be used in forming plant bottles. Furthermore, these bottles should have a recycling plant by establishing a collection system for the use of plant bottles to be remanufactured.

Furthermore, Recycled Polyethylene terephthalate (rPET) is suggested to replace PET. rPET is a type of plastic that is recycled and used to produce packaging including plastic bottles and food containers. rPET uses less energy than virgin PET to produce. As a result, rPET has a much lower carbon footprint, as it reduces GHG emissions by 71% (Evergreen, 2021). This suggestion is in line with the sustainability goals of this project. Using, less energy will achieve both economic and environmental issues by saving the cost of energy and reducing emissions.

We decided to visit all three companies and suggest rPET as a starting point for sustainable packaging. We used benchmarking for this, as Coca-Cola and other international soft drink companies have already started using rPET in their packaging. Additionally, PlantBottle manufacturing's capital investment will be very high. The reason behind this is that Kuwait will have to bring the raw materials (sugar cane) from outside sources. Thus, rPET packaging has been suggested as a solution for companies.

Moreover, the local soft drink company we pursued did not follow a water treatment technique. We used benchmarking to gather information on the most popular and most used water treatment techniques in the beverage industry: ultrafiltration and reverse osmosis (RO).
RO is a water treatment process that applies water under massive amounts of pressure so that it can be demineralized and deionized through the RO membrane (Woodard 2019). RO is used in small and large water flow applications, meaning it can be used in industries as well as homes. The flow chart below shows the five stages of RO.

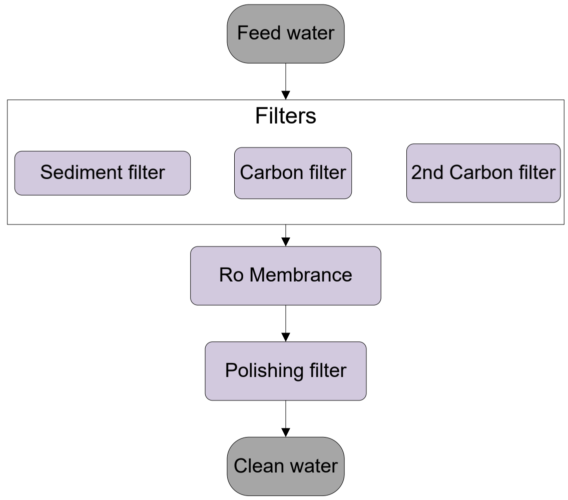

Figure 3. Reverse Osmosis Flowchart

Continuing onto what Woodard (2019) has stated, Ultrafiltration is the action of water purification through a semipermeable membrane, and it is quite like RO. Ultrafiltration uses a fiber membrane which is hollow to stop the microscopic contaminants from going into the water. The figure below shows the five steps of ultrafiltration.

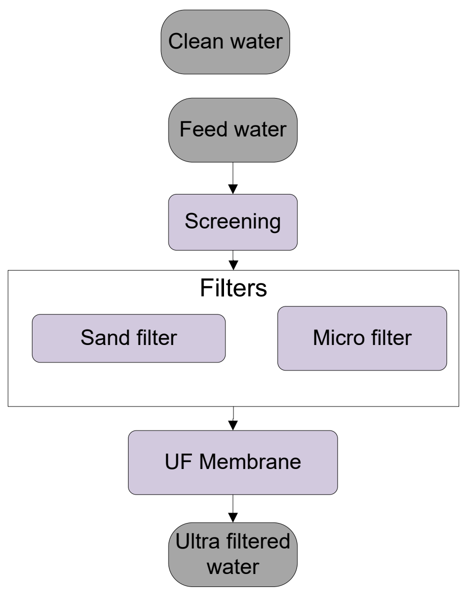

Figure 4. Ultrafiltration Flowchart

5.4 Simulation Model

To get a better understanding of the process of RO, we decided to create an Arena Simulation model of it.
The first model we created was a base model which does not have any water treatment implementation techniques. In the base model, tank 1 and tank 2 are filled with 50 and 60 liters of water respectively. The mixing tank then mixes this 110L of water, and the clean water (30L) gets sent to the clean water tank. The dirty/unclean water goes to the wastewater tank and it does not get used, it gets disposed of. This means that the base model is showing 80L of water that ultimately goes to waste.

Figure 5 shows the completed Arena simulation, where we used several mixing tanks. We added also our reverse osmosis tank and added the flows which represent the five filters in the reverse osmosis process. The simulation starts with two tanks of feed water as inputs. The first feed tank has an input of 50L, and the second tank has an input of 60L. The feed water from both tanks goes into the mixing tank (110L), and the levels separate the clean water from the dirty water. The clean water goes into the clean water tank (30L). The remaining 80L of dirty water goes through the five stages of reverse osmosis where all the contaminants are removed from the water. The simulation shows that 25% of water is cleaned in the reverse osmosis filters, resulting in 20L out of 80L that gets cleaned.

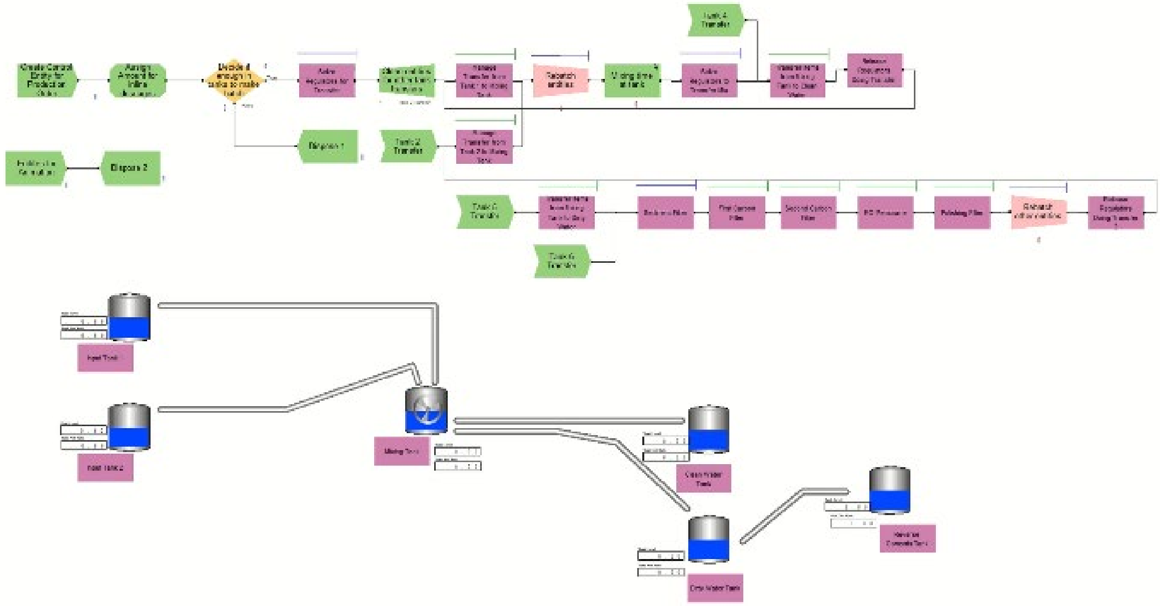

Figure 5. Arena Simulation after Implementing RO

6. Conclusion

To conclude, we were able to successfully fulfill the objectives of satisfying the United Nations Goals by reducing packaging waste, and water waste. 25% of water waste was saved through the RO technique. The methods were suggested to the soft drink companies and are being implemented in the future. Continuous checkups will be done to further test the companies' abilities to adapt to these sustainable practices. In the end, since the food and beverage industry is causing a lot of environmental damage, it is our ethical and professional responsibility to find methods to make this industry more sustainable.

The feasibility study showed that rPET is a better choice for the packaging issue, as benchmarking showed that it is already being used by other international companies around the world. The study also showed that RO is a better choice for water treatment as it removes more contaminants than ultrafiltration and that it has a longer lifespan as well. Arena simulation also proved that RO does in fact save 25% of feed water that goes into the system. By conducting a feasibility analysis, choosing between alternative solutions, creating a real-life simulation of water treatment, and conducting a regression analysis, we were able to find several different methods of evidence that prove that there is always a way to become more sustainable. Finally, analysis of the ESG data also showed that there is a U-shaped relationship between firm value and Environmental pillar score. This means the firms need to continue with the Environmental initiatives by following up with the results and this will have a sustained effect on the firm value.

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Biography

Kawthar Fadhlullah, Souad Alothman, Daniah Albahouh, Fay Alsanae, and Fayi Malallah, are all senior Industrial Engineering students at the American University of the Middle East. This study was conducted by all five students for their Bachelor of Science in Industrial Engineering degree. This research paper is the outcome of their project, before graduating and acquiring their degrees.

Abdullah S. Karaman is an Associate Professor of Industrial Engineering at the American University of the Middle East, Kuwait. He received his B.S. degree in Mathematics from Koç University, Istanbul, Turkey; M.S. degree in Industrial Engineering from Bilkent University, Ankara, Turkey; and Ph.D. degree in Industrial and Systems Engineering from Rutgers University, New Jersey, USA. His research and teaching activities have been in the areas of business analytics, supply chain management, sustainability, multi-criteria decision-making, and simulation modeling. His research has been supported by the Department of Homeland Security, USA, and Ankara Development Agency, Turkey. His works have been published in the European Journal of Operational Research, International Journal of Production Economics, Journal of Cleaner Production, Transport Policy, Sustainability Accounting, Management, and Policy Journal, and Journal of Air Transport Management, among others.