Title:

Designing a Sustainable Supply Chain Model for a Biofuel Industry to optimize and enhance the supply chain network and operations.

Abstract:

Biofuel is found to be an ideal replacement for fossil fuels due to its sustainable benefits (environmental & economic benefits). Due to the complex supply chain network involved in the conversion process of biofuels, this renewable energy sector has not been commercialized in a full-fledged manner. However, current developments of the model can be able to provide a wide range of business solutions in terms of profit and cost reduction but entirely lacks in terms of sustainability. Hence, the major aim of this research is to provide a sustainable supply chain model for the biofuel industry by incorporating sustainable practices in its operations. So, it is imperative to identify the factors affecting the sustainability of the model using sustainability indicators and develop alternative solutions to satisfy the sustainability and efficiency of the model. A hybrid model containing multiple objective goal programming is the preferred type to model the biofuel supply chain industry. This sustainable model will tend to enhance operations and commercialize the use of biofuels maximize profit, social, and economic benefits and reduce environmental impacts and inventory-related costs.

Project Justification:

Biofuels have gained attention as an alternative source of energy and competitor to crude oil because of the increase in demand and tremendous increase in energy consumption on a day to day basis especially in the transportation sector (Awudu, I. and Zhang, J., 2013). Biofuels can be generated using various domestic biomass sources which tends to emit less greenhouse-gas emission compared to the petroleum counterparts (Tong, K., You, F. and Rong, G., 2014). Due to the complex supply chain network involved in the conversion of raw materials to generate biofuels, the renewable energy is not commercialized as it is to be (Shabani, N. and Sowlati, T., 2016). Therefore, designing an effective supply chain model incorporating sustainability concepts not only help in commercialization but also can sustain over a long period of time.

Usually, the supply chain model is developed focusing on maximizing the value of biofuel supply chain and improving the process models by integrating the factors such as raw materials, conversion route, demand pattern and the final output. This model provides various solutions for strategic, tactical, and operational planning (Papapostolou, Kondili and Kaldellis, 2011). However, due to the rise in uncertainties in the biofuel supply chain such as the supply of raw materials, weather, cost of raw materials, technology, expansion plans, demand fluctuations can affect this model. So, to tackle the uncertainties optimization methods such as scenario and robust optimization were introduced in the model which was able to deal with uncertainties in a shorter scale which was not sufficient to handle large scale network. (Sharma, B., Ingalls, R.G., Jones, C.L. and Khanchi, A., 2013)Lately, simulation optimization was built-in the Mixed Integer Linear Program which was able to assess many scenarios in a real-world situation, but hybrid model containing stochastic programming with optimization was helpful in easing the complex mathematical calculations along with providing solutions for decision making of biofuel supply chains under various risks and uncertainties (Shabani, N. and Sowlati, T., 2016).

Though all the models provide a wide range of solutions the, sustainability of the model containing social, economic, and environmental aspects on a large-case scenario has not been addressed or established

effectively. Therefore, the major purpose of this project is to provide a sustainable supply chain design on a large-scale basis which satisfies today's environmental standards, economic prosperity, and social standards of living without negotiating future's prospects to meet their demands.

Project Aim:

To provide a sustainable supply chain design on a large-scale basis which satisfies today's environmental standards, economic prosperity, and social standards of living without negotiating future's prospects to meet their demands.

Project Objectives:

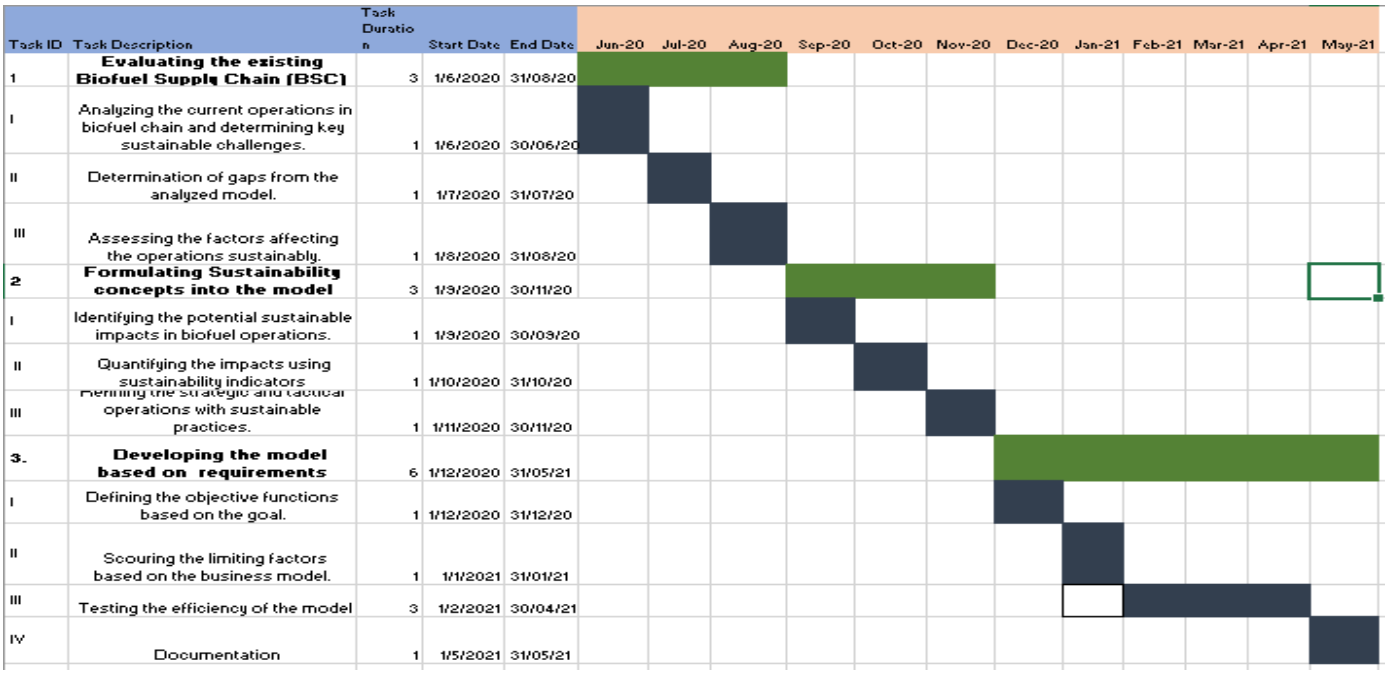
1. To analyze the previously existing models and formulate ideas to design a new model with the knowledge gaps found in the existing models.
2. To determine and address the sustainability issues like carbon emissions, land usage, employment issues in biofuel operation and formulate the sustainability concepts such as environmental, social, and economic concepts in this model.
3. To develop a hybrid model satisfying the sustainability conditions and stakeholders' interest in terms of Net profit.

Milestones and Tasks:

1. **Evaluating the existing Biofuel Supply Chain (BSC)**
    I. Analyzing the current operations in biofuel chain, stakeholders' requirements and determining key sustainable challenges.
    II. Determination of gaps from the analyzed model.
    III. Assessing the factors affecting the operations sustainably.
2. **Formulating Sustainability concepts into the model**
    I. Identifying the potential sustainable impacts in biofuel operations.
    II. Quantifying the impacts using sustainability indicators like **"**Life cycle energy efficiency, fossil energy ratio, Carbon footprint, Land use intensity and Emissions from carbon stock changes caused by land use**"**.
    III. Refining the strategic and tactical operations with sustainable practices.
3. **Developing the model based on the user and sustainability requirements**
    I. Defining the objective functions based on the goal/aim.
    II. Scouring the limiting/constraining factors based on the business model.
    III. Testing the efficiency of the model.
    IV. Documentation.

Project Timeline

Task ID	Task Description	Task Duration	Start Date	End Date
1	**Evaluating the existing Biofuel Supply Chain (BSC)**	3	1/6/2020	31/08/20
I	Analyzing the current operations in biofuel chain and determining key sustainable challenges.	1	1/6/2020	30/06/20
II	Determination of gaps from the analyzed model.	1	1/7/2020	31/07/20
III	Assessing the factors affecting the operations sustainably.	1	1/8/2020	31/08/20
2	**Formulating Sustainability concepts into the model**	3	1/9/2020	30/11/20
I	Identifying the potential sustainable impacts in biofuel operations.	1	1/9/2020	30/09/20
II	Quantifying the impacts using sustainability indicators	1	1/10/2020	31/10/20
III	Refining the strategic and tactical operations with sustainable practices.	1	1/11/2020	30/11/20
3.	**Developing the model based on requirements**	6	1/12/2020	31/05/21
I	Defining the objective functions based on the goal.	1	1/12/2020	31/12/20
II	Scouring the limiting factors based on the business model.	1	1/1/2021	31/01/21
III	Testing the efficiency of the model	3	1/2/2021	30/04/21
IV	Documentation	1	1/5/2021	31/05/21



Experimental Strategy and Approach:

This project tends to maximize the value of Biofuel Supply Chain (BSC) by optimizing the network operations by incorporating the uncertainties and sustainability factors like environment, social and economic concepts in the model. Therefore, to include the sustainability concepts in the model, a critical analysis and various research is done on the previously existing biofuel supply chain models to determine the factors and supply chain components which can have direct and indirect impact on environment and can tend to create socio-economic crisis. Using Mata, T.M. et al. (2011) research the potential social, economic and environmental impacts are determined using existing models and following impacts are as follows (i) Net GHG emissions, (ii) Emissions from carbon due to land use, (iii) Environmental risks, (iv) Energy use, (v) Materials used, (vi) Fertilizers, (vii) Chemicals used for extraction and biofuel production process (viii)Water usage and waste water (ix) Net profit generated and (x) Employment . The hybrid model of multiple objective goal programming is the preferred approach for modelling by assessing the stakeholders needs, evaluating sustainable requirements and geographic conditions involved in the biofuel supply chain network. Using various sustainability indicators with reference to Mata, T.M. et al. (2013) such as Life cycle energy efficiency, fossil energy ratio, Carbon footprint, Land use intensity and Emissions from carbon stock changes caused by land use, the sustainable evaluation of biofuel supply chain is performed. The five indicators determine the potential hazards quantitatively and provide insights for formulating the model and changes required in the operations.

Model Formulation:

A hybrid model of heuristic approach to the multiple objective goal programming is the method incorporated to include sustainability concepts in the model. With the solutions preferred above, weight/priority has been calculated using Analytical Hierarchical Process (AHP) to determine the priority. It is found that along with cost minimization, inventory minimization and profit maximization sustainability goals have been prioritized while defining the objectives by setting objectives as maximizing profit, reducing wastes and Co_2 emissions, and

maximum job creations as an objective function. Geographical Information System (GIS) is used for better decision-making purposes in terms of locations which can help to fetch more data about the locations and can be used for a large-scale purpose. Using GIS supplier locations, plants, warehouses, and logistic functions which can benefit the stakeholders. Constraints are set based on the demand required for the region with adequate land and water usage without harming or affecting the biodiversity and stakeholder needs. Along with that emission norms and standards are set as a constraint to limit the greenhouse gas emission. Further improvements required on the sustainability of the model can be carried out after analyzing the value of the model.

Expected Outcomes:

1. The application of model on a large-scale basis can improve and utilize social benefits like improving job opportunities and reducing poverties.
2. Reduction of greenhouse gas emission by following strict norms and procedures without affecting the value of the supply chain.
3. Profit maximization by sustainable business model.
4. Cost savings on inventory, productions, and logistics.
5. Commercializing the use of Biofuels by improving the supply chain process.

References

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