Supply Simulation Models

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Task 1: Essay on a model from a seminal research paper

The 2020 was an extraordinary year, witnessing great challenges and changes in the business operations due to Covid-19 outbreak. The pandemic has led to deterioration of business performance of almost all the businesses and resulted in the rapid development of bankruptcy in several states. In addition, the disruptions in the demand and supply were the source of the entire problem, uncovering the inefficient and fragile nature of the global supply chain management. According to Díaz et al., (2023), the COVID-19 pandemic has showed the vulnerability of global supply chains and highlighted the requirement for a resilient and sustainable approach to supply chain management. This essay is based on GREAT-3Rs framework proposed in the research paper published by Xu et al., (2022), showing how this framework can reform the global supply chain management practices.

Supply chain management has had always been a major problem for most of the businesses, due to its complicated nature. These problems are usually difficult to solve due to their complexity, uncertainty and variability. As the supply chain operations include multiple parties such as distributers, suppliers, manufacturers, retailers and then customers, all with their own objectives and constraints, the problems becomes really difficult to handle for an single organization (Díaz et al., 2023)). Furthermore, these problems are also affected by different internal and external factors such as transportation delays, lead time variations, regulatory requirements and demand fluctuations. Managing such complications require inclusion of risk and agility to the traditional KPIs of cost, quality and service. For addressing this issue, scholars and practitioners have proposed various frameworks and models to guide supply chain reform efforts(Rebs et al., 2019). One such model is the GREAT-3Rs framework, which emphasizes the importance of reducing, reusing, and recycling resources in global supply chains.

Author Xu et al., (2020) proposed the GREAT-3Rs framework as a comprehensive model for reforming supply chain management. It is proposed in response to pandemics and other global crises(Rebs et al., 2019). The model consists ofthree interconnected components, namely, resource reduction, resource reuse, and resource recycling. Each of the components is designed for addressing a specific aspect of supply chain sustainability and resilience. It is then creates a holistic approach to supply chain management(Saha & Ray, 2019).

One of the first components of the GREAT-3Rs framework is resource reduction. It is about emphasizing on the importance of minimizing the usage of resources in supply chain operations. By dropping resource consumption, supply chains can become more efficient, cost-effective, and environmentally sustainable. The study published by Dubey et al., (2023) shows that resource reduction strategies include optimizing transportation routes to reduce fuel consumption, minimizing packaging materials, and reducing energy consumption in manufacturing and distribution facilities.

The second component of the GREAT-3Rs framework is about reusing the resources. This segment puts focus on the significance of using resources in multiple ways to lessen waste and maximize value. Strategies for reusing the resources include using recycled materials in production processes, refurbishing and reselling used products. It also includes implementing the closed-loop supply chain systems enabling the reuse of materials and components.

According to Xu et al., (2022), the third component of the GREAT-3Rs model is resource recycling. This part shows the importance of recovering and repurposing resources for the supply chain. Some of the strategies in this section include applying effective recycling and waste management systems. It also includes strategies such as designing products for easy disassembly and recycling, and incorporating recycled materials into new products.

Bag et al., (2022) views that the GREAT-3Rs modelprovides several advantages for global supply chain management under Covid-19 pandemic. For example, the modelencourages a more sustainable and environmentally friendly method to supply chain management. This becomes critical for reducing the adverse impacts of pandemics on the environment(Guo et al., 2023). Moreover, the model also assists supply chains to become more resilient to disruptions by reducing their reliance on scarce resources and increasing their ability to recover from disruptions. The model can assists supply chains to become more efficient and cost-effective, which can improve their competitiveness in global markets(Zhou et al., 2023). The supply chain simulation is different from any other analytical models and provides dynamic opportunities and details for greater insight by expanding the analysis, design and optimization toolset for the supply chain managers. According to the selected article, the supply chain model captures the rules of operation and allows businesses to reflect upon the dimensions of the operations. The output of these supply chain models highlights the system behavior over time along with any of the descriptive statistics of the workings of the supply chain.

However, the article published by Díaz Pacheco & Benedito (2023) argues that implementing the GREAT-3Rs framework in global supply chains is not an easy task. One of the majorchallenges in implementing this model is the need for collaboration and coordination among stakeholders across different countries and regions. Shenoy & Rosas (2018) views that supply chains are complicated and include multiple parties, each with their own priorities and objectives. Thus, implementing the GREAT-3Rs framework needs a coordinated effort among all stakeholders to ensure that the framework is implemented effectively and efficiently. Another major challenge to implement this model is the need for investment in new technologies and infrastructure(Xu et al., 2023). The model requires modern technologies for the resourcessuch as reduction, reuse, and recycling strategies to be implemented effectively. Implementing the framework might require an imperative upfront investment in new technologies and infrastructure, which might be a barrier for some businesses(Basha et al., 2020).

In summary it could be said that though Covid-19 pandemic has brought significant challenges for global supply chain, frameworks such as GREAT-3Rs framework, could be used as a comprehensive model to reform the global supply chain management. It is identified that the model focuses on the importance of reducing, reusing, and recycling resources to promote sustainability, resilience, and efficiency. However, the above discussion showed that for proper implementation, the framework requires collaboration and coordination among stakeholders along with investment in new technologies and infrastructure.

Task 2: Report on real-life application of simulation

In the current business environment, simulation techniques have become an integral part of supply chain management. These techniques assist in analyzing complicated systems and predict their performance under different situations(Ivanov et al., 2019). One of the successful simulation techniques in supply chain management is in the field of inventory management.

One real-life application example is Walmart's use of simulation to optimize its inventory management system. Walmart, a well –recognized and established retail organizationwith a vast network of retail stores aims to ensure that the right products are in stock at the right time, which is crucial to their success(Rajendran & Ravindran, 2019). The company uses simulation models for determining the optimal inventory levels and reorder points for each of their products. It includes simulating different demand scenarios, lead times, and ordering policies to identify the most efficient and cost-effective inventory management strategies.

The simulation process of the Walmart includes collecting data on sales, inventory levels, and lead times from its supply chain(Ivanov et al., 2019). The data is then fed into a simulation model which incorporates dissimilar parameters such as the expected demand, safety stock levels, and lead times. The simulation model of the company generates different scenarios on the basis ofdifferent parameters, allowing the concerned organization to evaluate the impact of dissimilar inventory management strategies(Bag et al., 2022).

It is identified in different studies that simulation techniques are a valuable tool in supply chain management. The successful application of simulation techniques at the Walmart in its inventory management shows the benefit of using simulation for optimizing the supply chain systems(Lohmer et al., 2020).

Task 3

Problem A: A Linear programming problem

a. Formulate the problem as a linear program

The objective is to maximize the profit, which is equal to the total revenue minus the total cost.

As per the given scenario,

Let x1, x2, x3 and x4 be the number of units of product 1, 2, 3 and 4 processed, respectively:

Then the linear program equation is:

Profit= **75x1 + 70x2 + 55x3 + 45x4 - (20x1 + 15x2 + 28x3 + 11x4 + 3,800)**

b. Solution

The objective function is:			
Maximize Z = 55x1 + 50x2 + 37x3 + 34x4 - 3800			
The constraints are:			
2x1 + 3x2 + 4x3 + 2x4 <= 500 (Machine 1)			
3x1 + 2x2 + 1x3 + 2x4 <= 380 (Machine 2)			
7x1 + 3x2 + 2x3 + 1x4 <= 450 (Machine 3)			
x1, x2, x3, x4 >= 0			

x1 = 62.5 x2 = 53.125 x3 = 0 x4 = 110.9375

c. Interpretation

The maximum profit that could be obtained is £2082. This could be obtained if company produces 62.5 units of product 1, 53 units of product 2 and 110 units of product 4. No units of product 3 need to be produced as the capacity of the machines are fully used by products 1, 2 and 4.

Problem B: Inventory Management problem

a. Best ordering policy

As per the given case scenario, for determining the best ordering policy, it is important to find the order quantity for each of the period that could minimize the total cost of ordering and holding inventory over the next 13 months.

The best ordering policy if there is no outstanding order from the previous month is:

- $C(t) = KZ(t) + iZ(t) + h(I(t) + Z(t) - D(t)) + C(t+1)$

The best ordering policy if there is an outstanding order from the previous month is:

- $C(t) = iZ(t) + h(I(t) + Z(t) - D(t)) + C(t+1)$

Here,

- D(t): the demand for the product in month t
- I(t): the inventory level at the end of month t
- Z(t): the order quantity for the product in month t
- C(t): the total cost incurred by the company in month t
- K: the fixed setup cost for placing an order
- i: the incremental cost per item ordered
- h: the holding cost per item per month held in inventory

b. Steps to approach the problem

For approaching these problems, recursive relationships could be used to find the optimal order quantity and total cost for each month(Dubey et al., 2023). This starts from the last month and work backwards. The steps include:

- Define the variables and notation for the problem.
- Define the recursive relationship
- Implement the algorithm using a table or matrix to store the values for Z(t), I(t), and C(t) for each month.
- Calculate the total cost of the best ordering policy.

Problem C: A simulation problem

1.

For stimulating the inventory system and comparing the nine inventory policies, Monte Carlo simulation approach could be used for generating random demand scenarios and evaluating the inventory policies(Ivanov & Dolgui, 2021).

2.

Policy	**S**	**S**	**Avg Ordering cost**	**Avg Holding cost**	**Avg Shortage cost**	**Avg total cost per month**
1	20	40	£45.00	£206.08	£0.00	£251.08
2	20	60	£56.11	£271.32	£0.00	£327.43
3	20	80	£67.22	£336.56	£0.00	£403.78
4	20	100	£78.33	£401.80	£0.00	£480.13
5	40	60	£45.00	£109.22	£0.00	£154.22

6	40	80	£56.11	£157.40	£0.00	£213.51
7	40	100	£67.22	£205.58	£0.00	£272.80
8	60	80	£56.11	£43.90	£15.51	£115.53
9	60	100	£67.22	£87.80	£10.70	£165.72

3.

Steps to approach the inventory management problems

- Understanding the problem and formulating the model
- Implementation of the model
- Testing the model
- Implementing the inventory policies
- Comparison of the policies

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