INTRODUCTION TO COMPLEX SYSTEMS

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1.0 Introduction

This research will look into a company's supply chain management procedure. The intentional and planned administration of the transportation of products, services, data, and funds across an organization of interlinked organisations, from supplier to end consumers, is known as supply chain management. The basic purpose of supply chain management is to guarantee that items or services are manufactured, distributed, and made accessible to customers cost-effectively and effectively. Because of the intricate nature of supply chains, emerging technologies such as the IoT, blockchain technologies, and AI are being used to increase visibility, simplicity, and productivity. Supply chain management is critical to corporate success because it ensures that items reach customers at the ideal time, in the appropriate amount, and at the ideal cost.

2.0 Research aim and objectives

For organisational growth, many strong global executives place a premium on good supply chain management. The present research project is designed to explore the influence of several factors on future organisational growth (Agrawal ***et al.*** 2018). The conveyance of goods and services, information, and finances is a critical component of organisational development. The research objectives aid in the development of the study strategy. The research aims are as follows:

- To find out the consequences of fluctuating prices on the overall profit for various supply chain entities.
- To explore if dynamic pricing techniques improve the capacity of supply chains in the face of interruptions or shifts in economic conditions.
- To find out if price variability affects supply chain lead times and delivery efficiency.
- To find how the implementation of agent-based variable pricing techniques affects the operation of a multi-tier supply chain.

3.0 Research questions

The question that follows will be addressed in this study. The questions are written in alignment with the research's goals and objectives. As a result, people will be encouraged to connect the

question to the study's key objectives (Zekhnini ***et al.*** 2020). The subsequent research questions are discussed further below:

- What effects does variable pricing have on the total profit of the different supply chain entities?
- How can dynamic pricing techniques affect expenses associated with transportation, storage, and inventory holding?
- How does the implementation of agent-based price fluctuation techniques affect the efficacy within a multi-tier supply chain regarding inventory levels, prices, and fundamental efficiency?
- Does dynamic pricing affect supply chain time frames and order fulfillment efficiency?

4.0 Research methodology

A methodology for research is intended for collecting and accumulating knowledge and data in a meaningful manner to investigate the impacts of specific factors and, to a considerable extent, to help the supply chain management process.

Model Overview

The agent-based model represents a multi-tier supply network that includes manufacturers, vendors, distributors, and merchants. Each party portrays a supply chain unit, and they communicate by trading goods and data. The research will look at how variable pricing techniques affect inventory control, expenses, and the general efficiency of the supply chain (Ben ***et al.*** 2019). The model's setting is a modeled supply chain network in which agents engage and trade items. Demand trends, market circumstances, pricing computations, shipping expenses, and lead times are all control factors. The model's agents interact by exchanging products and sharing data. Suppliers supply raw ingredients to manufacturers, who then make items for wholesalers and retailers. Retailers meet client demand. Agents are linked in a multi-tiered system, allowing commodities to move along the supply chain.

Update rules

Demand Generation: Demand is generated by retail agents depending on client preferences and market circumstances.

Inventory Management: Inventory management includes adjusting inventory levels in response to accepted orders, manufacturing, marketing, and consumption.

Dynamic Pricing: Retailers modify prices according to factors such as current stock, demand, and rival pricing. Manufacturers may shift output in response to changes in demand and levels of stocks.

Order Fulfilment: Order fulfillment is done by distributors and retailers depending on the availability of stocks, lead times, and consumer demand.

Information Sharing: Agents communicate information regarding stock levels, orders, and price decisions to make educated judgments.

Simulation Steps

1. Initialize the supply chain system with the attributes and initial conditions of the agents.
2. Create patterns of demand for retailers.
3. By the present condition of the supply chain, agents update the level of stock, modify prices, and make production choices.
4. Allow encounters and choices to spread over the supply chain by simulating the passage of time.
5. Gather information on inventory levels, expenses, profitability, and other important variables.
6. Analyze the outcomes of simulations to determine the influence of dynamic pricing techniques on the performance of the supply chain.

Researchers may use this agent-based model for testing with different dynamic pricing algorithms, supply chain topologies, and scenarios to learn how price decisions impact the behavior of the whole supply chain and its efficiency metrics (Dolgui ***et al.*** 2018). Because it can represent numerous agents, record complicated interactions, simulate adaptable behavior, deal with uncertainty, and give an understanding of how supply networks function and respond to

varied tactics, agent-based modeling is appropriate for the supply chain management. Because of its adaptability and capacity to model real-world factors, ABM is an invaluable tool for researching and optimising supply chain systems (Ross ***et al.*** 2019). This method will assist in saving money and avoiding time wastage. The questionnaire will contain responses centered on information associated with the amount of tenure of positions in the organisation, which approaches are used in the organisation, how executives make decisions in times of recession, how management interacts with staff and worker perceptions of the degree of reliability and predictability for the company's future.

5.0 Research Approach

The research approach aids in understanding a researcher's understanding of the repercussions of the procedures used. Measuring and analysing the agent-based model's behavior in the context of researching the influence of dynamic pricing techniques on a multi-tier supply chain will require a mix of quantitative and qualitative methodologies (Behzadi ***et al.*** 2018).

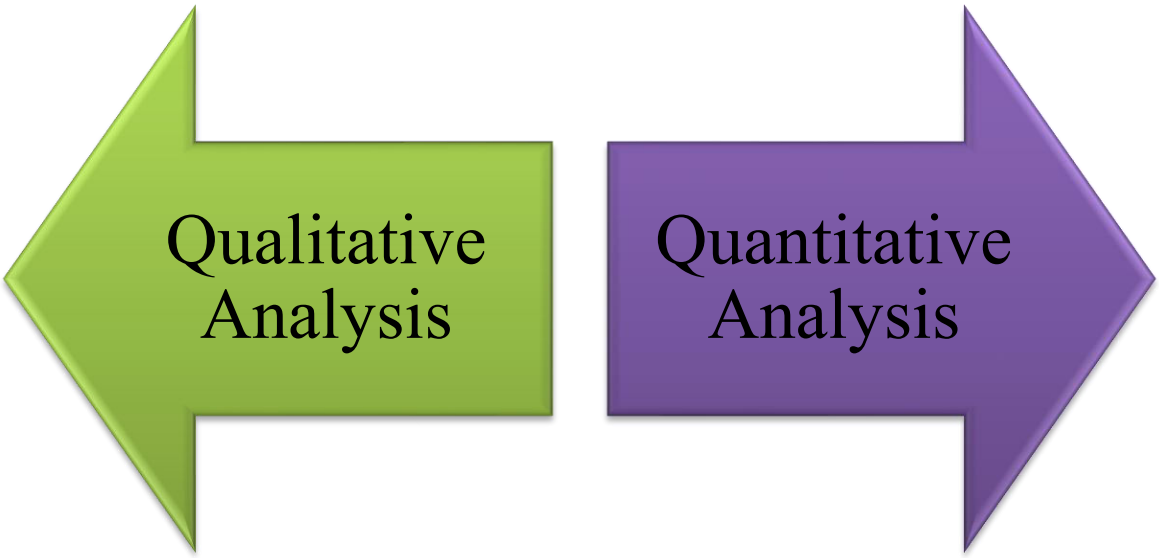

Figure 1: Research approach

(Source: self created)

This particular analysis will be directly related to the hypothesis and experimental issue. The following is a high-level overview of the measuring and analysis process:

Quantitative Metrics: Contrast inventory levels, expenses, order fulfillment, earnings, and revenue within dynamic pricing situations versus fixed price scenarios.

Scenarios for Simulation: Comparing dynamic pricing models to a fixed price baseline and doing sensitivity studies to determine how variations in parameters affect behaviour.

Visualization: Use diagrams and graphs to show data trends.

Statistical Analysis: Use statistical tests to establish the significance of discrepancies.

Qualitative Evaluation: Gather qualitative data for improved comprehension of agent decision-making.

Scenario Comparison: Determine the most effective dynamic pricing schemes.

Validation of Hypothesis: Determine whether or not the outcomes support the hypothesis.

Policy suggestions: Based on the findings, provide realistic suggestions.

The analytical method should be directly related to the hypothesis and experimental questions by investigating how the implementation of dynamic pricing strategies affects various elements of supply chain behaviour such as inventory levels, expenses, and overall efficiency. It seeks to give quantifiable facts and insights that will assist in answering the experimental questions and drawing conclusions regarding the hypothesis.

6.0 Identifying and analyzing

Finding current agent-based models in the literature that are connected to supply chain management including dynamic pricing methods is an important step in the study.

Existing Agent-Based Models in Supply Chain Management:

Supply Chain Optimization: Several ABMs are focused on optimizing supply chain activities, such as managing inventories, scheduling production, and distribution management. These models frequently employ agents to represent various supply chain stakeholders like vendors, manufacturers, and merchants.

Demand Forecasting: By modeling customer behaviour and market conditions, ABMs have been utilised to enhance demand forecasting. Individual consumers with diverse interests and purchase habits may be represented by agents in these models.

Pricing and Revenue Management: Certain ABMs investigate pricing methods inside supply chains. They might simulate how shops modify prices in response to levels of stock, demand, and competitive pricing (Dev ***et al.*** 2020). These models can assist in determining the effect of dynamic pricing on earnings and market shares.

Explanation of how this chosen model relates to and extends existing models

Encompass Dynamic Pricing tactics: Evaluate how it will include and maybe build on existing dynamic pricing tactics. This might imply more sophisticated price algorithms or a greater range of pricing circumstances.

Model Complexity: Determine the level of intricacy of existing models is needed. Depending on the research's objective, researchers could opt to develop a more sophisticated, delicate model that accounts for more supply chain intricacies, or they might want to look into a simpler model to emphasize key dynamics.

Data Utilisation: Determine how the model will incorporate real-world data if it is available. Including data in your ABM may boost its authenticity and prediction potential.

Comparative Analysis: Comparing the results of the model to those of current models to identify differences and insights relevant to the topic at hand.

Validation and Sensitivity Testing: Validate the model's hypotheses and parameters remain well-validated, and run sensitivity analysis to investigate the durability of the results.

Implications for Practice: Analyse the practical supply chain management implications associated with the model's findings. How can businesses and politicians use the model's findings

Documentation: Record the model thoroughly, encompassing assumptions, variables, and code, to ensure accessibility and reproducibility for future researchers.

Experts can develop a model that offers significant insights and improves the current debate in the areas of supply chain management along dynamic pricing strategies by thoroughly assessing these elements and constructing previous models while addressing particular research issues.

7.0 Conclusion

So, to summarise the entire part, this section has provided a thorough understanding of the efficacy of the research. All steps of system construction have been described in full. Significant objectives have been associated with observations and outcomes in this part to help gain an improved comprehension of the research. To render the research more efficient and instructive, many standard features of the model were examined. The primary study objectives are accomplished and explained in depth within those sections.

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