MODELLING AND SIMULATION BASED OPTIMISATION OF FOOD GRAIN SUPPLY CHAIN USING MULTI AGENT SYSTEM AND GENETIC ALGORITHM- WITH REFERENCE TO PUBLIC DISTRIBUTION SYSTEM

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ABSTRACT

Government intervenes at all stages of food grain supply chain (FGSC) through Public Distribution System (PDS) in order to provide food security to the population and fair prices to the farmers. These objectives can be achieved with an efficient and effective distribution system which will address the complexity and inherent decentralization of activities present in the system. Researchers have observed that due to its complex nature PDS has several issues within all its stages namely, procurement, storage, and distribution, leading to inefficiencies in the supply chain. Moreover, the research addressing PDS from the perspective of supply chain management either just describes the supply chain or analyses it with a focus on one of the niche areas of supply chain. Therefore, the objective of the present study is to develop a supply chain model to address these inefficiencies.

The study was conducted in three phases. The first phase of study maps the PDS supply chain for understanding various agents involved in the PDS, describes their interaction and presents the environment in which they are working. The mapping act as base for modelling building and also present the complexities in the system. The second phase models the processes in the PDS on a software platform and used these models for scenario generation and further understanding the impact of different supply chain policies on the performance of the PDS. The third phase of study optimises the inventory policy in TPDS using simulation optimization via genetic algorithm.

In the first phase, the mapping is done using principles of multi agent system (MAS). The PDS is mapped as two different stages. The first stage covers the processes of procurement and storage, and the second stage covers the distribution process. The study also proposes the performance matrix for the PDS supply chain based on various processes of the supply chain.

In the second phase, the processes discussed in the mapping are modelled using MAS. We developed a customised model specific to the context of Targeted Public Distribution System (TPDS) and open market sales as the objectives of these processes are different to that of a generic supply chain. NetLogo programmable modelling environment is used for modelling the supply chain.

In the third phase, we adopted a two-stage modelling approach for this purpose. In the first stage, a simulation model was developed for periodic review, base-stock policy with appropriate assumptions. The objective here was to minimise Total Supply Chain Cost (TSC). The TSC consists of three cost elements namely, ordering cost, holding cost and shortage cost. The three cost elements in turn depend on the inventory policy parameters such as review periods and base stock levels at various echelons. In the second stage, a Genetic algorithm (GA) based optimization approach is used. The GA implementation is based on simulation for a given set of policy parameters. The aim of GA is to identify an optimal set of policy parameters of the system.

Key Words: Food Grain Supply Chain, Public Distribution System, Multi Agent System, NetLogo, Genetic Algorithm

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ABBREVIATIONS

AAY- Antyodaya Anna Yojana

APL- Above Poverty Line

BPL- Below Poverty Line

CWC- Central Warehouse Corporation

FCI-Food Corporation of India

FGSC- Food Grain Supply Chain

FPS- Fair Price Shop

GA- Genetic Algorithm

IC- Issue Centre

MAS- Multi Agent System

MSP- Minimum Support Price

PDS- Public Distribution system

SD- Storage Depot

TPDS- Targeted Public Distribution System

TSC- Total Supply Chain Cost