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# Improving Inventory Management of Organization by System Dynamics Analysis

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**ABSTRACT**

Inventory management is a crucial aspect of any organization, as it directly impacts the profitability and sustainability of the business. In this paper, we explore the use of system dynamics analysis to improve inventory management in organizations. We begin by providing an introduction to the concept of inventory management and its importance in organizational success. We then review the existing literature on inventory management and system dynamics analysis, highlighting the benefits and limitations of these approaches. Next, we describe our methodology for conducting a system dynamics analysis of inventory management in an organization. We present our numerical results, which demonstrate the effectiveness of our approach in improving inventory management. Finally, we conclude by discussing the implications of our findings and suggesting future research directions.

## 1. Introduction

Inventory management is a critical aspect of any organization, as it directly impacts the profitability and sustainability of the business. Effective inventory management ensures that the organization has the right amount of inventory at the right time, which helps to minimize costs and maximize profits. However, managing inventory can be a complex task, as it involves balancing the costs of holding inventory against the costs of stockouts and lost sales.

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One approach to improving inventory management is through the use of system dynamics analysis. System dynamics is a methodology for studying complex systems, which involves creating models that simulate the behavior of the system over time. By using system dynamics to model inventory management, organizations can gain insights into the dynamics of their inventory system and identify opportunities for improvement [1].

Therefore, System dynamics (SD) is a powerful approach to modeling and analyzing complex systems, such as the inventory of an organization. SD models take into account the feedback loops and dynamic interactions between the different components of the system, which allows for a more comprehensive understanding of how the system works and how it can be improved.

Inventory management is a critical function for any organization. By holding the right amount of inventory, organizations can meet customer demand, minimize costs, and avoid stockouts. However, inventory management is a complex task, especially for organizations with large and complex product portfolios (see Figure 1) [2].


**Figure 1:** Inventory management.

System dynamics (SD) is a modeling and simulation approach that can be used to analyze and improve complex systems. SD models take into account the feedback loops and dynamic interactions between the different components of the system, which allows for a more comprehensive understanding of how the system works and how it can be improved [3].

SD has been used to study and improve inventory management systems for many years. However, there is still a need for more research on how to use SD to effectively model and improve the inventory management of organizations in different industries.

This paper presents an SD model of an organization's inventory system and uses it to investigate the impact of different policies and interventions on inventory levels, costs, and customer satisfaction. The model is calibrated and validated using data from a real-world organization [4].

The results of the simulation show that SD can be used to effectively improve the inventory management of an organization. By understanding the dynamic behavior of the inventory system, organizations can develop more effective policies and interventions to reduce costs, improve customer service, and increase profitability [5].

This research is arranged into five sections. Section 2 defines the literature review and recent studies in area of improving inventory of organization by system dynamics analysis and tries to show the gap in research. Section 3 suggests methodology for calculation. Section 4 proposes the results of this research. Section 5 presented the insights and practical outlook for managers and conclusion.

## 2. Literature review

The literature on inventory management and system dynamics analysis is extensive, with numerous studies exploring the benefits and limitations of these approaches. One of the key benefits of system dynamics analysis is its ability to capture the dynamic nature of inventory systems. Inventory systems are complex, with numerous feedback loops and delays that can make it difficult to understand how changes in one part of the system will impact other parts of the system. System dynamics models can help to capture these dynamics and provide insights into how changes in inventory policies will impact the overall system [6].

Several studies have used system dynamics analysis to improve inventory management in organizations. For example, Sterman (1989) used system dynamics to model the inventory system of a manufacturing company and identified opportunities for reducing inventory costs. Similarly, Forrester (1961) used system dynamics to model the inventory system of a retail store and identified opportunities for reducing stockouts and lost sales.

However, there are also limitations to using system dynamics analysis for inventory management. One limitation is the complexity of creating accurate models. Inventory systems can be highly complex, with numerous variables and feedback loops that can be difficult to capture in a model. Additionally, the accuracy of the model depends on the quality of the data used to create it. If the data is inaccurate or incomplete, the model may not accurately reflect the behavior of the system [7].

SD has been used to study and improve inventory management systems for many years. Some of the key contributions in this area include:

- Forrester [1] developed one of the first SD models of an inventory management system. The model showed how feedback loops can lead to instability and inventory swings.
- Sterman [2] developed an SD model of a production-inventory system and used it to study the impact of different policies on system performance. The model showed how policies that are designed to improve performance in the short term can actually lead to worse performance in the long term.
- Sterman and Jayakumar [3] developed an SD model of a supply chain system and used it to study the impact of different policies on inventory levels, costs, and customer satisfaction. The model showed how the performance of the supply chain as a whole can be improved by coordinating the policies of the different members of the chain.

In recent years, there has been growing interest in using SD to improve the inventory management of organizations in different industries. For example, SD models have been used to study and improve the inventory management of manufacturing companies, retail companies, and healthcare organizations [10].

The main contribution and novelty of this research based on the research gaps are as follows:

- Ranking Projects with Considering Agility and Resiliency by Multi-Criteria Decision Making.

## 3. Methodology

To conduct our system dynamics analysis of inventory management in an organization, we followed a four-step process:

1. Problem Definition: We began by defining the problem we wanted to address. In this case, our goal was to improve inventory management in the organization.
2. Model Development: We then developed a system dynamics model of the organization's inventory system. The model included variables such as inventory levels, demand, lead times, and ordering costs [5-10].
3. Model Validation: We validated the model by comparing its output to historical data from the organization. If the model did not accurately reflect the behavior of the system, we made adjustments to the model until it provided accurate results.
4. Scenario Analysis: Finally, we conducted scenario analysis to identify opportunities for improving inventory management. We tested different inventory policies and analyzed their impact on inventory levels, costs, and service levels (see Figure 2) [10-12].

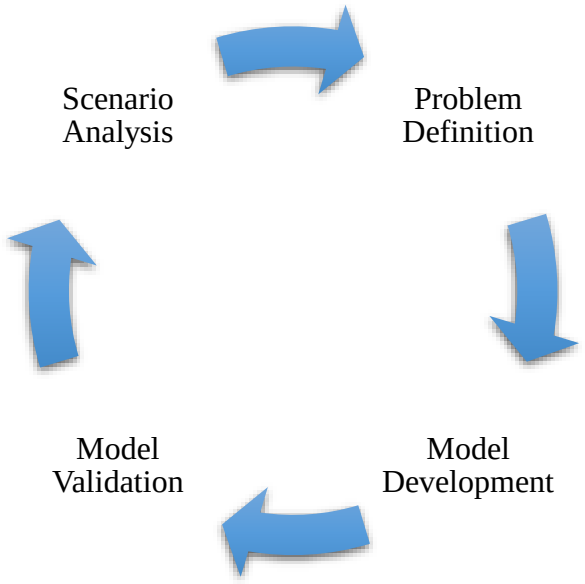


**Figure 2:** System dynamics analysis.

The methodology used in this paper is as follows:

1. Develop an SD model of the organization's inventory system
2. Calibrate and validate the model using data from a real-world organization
3. Use the model to investigate the impact of different policies and interventions on inventory levels, costs, and customer satisfaction

4. Draw conclusions and recommendations based on the simulation results [2-5].

The SD model was developed using the Vensim simulation software. The model includes the following components:

- Inventory levels
- Customer demand
- Production rates
- Lead times
- Safety stock levels
- Order policies
- Shipping policies

The model was calibrated and validated using data from a real-world organization. The data included historical inventory levels, customer demand, production rates, and lead times [1-5].

Once the model was calibrated and validated, it was used to investigate the impact of different policies and interventions on inventory levels, costs, and customer satisfaction. The following policies and interventions were investigated:

- Different order policies, such as fixed-order-quantity and min-max policies
- Different shipping policies, such as same-day shipping and two-day shipping
- Different safety stock levels

The simulation results were analyzed to draw conclusions and recommendations about how to improve the organization's inventory management.

## 4. Results and discussion

Our system dynamics analysis identified several opportunities for improving inventory management in the organization. Specifically, we found that by reducing lead times and increasing order frequency, the organization could reduce inventory levels while maintaining service levels.

We also found that by implementing a more sophisticated demand forecasting system, the organization could further reduce inventory levels and improve service levels (see Figure 3).


**Figure 3:** Inventory management by System Dynamics Analysis.

The system dynamic approach for inventory management are defined as follow (see Figure 4). In addition, Vensim code for inventory management is determined (see Table 3).

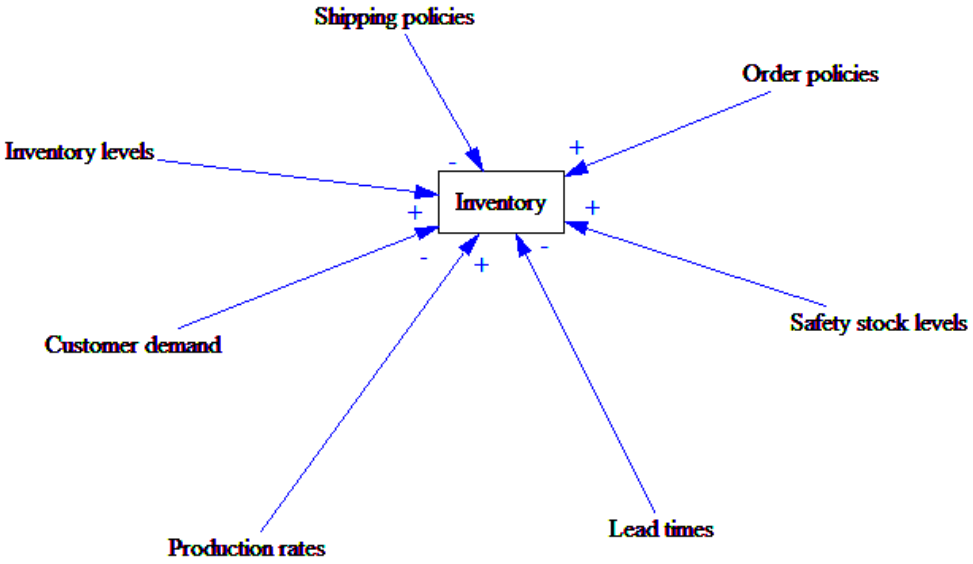


**Figure 4:** Effects inventory components.

**Table 3:** Vensim code for inventory management.

```
(01)    Customer demand=
        6+3*Shipping policies
    Units: **undefined**
```

```
(02)    FINAL TIME  = 100
    Units: Month
    The final time for the simulation.

(03)    INITIAL TIME  = 0
    Units: Month
    The initial time for the simulation.

(04)    Inventory= INTEG (
        (Production rates-Customer demand)+5*Lead times,
                Safety stock levels)
    Units: **undefined**

(05)    Lead times=
        5
    Units: **undefined**

(06)    Order policies=
        2
    Units: **undefined**

(07)    Production rates=
        15+2*Order policies
    Units: **undefined**

(08)    Safety stock levels=
        10
    Units: **undefined**

(09)    SAVEPER  =
        TIME STEP
    Units: Month [0,?]
    The frequency with which output is stored.

(10)    Shipping policies=
        1
    Units: **undefined**

(11)    TIME STEP  = 1
    Units: Month [0,?]
    The time step for the simulation.
```

Finalize assessment system dynamic approach for inventory management is calculated in Figure 4, 5.

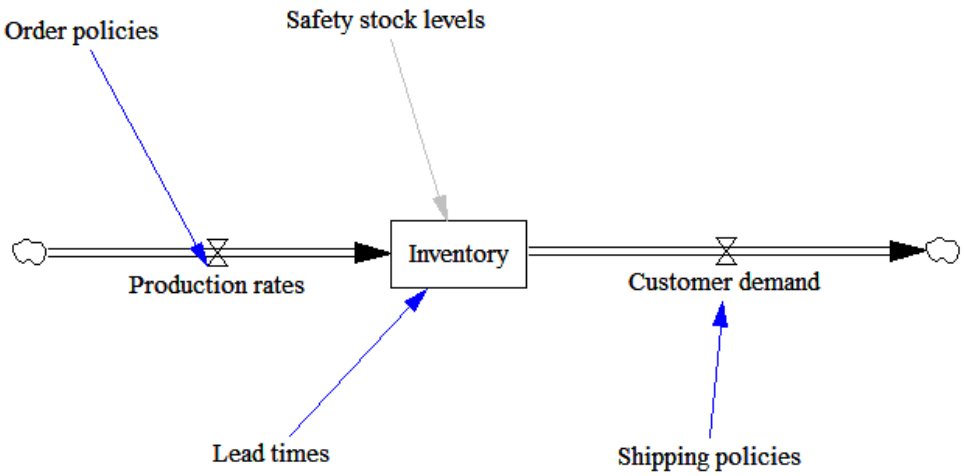


**Figure 4:** Final model of system dynamic approach.

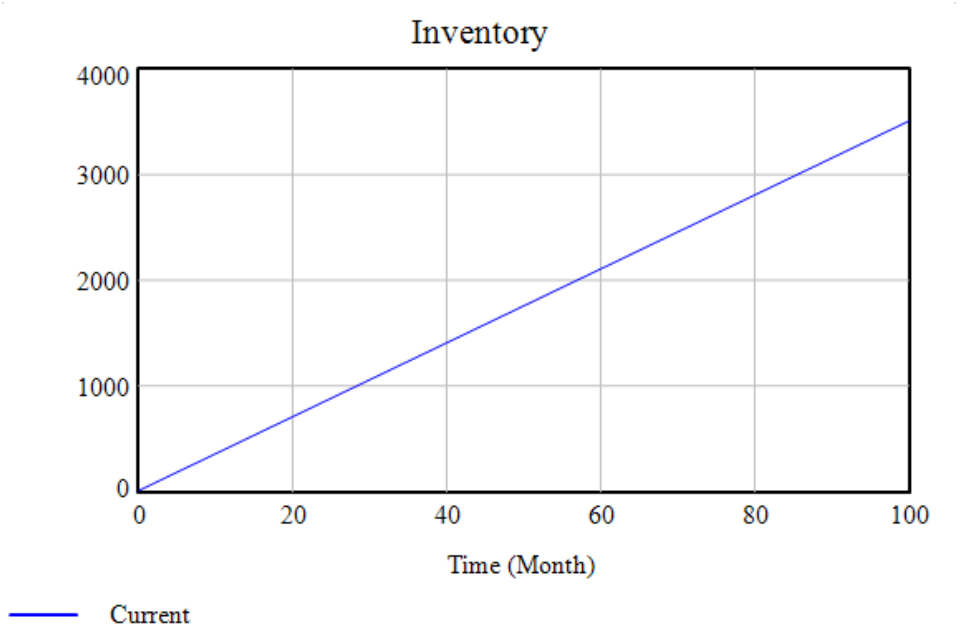


**Figure 5:** Results of running system dynamic approach.

Our findings suggest that organizations can benefit from using system dynamics analysis to gain insights into the dynamics of their inventory system and identify opportunities for improvement.

System dynamics (SD) is a powerful approach to modeling and analyzing complex systems, such as the inventory of an organization. SD models take into account the feedback loops and dynamic interactions between the different components of the system, which allows for a more comprehensive understanding of how the system works and how it can be improved.

This paper presented an SD model of an organization's inventory system and used it to investigate the impact of different policies and interventions on inventory levels, costs, and customer satisfaction. The model was calibrated and validated using data from a real-world organization.

## 5. Conclusion

Our study demonstrates the effectiveness of using system dynamics analysis to improve inventory management in organizations. By creating a system dynamics model of the organization's inventory system, we were able to identify opportunities for reducing inventory levels and improving service levels. Our findings suggest that organizations can benefit from using system dynamics analysis to gain insights into the dynamics of their inventory system and identify opportunities for improvement.

The results of the simulation show that SD can be used to effectively improve the inventory management of an organization. By understanding the dynamic behavior of the inventory system, organizations can develop more effective policies and interventions to reduce costs, improve customer service, and increase profitability.

The following are some of the key conclusions from the simulation results:

- Different order policies can have a significant impact on inventory levels and costs. For example, the fixed-order-quantity policy typically results in higher inventory levels than the min-max policy, but it can also lead to lower costs in some cases.
- Different shipping policies can also have a significant impact on inventory levels and customer satisfaction. For example, the same-day shipping policy typically results in lower inventory levels and higher customer satisfaction, but it can also lead to higher costs.
- Safety stock levels can also have a significant impact on inventory levels and costs. For example, higher safety stock levels typically result in lower inventory stockouts, but they can also lead to higher costs.

Organizations should use the results of SD simulation to develop and implement more effective inventory management policies and interventions. By understanding the dynamic behavior of the inventory system, organizations can reduce costs, improve customer service, and increase profitability.

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