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A Simulation-Based Modeling Of an (SCN) Supply Chain Network

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Abstract

The study employs a simulation technique and creates a general manual for building ETE-SC simulation models. Industry experts validate the conceptual framework, and illuminating observations are made. Simulating an ETE-SC system is difficult and often lacks time and resources for modeling. The theoretical and practical contribution of this research is a manual for creating ETE-SC simulation models, which is highly sought after by businesses dealing with daily problems and challenges. The study also highlights the challenges in creating simulation models, such as technical limitations and the near impossibility of accurately reflecting the ETE-SC system. The assessment of the general expansion direct for the ETE-SC simulate model remains an important aspect of the dissertation.

Keywords: Supply chain network, simulation modeling, efficiency, resilience, optimization.

1. Introduction

By first explaining the motivations behind this inquiry and defining the research environment and scope, the study tries to briefly introduce the goal of this study. A connection is made between the structure of the remaining portions of the thesis by defining and elaborating on the important terminology and concepts pertinent to this research. Systems and networks for the supply chain (SC) are essential components of the modern world. The management of materials and information along an entire supply chain, from component producers and other parties engaged in assembly or other tasks necessary to prepare finished goods for distribution to the ultimate customers' customers, is commonly referred to as supply chain management [1]. The competition between supply chain systems has changed due to rising customer expectations, and supply chain leaders now face more difficulties and challenges in managing these intricate structures so that their products maintain their competitiveness without jeopardizing business profits and gross margin. Utilizing models and modeling approaches from operational research and management science is one of three ways to assist company executives. In an effort to govern supply chain systems, models and modelling, particularly simulation modelling, have been recognized as a decision-supporting strategy [2]. Tolga Tipi [3]. This study aimed to identify causes of technical waste in Turkish counties of Balikesir and Istanbul by assessing operational and scale efficiency of sample rice farms. Data was gathered from a 2007 direct interview survey among 70 households. The median technical efficiency score was 0.92, indicating that farms could use 8% less input while producing the same amount of rice. Five factors were identified as contributing to success.

John B. Taylor [4]. From the standpoint of current research on monetary policy rules, this study analyses multiple periods or occurrences of American financial history. It investigates the appropriateness and politically rationales behind shifting between from financial policy norm to something else also investigates the consequences of various macroeconomic policy regulations on the economy as a whole. The research also proposes a numerical measure of the magnitude of prior errors in monetary policy, taking into account both current knowledge and historical perspective. It also looks at any potential economic repercussions that these blunders might have had. Since it shows the efficacy of various fiscal regulations, the evolution of these modifications with errors has significance for macroeconomic strategy now.

James A. Khan [5]. The reality that manufacturing variability surpasses revenue variation represents a stylized truth related to stock management. The framework of manufacturing choices given unreliable demands in the current study also includes no negativity limitations for stocks. If need shows an upward series correlation or there is evidence that the company may backlog surplus demand, optimal behavior by the firm is still compatible with that stylized fact regardless of the absence of efficiency increases.

Richard Metters [6]. Take into account numerous businesses that function as a serial supply chain. In this scenario, the demand for the final supplier is created by end users, whereas the demand for upstream suppliers is created by the suppliers in the next link in the supply chain. Demand seasonality and forecast error have been demonstrated to get worse as we move up the supply chain. For upstream enterprises, this "bullwhip" impact or demand distortion results in inefficiency. By providing an empirical lower bound on the profitability impact of the bullwhip effect, this paper aims to quantify the scope of the issue. The findings show that depending on the particular business climate, the bullwhip effect's significance to a corporation varies significantly. But under the right circumstances, removing the bullwhip effect can boost product profitability by 10% to 30%.

Seyda Serdarasan [7]. This paper analyzes supply chain complexity, focusing on the dynamic and static aspects. It identifies factors such as suppliers, customers, interactions, competing policies, demand amplification, divergent decisions, and incompatible IT systems. The paper presents a matrix of complexity drivers and solutions, based on real-world supply chain issues. Decision-makers need a combination of effective approaches to manage complexities in supply chains, utilizing various sources like states, documents, findings, and interviews.

1.1. Supply-Chain Management (SCM)

Supply chain management (SCM) is one of the most well-liked tactics for giving a competitive edge to firms that make an effort to coordinate their strategic, tactical, and operational actions in order to be more responsive to client demand [8]. Wu et al. (2013) many SCs are vulnerable [9] to hazards, and addressing such risks appears to be difficult. The significance of effectively controlling SCs has been the focus of various research. The design, planning, and operations of SCs in accordance with choices impact of strategies utilized are the SCs most commonly examined features [10, 11].

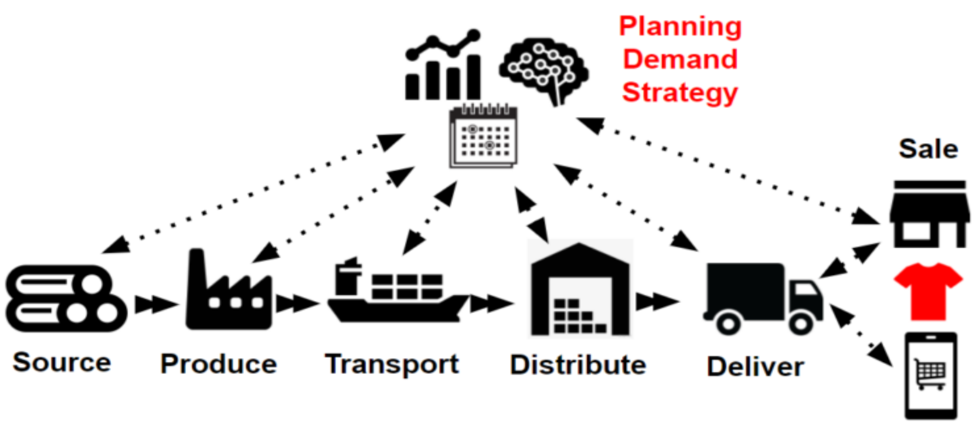

Fig.1. An illustration of supply chain organization

According to Wu et al. (2013) [12], making strategic, tactical, and operational decisions on capacity and resource allocation to manage demand unpredictability is essential for improving SC resilience to turbulence.

The idea of SCM is frequently supported by a desire for interaction and integration. Given the emergent qualities that result from integrating, feedbacks, nonlinearities, modifications, and strategies, this may be tackled in theory and practice in an overly simplified manner [13]. The scope and context dependencies of interactions are frequently overlooked or handled incorrectly. The idea that all stakeholders, from far upstream suppliers to far downstream customers, can be precisely identified, objectively prioritized, and truly integrated with error-free flows of information, products, and services is also oversimplified since the boundaries of control are only limited to one organization rather than the entire chain or network [14]. The performance of the ETE-SUPPLY CHAIN system can also be influenced by instability and dynamics [15], and there is a lack of research-based knowledge of when or how SC dis-integration or re-integration happens. The literature extensively examines the demand amplification; which SC Dynamics refers to as one of the sources of the bullwhip effect [16]. Due to a poorly designed demand management approach, where decision makers overreact to variations in demand by placing larger orders, the supply chain experiences a minor rise in demand from consumers upstream [17].

Furthermore, communication and material time gaps lead to an erroneous sense of a deficit in manufacturing capacity. As orders migrate upstream in the SC, particularly at the plant level, the view of finished goods orders in the system becomes distorted, increasing the noise level. The Forrester effect, sometimes known as the Bullwhip Effect, was initially investigated.

In order to better strategic approaches and increase responsiveness to consumer demand, this research sees ETE-SCs as complex systems that work in dynamic and constantly changing environments (Wu et al., 2013) [18]. The supply chain [19] exhibits three different forms of complexity:Dynamic refers to the operational behaviors of the supply chain and its surroundings, while static refers to the structure and relationships within the subsystems. Complexity, which is influenced by decision makers, combines both static and dynamic features.

1.2. Developing, Planning, and Regulating the Supply Chain

Multi-echelon SC is confirmed to include several activities including purchasing, manufacture, picking, and transportation in addition to numerous stock-points (buffer or storage). The planning processes, which may be classed as cyclic or non-cyclic, are based on continuous or periodic inventory reviews, according to the authors. While the duration of the intervals fluctuates in non-cyclic planning, production intervals are set in cyclic planning and applied to all activities (order, production, or delivery). Similar to this, cyclic planning appears to be more appropriate for multi-product and multi-stock policies. This is largely because it allows for greater control through a streamlined planning process and may have fewer administrative expenses as a result, which leads to lower inventory costs. The substantial demand unpredictability that frequently happens during product launch and the end of the product life-cycle makes the non-cyclic planning technique more practical, the authors emphasize.

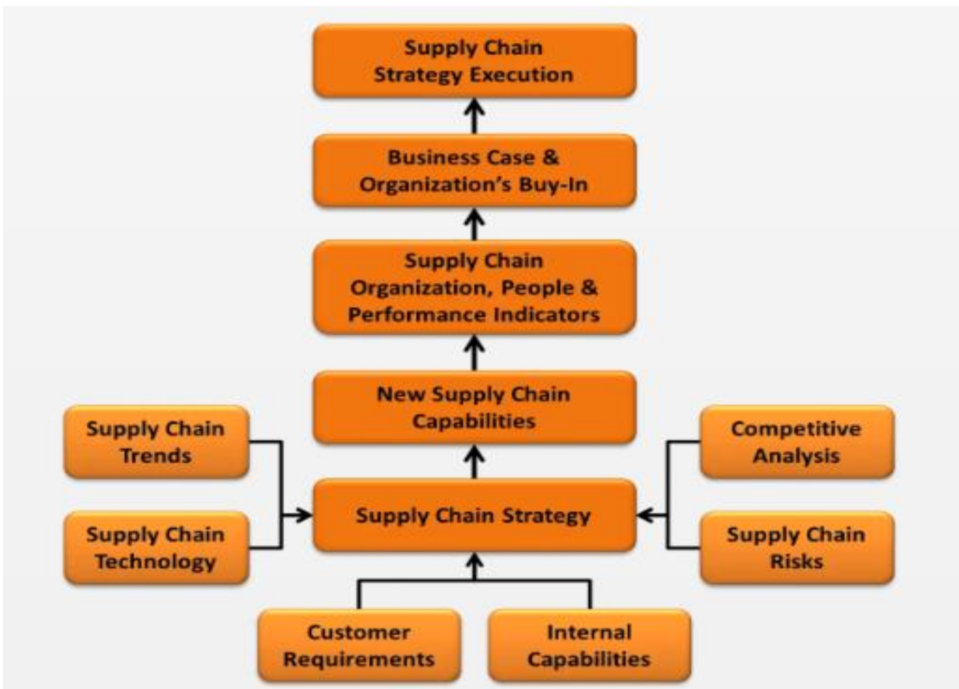

Fig. 2. A framework of supply chain development.

2. Methodology and Model

The necessity towards a general strategy for simulating End to End supply chain (ETE-SC) networks employing modeling which may take into account each of the three elements established in the theoretical foundation is going to be explained, followed by discussions of applications of operation research (OR) methods and combined/hybrid modeling approaches. It also promotes the scientific quality of the study, which involves the need to clearly communicate the theoretical basis to both practitioners and academics. By discussing the philosophical foundations and methods that provide important insights inside the study layout, this can be done in the current section of the dissertation.

2.1. Study of Design Components

In this study the investigation's motivating variables in addition to the study backdrop and environment have been clarified, the present study was designed to tackle the aforementioned aims. Investigation goals, objectives, and study objectives were all specified in this study. The thorough literature study that led to the creation of the framework for thought, including encompassed the components of general ETE-SC technologies and supported the necessity for a generalized ETE-SC model, added to this. The study goal was defined by the determination of the study's goals, and the present section serves as an effort to reach ontology and epistemology agreement for the current dissertation.

The relationship between the three main components of the study design—philosophical foundations, inquiry approach, and methodologies used. These three aspects are further discussed in the setting of this research. Clarification of the ontological as well as epistemological presumptions forms the basis of any study. If these presumptions were thoroughly grasped and their advantages and disadvantages are recognized, the study's effort will probably to be repaid. The table 1 illustrates the way three key aspects of the investigation's design—philosophical foundations, an inquiry strategy, & the methodologies used—are related to one another and the manner in which they continue to be addressed in the context of this study.

The study recognized modeling as a method for learning about the complexity of ETE-SC systems. The goal of the study is to examine the difficulties and problems that might arise while simulating an ETE-SC system and to talk about the consequences of include aspects from the theoretical structure in the model that is used for simulation as shown in table 1.

Table 1. Theoretical structure in the model that is used for simulation.

Supply Chain Design	Characteristics of Supply chain Design
Problem specification	A general modeling foundation
Study purpose	Description of the End-To-End Supply Chain system Design of a simulation model to describe various levels of confluence
Research strategy	Creation of models for simulation utilizing the theoretical framework's components. Evaluation of the simulation framework by interviews that were semi-organized
Methodological formulation	Using a methodology that is quantitative construction of models for simulation Model development with organized tour validation verification by professionals in the sector
Data synthesis technique	literature review qualitative information gathered through interviews

2.1.1. Paradigmatic approach to research

The research paradigm, which represents the researcher's perspective on the immediate environment, is frequently seen as a vital component of the research process (Naslund, 2002). The core pillar and podium for the research philosophy are therefore frequently heavily influenced by the researcher's background. Clarifying one's ontological, epistemological, and methodological positions would therefore not only offer direction for the research process, but would also maximize reflection by recognizing the effects of research decisions on the outside world and the potential for change they may bring about.

2.1.2. End-To-End Supply Chain (ETE-SC) Modeling using ontology and epistemology

The establishment and perception of an ETE-SC system/model scope are obstacles to modeling an ETE-SC system. Different understandings regarding the scope, limitations, and goals of modeling an ETE-SC may be caused by the presence of multiple ontological derivatives. The article emphasized a mix of competing objectives and divergent viewpoints on how reality is seen by experts adopting related philosophical stances. Their research came to the conclusion that even when viewed from the perspective of a positivist philosophical attitude, only a partial image of the real world as a whole might have been painted.

2.1.3. The function of models and modeling

The present study on simulating an ETE-SC system offers a platform where scientific discoveries and expertise play a significant role in advancing our understanding of such structures. There could be a lack of a precise definition of a mathematical model, or it could be determined by a scholar's ontological standpoint, even though algorithms may identify or indicate a real or imagined structure, conceptual or conceptual frameworks, formulas, or explanations in various degrees of convergence between any or all of them.Here, it's crucial to define and comprehend a structural representation of a system because the representation's rigor is frequently questioned. To do this, clear assumptions must be made about the system's objects, elements, boundaries, etc.

2.2. Inquiry Method

In order to expand the knowledge engine, reaffirmed that research must have a comprehensive grasp of the ontological and epistemological perspective. This calls for a good understanding of the researcher's and others' perspectives on the social issues under study. Since the bounds of an ETE-Supply Chain system dictate its scope & design, the current study's focus of study aims to comprehend the social context or phenomena.As a consequence, a general overview of the ideas and laws governing the behavior of the material world/system emerges, thereby establishing a connection between the real and theoretical worlds. It necessitates a logical conception of the things which make up and characterize the term "ETE-Supply Chain system. The way a system functions is described by its primary entities, architectural traits, conversations, or laws from the point of view of ontology.

2.3. Complex Method

A system is defined as a group of parts that cooperate as a mechanism or network as well as a structured scheme or procedure by the Oxford Dictionary of English in 2005. According to these components regularly interact with one another and are interdependent in order to perform a certain goal (aim). The behavior and performance of the ETE-Supply Chain systems may be negatively impacted by their observed complexity. The ETE-Supply Chain is made up of a variety of nodes that are connected to one another and operate within boundary circumstances, but their interactions frequently lead to the creation of new information, especially when they are exposed to alterations in the system environment.

2.3.1. Observed characteristics of a complicated system

Many parts of a complicated system, either known or unidentified, and their interactions may be observed as either the objective or subjective characteristics associated with system difficulty While the quantity of subjects, echelons, or Supply Chain quantities had been clearly known, goal indicators of a system's complexities have been assumed to be provide. These psychological elements of the system's attributes have been given by the systematic company an essential component within the End to End Supply Chain system.

2.3.2. Creating a system model

System models, like the ETE-Supply Chain system model described in this study, have been developed using presumptions about structural and systemic organizational components and take into account appropriately chosen, informative vehicles in the shape of computer science methods to represent these kinds of systems. This suggests that there are modeling methodologies that are more suited to reflect specific system components and their functions; for example, simulation works well to portray Supply Chain systems, that are characterized by a variety of qualities and their dynamic nature. The new era of organized complexity was characterized by conscious examination of the epistemic representations of networks and an effort to draw conclusions about alterations seen in systems. A vehicle (for example, a Supply Chain model) that was informative about its target and thus constantly reflected such go after was needed in the early attempts to comprehend why complicated structures have constantly changing and interrelated as well as how fraud of one or more system components can trigger modifications to other components of the system. This suggested that in order to provide a precise assessment of the mechanism, the car, or in the case of the Supply Chain system, modeling methodologies, had to be properly chosen.

2.4. End-to-End Supply Chain Modeling (ETE-SC)

ETE-Supply Chain networks and systems must be modelled in order to develop an end-to-end approach to risk management, assess the operation of the whole Supply Chain structure, or comprehend the mental makeup of the ETE-Supply Chain decision maker among the most effective methods that an administrator may use to solve the many complicated issues involving research in Supply Chain is modeling through simulation.

Simulation modeling enables the description of ETE-Supply Chain system behavior and aids in evaluation and evaluation of different strategic, tactical, and operational decisions and their effects on the system's operation as a whole. Similar to how external influences and the surrounding environment may be taken into account during conceptualization and creation of models, so too many different existent complexities. whichever is the goal of the research or study, simulation modelling is a technique of creating a streamlined version of an ETE-Supply Chain system, regardless of whether the system currently exists or has to be created. The goal of the present study was to construct a general ETE- Supply Chain system model, and it discusses the value of modeling technique in doing so. The significance of the complexity concept or systemic thinking is well-known.

2.4.1. Foundation for holistic End to End- Supply Chain (ETE-SC) modeling

This study uses Mitroff's scientific inquiry model which offers an extensive approach to an identifying and solving issues investigation, utilizing several of its key frameworks.

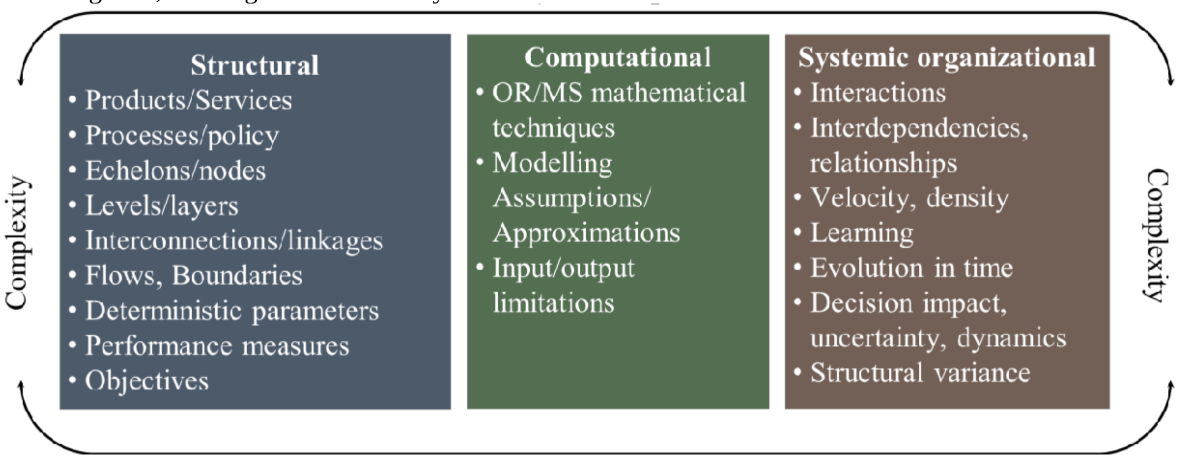

Fig. 3. Foundation for holistic End to End – Supply Chain modeling.

Although deficient in general scientific understanding about the business processes, his study field employed analytical methodologies focusing on the engineering parts of operational

3. Development of Supply Chain Model

A two-pronged strategy was utilized used for validating and confirming the general algorithm's application. Initially the steps that followed had to be carried out to make arrangements the model's functioning functions as meant it to: a planned walkthrough alongside a simulated a specialist by means of the model's components as well as sub-models, a discussion of The theory presumptions, code inspection, an examine of all confirmation processes, a copies evaluation, the examine of the outcomes, along with scenario evaluation. Secondly, the computerized simulation was verified on the basis of its conceptualization & architectural when organizational similarities with the actual ETE-Supply Chain system without the aid of industry specialists representing business A.

When creating ETE-Supply Chain computer simulation frameworks, the following subsection explores the value of complexity theory and the system thinking method. The goal of the project was to learn how to use simulation to create a general ETE-Supply Chain system model. In the course of developing the model, special attention was paid to all general ETE-Supply Chain system components that had been discovered after a thorough literature research. It had been chosen to use a collaborative approach that included general information from Microsoft (MS) Excel using DES modeling as well as OR/MS approaches.

Information utilized to enable the creation of the ETE-Supply Chain system simulation model was provided in the MS Excel master data file. The steps for developing a general ETE-Supply Chain system model are going to be presented in the parts that come next, with the goal of addressing the inquiry that follows: When could segmentation modeling mesh into modeling given the multimodal character of the study stream.

The following two goals will also be addressed in this section of the research:

- To create an automated model utilizing simulations that serves as a framework for mixing different modeling methodologies.
- To assess the modeling consequences whenever various components of the suggested conceptual framework have been integrated into the computerized/scientific system.

This study discusses wherever complication may be discovered in the ETE-Supply Chain systems as well as how it may affect the procedure of developing simulation models.

In complex End-to-End supply chain (ETE- Supply Chain) systems, simulation approaches frequently serve as facilitators for the investigation and assessment of successful management strategies. The majority of simulation techniques operate in isolation and seem to remain concentrated on the unique features that need to be studied or a particular Supply Chain development objective. This study suggests an integrated technique, also known as combined or hybrid modeling, that integrates simulation methodology with information on expanded supply chain systems including computational complexity particular regard to simulating the architecture of ETE-Supply Chain systems. By putting out a hybrid approach based on the principles of system thinking with chaos theory with strengthened by the potent powers of simulations methodologies using mathematical analysis approaches, the research tried to add to the existing wealth of information on modeling ETE-Supply Chain systems.

Beginning using a taxonomy of Supply Chain modeling techniques, the study went on to give a summary of hybrids modeling as hybrid simulations. It covered the significance of employing this strategy for modeling ETE-Supply Chain systems as well as the joint strategy including hybrid simulations and OR approaches. The Arena modeler simulation software was then covered, along with its features and characteristics. Concepts for simulation modeling that needed to be included in later studiess became clear as it went on.

A general ETE-Supply Chain simulation model creation guideline was then offered, with an emphasis upon hierarchical model components and a description of sub-models and modeling levels. In this sense, the study's goal was to introduce a novel technique of modeling complex systems by connecting the conceptual framework, the organizational and structural components of the ETE-SC system, simulation methodology, and computational complexity. In conclusion, it showed the necessity for a combined approach that can incorporate modern computing techniques (OR methods), such as optimization inside computational models, programming in linear form, and vehicle routing issue models.

These have been put into the following categories based on the technique mentioned:

- Agent based simulation (ABS): it represents a method for simulating structures as self-governing as well as intelligent beings that frequently incorporates information from different fields (such as theoretical games, biological processes, while computational aspects cognitive ability) as well as being selection modeling approaches (such as optimization or heuristics). It additionally involves agent-based automobiles.
- Discrete-event simulation (DES): This method depicts the entire structure as a series of discretely changing actions &queued.
- System dynamics (SD): This provides a method for analyzing the dynamic behavior of organizations that employs graphical representations with an input-output notion in the framework of the system modeling. These visual representations have then been turned to mathematical equations by computer software.
- Monte Carlo/Queuing simulation (MCQS): it was a modeling technique that replicates an arrangement by altering its settings in accordance with pre-established distributed to produce statistically disruptions.
- Analytical Model/ Simulation Study (AM/SS): it is a modeling strategy centered on the creation of sophisticated analytical methods backed by simulation.
- Hybrid simulation (HBRD): This is a modeling strategy focused on creating a framework as well as infrastructure that integrates multiple modeling methodologies.

3.1. Elements in an E2E-SC framework

This thesis examines the development of the ETE-Supply Chain model, focusing on its impact on supply chain members and the complexity of ETE-Supply Chain systems. It employs a multidisciplinary approach, combining expertise in ETE-Supply Chain structures, modeling techniques, systemic thinking, and complexities concepts to tackle the problem. The study aims to aid decision-makers and academics by examining the processes involved in creating an ETE-Supply Chain system simulation model, considering the main variables increasing their complexity. The proposed modeling framework is built on various dimensions and uses cross-functional knowledge and expertise to direct research into the subject and problem. System Learning Regression (SLR) was used to create the conceptual framework, acknowledging complexity factors as the main influences on ETE-Supply Chain system performance as shown in table 2. Existing methodologies provide principles and guidelines for creating and conducting simulation modeling research. The project life cycle framework for large-scale complex simulation projects, focusing on organization of processes, product work, quality assurance, validation, verification, and project management activities. Study highlighted the need for a foundation for modeling-driven modeling through simulation.

Table 2. Methods for simulating ETE-Supply Chain systems modeling

Understanding:(a) Issue (b) Description	Supply Chain Model Purpose: Control, Design, and Evaluation.
(c) Speculative (d) Modeling (e) Construction	Construction Materials: Type Supply Chain, Supply Chain design, Reviewed procedures/policies limits of the system & links amount of connections, the movement of data are taken into account quantity of goods. Organization Supply Chain: Characteristics of dynamic systems, Describe system unpredictability, Connections among system components, Links' features.
Modelling: (a) Development of Logical Models	Modeling Purposes: Maximize, Evaluate, avert.
	Model parameters:Hybrid, Discrete, Continuous.
	Model's computationally elements: Input/output specifications, Model presumptions or estimates, Stochastic vs. predictable types of data methods and algorithms used in mathematics.
	Collecting information: Prerequisites for information and its source, Technique for gathering, and storing data.
	Choosing a tool for modeling: Software Packages: DES (Arena), SD (iThink), Stella, and Hybrid (mixed method). Python, C, Fortran, C++, Java, and other programming languages.
	Evaluation & Confirmation of Models: Supply Chain topic, Model for an organized examine.
Model Operating/Solving: (a)Create a simulation	Setup Parameters: Units of performance, Replication rate as well as duration of recurrence, amount of the warm-up interval for development.
(b) Fix the problem	Modeling outcomes: Find the offered solutions, Determine the report format.
Putting into practice through evaluating scenarios: (a) Application,	Simulation usage instructions: Following modeling execution, keep track of its performance, Indicate the organizational & building components that might be altered with no impact on the model's intended application. Methods that are experimental: Program rerun using certain portions of the data gathered.
(b) Examination of the findings	Choosing the right method for input/output evaluation: Outcome of analysis presented,Examine the proposed answer, including the following: ANOVA, comparison analysis, & sensitivity inspection are three types of analysis, Explain the model approach in light of the modeling goals.
	Behavior models and modelers: Analyze model behavior and the modelers mental processing using existing information, Specify the model restraints, Offer suggestions for using the model.

With an emphasis on systemic characteristics with concept of complexity, this portion of the study aims to analyze the key components of the creation procedure for simulation models by combining multidisciplinary expertise in the fields of modeling for simulation and ETE-Supply Chain networks.

3.2. Logic in the End to End – Supply Chain System Model

The ETE-Supply Chain model logic in Arena gets explained in this section. The ETE-SC process could include a number of subjects, some of which can have competing goals but nevertheless share a shared objective of getting the finished product through the hands of the final consumers. The framework takes into account three different forms of circulates: monetary flow, flow of data, and flow of goods. Raw materials are moved across the supply chain, transformed into finished goods, and then delivered to the client. Machining or assembling of materials may also be involved. Methods along with regulations for an ETE-SC network have been determined to accomplish this.

1. The amount of storage points.
2. The kind of inventory holding policy during every storage point.
3. The policies to stay offering data on inventory.
4. The customer demand as well as time-to-market demands.
5. The level of capacity utilization at each creating nodes.
6. The production-distribution procedures, and the monitoring as well as risk management procedures.

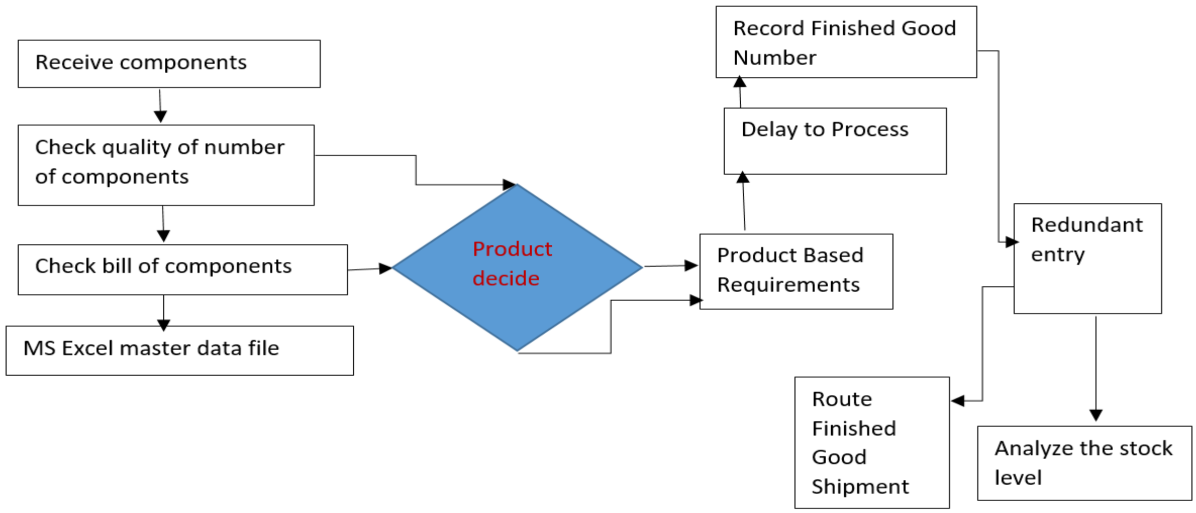

Fig. 4. Presents the logic for the manufacture and model.

4. Results and Discussion

The simulation run settings have been established then an assessment of the simulation results offered in this portion of the dissertation. Tables provide an overview of the information that was utilized during the simulation run in relation to the model logic outlined previously. The entered data & simulation run outcomes undergo evaluation at this point of the study as shown in table 3,4,5,6,7, and 8.

Table 3. Supply 1 input data.

Suppliers	Identifier	Value	Units	Additional Data
Supply Arrival	Component 1	1 unit	Hour	
	Component 2	1 unit	Hour	
	Component 3.1	1 unit	Hour	
	Component 3.2	1 unit	Hour	
	Component 4	1 unit	Hour	
	Component 5	1 unit	Hour	
Supply Processing	PrepTime	0.2	Hour	Delay
	PrepTime	0.2	Hour	Delay
Deliver Supply	Delay S1.L1	1	Hour	
	Delay S1.L2	1	Hour	
	Delay S2.L1	1	Hour	
	Delay S3.L1	1	Hour	
	Delay S4.L1	1	Hour	

Table 4. Manufacturer input data.

Manufacturer	Identifier	Value	Unit
Delay to Inspection	Delay to S1 Inspection	1	Hour
	Delay to S2 Inspection	1	Hour
	Delay to S3 Inspection	1	Hour
	Delay to S4 Inspection	1	Hour
	Delay to S5 Inspection	1	Hour
Passing Inspection	S1 Inspection Pass?	99.5%	n/a
	S2 Inspection Pass?	99.5%	n/a
	SS Inspection Pass?	99.5%	n/a
	S4 Inspection Pass?	99.5%	n/a
	S5 Inspection Pass?	99.5%	n/a

Table 5. Distributors input data.

Distributors	Identifier	Value	Unit
Delay for Processing DC1	DC1ProcessingTime	0.1	Hour
Delay for Processing DC2	DC2ProcessingTime	0.1	Hour
Route to Customers	DC1	1	Hour
	DC1	1	Hour

Table 6. Retailers input data

Retailers	Identifier	Value	Unit
Processing	Retail1Processing	1	Hour
	Retail2Processing	1	Hour
	Retail3Processing	1	Hour
	Retail4Processing	1	Hour
	Retail5Processing	1	Hour
	Retail6Processing	1	Hour

Table 7. Resource spreadsheet view in the Basic Process Panel

Name	Type	Capacity
Dispatch Operative	Fixed Capacity	1
FactoryOperative	Fixed Capacity	1
ResourceRetail1	Fixed Capacity	1
ResourceRetail5	Fixed Capacity	1
ResourceRetail6	Fixed Capacity	1
S1.Line1	Fixed Capacity	1
S3.Line1	Fixed Capacity	1
M1.Line1	Fixed Capacity	1
S2.Line1	Fixed Capacity	1
ResourceRetail4	Fixed Capacity	1
PackageMan1	Fixed Capacity	1
PackageDC2	Fixed Capacity	1
ResourceRetail2	Fixed Capacity	1
ResourceRetail3	Fixed Capacity	1
S4.Line1	Fixed Capacity	1
S1.Line2	Fixed Capacity	1

Table 8. Inventory evaluation data input

Variable Name	Value
Inventory LevelS1 (…,S5)	10
Little s	5
Big S	10
Setup CostS1 (…,S5)	32
Incremental CostS1 (…,S5)	3
Unit Holding CostS1 (…,S5)	1
Unit Shortage CostS1 (…,S5)	5
Interdemand TimeS1 (…,S5)	EXPO(0.1)
Evaluation IntervalS1 (…,S5)	1
Delivery LagS1 (…,S5)	UNIF (0.5, 1.0)

This study will validate the conceptual framework as well as the ETE-Supply Chain model created utilizing computer simulation in order to guarantee research validity and reliability. The following goals will be addressed in this study in order to accomplish the following:

1. Interviews with industry professionals to explore the model's computational, systemic, and structural organizational components.
2. Evaluation of the ETE-Supply Chain simulation model critically in order to draw conclusions and offer recommendations for development.

This study started out with a brief introduction before going on to detail the goals that were established to guarantee the reliability and validity of the research. To validate the conceptual framework for the study and the general, step-by-step instructions for developing the End to End – Supply Chain simulation model, a series of interviews were undertaken. In light of the ETE-Supply Chain simulation model that was developed as part of this research, a critical assessment of the validation procedure for a general simulation model is offered. This study will proceed to address validation issues before coming to a recommendation for a combined strategy for simulating the ETE-Supply Chain systems and offering recommendations for future research and advancements. The reliability of the research findings will be covered in the following section. The conceptual framework and general specifications for modelling ETE-

Supply Chain while utilizing simulation are the results of this study.

4.1. End to End – Supply Chain model validation and verification

Generic ETE-Supply Chain system model has been developed in this study as a result of the two key ontological derivatives' differing levels of convergence: (1) that views the ETE-Supply Chain system as a physical construct, where the observer's perception depicts the system description, and (2) that sees the ETE-Supply Chain system as a perception of the ideal, heuristic, and pragmatic model in nature designed with the aim to evaluate, improve, and continue Edgar Morin, a French philosopher who valued both the advantages of knowledge generation and the significance of system structural components, served as an inspiration for both of these features. The conceptual framework's two foundations were these structural and systemic organizational aspects, which were acquired through data synthesis during a thorough literature study process.

Table 9. The validity as well as dependability of the ETE-Supply Chain simulation framework.

Group	Summary
Interview subjects	Interviews with the SC director and SC capability managers; purposeful sampling. Various functional domains and industry backgrounds.
Explanation of the simulation framework principles	A theoretical framework that helped with the creation of models. Foundation along with empirical validation of models with business and academic specialists.
Internal verification of the modeling procedure	Confirmation using organized inspections to confirm that a source code's correct information is there. The simulation model's logic and design, together with the algorithms employed, were analyzed. Continuity of the model has been verified. The creation of the model became documented extensively.
Application of simulation models in Business	Clear definitions of the study's context and participants are necessary for generalization.
Evaluation of model outcomes	Interviews have been employed to support the creation of simulation frameworks. To facilitate verification of models, a moving model was created. To verify the correctness of the model, performances records have been reviewed.

All four of the chosen candidates have in-depth understanding of ETE-Supply Chain strategic, tactical, among operational frameworks as well as experience with a variety of supply chains, including those in the automotive, fast moving consumer goods (FMCG), electronics, and food industries. Each participant has knowledge of both the FMCG industry and other Supply chain (SC) areas. It took 56 to 1 hour and 16 minutes to complete each interview. Due to concerns over privacy, interviews did not take place, but detailed notes have been taken then physically recorded in the MS Excel file as shown in table 9. The following steps are taken as shown in fig.5 and 6.

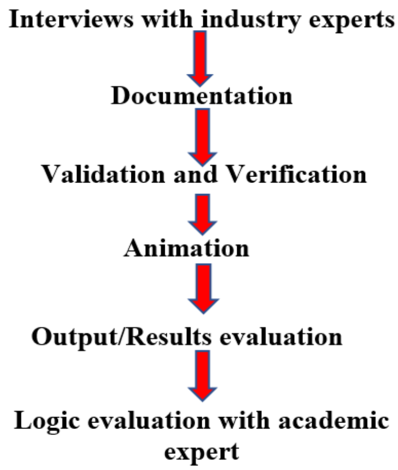

Fig.5.Validation and verification components of the E2E-SC model.

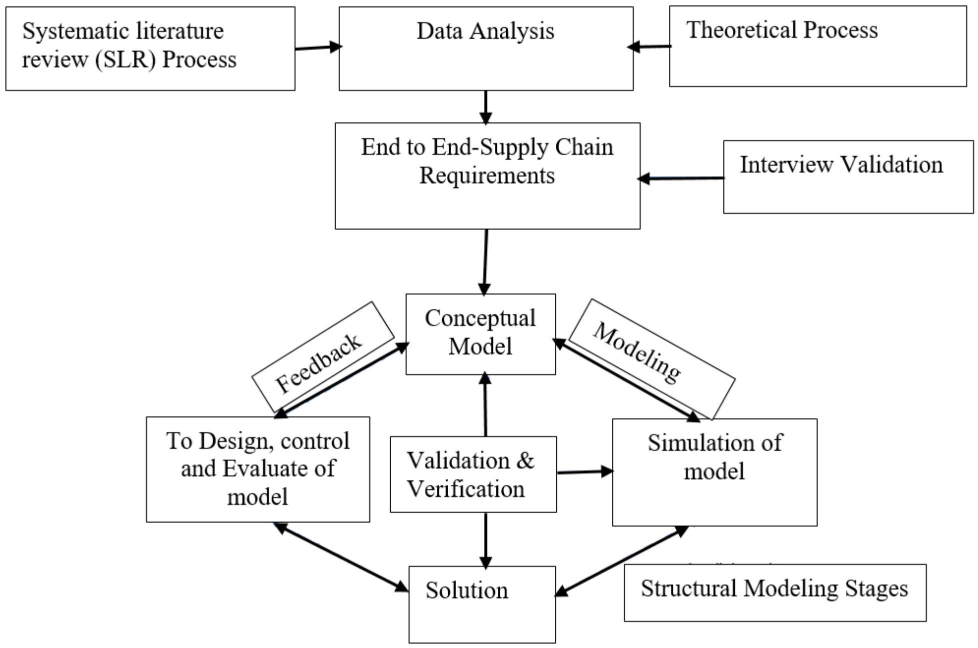

Fig. 6. The conclusion, methodology, and validation of data.

5. Conclusion

To clarify the study strategy by outlining the connections among its many components. Additionally, it promoted the scientific rigor of the study, which suggested the need to clearly communicate its theoretical framework to academics and practitioners. This was accomplished by carefully considering the approach to methodology and philosophical foundations that provide valuable points inside the study design. An illustrated process for developing the ETE-Supply Chain simulation model has been given in the next section.

- To enhance their End to End supply chain system for Businesses often look for ways to support decision-makers by employing modeling approaches like simulation to assess, control.
- The End to End – Supply chain simulation model incorporates the expertise and computational complexity of extended supply chain systems in modeling these system structures.
- The End to End - Supply chain system is controllable, and its performance can be modified by shifting the control responsibilities to a focal company or important organizations.
- The End to End – Supply Chain system models may incorporate software learning principles to create intelligent and complex evaluation models.

References

[1]. Christopher, M 2005, Logistics and supply chain management – creating value-adding networks, 3dt Ed. FT Prentice Hall, London.
[2]. Tipi, T., Yildiz, N., Nargeleçekenler, M., & Çetin, B. (2009). Measuring the technical efficiency and determinants of efficiency of rice (Oryza sativa) farms in Marmara region, Turkey. New Zealand Journal of Crop and Horticultural Science, 37(2), 121-129.
[3]. Taylor, J. B. (1999). A historical analysis of monetary policy rules. In Monetary policy rules (pp. 319-348). University of Chicago Press.
[4]. Kahn, J. A. (1987). Inventories and the volatility of production. The American Economic Review, 667-679.
[5]. Metters, R. (1997). Quantifying the bullwhip effect in supply chains. Journal of operations management, 15(2), 89-100.
[6]. Serdarasan, S. (2013). A review of supply chain complexity drivers. Computers & Industrial Engineering, 66(3), 533-540.
[7]. Chan, F. T., & Chan, H. (2005). Simulation modeling for comparative evaluation of supply chain

management strategies. The International Journal of Advanced Manufacturing Technology, 25(9), 998-1006.

[8]. Wu, T., Huang, S., Blackhurst, J., Zhang, X., & Wang, S. (2013). Supply chain risk management: An agent-based simulation to study the impact of retail stockouts. IEEE Transactions on Engineering Management, 60(4), 676-686.

[9]. Surana, A., Kumara*, S., Greaves, M., & Raghavan, U. N. (2005). Supply-chain networks: a complex adaptive systems perspective. International Journal of Production Research, 43(20), 4235-4265.

[10]. D. Ambrosino and M. Grazia, "Distribution network design: New problems and related models", European Journal of Operation Research, vol. 165, no. 3, pp. 610-624, 2005.

[11]. D. Cope, M. Fayez, M. Mollaghasemi and A. Kaylani, "Supply chain simulation modeling made easy: An innovative approach", Proceedings of the 2007 Winter Simulation Conference, pp. 1887-1896, 2007.

[12]. I. Munasinghe and T. Rupasinghe, "A supply chain network design optimization model from the perspective of a retail distribution supply chain", Proceedings of Manufacturing & Industrial Engineering Symposium (MIES), 2016.

[13]. F. Varasteh, "Using genetic algorithm for supply chain network optimization", first joint congress on fuzzy and intelligent systemsIn first joint congress on fuzzy and intelligent systems, pp. 1-6, 2007.

[14]. G. Askin, B. Ilaria and M. Xia, "Multi-commodity warehouse location and distribution planning with inventory connsideration", International Journal of Production Research, vol. 52, pp. 1897-1910, 2014.

[15]. H. Ding, W. Wang, J. Dong and C. Ren, "IBM Supply chain network optimization workbench: An integrated optimization and simulation tool for supply chain design", Proceedings of the 2007 Winter Simulation Conference, pp. 1940-1946, 2007.

[16]. H. Zeinab, M. Romeo and L. Lee, "Optimization of multi-commodities consumer supply chain for -part I-modeling", Journal of Computer Science, vol. 9, no. 12, pp. 1830-1846, 2013.

[17]. S. Bagchi, S. Buckley, M. Ettl and G. Lin, "Experience using the IBM Supply Chain Simulator", Proceedings of the 1998 Winter Simulation Conference, pp. 1387-1394, 1998.

[18]. T. Biswas and S. Samanta, "A strategic decission support system for logistics and supply chain network design", Indian Academy of Sciences, vol. 41, no. 6, pp. 583-588, 2016.

[19]. Y. Chang and H. Makatsoris, "Supply chain modeling using simulation", International Journal of Simulation Systems, vol. 2, no. 1, pp. 1473-8031, 2001.