A review: hybrid simulation in forestry supply chain

N Sembiring*, H L Napitupulu, M T Sembiring, A Ishak and F Irwany
Department of Industrial Engineering Faculty of Engineering, Universitas Sumatera Utara, Medan, Indonesia

*Email: nurhayatipandia68@usu.ac.id

Abstract. Changes in supply chain availability in the forestry sector can significantly change efficiency responsiveness. This forestry supply chain network involves various processes such as harvesting, energy generation, wood, paper and board production. Methods that can be used to perform supply chain optimization are hybrid modelling and simulation. Substructure techniques with experimental testing methods that target numerical component conductors with communication loop components as well as transfer systems to form an entire system commonly referred to as Hybrid Simulation. In this study, we aim to find solutions so that the supply chain network in the forestry sector is not cut off by using hybrid simulation method. Hybrid simulations used can take into account when the supply chain will run out and prevent excessive exploitation so as to repair damage and recycle the supply chain so that it is not disconnected until the time period is taken into account. Each scientific article is rigorously selected to obtain articles that align with the purpose of this research.

1. Introduction
The forestry sector plays an important role that greatly affects the industrial sector, namely as a supplier of raw materials used for the production process [1]. It can be seen how important the role of trees as the main materials of the paper making industry, the building materials industry of wood, rattan processing industry. Overtime, humans depend on natural resources that can only be obtained from forests so that the forestry sector greatly affects global conditions ranging from economic aspects to international development [2].

However, it is very important to pay attention to the availability of forestry resources called supply chain networks. Changes in supply chain availability can significantly change the response level of supply chain efficiency. The sustainability of supply chain networks in the forestry sector has received attention in recent years because resources are exploited to the point of depletion without regard to their impact on the environment so that the supply chain network is interrupted.

This research is focused on finding a solution so that the supply chain network in the forestry sector is not interrupted by using hybrid simulation which is a pseudo dynamic substructure testing method because hybrid simulation is a method that has a lot of potential but also has many challenges. This hybrid simulation is used to find solutions to keep the forestry supply chain sustainable.

1.1. Literature Review
Substructure techniques with experimental test methods by targeting connectors numerical components with communication loop components and transfer systems to form the entire system can be called Hybrid Simulations [3,4]. Certain types of hybrid simulation, for example, the hybrid model is based on two or more simulation models, the relationship between the model simulation and convenience or analysis models from a broader field of operation or discipline [5].
A supply chain is an organized chain to obtain raw materials, produce different products, and the results are distributed to consumers. One of the critical supply chain jolts is stock since changes in stock approach can radically alter the level of responsiveness and effectiveness of the supply chain [6]. An effective supply chain can be accomplished in case the administration and supervision of dispersion channel connections is carried out agreeably by all parties included. Paying attention to the form of supply chain regulation is very important.

The forest supply chain itself covers various stages and forms such as collection, transportation, the era of vitality, wood, paper, board production, and energy generation [7]. That means the forestry sector in addition to being a supplier of raw materials production processes in the industry can also be a source of energy raw materials that can reduce greenhouse gas emissions [8]. Forest supply chains are presently to a great extent characterized as discrete and detached substances that fulfill their trade exercises through exchanges [9]. Companies regularly work autonomously based on gauges taken from authentic information from clients of their coordinates that are at subordinate points to their downstream clients. This has prompted companies to function based on incorrect data, the well-known "bullwhip impact," coming in a variety of wasteful aspects and high work costs separately and collectively for the supply chain. Through collaborative arranging, request can be effectively satisfied from the closest forest supply range and wood transport can find the perfect course among all conceivable collaborative courses. For more details can be seen in the Table 1.

| Paper By | Research’s scope | Result | Volume and Year |
|----------|------------------|--------|-----------------|
| Elsevier | Industrial case in Sweden's forests are determining the development of maritime supply chains | The criteria for determining the mode of transportation of forestry results are indirect location of the letter and the nature of the disputed goods. However, the factors who determine variable are price, said, lead time, energy, and safety, as well as transportation that cannot be tightened [10]. | 8(2020) |
| Elsevier | Forestry waste materials in British Columbia | In this study it was found that, the selection of the best materials for the limited biomass supply should be based on the savings and costs of greenhouse gas reduction. And in the long run, improved conversion efficiency and cost reduction will be key to building improved biofuel survival [8]. | 150(2021) |
| Elsevier | Effects of forestry climate and substitution of concrete buildings and fossil energy | Compared with setting aside forest land arrive to store more carbon within the woodland and diminish the collected biomass, dynamic ranger service with tall gather rates and proficient utilize of gathered biomass to supplplant carbon and fuel-intensive non-wood items gives noteworthy benefits the climate has facilitated [11]. | 136(2021) |
| Elsevier | Industry 4.0 will change the forest value chain by digitizing the wood supply | Applications Industry 4.0 within the wood supply chain, such as back frameworks in logging plans, as well as electronic control of logging operations, machine-to-machine communication, machine vision and robotization, and post-harvest quality control | 162(2019) |
| Journal | Title                                                                 | Abstract                                                                                                                                                                                                                                                                                                                                 | Year |
|---------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Emerald Insight | The complexity of the sustainable wood supply chain in the Amazon | Coordinates activities are required between center supply chain members, such as loggers (suppliers), wholesalers and retailers, and other partners exterior the supply chain to advance the appropriation of Amazon's wood supply chain [13].                                                                                                      | 31(2020) |
| IOP Publishing | Supply Chain Management of the Plywood Industry in Indonesia        | Product flow flows from upstream to downstream, standard material supply, production and marketing process. Source of raw materials based on forest concessions. Related financial flow to the system of purchasing & delivery of plywood products, & selling price of plywood. Create a plywood purchasing system using a shipping order system according to the convention and between manufacturers & consumers [14]. | 593(2019) |
| IOP Publishing | Collaboration practice in supply chain of unshu citrus in Muchacha-En, Ltd, Japan | Collaboration, religion, partnership, & supply chain performance are significantly defined on each connection. Collaboration through partnerships has a smaller impact on supply chain performance than religion through partnership. Higher trust through convention and competence to manage resources required by both parties, and the quality of the relationship, which is maintained by means of improving skills and ability to develop citrus cultivation better and receive high supply chain performance [15]. | 681(2021) |
| IOP Publishing | Supply chain control performance closer to competitiveness of chili as essential agriculture commodity | Based on the output of narrative statistics that could be the following key: bid implementation chain management & chili competitiveness in Tanralili District, Maros counties from powerful narrative statistics using the output breakdown for supply chain management performance 1602 & competitiveness 1556. From the statistics of the output narrative, all functions in the management of related supply chain performance use basic combat, require an internal integration process in order to plan a better framework, as well as have a significant effect on the development of distribution of agricultural and crop processes. Chile to achieve competitiveness during intense competition [16]. | 343(2019) |
| Publishing/Source | Title | Abstract/Details |
|-------------------|-------|------------------|
| IOP Publishing    | Forests that can be protected by the company's zero deforestation commitment | The results of the study were located between 34%-74% of all forests can disrupt increasingly high value protection forests (HCVF), high carbon stock forests (HCSF) or Humid Peat Forests. This large range of sub-district level in forest areas that can be put to sleep development if this commitment is good. In addition, in the most common problem, protected forests are legally only 28%-34% of forested areas [17]. |
| Springer          | Forestry Supply Chain Optimization with Digital Method | From the literature, the author lays out that capital and optimization tools exist regarding planning in FbSC (forest-based supply chain). Large split models on one or only a few forest planning issues. Therefore, it’s far important to devise with an integration version that is strategic, operational, and intermediate stage choices and in addition to easy optimization equipment for experts [18]. |
| MDPI              | Cost creation within the woodland products industry with sequential optimization approach in tactical making plans | Improving the product supply chain and net income of the supply chain can be done by planning long-term forest management with a new model approach considering the parameters of the forest product supply chain. This model allocates products sequentially starting with high-value factories. The implementation of forest plans requires empirical supply chain data with region-specific parameters in this flexible model. Our modelling framework does not take into account external sources such as market changes, production regimes, and disruption impacts [19]. |
| Gestão & Produção | Forest Supply Chain Framework to Industry 4.0 | This article is coordinating for forestry village 4.0 from a forest charge device chain angle to the whole capacity of virtual generation in a clearly connected, good, and excellent network chain ecosystem. It’s word by word with paradigm changes to total digitization, automation, and precision of forest message chain systems. This is the end-to-end digitization of all physical assets of the forest chain to become and with both network partners, customers, and other partners. Total network chain of forest network and interoperability cannot be realized without chain collaboration and vice versa [9]. |
2. Materials and Method
This research aims to find ways to optimize the application of hybrid simulations in forest supply chains, determine the factors that influence the use of hybrid simulations in forest supply chains, and determine what improvements can be made further. The premise for conveying the ideal Reason. Each of the previous literature studies has an interesting and diverse methodology. The different methods of each given paper will give researchers a new perspective on the methods to be applied in the implementation of hybrid simulations in forest supply chains.

The scientific articles analyzed by the researchers came from various sources with one discussion, namely the application of hybrid simulation. The focus of this research is on the factors that influence the application of hybrid simulations with the aim of maximizing forest supply chain management.

The first stage of this research is to find the latest scientific articles based on appropriate and well-established topics. At this stage, the researcher collects data that will be used to produce arrangements to solve the problems encountered and read references from previous research to enable researchers to understand the problem. The sources of scientific articles in this research come from international
journal publishers with the ability and capability in their field. These articles are collected, then reviewed and arranged according to the topics explored to get the best papers.

After getting the expected quality and quantity required, then re-examined. Reanalysis is used to determine which implementations and improvements need to be made, and can be applied to hybrid simulation applications in forest supply chains. The stages of this research that can be seen from Figure 1.

![Diagram of Research Implementation Stages](image)

**Figure 1.** Stages of Research Implementation

3. Result and Discussion
Hybrid simulation can be characterized as a modelling strategy that combines two or more strategies such as, discrete occasion reformation, framework flow, and agent-based reformation. Hybrid Simulation includes an critical component within the improvement handle, to be specific the interface between sub-models: for example, how to interface the method stream show, state chart, and stock stream demonstrate. Applications of hybrid simulation moreover reflects the broad single-method demonstrate library that exists in certain areas, and has ended up the premise for encourage enhancement through the utilize of other modeling strategies. The hybrid simulation technique was appeared to be a attainable arrangement of conducting large-scale or full-scale supply chain ranger service.

Based on the analysis that has been done in previous articles, hybrid simulation facilitates the management of forestry supply chain in conducting prevention so that the supply chain from forestry used as raw materials of the production process is not cut off. Hybrid simulations used can take into account the period of supply chain continuity of the forest so that action can be taken to extend the shelf life of the supply chain from forestry and prevent forest destruction due to excessive exploitation.

4. Conclusion
The forestry sector of supply network that strongly supports the production process ranging from raw materials to energy which use during the production process. Due to the complexity of the network chain in forestry’s system such as producers, customer and stake holder, the supply chain application of the forestry sector could use hybrid simulation method as a solution.

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