



# Oromia Forest Industry's Supply Chain Network Performance Analysis

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**Abstract:** Supply chain network performance measurement is the process of qualifying the efficiency and effectiveness of the supply chain. Supply chain network performance analysis is one of the promising tools employed for assessing performance and then taking the necessary measures for improvements of existing supply chain network. Ethiopia's forest coverage is estimated about 10 to 30 percent. Still there are efforts to increase the coverage. Reducing deforestation has equal importance with that of increasing plantation to improve forest coverage in the country. For instance, in order to reduce deforestation the government has put in place a policy to import wood and wood products without tax. However, if the forests are not properly cultivated or harvested then forests will decay and also triggers illegal users which intern will have impact on the forests coverage in the country. In this study, Oromia Regional State which covers 70% of the total forest coverage in the country is considered and the research identified that forests are decaying in the region. This is partly because the major customers are far from the forests. Hence, the forest products supply chain network is first analyzed. For this purpose, main sources of data were interview, observations, secondary data, Geographic Information System (GIS), and standard preference table. Based on the findings a new supply chine network is designed which enables the Oromia Forests Industry optimally utilizes its resources and at the same time address customers' requirements keeping the current forest as well as improving forest coverage of the region.

**Keywords:** Supply Chain Network, Performance Analysis, Geographic Information System (GIS), Forest Industry

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## 1. Introduction

Enterprises create and deliver products and services through increasingly global and complex supply chains. The hypercompetitive nature of today's business environment, however, requires enterprises to continuously seek ways to decrease operational costs, provide satisfactory customer service, and minimize existing and anticipated disruption risks by designing and managing efficient supply chains. A supply chain can be considered a complex system consisting of a set of activities, workers, technological and physical infra- structures and policies involved with the procurement of raw materials, conversion of these raw materials to finished and semi-finished product, and logistics of these products [11].

Supply chain Network performance (SCNP) depends on all the constituents of the supply chain. Long term issues in SCNP involve location of production and inventory facilities, choice of alliance partners such as the suppliers and distributors, and the logistics chain. The long term decisions also include choosing between make to order and make to stock policies, degree of vertical integration, capacity decisions of various plants, amount of flexibility in each subsystem, etc. [10]. The emergence of the global economy and intensified competition have led many firms to recognize the importance of managing their supply chains for fast product introduction and service innovations to the markets. For improved competitiveness, many firms have embraced supply chain management (SCM) to increase organizational effectiveness and achieve such organizational goals as improved customer value, better utilization of resources, and

increased profitability [8 & 9].

An important component in supply chain design and analysis is the establishment of appropriate performance measures. A performance measure, or a set of performance measures, is used to determine the efficiency and/or effectiveness of an existing system, or to compare competing alternative systems. Performance measures are also used to design proposed systems, by determining the values of the decision variables that yield the most desirable level(s) of performance. Available literature identifies a number of performance measures as important in the evaluation of supply chain effectiveness and efficiency [7].

According to recent Forest Resources Assessment estimate the global forest coverage is just over 4 billion hectares, which is 31% of total land area of the world. Ethiopia is categorized among countries with forest coverage of 10-30% which accounts for 12.2 million ha (11%) (FAO, 2010) [1]. Oromia Regional State has a forest coverage (only high forests) of 3.1 mill ha, which is 8.5% of its total land area, and accounts for 70% of Ethiopia's total forest coverage. The total forest concession is 1,752,488 hectares, of which 74,215 ha, 1,209,955 ha and 468,318 ha are classified as plantations, natural forests and other lands, respectively [3].

Currently, Ethiopia is importing forest products. On the other hand, forest products (forests) are decaying in Oromia. Hence Oromia Forest Industry (OFI) is not using the available forest resources efficiently and effectively. The main causes attributed for these are: huge amount of the forest resource is decaying in the forest and some of them are used by illegal users. The problem is the plantation forests & the sawmill factories and the demand are located apart. Therefore, the researchers select Oromia Forest Industry for case analysis. The objective of this paper is to analysis the supply chain network performance and design well integrated supply chain network for OFI. Mainly it focuses on determining the optimal distribution centers. GIS is used to show the location of the forest industries and the optimal distribution centers.

## 2. Forest Industry

Forest industry is an industry like other industry such as metal industry, construction industry, automotive industry...etc. It is included in the GTP to contribute its role in the development of the country. Forest industry uses forests (logs) as raw material and it sells the products mainly as sawn woods (logs) and lumbers. The logs are processed using sawmills and changed in to different dimensions of lumbers. Forest industries play a great role in preventing erosion, protecting wildlife animals being a shelter for them, protecting deforestation...etc. The Forest Industries kept the natural forests not to be harvested by illegal users, uses the plantation forest efficiently to contribute its role in the development of the country and replants the harvested area of the forest in order to substitute the harvested area. Forest industries harvest and replant the forest area in scientific way with the help of different professionals in order to increase

the efficiency of these industries and to avoid the miss use of the forests. In addition to these, forest industries prevent the forests from illegal users.

Ethiopia is following the import substitution strategy on forest products. This means forest products are imported to Ethiopia free of tax. Ethiopian policy on forest industries is to meet public demand in forest products in one hand and keeping the contribution of forests in enhancing the economy of the country through appropriately conserving and developing forest resources' on the other hand [5]. This is for two reasons: to satisfy the forest products demand and to protect deforestation.

But it is not possible to protect deforestation simply by importing forest products from foreign countries. Mainly deforestation is occurred by uncontrolled logging and the illegal export of wood stems to urban centers like Addis Ababa and is a threat for the natural high forest of the country [6]. Illegal users use the forest products illegally for the sack of their individual benefits. In addition to this, illegal users didn't replant the forests. Hence, instead of importing forest products it better to establish forest enterprises for Ethiopia's forests and give legal guaranty. These enterprises should have to have a mandate of using the plantation forest resource efficiently and keeping the natural forest. Using the available plantation forest resource generates income for the country as well as for the established forest industries. It is also possible to export forest products by increasing the productivity of these forest industries. During the data collection some of the furniture industries obtain their raw materials (logs) from individuals who do not have licenses on forests or forest products. This shows still illegal users are using the forests for their individual purposes. Hence importing forest products will not completely prevent deforestation. Hence, using the plantation forest efficiently by replanting will not lead to deforestation; rather illegal users aggravate deforestation.

The activities that have to exist in order to get the correct amount of raw materials from the forest without reducing future harvest possibilities, are planting, cleaning, thinning, and harvesting. The assortments obtained from forest raw materials can be classified according to their use. Saw logs, pulp wood, and forest residues are the major parts of the assortments. Each part can be further divided into several subgroups according to their qualities and dimensions. In forest supply chain after harvesting, timber is transported to saw mills. The timber can also be transported to terminals for storage before transportation to the saw mills. Similar conditions hold for pulp wood, it is either transported directly to pulp mills, or is taken via terminals for intermediate storing. By products from saw mills, such as chips, are transported to pulp mills and heating plants for further use. The final pulp products are transported to paper mills to make paper products. The last transportation is transportation from the saw mills, paper mills, and heating plants to the final customer [4]. Hence supply chain of the forest products allows the industry in using the available resources efficiently, fulfills the customers demand and provides to

increase the overall profitability of the supply chain. But in case of OFI, the industry is not using its available resources efficiently and it is not satisfying its customers. This is mainly due to the gap between the sources and the destination.

Since forests and the customers fall apart potentially, the forests outputs may not be directly accessed by the customers. This triggers illegal users to misuse the forests.

### 3. Oromia Forest Industry

Oromia Forest Industry is a public enterprise mandated with sustainable protection, development and utilization of forest and wildlife resources in Oromia Regional State. It is an autonomous public enterprise established with Reg. No.122/2009, issued by the Oromia national regional state council in July 2009. It is mandated to administer and sustainably manage regional forests, woodlands & wildlife conservation areas in Oromia. OFI is accountable to Board of management and have a total capital of about 1.5 billion birr. The enterprise is structured in to 9 branch offices and 38 forest districts and has a total of 1,980 permanent, 1,029 contractual employees and employs some 10,060 casual laborers in a year.

OFI provides sawn timber, chipboards, furniture, veneer and impregnated poles. Oromia Forest Industry has 31 sawmills located in different zones of Oromia and also within the capital Addis Ababa as they call it Finfine, three joineries (furniture making), one veneer machine and one briquette plant. Currently, the forest industry is one of the largest suppliers of round wood and sawn timber in Ethiopia. It is striving for a leading position as a full service provider in forest resource-related products in the country.

### 4. Research Methodology

In order to analyze, identify the existing supply chain network performance of OFI, get the findings and to reach to a certain conclusion, primary and secondary data are collected from Oromia Forest Industry (OFI), Ethiopia SNS furniture manufacturing, Ethiopian Electric Power (EEP), Ethiopian Chip wood and Furniture Company (ECAFCo), OFI's furniture manufacturing and 3F furniture by interviewing managers of the offices and industries as well as randomly selected workers of the industries and by direct observations of the furniture industries and sawmill factories.

Finally, the data which are collected by interview, direct & indirect observation and data collected from the documented files are analyzed and synthesized using GIS and standard preference table. The data are analyzed qualitatively and quantitatively. The qualitative analysis helps to map (show) the supply chain network performance, their integration, material, financial and information flows. The quantitative analysis is used to determine the alternative optimal distribution centers, to determine the optimal distribution centers and supply chain networks for OFI. GIS is the only

tool used to analyze spatial data. Hence, GIS is used to show the locations of OFI forests, sawmills and distribution centers. To compute and select the distribution centers standard preference table is used. This means 1=less preferred, 2=moderately preferred, 3=strongly preferred, 4=very strongly preferred and 5=extremely preferred.

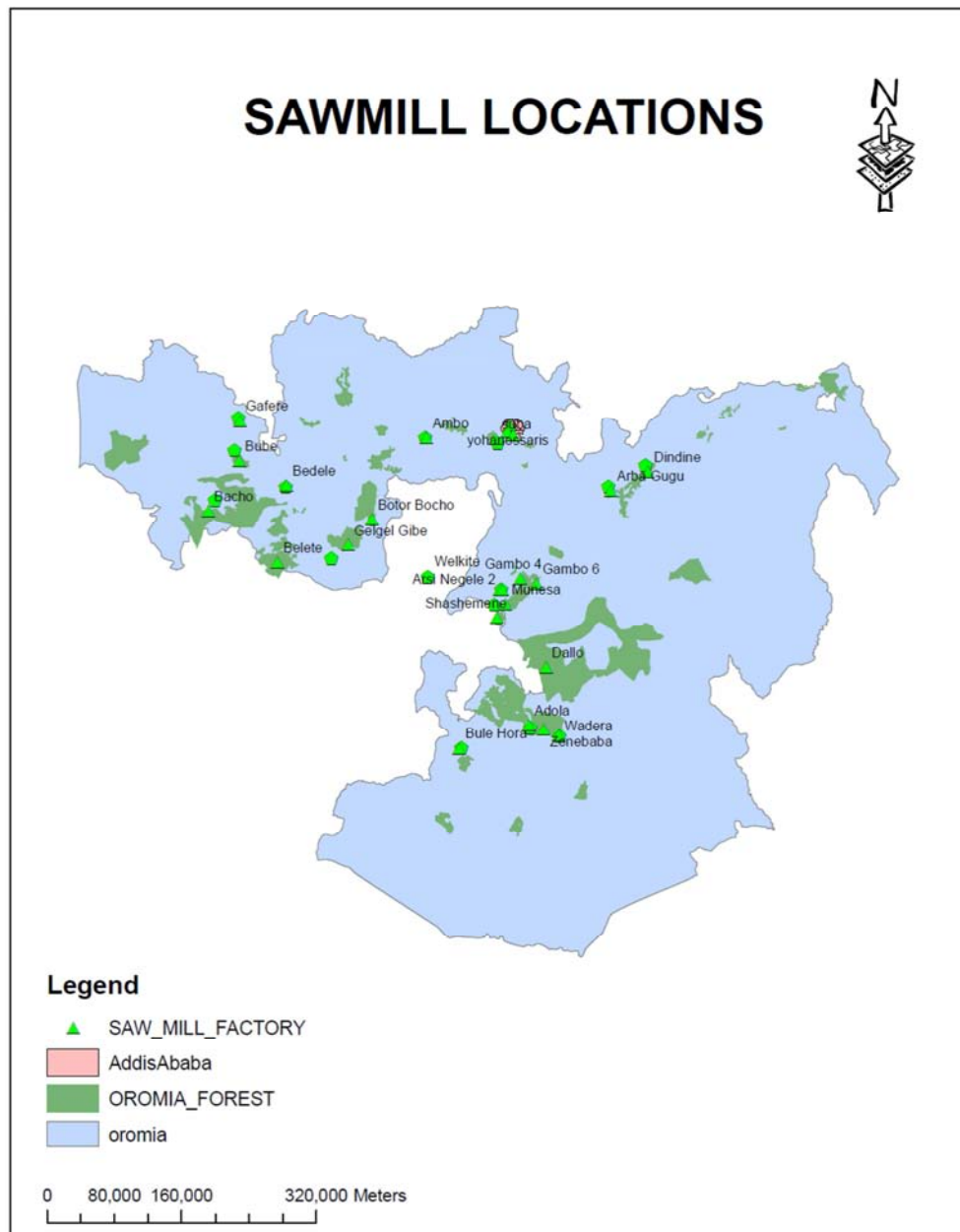
### 5. Results and Discussions

Based on the methodology described in this paper, data are collected and analyzed. As a result there are 31 sawmill factories, 9 branches and 43 districts. There are two types of sawmill in OFI. These are band sawmills and circular sawmills. Circular sawmills are power full or have high capacity than band sawmills. The existing locations of sawmills are located with Geographic Information System (GIS) in geographic map of Oromia region as it is shown on Figure 1. The sawmills are located near their suppliers (plantation forests) but they are located too far from the demand market area (Addis Ababa) in which the customers of OFI are located. Based on this figure and the data collected from documented files of OFI and its customers, from interview; the overall existing supply chain network (material flow) is drawn as it is shown on Figure 2. Hence, in the existing supply chain network there is no distribution centers. Customers are taking products directly from OFI and the transporting of the materials is seasonal based. Since the manufacturers are located in a remote directly from the forest which is not convenient since it is remote area, muddy road, etc. Due to this OFIs' are not manufacturing in their full capacity though this is not the only reason.

Hence, customers are obliged to buy a large amount of products during the suitable season in order to compensate the problem to transport products during rainy seasons. This leads to the customers to be challenged with unwanted inventory costs followed by customer dissatisfaction.

After identifying the existing supply chain network of OFI, the next step is analyzing the performance of the existing supply chain network. Therefore, based on the nature of the industry; resources, output and quality performance parameters are selected to measure the existing supply chain network of OFI.

As the results of data analysis shows, in OFI most of the saw mills are working under their capacity (underperformance). If the sawmills work under their full capacity they can produce  $115\text{m}^3$  of additional lumbers= $707,317.85\text{Birr per year}$ . And some forests are decaying there in the forest land. As a result,  $36,523,480\text{Birr}$  is under question whether to be lost or not. There is no guaranty whether this much of birr is going to be lost or not. It is under question. This shows there is inefficient utilization of the available forest resource in OFI which indicates OFI is working under its intended performance. Hence, OFI is not using the available equipment/machines, human resources and forests efficiently and effectively.



**Figure 1.** Locations of OFI sawmill factories.

#### *Suppliers*

Suppliers of OFI are the plantation forests. These plantation forests are administered under branches and districts. Hence there are 9 branches and 38 districts. Since Arsi branch is the most potential resourceful branch it is the only branch that is administered directly by the main office of OFI. The demarcation area of the plantation forests (sites) and their capacity is not yet clearly identified by OFI. The plantation forests in hectare and how many logs in m<sup>3</sup> they can produce is currently on the way of studying (doing) by OFI. This indicates that OFI is not using its resources effectively. Hence, some of its forests (logs) are stolen and sold to the market by illegal users.

#### *Manufacturers*

The manufacturers of OFI are the saw mills. In OFI there are 31 saw mills which are located in different locations of

Oromia region. They are located too far from Addis Ababa and most of the saw mills are located at or near to the plantation forest. The sawmill factories are located around 50km to 620km from Addis Ababa in which the market demand of wood products is located (found) or the major customers of OFI are located. On the other hand the saw mills found in Addis Ababa which are administered under sheger branch are too far from the plantation forest. They got the logs from Jimma branch and shashemene district which are 295km-385km and 260km far from Addis Ababa.

Generally Arsi Branch, Bale Branch, Borena Gugi Branch and Hararge Branch are found at South & South East of Ethiopia. Jimma Branch, Elubabor Branch and Welega Branch are found at West part of Ethiopia. Finfine Branch and Sheger Branch are found at the middle of Ethiopia (Addis Ababa).

### Customers

Major customers of OFI are located at Addis Ababa. Some of the customers are private sawmill enterprises, furniture manufacturing factories, wooden pole preparation centers, private wood product enterprises and cheap wood factory. Some of the customers bought the products with the initial fixed costs determined by the tendering committee of OFI. For example EEP and ECAFCo buy the products from OFI with the initial fixed cost without the tendering procedures.

While the majority of the customers buy the products after winning the tender and fulfilling the required procedures. These customers are located too far from the manufacturers and they transport the products by their own transportation. Customers of OFI obtain lumbers from the manufactures and logs directly from the suppliers. Hence, based on the natures of suppliers, manufacturers and customers of OFI their relationship or product flows is shown on Figure 2.

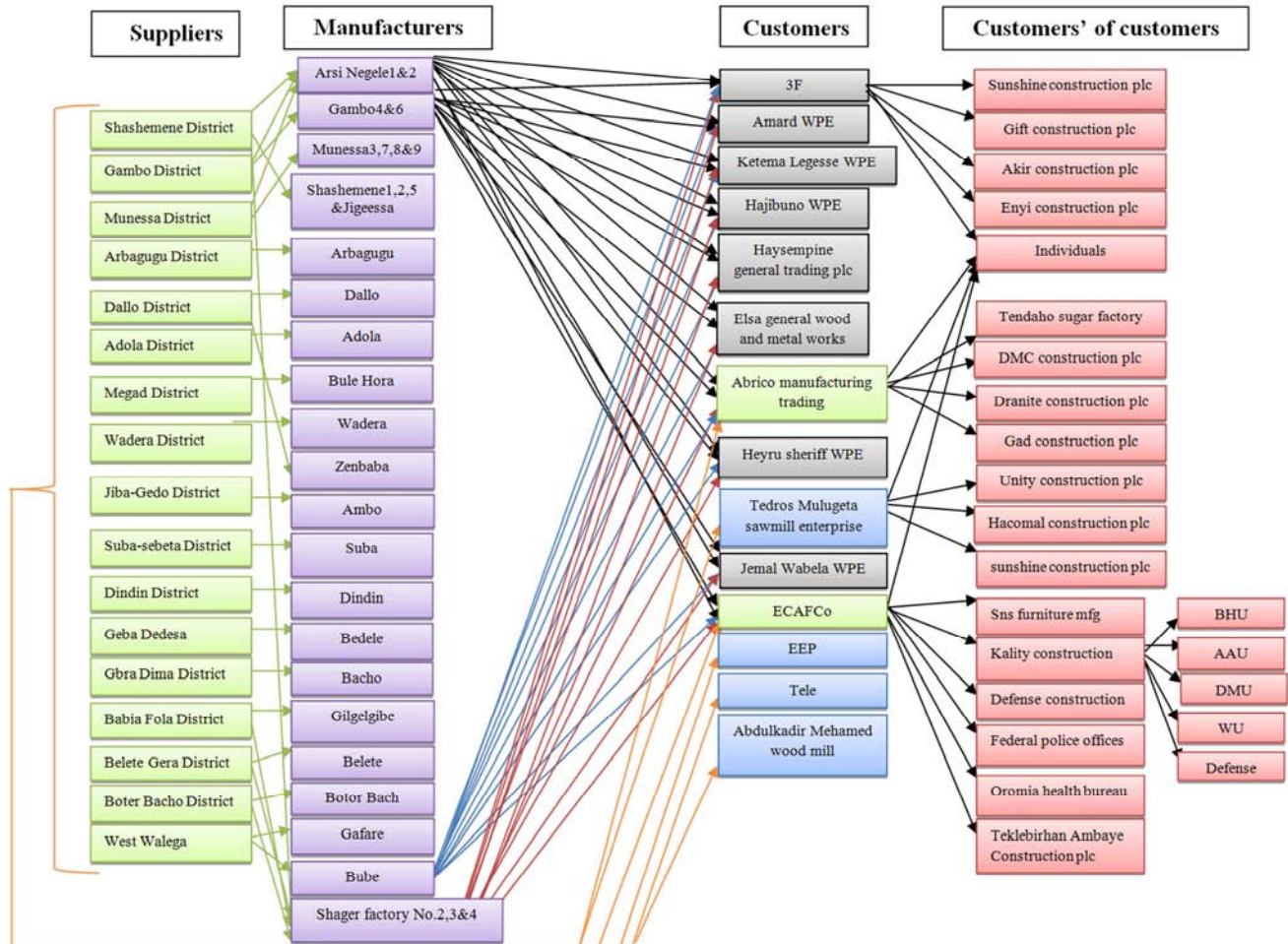


Figure 2. Existing supply chain network of OFI.

## 6. Proposed Solution

Most of the customers of OFI are complaining on transportation problems since the industries are too far from the customers, availability and price of the raw materials. Moreover, the quality of the products of OFI are dependent on how long they stay in the forest. As they stay in the forest as a tree in the forest, the inside part of the log becomes hallow. This has a direct impact on the quality of the lumber. It makes the lumbers to be cracked during processing in the sawmills. As the trees stay in the forest more and more, they depreciate their quality and finally they decay. To quantify this in-terms of costs of quality, it is almost internal failure costs. Taking the average cost of logs, taking Jimma as one

case, it is 1,700Birr per  $m^3$ .

After analyzing the performance of the existing supply chain network of OFI the next step is designing (redesigning) SCN for OFI. As a result the sawmills which are found at Addis Ababa (Sheger branch) are relocated to Arsi Negele branch. Optimal distribution centers are also designed for OFI. To select the distribution centers; land availability and building costs, nearness to the sawmills, proximity to market, transportation, availability of infrastructural facilities, labor availability and cost, safety and security and future expansion are considered.

Hence, *Welkite, Ambo, Adama, Ziway and Addis Ababa (Torhayloch)* are selected as distribution centers for OFI as it is shown on Figure 3 and Figure 4. These distribution centers facilitate the distribution of forest products. They will

distribute forest products to each customer by getting the forest products from the manufacturers. They are intermediate between the manufacturer and the customer. Hence, these distribution centers help in increasing the profit of OFI by making to use the resources efficiently, increases customer satisfaction (customers can obtain the products at any time which is not seasonal based), because of the availability of these distribution centers, OFI can produce forest products with its full capacity of the sawmills, hence increases efficient utilization of machines/resources and eliminates wastage of forest resources...etc. Generally, due to the presence of these distribution centers; OFI can only plant, harvest and manufacture the forest products with its full capacity which makes it to use its resources efficiently and effectively. It will not be a worry on how to distribute and when to distribute. It is the tasks of the distribution centers. The forests which are sold every year to EEP and its

associated problem will also be eliminated due to the presence of these distribution centers.

The capacity of distribution centers is calculated by taking the total physical size of inputs (lumber and logs) coming from the factories and the plantation forest in to account. In this particular case, the distribution centers capacity at each location is determined by taking the annual production plan of OFI and the demands. Therefore, the capacity of *Welkite* distribution center is  $2,000m^3$  per month, the capacity of *Ambo* distribution center is  $1,000m^3$  per month, the capacity of *Adama* distribution center is  $1,000m^3$  per month, the capacity of *Ziway* distribution center is  $4,000m^3$  per month and the capacity of *Torhayloch* distribution center is  $6,000m^3$  per month. The capacity of *Torhayloch* distribution center is done by considering that products can be transported from the other distribution centers to *Torhayloch* (Addis Ababa). And the new SCN is shown in Figure 4.

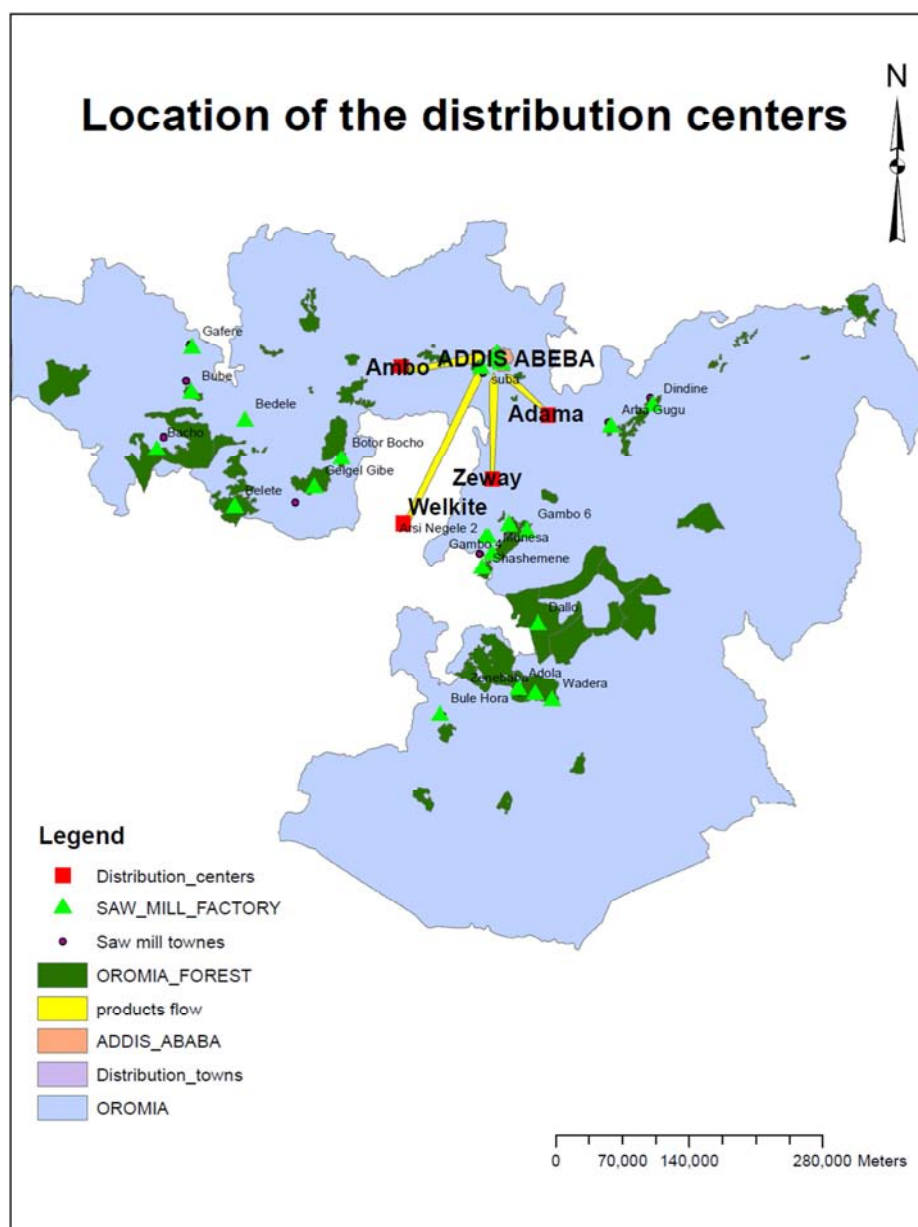


Figure 3. Location of the distribution centers.

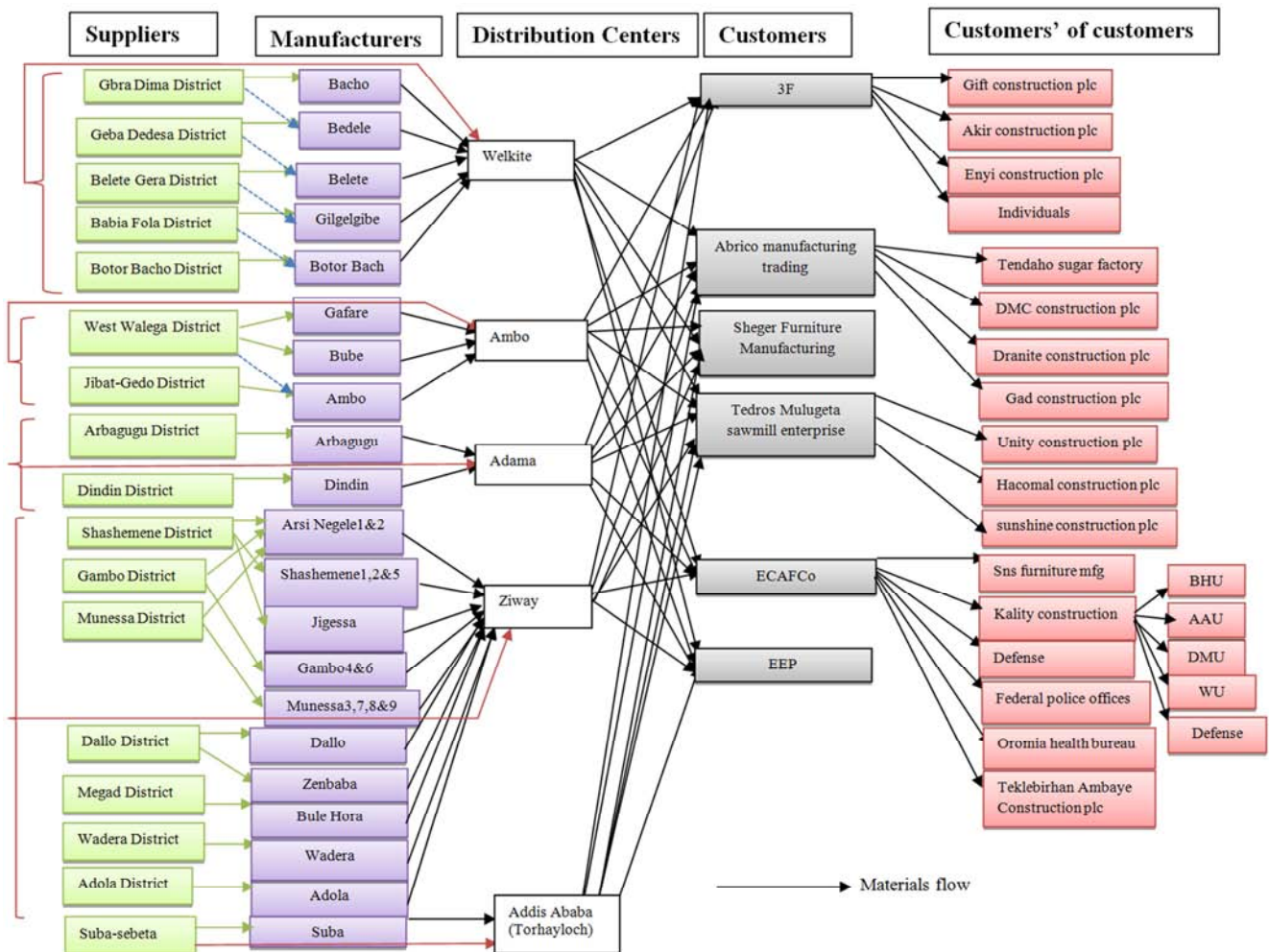


Figure 4. New supply chain network of OFI.

## 7. Conclusion

From the literature review, though there are so many researches in the area of supply chain management its application in the forest industry is not yet established and hence this could be a contribution to the field.

From the data collected, analyzed and results the following conclusions are dawn:

OFI is losing on average *294,584.4Birr* per year due to inefficient resource utilization, *707,317.85Birr* per year due to underutilization of the sawmills, *25,867,972.16Birr* due to the absence of distribution centers. Ethiopia Electric Power (EEP) is one of the constant customers of OFI which consumes more than 70,000 logs per year. This means taking the minimum length (8m) of the logs which is  $0.28\text{m}^3$ ; equals  $76,730 \times 0.28 = 21,484.4\text{m}^3$  per year. EEP buys logs with  $1,700\text{Birr}/\text{m}^3$ . This imply  $21,484.4 \times 1,700 = 36,523,480\text{Birr}$ . Hence more than *thirty six million birr* is under question whether to be lost or not every year. Hence it can be conclude that this designed supply chain network gives guaranty for more than *thirty six million Birr*. Totally OFI is losing *26,869,874.41 Birr* per year ( $294,584.4 + 707,317.85 + 25,867,972.16 = 26,869,874.41$ ) due to inefficient and ineffective utilization of the available

resources.

Geographically the locations of the industries are located scattered. Hence cost wise it is almost impossible to transport products from one distribution center to another, from one district of the plantation forest to another. For example cost wise it is almost impossible to transport logs/lumbers from Arsi Negele district to Jimma district. But it is possible to transport from one district to another; which is with its nearby district. And most of OFI forest products are sold directly to customers as logs which are more than 50% of the available forest resources that are ready to be harvested. From the existing OFI, Arsi Negele is the most potential area in production as well as in resource availability which has the latest sawmills.

As the interviewed data shows most of the customers are complaining about the price of the forest products, the locations of the forests (which are too far from the customers) and its monopolist. From this it can be conclude that OFI is not satisfying its customers. This indicates that, if good competitors' comes definitely the customers will shift to the new competitors. OFI can save *25,867,972.16Birr* due to the presence of these distribution centers.

## 8. Recommendation

Based on the conclusion and direct observations the following recommendations are forwarded:

Nowadays Chinese companies are coming to Ethiopia to fill the gaps of forest products demand. This indicates competition is increassng. Hence, OFI should compute with these companies by providing products with less cost, good quality and good service to satisfy its customers and increase its profits. Some of the customers' of customers of OFI do not know that OFI is the biggest supplier of forest products. Hence, it is recommended that OFI should work on promoting of its products.

As it is observed most of the byproducts of OFI like chip woods, are not used for further end products. From this OFI should communicate with different chip wood, particle board and paper industries in order to use the byproducts efficiently.

As the interviewed data shows OFI have a problem of manpower specialized in operation and maintenance of sawmill machines. Even it is becoming impossible to get from the market who specialized (familiar with) in sawmill machines. So, to solve this problem permanently, OFI should work jointly with universities and TVET institutions so that it can be included as one area of field of study. In addition, to this OFI top managements should be committed to replace the very old sawmills, obtain the prize (award) given from the government per machine and be competitive enough locally as well as globally.

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## References

- [1] Yitebitu, M., Zewdu E., & Sisay N. (2010). Ethiopian forest resources: current status and future management options in view of access to carbon finances, *Addis Ababa*.
- [2] Million, B., (2011). Forest plantations and woodlots in Ethiopia. *African Forest Forum vol.1 (12), Kenya*.
- [3] Oromia Forest and Wildlife Enterprise (OFWE). (2014). Oromia Forest Industry (Brochure), Addis Ababa, Ethiopia.
- [4] Helene, G. (2007). Supply chain optimization in the forest industry. Linkoping Studies in Science and Technology Dissertations No. 1105, Linkoping, Sweden.
- [5] Abebe, H. G., Million, B., & Andrew, B. (2009). Small and medium forest enterprises in Ethiopia, International Institute for Environment and Development, No. 26, London, UK.
- [6] Adugnaw, B. (2014). Environmental Degradation and Management in Ethiopian Highlands, *International Journal of Environmental Protection and Policy, Vol. 2(1)*.
- [7] Benita M. Beamon (1998), Supply chain design and analysis: Models and methods, Int. J. Production Economics, Department of Mechanical, Industrial, and Nuclear Engineering, University of Cincinnati, Cincinnati.
- [8] Kee-hung Lai et al. (2002), Measures for evaluating supply chain performance in transport logistics, *Transportation Research Part E* 38.
- [9] Kaushik Sengupta et al. (2006), Manufacturing and Service Supply Chain Performance: A Comparative Analysis, *The Journal of Supply Chain Management*.
- [10] G. P. Kurien and M. N. Qureshi (2011), Study of performance measurement practices in supply chain management, *International Journal of Business, Management and Social Sciences* Vol. 2, No. 4.
- [11] Marcus A. Bellamy and Rahul C. Basole (2012), Network Analysis of Supply Chain Systems: A Systematic Review and Future Research, *Systems Engineering* DOI 10.1002/sys.