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Supply Chain Analysis of the Handmade Textile Manufacturing Sector Based on Supply Chain Operations Reference (SCOR) Model

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Abstract

Supply chain management has gained wider acceptance to compete in the current business environment in the developed world. However, its application has remain limited in developing countries. In recent years, supply chain management has shown growth in the developing world. However, there is limited experience and application in the traditional manufacturing sector, like handcraft industries. In order to increase productivity and meet consumer demands, this study will examine how the Handmade Textile Manufacturing Industry (HMTMI) in Gamo Zone operates its supply chain. Data for the study was gathered through observation techniques, questionnaires, and interviews. The current supply chain operations have been examined to find areas for future development using the Supply Chain Operations Reference (SCOR) model. The main issues found in the analysis of the current SC operation were the high cost of sourcing because of the drawn-out supply chain process, the scarcity of raw materials and issues with quality, the low production efficiency and capacity utilization, the absence of modified weaving technologies, the inadequate scheduling of production, the poor management of orders and deliveries, and the inadequate marketing system. Using modified production technologies, minimizing non-value-adding SC actors, establishing distribution centers for weaving associations in urban areas, strengthening market links with final product users, and switching up source points and connecting potential suppliers are all ways to improve the performance of SCs. By taking this improvement measure, the industry will become more efficient in meeting client expectations while reducing manufacturing and sourcing costs as well as delivery times.

Keywords: SCM; Handmade Textile Manufacturing Industry; SC Analysis; SC Processes; SCOR.

1. Introduction

Supply chain management (SCM) is a means to improve different processes using a variety of tools by managing both internal and external environments that are consistent with the overall firm's objectives and strategies (Georgise et al., 2011; Thando and Anthea, 2017; Ivanov, 2021; Venkataraman & Demirag, 2023).

It is important to analyze supply chain management performance to improve its efficiency, reduce costs of production, increase the efficiency of firms, and meet customer demands. According to Chopra and Meindl (2007), a company's ability to match customer preferences in terms of service, cost, quality, and flexibility over the long term depends on how effectively it designs its supply chain to be more effective and efficient than that of its rivals.

Historically, many developed and developing countries have utilized textile and garment sectors to initiate their development and gain foreign currency as strategic sector due to their labor and raw material competitive advantages like India and China (Bedi, 2009; Chandra; 2006). In the modern global economy, this development continues; however, the effort has moved toward supply chain resilience and sustainable manufacturing as critical drivers for maintaining competitiveness in new markets scenarios (Adane & Gnanadhas, 2022; Statista, 2024; Taplin, 2021). One of the sectors that needs strategic and operational interventions is handmade textile manufacturing industries in developing countries. One of the important sectors that requires urgent operational improvements is the handmade textile manufacturing industry in developing countries. Recent findings has demonstrated that this sector is vibrant for cultural preservation and rural employment however, it faces significant challenges including fragmented supply chains, low technological adoption, and limited access to global digital markets, all of which necessitate modern management frameworks (Molla & Goshu, 2023; Saini & Saha, 2024; UNCTAD, 2022).

The Handmade Textile Manufacturing Industry (HMTMI) is a cottage industry producing handmade textiles in Ethiopia (Walktole, 2016). With a long-lasting tradition, the country is undoubtedly the most important center for the production of handmade clothes in Eastern Africa and has always held this position of preeminence (Japan Embassy, 2008; Hitesh and Chaudhari, 2020). According to the Central Statistics Authority (CSA) (2018), data weaving establishments were estimated to be 330,341 for the whole country, and the second highest number of establishments in the cottage and handicraft manufacturing industry employs the second highest number of people, which accounts for 23% of the total employment following food products and beverages. The manufacturing of handmade textiles in the Gamo highlands in the Gamo zone is prominent in Ethiopia. Weavers from the Gamo Highlands are known to be among the weaving pioneers of the country and are held in high esteem for their superb skill and for producing exquisite textiles and garments whose design, style, and structure vary from simple to complex (Kedir, 2016).

Manufacturing companies have many challenges with SCM-related issues of integration of internal functions within a company and linking them with the external operations of suppliers and supply chain members to overcome the challenge of high market competition. The goal of SCM is to maximize overall SC performance by minimizing costs and achieving low costs, and a company needs to have excellent internal and external performance (Chopra and Meindl, 2007). In HMTMI, due to weak supply chain management, there is a problem with the sourcing of raw materials, production efficiency, and delivery process, and there is also non-satisfaction among customers (Kalyani, 2021). Challenges related to sourcing were serious because the relationship between suppliers and manufacturers is weak and has no consistency, resulting in supply uncertainty, and the production process is inefficient due to raw material supply disruption and delivery and marketing processes not satisfying customers (Girum, 2016).

Currently, there are so many unorganized private hand looms that operate individually and 123 legally certified associations of handmade textiles and garment producers in the Gamo zone. From these 123 legally licensed associations, 92 are at the micro-enterprise level with a total capital of less than 100,000 Birr, 26 are at a small level with a total capital between 100,000 and 500,000 Birr, and 5 are medium-scale enterprises with a total capital between 500,000 and 1,500,000 Birr (Gamo Zone, 2021). From the literature review and knowledge of the researchers from the study area, the case industry has supply chain operation challenges, which are high cost of sourcing due to prolonged supply chain processes, shortage of raw materials and quality problems, low production efficiency and capacity utilization, a lack of modified weaving technologies, and a weak marketing system. Consequently, there are many supply chain weaknesses and drawbacks that have been causing the high cost of the supply chain, and organizations are unable to compete in the current market. In this research work, the supply chain operations of HMTMIs analyzed to identify the challenges of sourcing, production, distribution, and marketing to minimize overall SC costs and satisfy customers to compete in the current market.

2. Literature Review

A supply chain (SC) consists of all parties involved, directly or indirectly, in fulfilling a customer request and is characterized by the flow of goods, services, money, and information both within and among business entities, including suppliers, manufacturers, and customers. It also includes all types of organizations engaged in transportation, warehousing, information processing, and material handling. Sourcing, procurement, production scheduling, manufacturing, order processing, inventory management, warehousing, and finally customer service are the functions performed throughout the supply chain (Chopra Meindl, 2019). An effective supply chain may be defined as the art of bringing the right amount of the right product to the right place at the right time while minimizing related costs within and between all parties (Saad, 2002). In recent years, the supply chain resilience has become increasingly imperative, particularly in response to global production disruptions such as the COVID-19 pandemic and geopolitical tensions. This resilience incidents could be addresses by designing a new flexible and adaptable organizations that evolve through the dynamic challenges (Ivanov, 2020; Scholten Schilder, 2021).

2.1. Supply Chain Management

Supply chain management (SCM) is the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities (Chopra & Meindl, 2020). Significantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers (CSCMP, 2021). It is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores so that merchandise is produced and distributed in the right quantities, to the right locations, and at the right time in order to minimize system-wide costs while satisfying service level requirements. It has shifted the emphasis from the internal structure to external linkages and processes and is dependent on the interaction between the organization and its external environment, with strong feedback linkages and collective learning (Harrison van Hoek, 2019).

2.2. Supply Chain Management and its Challenges of HMTMI

There is a strong relationship between supply chain management practices and production performance in the hand-loom industry, and supply chain management practices have high significance for the production performance of the hand-loom industry (Kalyani, 2021). The SCM process involved in the handmade textile sector is haphazard, i.e., it lacks adequate mechanisms of sourcing, production planning, distributing, and marketing, and it has numerous problems in terms of technology, working capital, raw material supply, production planning, pre-loom process, marketing, competition, and related problems (Kalyani and Samala, 2017). Weavers use three kinds of raw materials to produce woven fabric: 'dir' or warp, 'mag' or weft, and 'tilet' that come from different sources, and their supply system is not organized (Hofverberg, 2010). The knowledge of weaving and the production process of weavers are influenced by different factors like lack of raw materials, training, shortages of capital, and the market, and their economic development highly depends upon the provision of proper marketing arrangements (Girum, 2016). The marketing system of handmade textile products in Ethiopia is not structured and full of uncertainties (Abdella et al., 2007). The manufacturing process of handmade textiles in Ethiopia is not simply a particular way of making cloth but is inextricably bound up with the structure, values, history, and identity of the community in which it is practiced. Hand-woven cotton garments, also called *shemma*, were traditionally worn by different religious followers of Ethiopia. Even though the costumes that participants wear in ritual activities, religious, political, and other cultural events are provided by local weavers, their production process is costly due to the weak linkage between producers, suppliers, and customers (Temesgen, 2018).

2.3. An Overview of SCOR Model

The SCOR model is a supply chain analysis model introduced in 1996 and includes six basic processes, including plan, source, make, deliver, return, and process enablers (Bolstorff, 2003). The SCOR model has been used in many case studies, starting with enhancing business competitiveness, such as ready-made garments for small and medium-sized enterprises (SCOR v12.0). As APICS (2017) notes, the SCOR model provides a systemic approach for identifying, evaluating, and monitoring SC performance. The model provides not only an opportunity to see how the firm is doing but also a common framework of reference and language across SC. The processes in SCOR have been identified as unique processes a supply chain requires to execute in order to support its primary objective of fulfilling customer orders. SCOR is based on hierarchical modeling and analyzes a company's supply chain operation at three levels. The first level (top level) represents the core management processes and the metrics and measures corresponding to the management processes.

The three types of processes (MTS, MTO, and ETO) are represented in level two of the model. The plan process types are represented as sP2, sP3, sP4, sP5, and sP6 for plan source, plan make, plan deliver, plan return, and plan enablers. The basic sources—makes, deliver, and return—have variants like make to stock, make to order, and engineer to order. Level-3 processes are the lowest level in the scope of the SCOR model, in which processes decompose into operational components. Implementation levels that are below level 3, in which we decompose process elements into tasks and further activities in a classical hierarchical manner, are not in the scope of the SCOR model. Level 3 allows businesses to define in detail

the processes identified, as well as performance metrics and best practices for each activity. Performance levels and practices are defined for these process elements (SCOR v. 12.0) (SCOR, nd, etd, nd). Figure 1 demonstrates the first-level view of the SCOR v12.0 model (APICS, 2017).

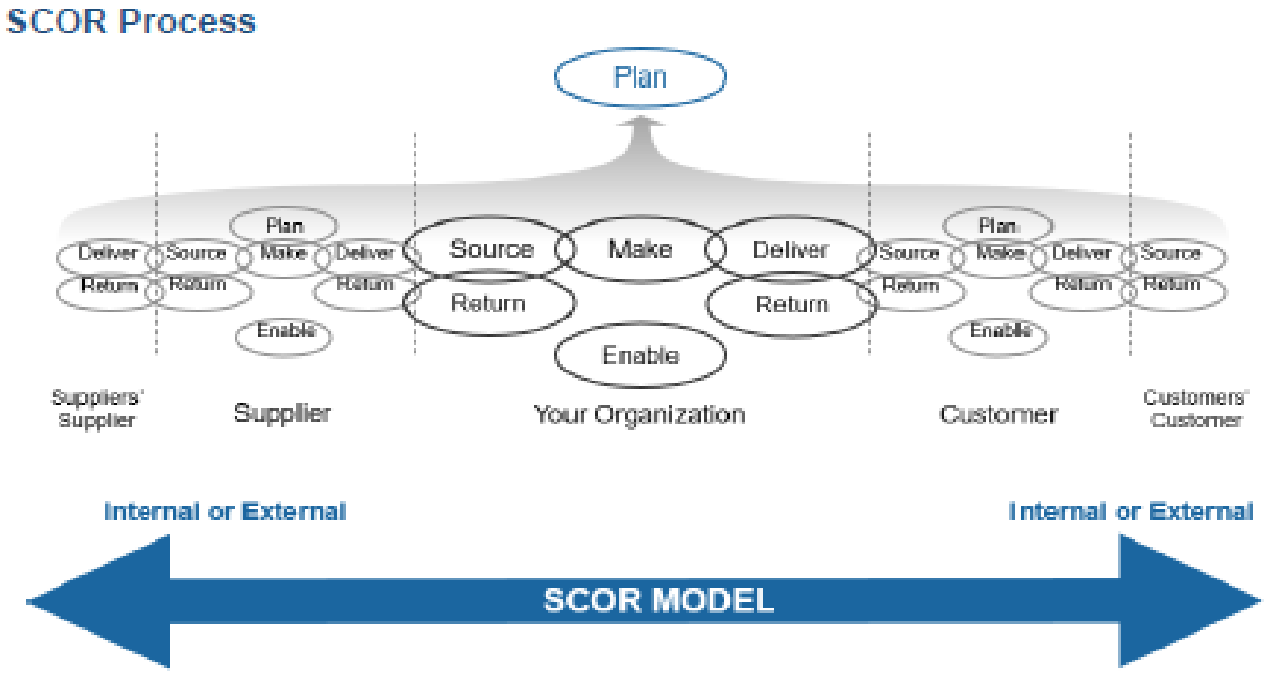

Figure 1. SCOR model business process (SCOR v 12.0) (APICS, 2017).

Measuring how well the supply chain performs is as essential as understanding how it operates, and measurements must link to business objectives, be repeatable, provide insights into how to manage the supply chain more effectively, and support conflicting targets. SCOR defines five generic performance attributes (SC reliability, responsiveness, flexibility, cost, and asset management efficiency) and three levels of measures that the analysts can use. The SCOR model has got high acceptance and applicability in different sector of business to measure, compare and utilize as improvement tools (Rodríguez et al, 2022; Ruamsuke, and Ongkunaruk, 2021; Kusrini et al., 2019; Kamarudin and Izaidin, 2018; Hasibuan and Dzikrillah, 2018; Delipinar and Kocaoglu, 2016).

2.4. Knowledge Gaps in the Existing Literature

Though the handmade textile sector plays a significant role in the economies of developing countries, it is under the pressure of an inefficient SCM process, and weaving enterprises find it difficult to procure the raw materials as well as in the process of production and finally sell those products in the market due to poor marketing links (Kalyani and Samala, 2017). Also, the marketing system of the weaving enterprises is unstructured, uncertain, and challenged by competition (Abdella and Gezahegn, 2008). Even though the costumes that participants wear in ritual activities, religious, political, and other cultural events are provided by local weavers, their production process is costly due to the weak linkage between producers, suppliers, and customers (Temesgen, 2018). The economic development of weavers highly depends upon the provision of proper marketing arrangements (Girum, 2016).

The raw materials of weavers come from different sources, their supply system is not organized, and the product marketing system is also highly uncertain of market demand (Hofverberg, 2010). Other researchers conducted studies to assess the SCM problems of HMTMI and identified some of the problems that hinder the SC performance of the industry, but the detailed analysis of the problem and the way out was not addressed well. Therefore, this research work tried to analyze the SC operation of the handmade textile manufacturing industry to improve its efficiency, cost, and time of delivery to satisfy customers.

3. Research Methodology

This research considered SME weaving associations and their customers in Gamo Zone; Ethiopia, to analyze the supply chain operations of the case industry. The study utilized a qualitative and quantitative design by conducting interviews, questionnaires, and observations to give answers to the research questions (Witkin, 1995; Kotari, 2006). Keeping in mind the educational background of the respondents and the nature of the topic selected for study, the study used a closed-ended questionnaire translated in an appropriate language, a semi-structured interview, and an observation method. The SCOR model was used to analyze the existing SC operation, identify the gap, and identify an improvement opportunity because the SCOR model is a universal model with a balanced approach that is suitable for all types of businesses, facilitating SCM analysis for internal and external process improvement of business operations.

3.1. Data Sources

Data was collected from primary and secondary sources. Primary sources were SME weaving associations and their customers found in Gamo Zone because these association groups have better information about the SC of the case industry than micro-level associations and individual weavers. In addition to primary sources of data, the researcher utilized secondary data by reviewing literature from different sources, like journals, documented materials, publications, and different reports.

3.2. Sample Design and Sample Size

The study used a population group of SME hand-loom weaving associations and their customers that are licensed traders in the study area. The study utilized stratified sampling methods to select the samples from different population groups. There are 31 SME weaving associations in the area, and each association has 5 to 25 members and 44 licensed traders. SME associations and licensed traders were selected purposefully. For the interview and questionnaire methods, due to constraints such as time and budget, it was not possible to collect data from the entire population of all association members. Therefore, the strata sampling procedure was used because the samples were drawn twice from different populations. Primarily, associations were sampled purposefully, and each operator or weaver of association members was drawn randomly. For the interview method of data collection from association members', one sample was randomly drawn by taking the name list of the members of the association. That means 31 samples from 31 associations were taken for interview purposes. For the questionnaire, 75 respondents—31 from associations and 44 from traders—were selected from two population groups. From SME associations, 31 respondents that can read and write were selected purposefully, excluding the member that was selected for the interview, and 44 licensed traders were selected purposefully. All SME associations were used for the observation method to visualize the SC operations of the case industry.

3.3. Data Analysis Method

To analyze the data obtained through data collection methods, the SCOR model was used. The general situation of variables on the basis of SCOR model processes such as plan, source, make, and deliver at each level and performance attributes like reliability, responsiveness, flexibility, cost, and asset management performance were used to analyze the data, and different software like Microsoft Excel for data analysis and Microsoft Visual Studio to draw diagrams during data analysis were used. To analyze the questionnaire results, Likert's five-point scale response criterion with ranges of 1.00–1.80, 1.80–2.60, 2.60–3.40, 3.40–4.20, and 4.20–5.00 for very poor, poor, moderate, good, and very good performances, respectively, was used for descriptive statistics analysis in this study.

4. Data Analysis and Discussion

This section presents the main findings of the study. The section divides its discussion into three main categories.

4.1. Respondents' Profile

As mentioned in the preceding part of this study, the population of the study was SME handloom associations and their customers, licensed traders in Gamo Zone. For this study, 31 SME associations and 44 licensed traders were selected. A total of 75 respondents were selected, as mentioned above: 31 from associations and 44 from traders. Considering gender for the interview, all are males because most of the time weavers are males in the study area and women participate in weaving preparatory work. For the questionnaire, 76% (33) were male and 24% (11) were female. Considering age (65.6%), the majority were aged between 26 and 45 years, with educational qualifications below secondary school (51.4%) and secondary school complete (28.6%), and diploma and first-degree holders together making up only 20% of the total. All the respondents have weaving and trading experience spanning more than 10 years.

4.2. Characteristics of the HMTMIs

HMTMI in the study area is characterized by a shortage of working capital, a lack of infrastructure, and a lack of technology and skills to manage business processes. A working capital shortage is the main characteristic problem of HMTMI. Its problem of sourcing quality raw materials is mainly caused by a shortage of working capital, and most of the enterprises are suffering from financial shortages to properly run their businesses. The scarcity of working capital highly upsets the production process of the case industry in the area (Girum, 2016).

Lack of infrastructure like road access and electric is another characteristic of the case industry that affects their production process, and there is also a lack of skill to manage the business process because hand-loom weaving is taught from generation to generation with only the skill of weaving. The skill of managing the production process remains limited to performing activities like purchasing raw materials, pattern making, the technical skill of producing the required design by weaving, and other business development activities. It also prevents them from climbing to a level of value-added or complex weaving industry like other developing countries, which is also important for revenue. There is no labor skill training institution in the country at the level of weaving by hand (Girum, 2016).

4.3. Interview Result

From the interview respondents, 35.5% identified sourcing process-related problems as the first challenge, 41.9% of the respondent's identified delivery and marketing-related problems as primary, and the remaining 22.6% identified production efficiency and planning as the first problems of the case industry. Under each process, there were many challenges identified as SC gaps and ranked by interview respondents based on their effect on supply chain efficiency.

4.3.1 Plan Process Analysis

According to the interview respondents' responses, there is a lack of a SC plan in HMTM associations, including a weak plan for sourcing, production, and delivery processes. Only 16% of the associations have a written plan to produce what type of product at what time based on past demand history. In HMTMI, there is product demand seasonality and needs forecast accuracy and seasonal planning, including planning based on seasonal demands that arise due to seasonal occasions like "Meskel," "Timket," cultural festivities, and other celebrations by which people demand the products of this HMT like "netela'', "habeshakemis," "t-shirts," "scarfs," etc. But there is no appropriate plan to respond to this seasonal demand for the products.

4.3.2. Supply Chain Challenges of Sourcing Process

4.3.2.1. Shortage of Raw Material

According to interview respondents, this is the main challenge that the sector faces today. The shortage of raw materials causes production disruption in handmade textile manufacturing enterprises, which leads to longer lead times and a high cost of production as a major impediment to their operation. Most of the raw cotton was supplied by individual farmers, and currently, these farmers are abandoning cotton farming and shifting to other cash crops in the area. Due to this, there is a shortage of raw cotton to purchase because associations are not purchasing raw cotton from larger suppliers, like cotton farm investments in the area. The reason behind this is that association purchase volume is small, and there is a consolidation problem with purchasing orders to minimize the cost of sourcing and transportation and to purchase from larger suppliers of raw materials (Thando and Anthea, 2017).. Because of this, there is a high cost of sourcing, and the SC process takes a long time. This problem was identified as the first problem of sourcing by 67.7% of the interview respondents.

4.3.2.2. Increasing Cost of Sourcing Raw Materials

According to the interview respondents' responses, the ever-increasing cost of raw materials is a major concern among the weavers. Raw material prices, mainly cotton and yarns, are highly increasing and pose a great threat to the traditional weaving sector. Because of this, 61.3% of the respondents identified this problem as the second most affecting and 16.12% as the first challenge for the SC of HMTMIs. According to their response, large cotton farms around Arba Minch Zuria district are not willing to sell to local spinners or weaving associations in small volumes because their products are delivered to the central market or to larger modern textile factories in large volumes only.

4.3.2.3. Raw Material Quality Problem

Lack of quality raw material forced handmade textile firms to use raw materials like cotton of inferior quality (might be grade B or C) with the highest cost. According to the respondent's report, this is because quality cotton (grade-A) is either exported or goes to large domestic textile mills. This also raises a major issue with the final quality of the product produced for the local market or for export. According to the interview respondents in the HMT manufacturing process, the quality of fiber, yarn, and other raw materials is very essential to minimizing production time, loss of product quality, and cost of production. According to their response, the high frequency of yarn breakage due to low quality results in more time to knot each thread to continue weaving, and to avoid this problem, some associations are purchasing raw materials like ginned cotton of high quality from Addis Ababa and Adama by incurring high transport costs. Because of this, 54.8% of the respondents identified the raw material quality problem as the third basic problem of sourcing.

4.3.2.4. Prolonged SC Process of Raw Material Supply

Semi-processed inputs required for the production of hand-woven products like warp and weft yarn and colored threads/'tilet' pass through different stages until they reach weavers. There are many non-value-adding middlemen actors that contribute to the increase in cost and time of delivery. In the case of hand-spun yarn supply, raw cotton traders collect the cotton from farmers and sell it to ginners; ginners sell it to spinners; spinners sell it to yarn traders; and yarn traders sell it to weavers. Marginal profit and other costs are added on until it reaches weavers, and the final price when the raw material reaches weavers is highly increased.

4.3.2.5. Lack of Integration between Suppliers and Weavers

According to the interview respondents' responses, associations have no such strong and long-lasting relationship with raw material suppliers except the relationship with hand-spun yarn suppliers. Mostly, they change their suppliers in a short time when they see some faults in their products, and this problem was identified as the fifth challenge of the sourcing process by 51.6% of the respondents to the interview question.

4.3.3. Supply Chain Challenges in Make or Production Process

4.3.3.1. Low-capacity Utilization Of Handlooms

Production capacity utilization of weavers was low to compete in the current market, and this problem was identified as the first challenge of the production process by 61.3% of the interview respondents. According to the interview respondents, weaving associations were not using their full capacity due to raw material supply problems, weak production scheduling, and a lack of modified technologies like modified looms, weft winding machines, and others to improve their productivity. According to interview informants, a weaver can weave 1 meter of plain fabric per hour even by using traditional looms, but they are weaving below 60% of their full capacity due to the above reasons.

4.3.3.2. Weak Production Scheduling Process

There is a problem of a weak production schedule that results in wastage of time and other resources, and this problem was ranked as the first challenge by 29% and as the second challenge of the production process by 58% of the total respondents. Except for the six enterprises that are trying to prepare their production schedule to indicate what type of product will be produced at what time, the rest have an informal or unwritten production schedule.

4.3.3.3. Production Disruption Due to Poor Inventory Management

The other SC challenge of the production process in weaving enterprises is poor inventory management that results in production disruption, and 58% of the respondents ranked this problem as the third challenge of the production process. This is because weaving associations purchase raw materials in small volumes to weave a few pieces of fabric, and when the inventory runs out, the production process is interrupted until the product produced is sold and raw materials are purchased, and there is a high schedule change rate due to this problem.

4.3.3.4. Low Product Variability

Most of the traditional weavers are engaged in producing common hand-woven products that are not fundamental wears like “Kemis, Netela, and Gabi," etc., which gives them immediate income. It is possible to weave different products by using hand looms, like fabrics to make shirts and other fashion wear and home furnishing fabrics like tablecloths, bed sheets, pillowcases, and others, to widen the market for the products. This gap was identified as the fourth problem by 51% of the total respondents.

4.3.3.5. Lack of Quality Control Management System

There is no quality control system for traditional weaving products. Weavers produce handwoven products, and buyers determine both the quality and the price. There is no institution that provides support to the weavers in organizing and following up on technical support for quality control of their products. Lack of hand-woven cloth quality standardization is the problem facing weaving enterprises. This challenge of weaving enterprises was ranked as the fifth problem by 48.4% of the total respondents.

4.3.4. SC Challenges in Product Delivery and Marketing Process

4.3.4.1. Poor Market Linkage

The market linkage between producers and final customers was weak, and this upsets the industry from growing and weavers from earning more revenue. This problem was considered the first problem of product delivery and marketing by 80.6% of the total respondents. There is no direct market linkage that connects weaving associations with end users. According to the interview report, for instance, the price of ‘Kemis’ with a ‘Netela’ was reported to be on average birr 850.00 for buying from weavers, while for selling to the final customer, it was reported to be on average birr 2350.00. In fact, the licensed trader puts in additional costs for garmenting, finishing, and selling the product. The gross profit made on the buying and selling of a ‘Kemis’ with ‘Netela’ is about 1500.00 birr. This shows that weavers are not earning revenue based on their efforts because of a lack of direct market access to sell their products to final consumers.

4.3.4.2. Poor Order Management

According to the interview respondents' report, the order management of the weaving associations is poor because their order receiving, entering, and managing system has no ready format, and this problem was ranked as the second problem by 71% of the total interview respondents. There was no delivery lead time record, and it was unclear how often it was delivered on the committed date of delivery and how often it was not achieved due to different reasons. According to the interview respondents, because of this problem, the percentage of orders delivered in full was below 75% of the total orders delivered.

4.3.4.3. Lack of Own Distribution Center

One of the challenges of the supply chain delivery process of associations is that the weaving associations have no own distribution centers or display shops where their products can be stored or displayed. Because of this, they were selling their MTS products on the open market for collectors at a price fixed by collectors. Unfortunately, if the product carried to the open market is not sold, they carry it back to their working site, incurring double transportation costs (Thando and Anthea, 2017).. Because of this challenge, this problem was ranked third by 58% of the total interview respondents. As interview respondents reported, for instance, 'kemis" and 'netela' are sold to collectors for Birr 850.00; on average, they can be sold for Birr 2350 in the presence of their own distribution centers.

Other problems identified through the interview method were: lack of product promotion and advertisement system; low demand for handwoven products; high competition from power loom products; and others. The other SC gap in this industry was the lack of return processes, which was not practiced in the case industry and gave no emphasis to returning defective or excess products in the company because, as a trend, most of the supplied raw materials and delivered products were not returned.

4.4. Questionnaire Result of Supply Chain Performance Analysis

The questionnaire contained many closed-ended items based on SCOR model performance attributes like reliability, responsiveness, flexibility, cost, and asset management efficiency that were prepared in English and translated to Amharic considering the educational background of the respondents. This method is used to measure the supply chain performance of the case industry by taking reliability, responsiveness, and flexibility from customer-facing attributes and cost and asset management from internal-facing attributes. For descriptive analysis using data obtained from the questionnaire method, the mean scores and the corresponding standard deviations under the respective scales of each of the measurement items of the dimensions were used. To analyze reliability performance, customer commitment date attainment, orders delivered without quality problems, ways of customer complaint solving, and order validation and verification processes were considered, and the mean value was below good. The responsiveness performance was analyzed by using cycle time metrics like speed to source, to make, and to deliver, and the organizations' responsiveness performance measurement metrics and the mean value obtained were poor.

Flexibility was measured by using supply and demand change management speed, production volume flexibility, flexibility on quantity delivered, and supply and demand unbalance management, and the mean value of the performance was poor. The analysis of SC cost minimization performance was

measured using the economic order quantity of inventory, economies of scale during raw material order, production, and transportation, and the practice of a cost minimization approach to minimize their SCM costs. The mean value was poor. Asset management efficiency analysis was performed by using the return on investment of fixed and working capital, investment in raw materials, flowback time, and evaluation practice of asset management within a given time interval. The mean value of asset management efficiency was at a moderate level, as shown in Table 1. The overall existing SC performance of HMTMI considering most of the performance criteria was poor, with an overall mean value of 2.59, which is poor performance as shown in Table 1.

Table 1. The existing overall SC performance of HMTMI; Source: Questionnaire result (2022)

Performance Attributes	N	Minimum	Maximum	Mean	Std. Dev.
Reliability performance	75	2.58	2.72	2.67	1.13
Responsiveness performance	75	2.52	2.62	2.56	1.07
Flexibility performance	75	2.43	2.53	2.52	1.05
Cost performance	75	2.19	2.54	2.32	0.99
Asset management performance	75	2.74	3.1	2.9	0.96
Existing SC performance				2.59	1.04

4.5. Observation Result

Observation was used as an instrument to collect information about the flow of material, information, and processes to visualize supply chain links and get a clear picture of HMTMI SC processes. As seen from observation, one of the challenges of the sourcing process was its long chain due to non-value-adding actors in SC. When enterprises buy weft from the market, there are many non-value-adding chains like cotton and hand-spun yarn traders and middlemen. For instance, the raw material price to produce a single 'gabi' is 350–400 birr, which was sold at the producers' level for 200–250 birr.

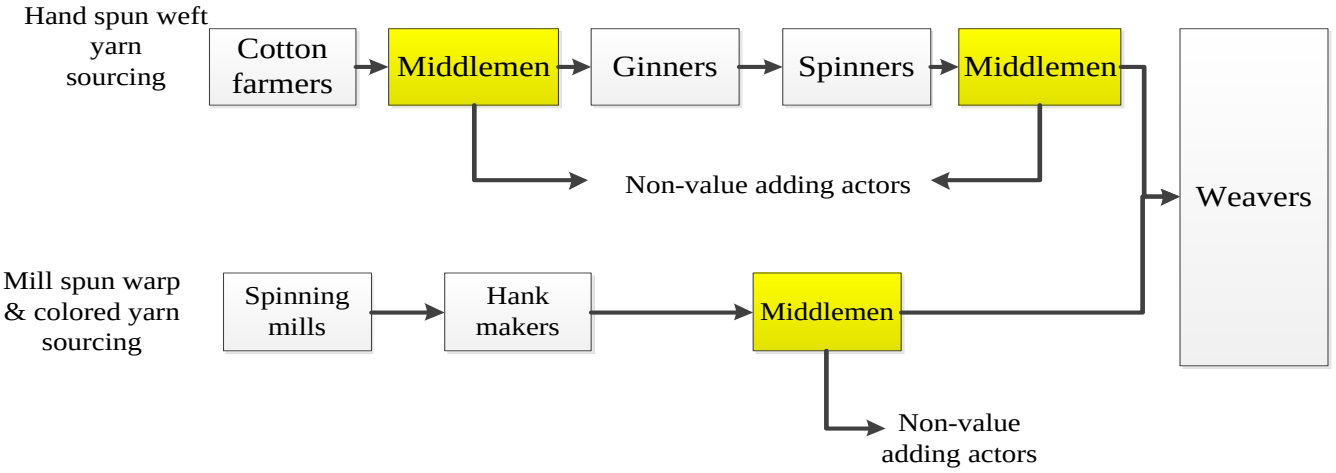

Figure 2. Sourcing process diagram (observation result, 2021)

The price increase of 150 birr was due to non-value-adding actors. Cotton traders buy raw cotton from farmers and sell it on market centers like Chano and Shelle market centers to spinners and spinners gin and spin cotton fiber, and again to yarn collectors, and these yarn collector traders sell to weaving associations, as shown in Figure 2. This process takes longer until yarn or mag" reaches weavers. This long chain resulted in a longer lead time for sourcing delivery and a change in scheduled product delivery.

The production process in the handmade textile manufacturing industry is mainly the process of weaving preparatory work, weaving, and garment making. The preparatory process includes sizing the warp yarn, squeezing out the moisture and drying it by sunlight, the warping process, knotting the warp yarn on the loom, winding the weft yarn, or 'mag', and decorative colored yarn on the hollow ‘qesem’, meaning reed by hand using bobbin winders or spinning wheels called 'diweramekina', mostly done by women or children, and these processes in most of the associations were unmodified and time-consuming, as shown in Figure 3.

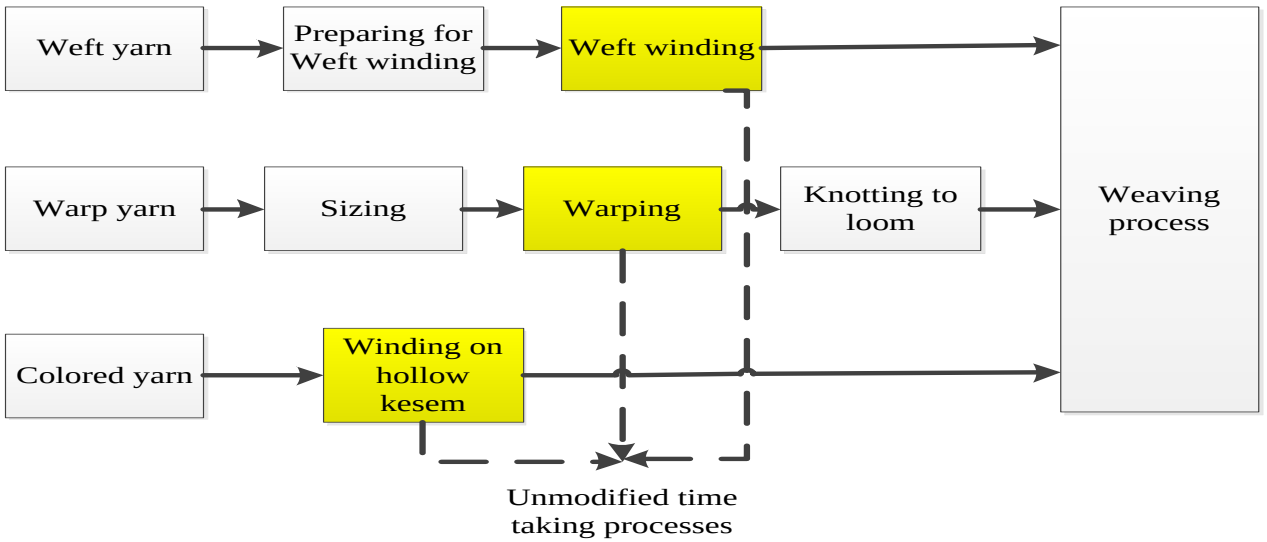

Figure 3. Weaving preparatory process diagram (observation result, 2021)

The low productivity of traditional looms was another challenge for HMTMI. Weaving on unmodified traditional looms has very low productivity when compared to modified handlooms. From the observed 31 weaving associations, only 1 association is using modified looms, and these looms have a production rate of 1.5 m/hr. with the capacity to weave 1.5m wide fabric, which is 2.25 times faster than traditional looms, which have a maximum speed of 1 m/hr. and can weave only 1m wide fabric. This modified loom can also eliminate the process of warping by taking warp yarn directly from the yarn source adjusted at the back of the loom.

The other challenge identified by observation was the lack of transparency on the costs of inputs among the supply chain actors. As observed from the field, the prices of inputs like warp, weft, and colored threads/ ‘tilet’ required for weaving at all levels, including the producers, wholesalers, and retailers, are not transparent, and they add up their profit margin as they want on the selling price, as shown in the Figure 4.

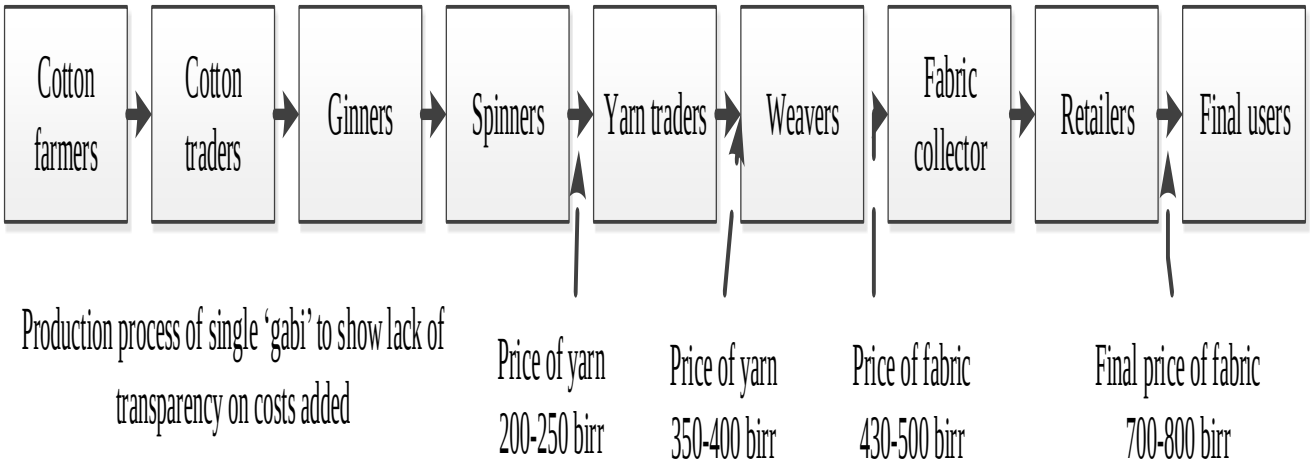

Figure 4. Diagram to show transparency of costs added (Observation result, 2021)

4.5.1. Existing SC Level II Process Map of HMTMI

There are two main sourcing categories in HMTMI SC: source MTS products and MTO products. Level-2 source processes include plan source, including hand spun and mill spun yarns and sizing chemicals (sP2), source stocked product (sS1), and source MTO product (sS2). As observed from the production site, about 50% of the products produced were produced in stock or without a specific customer order (sM1), and the remaining 50% were produced based on the customer order (sM2). Delivery process: MTS products produced to stock are delivered either to the open market or to collectors that are collecting the stocked products from the weavers working site (sD1), and MTO products are directly delivered to the customer based on their order (sD2), as shown in Figure 5.

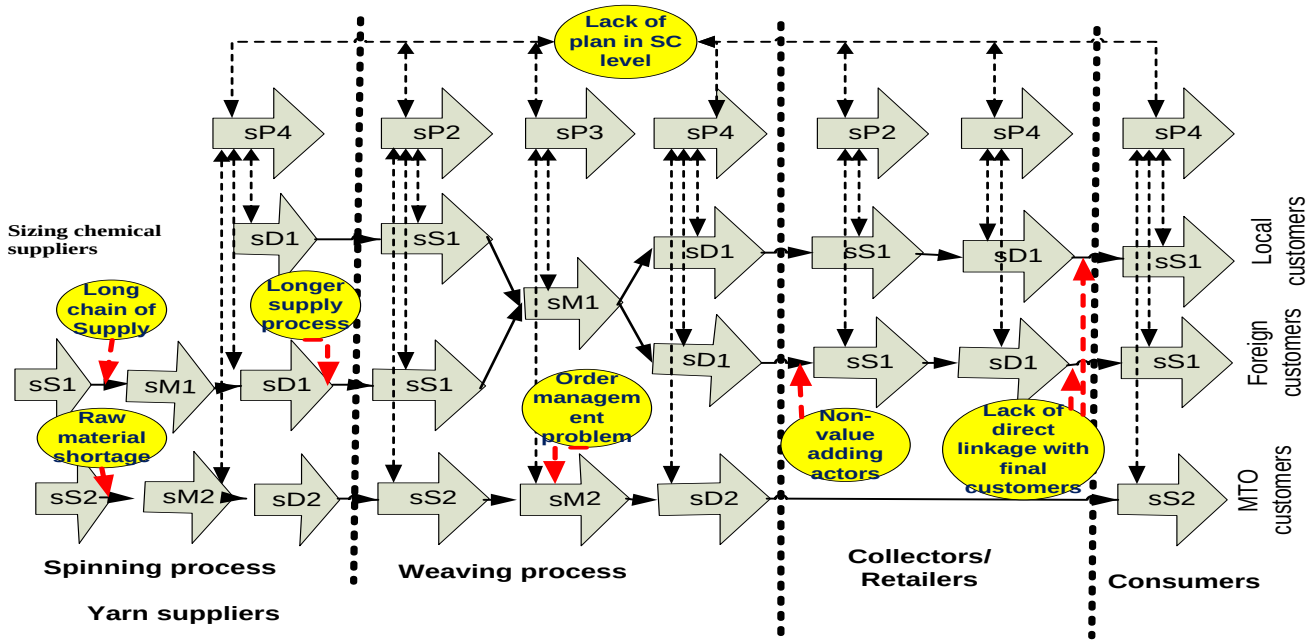

Figure 5. Exiting SC level II of HMTMI

4.5.2. Existing SC Level - 3 Analysis of HMTMI

To plan supply chain improvement and define appropriate goals, understanding the inputs of processes and predicting outcomes is a very important factor. Therefore, identifying related third-level supply chain processes and examining the criteria associated with these processes will help the case industry plan and make the right decisions. Therefore, processes like source, make, and deliver were analyzed and mapped at this level to identify the gaps in the SC operations of the case industry.

4.5.2.1 Sourcing Process

Source process (sS1/sS2) is broken down into five process elements like scheduling raw material receipt (sS1.1/sS2.1), receiving it (sS1.2/sS2.2), verifying the quality and quantity (sS1.3/sS2.3), and transferring to inventory (sS1.4/sS2.4), as well as authorizing payment (sS1.5/sS2.5). In the existing supply chain of the case industry in the sourcing process, there is a lack of a sourcing plan, a problem of reliability on product receipt that leads to schedule changes, and a lack of order consolidation, validation, and verification of raw materials. Raw material delay due to non-value-adding actors was the main problem related to sourcing for weaving associations, and there was also a quality checking problem and weak linkage with local suppliers to purchase from larger suppliers of raw materials. Because of this, the sourcing process is expensive, as shown in Figure 6.

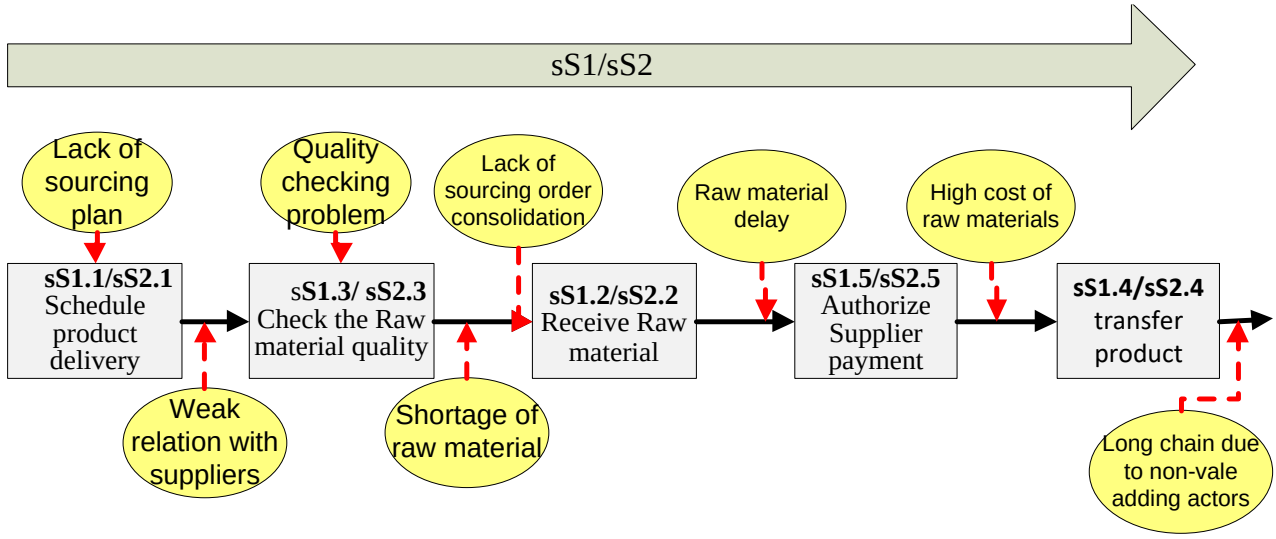

Figure 6. Existing SC of source process

4.5.2.2. Make Process

The make process of the existing supply chain at this level includes activities like scheduling production activities (sM1.1/sM2.1), issuing raw materials and beginning production (sM1.2/sM2.2), producing and checking the quality of the product (sM1.3/sM2.3), packaging or sacking with a suitable bag and storage in a suitable place (sM1.4/sM2.4), and distributing finished products to customers (sM1.6/sM2.6). The problems identified were poor production scheduling activity and poor capacity

utilization. Production planning is also one of the problems in the production process of associations that contributes to poor management of working time and leads weavers to produce without making an appropriate decision of when to produce, what type of product, in what quantity, and quality. Production disruption due to poor inventory management, a lack of quality control systems, and low product variability were the gaps identified in the manufacturing process, as shown in Figure 7.

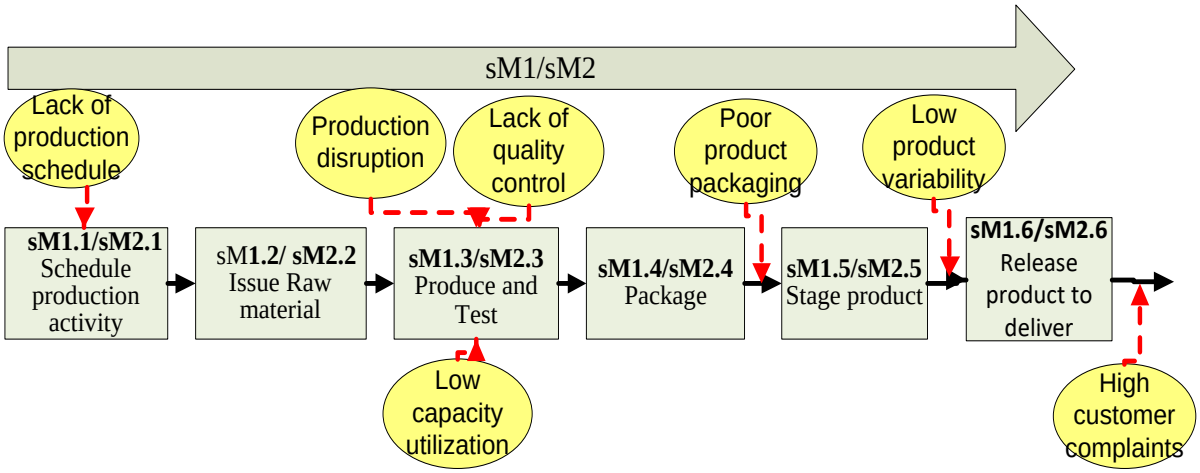

Figure 7. Existing SC of make process

4.5.2.3. Delivery Process

The delivery process in the existing SC has the following elements: process inquiry (sD1.1/sD2.1), receive, enter, and validate orders (sD1.2/sD2.2), reserve inventory and determine delivery dates (sD1.3/sD2.3), consolidate orders (sD1.4/sD2.4), receive product from make (sD1.8/sD2.8), pick product (sD1.9/sD2.9), pack product (sD1.10/sD2.10), deliver product (sD1.12/sD2.12), and receive and verify the product by customer (sD1.13/sD2.13).

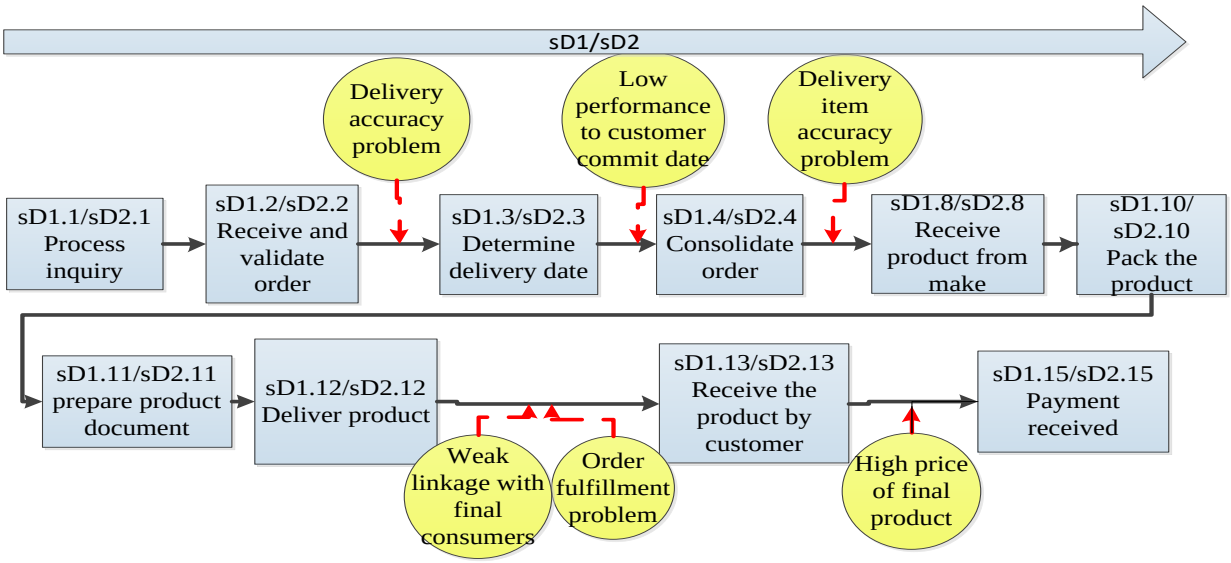

Figure 8. Existing SC of delivery process

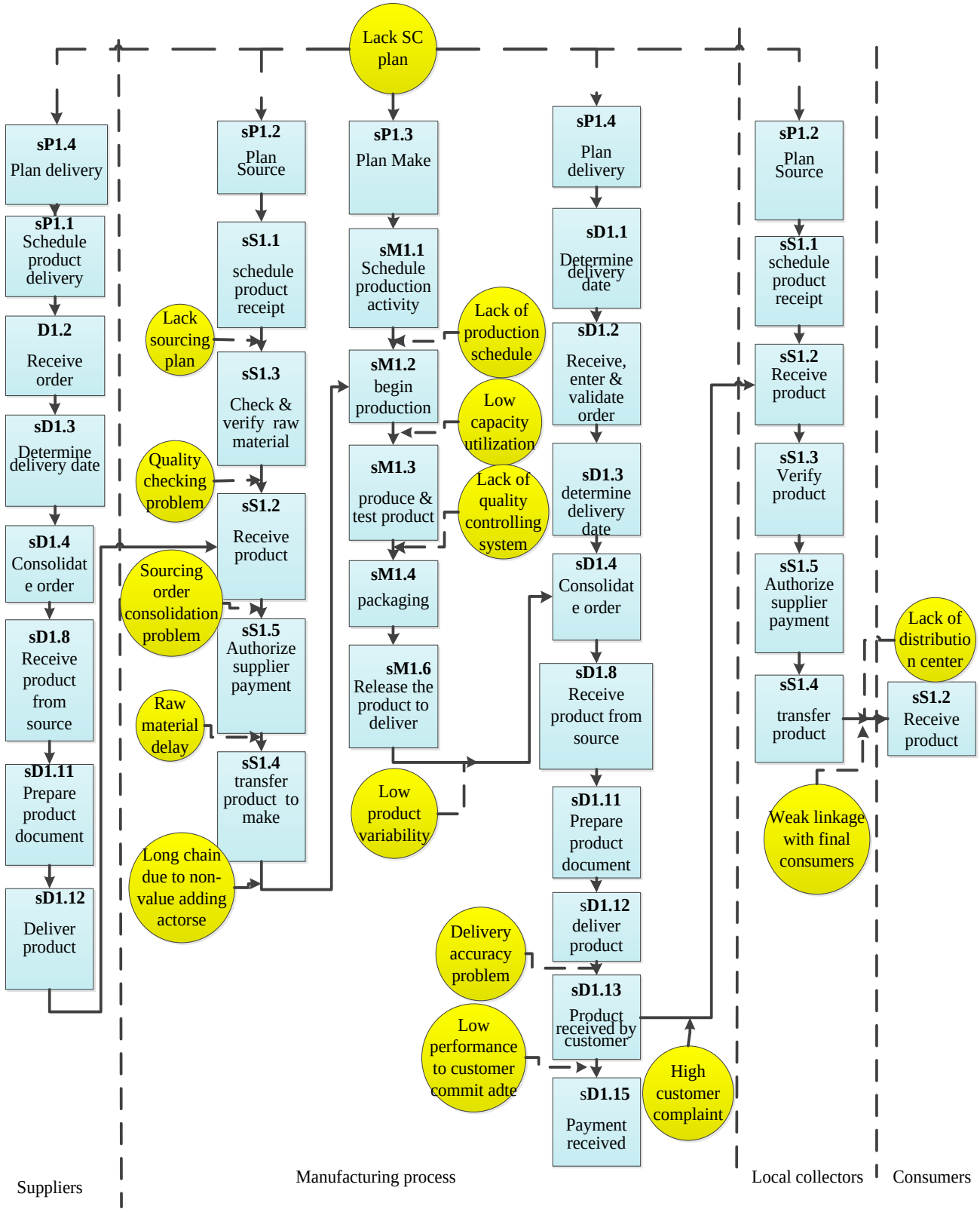

Figure 9. Existing SC level-3 process map

The delivery process includes activities like order verification, picking up products, packing them, and transporting them to the customer. In this process, the problems identified were poor delivery accuracy, order consolidation problems, the problem of achieving the committed date, the problem of receiving and validating orders appropriately, and weak linkage with final consumers, as shown in Figures 8 and 9. Achieving the commitment date and quality of the ordered product is a crucial issue because every handmade textile product has its own design and specifications that should be fulfilled to satisfy customers.

4.6. "To-Be" Analysis of Supply Chain Operation of HMTMI

The results from the interview, questionnaire, and observation used to analyze the "as-is" supply chain process revealed real, practical, and actual situations in the case industry. This will be the basis for further improvement activities. For this reason, to overcome the challenges that existed as a gap in "as-is" SC operations of business processes in the case of industry SC in the previous section, the actions to be taken are associated with developing the plan for change, including identifying the steps required to implement changes to facilities, staffing, automation, and processes.

This includes reviewing the specific change with key stakeholders (SCC, 2012). With the analysis of the level-2 and level-3 processes of the supply chain and based on the best practices of the SCOR model as well as existing opportunities, some improvement plans have been proposed to improve the supply chain operations of the HMTMI.

4.6.1. Improvement Map on Level - 2 Processes

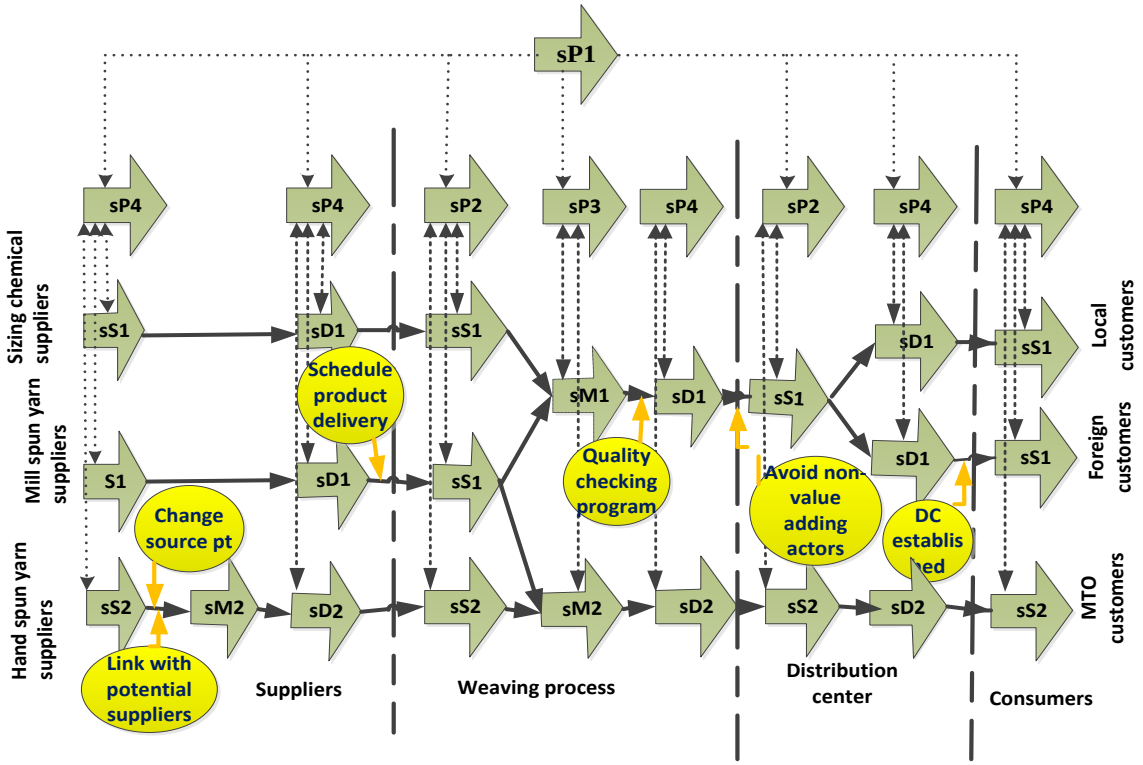

Figure 10. Map of "To-Be" analysis of level-2 process of HMTMIs

Improvements in this level include an SC plan for HMTMI that can show a plan for raw material sourcing, production, and delivery processes at the SC level. The sourcing process should avoid delays in receiving raw materials by changing source points for local potential suppliers and planning the sourcing process properly. Avoiding non-value-adding SC actors and establishing product quality control systems and distribution centers for HMTMI products are very important activities of improvement at this level, as shown in Figure 10.

4.6.2. “To- Be” Analysis of SCOR Model Level 3 Processes

The "to-be” analysis of the case industry suggested that improvement action can be taken to respond effectively to the challenges that businesses are currently facing in their business operations that hold back their SC processes of sourcing, production, and delivery of cases. The improvements required at this level based on SCOR model best practices are: changing sourcing decisions to local source points and potential suppliers; sourcing order consolidation; use of appropriate production schedules; shortening the SC process by avoiding non-value-adding SC actors; improvement on inventory management; product distribution and delivery processes; and use of modified technologies. Proper management of these activities can reduce sourcing costs, production disruptions, and delivery date failures, and increase capacity utilization and productivity in the case industry.

4.6.2.1. Source Process Improvement

Sourcing of raw cotton should be changed from individual cotton farmers to larger cotton farmers by consolidating purchasing volume and creating linkage with potential suppliers. Associations should improve their relations with suppliers of raw materials like raw cotton, warp, and weft yarn and sizing chemicals to take advantage of long-lasting customer relations with the suppliers and avoid production disruption when a raw material shortage occurs. Checking and verifying the quality and quantity of raw materials should be performed properly because the quality of the final product is determined by the quality of the raw materials used in the industry. Figure 11 shows the map of the sourcing "to-be" process.

Production process improvement can improve the production process of an industry by contributing to improvements in working time management, capacity utilization, and productivity. Therefore, scheduling production and managing the production process according to the plan are crucial to competing in the current market. The production plan and schedule should clearly indicate what type of product will be produced following different seasons and occasions that affect the demand for woven products.

Capacity utilization and productivity of the weaving associations should be improved by improving raw material supply, inventory management, and the use of modified technology developed, like modified looms and other technology, to improve productivity. The production process at HMTMI should be improved by diversifying the products they produce. They have to produce products other than ‘Kemis’, ‘Netela’, 'Gabi', etc. that are their usual products because it is possible to weave different products by using handlooms like fabrics to make shirts, T-shirts, and other fashion wear, as well as home furnishing fabrics like tablecloths, bed sheets, pillowcases, and others to widen the market for the products. The other issue that needs improvement is the quality control system of the case company.

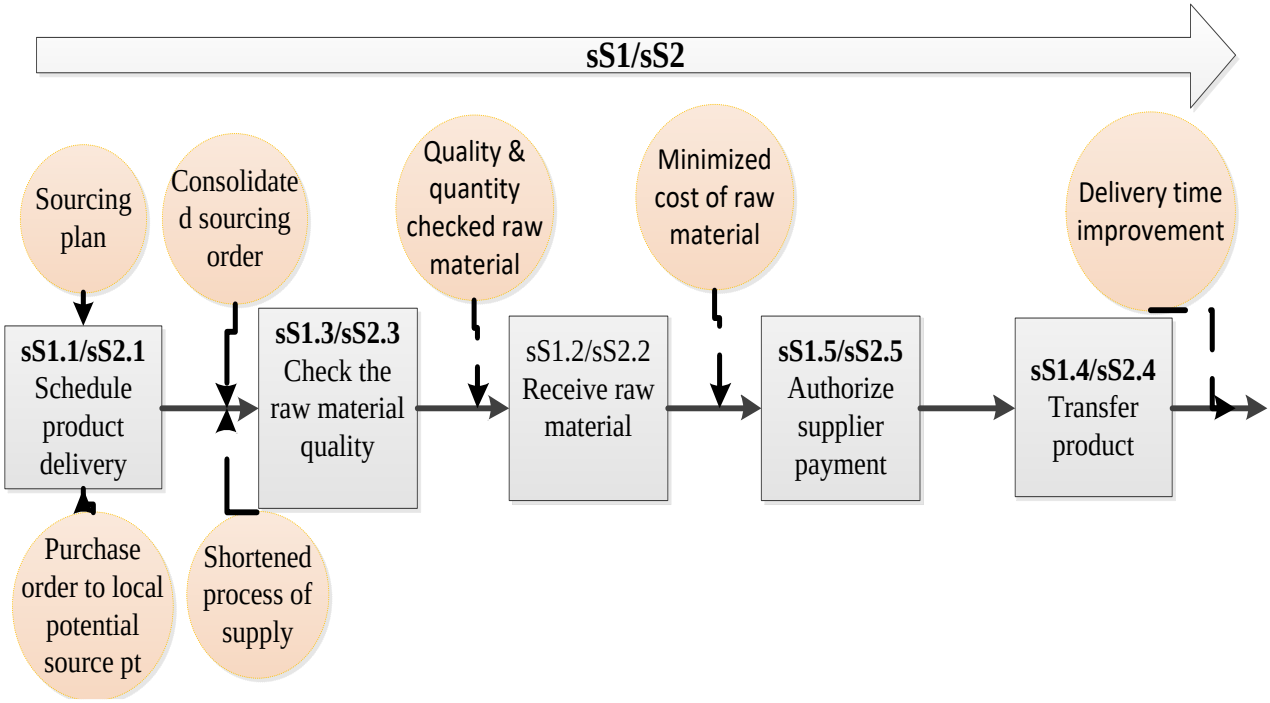

Figure 11. "To-Be'' map of Source Process

After production of the fabric, it should be checked for its quality and design fitness to check whether the 'Tibeb' is according to the order or not, for MTO products and for other faults. Storage of the product in the production process needs attention because most HMT products are sensitive to dust and other dirty particles and can lose their quality. Figure 12 demonstrates the new model for make "To-Be" Process.

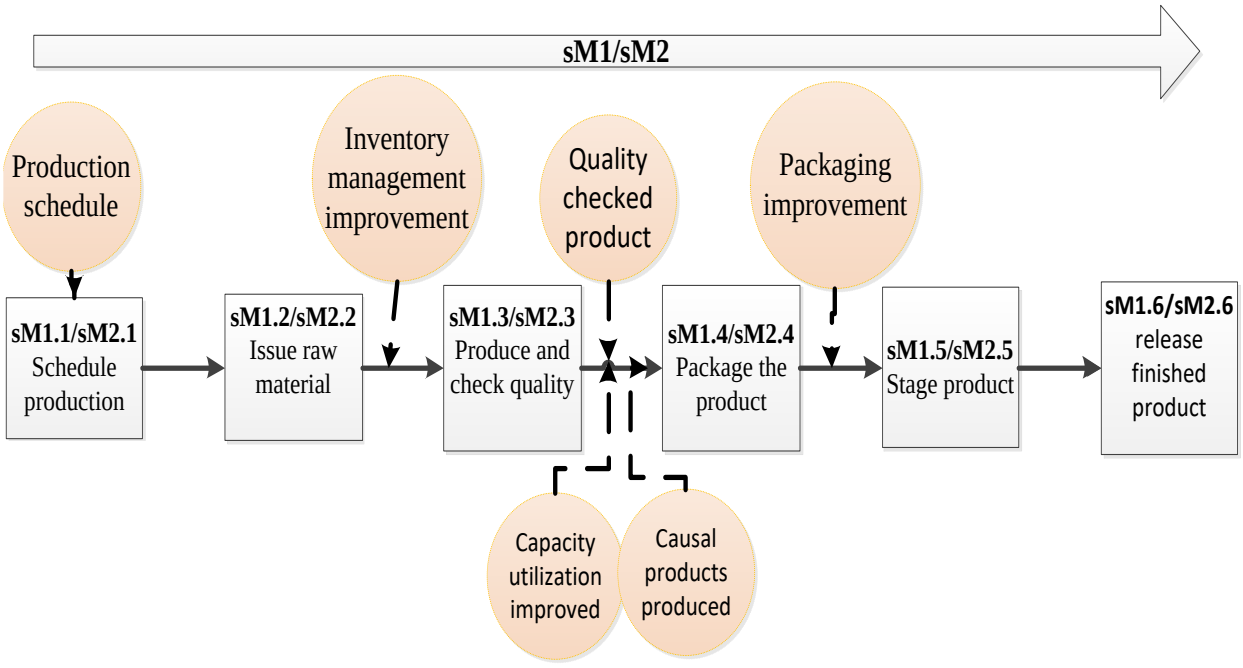

Figure 12. 'To-Be' map of make process

Deliver process improvement can improve the product distribution and marketing processes of the case industry, which has many challenges related to activities of order management like a lack of order receiving format, a validation process, and determining the delivery date properly. To fulfill customer orders and satisfy customers, order management processes like receiving, validating, and checking inventory availability should be performed properly. Customers' order commitment date fulfillment should be improved to minimize customers' complaints due to late delivery and delivery with quality and quantity problems. The delivery process improvement map explains by Figure 13.

To improve customers' satisfaction, associations should record past information about how long it took to deliver the product to the customer, starting from the time of receiving the order. Inventory management should be optimized using an economic order quantity level in production and throughout SC. To be cost-effective in transportation, the load size to be transported should be considered in terms of cost or transport rate. The other important activity that should be improved in the SC of HMTMI is product marketing. To improve the product marketing system, weavers should use product promotion and advertisement systems by using modern communication systems to improve the demand for the product in the market.

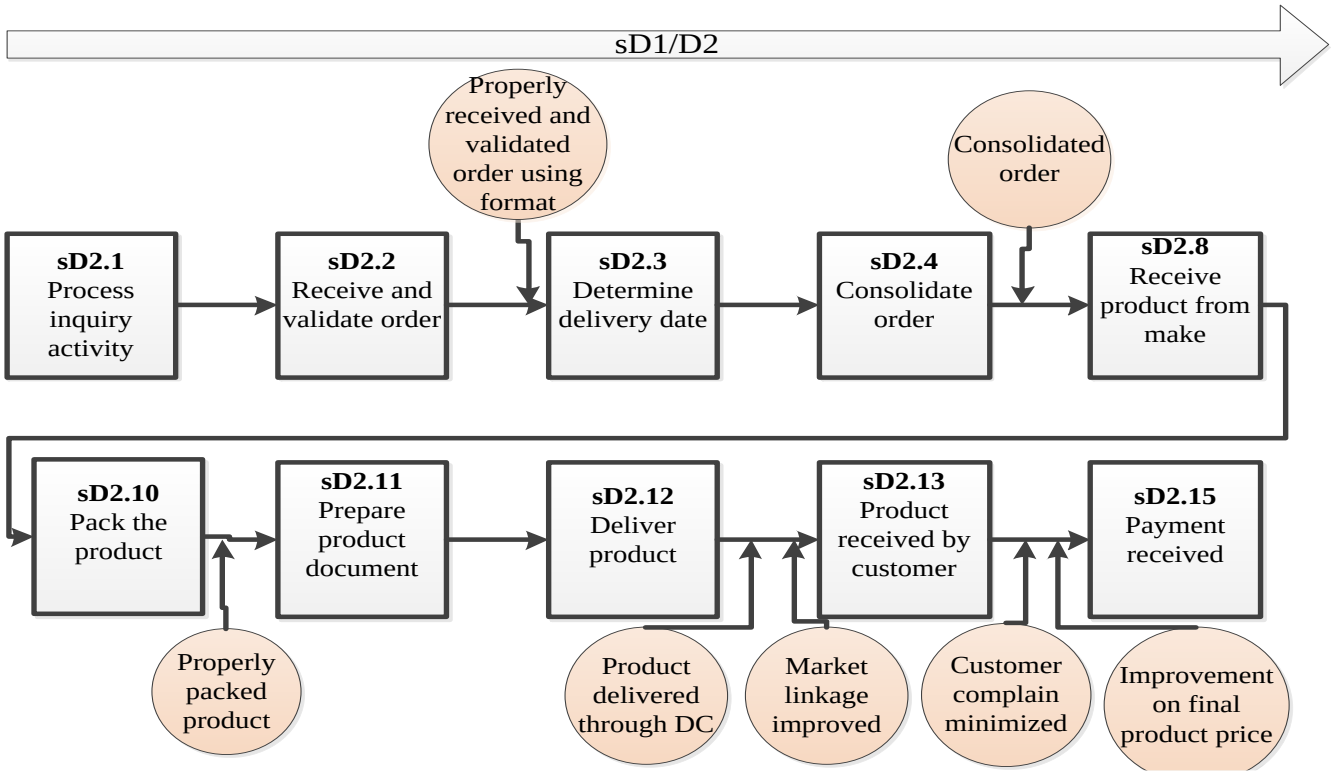

Figure 13. Delivery process improvement

The weaving associations have to communicate directly with their final customers or end users to sell their products, avoiding middlemen intervention, because middlemen in SC of HMTI increase the price of hand-woven products since they are only thinking of their large profit margin. Figure 14 demonstrates an improvement model of level III process of HMTMI.

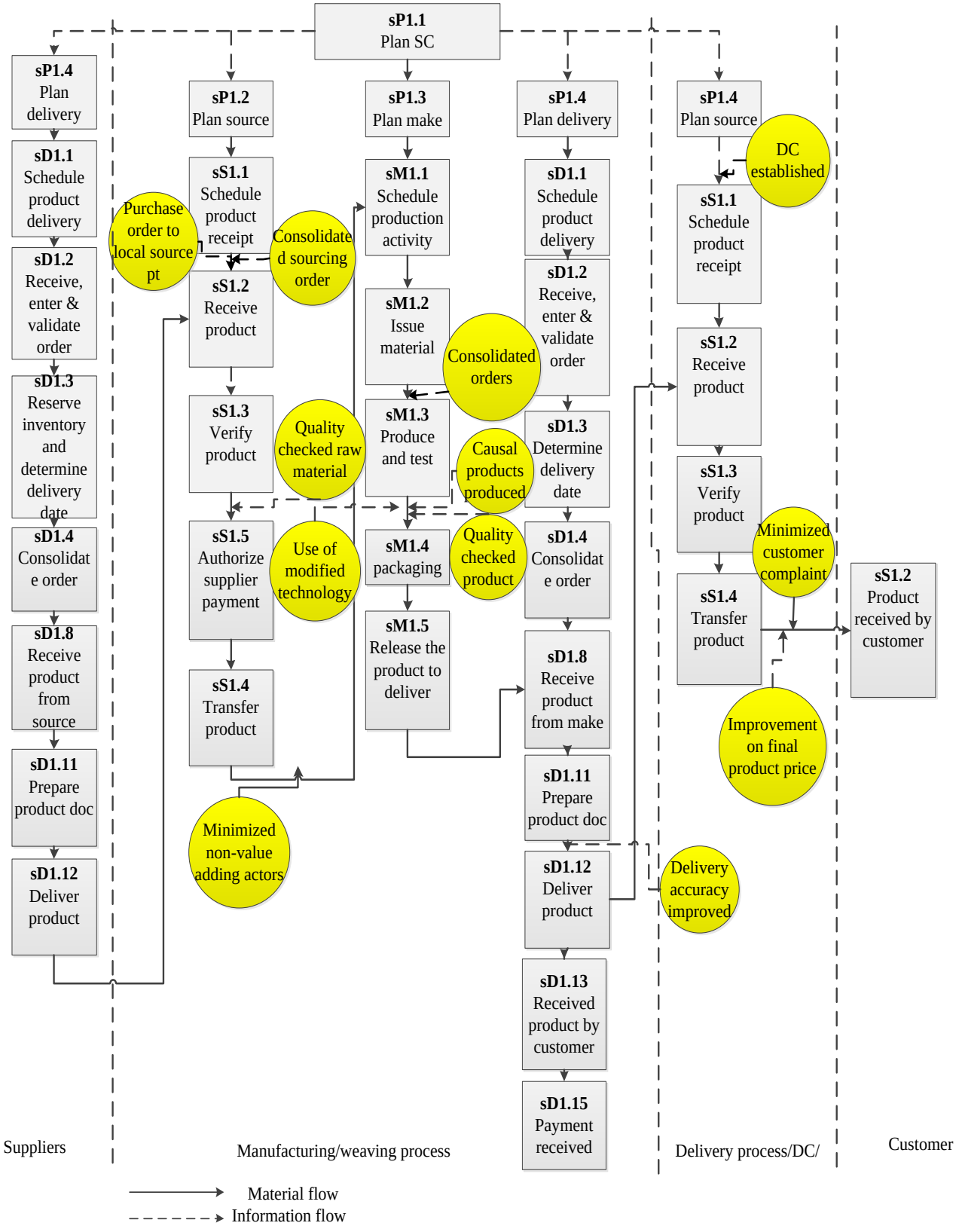

Figure 14. Improvement model of level III process of HMTMI

5. Conclusion

The SCOR model was used to identify SC challenges, gaps, and improvement opportunities for HMTMI. The findings of this study are to identify the weaknesses of the SC operations of HMTMI that hold back the efficiency of the SC operations of the industry and should be tackled for the sustainability of business operations. From the study results, the researchers determined that SC processes like plan, source, make, and deliver processes in the case industry have many challenges that upset their efficiency. The sourcing process of HMTMI has many challenges identified by the study and should be tackled by changing source points to potential suppliers, creating direct linkages with suppliers, and avoiding non-value-adding SC actors. Production processes have low capacity utilization, weak production scheduling, and poor inventory management.

The use of unmodified weaving instruments with low productivity and low product variability should be avoided by encouraging the use of modified technology that can increase the productivity of the weavers. Product distribution and marketing systems should be improved to improve the competitiveness of the case industry in the current market. Establishing distribution centers for woven products in urban areas, product promotion, creating direct linkages with final users of woven products and advertisements using modern technologies, and improving order management are important activities that can improve the marketing performance of the industry. From the SC performance measurement result, it can also be concluded that the performance of the case industry SC based on reliability, responsiveness, flexibility, cost, and asset management metrics as analyzed based on the questionnaire responses of the respondents was poor and that it needs improvement to satisfy customers.

Generally, there are so many SCM challenges and gaps, and by doing so, they are losing their production potential and the power to compete with power loom products imported from abroad at a low price. So, the ever-growing fierce competition globally by cost and delivery time in the textile product area was a sign of warning for HMTMI that it must provide customers with a quality product at a comparably lower cost and whenever demanded at a required amount. To do so and stay in competition, the industry has to try to avoid the weaknesses of SCM and must tighten the belt in fighting these challenges using opportunities to continue improving, unless otherwise the field in the marketing competition, especially competition from power loom products, becomes tighter and tighter, forcing it to be out of the competition.

Author contributions statement

All authors (Fasika Bete Georgise, Aygota Aka and Temesgen Endale Andualem) were involved in the conception and design, or analysis and interpretation of the data; the drafting of the paper, revising it critically for intellectual content; and the final approval of the version to be published; and that all authors agree to be accountable for all aspects of the work.

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Concerns to Publish

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References

Abdella & Gezahegn. (2008). Concept Note on the Handloom Sector in Ethiopia: The Case of the Gullele Cluster. Addis Ababa: Ethiopian Development Research Institute.

Adane, M., & Gnanadhas, M. E. (2022). Challenges and opportunities of the Ethiopian textile and apparel industry. Journal of Engineering, Design and Technology. https://doi.org/10.1108/JEDT-03-2022-0145.

APICS, Supply Chain Operations Reference Model SCOR Version 12.0, 2017 APICS.

Bedi, J. S. (2009). Assessing the Prospects for India's Textile and Clothing Sector.

Bersoff, D. M. (2003). Ethical Conflicts in Psychology. In D. M. Bersoff, Academia: Research, teaching and supervision. In D. N. Bersoff (pp. 3rd ed., pp. 377-378). Washington, D C: American Psychological Association.

Chandra, P. (2006). The Textile and Apparel Industry in India, in Basu, K. (Ed), The Oxford Companion to Economics in India, , . New Delhi: Oxford University Press.

Chopra, S., Meindl, P. (2019). Supply Chain Management: Strategy, Planning, and Operation (7th ed.). Pearson.

Chopra.S & P. Meindl. (2007). Supply chain management strategy, planning and Operation. Third edition ;pearson education, Inc.

Council of Supply Chain Management Professionals (CSCMP). (2021). Supply Chain Management Definitions and Glossary of Terms. Retrieved from CSCMP website (https://www.supplychainminded.com/).

Delipinar, Gul Esin, Kocaoglu & Batuhan. (2016). Using SCOR model to gain competitive advantage: A Literature review, 5th International Conference on Leadership, Technology, Innovation and Business Management Procedia - Social and Behavioral Sciences 229 398 – 406, 10.1016/j.sbspro.2016.07.150.

Gamo zone, (2021). Unpublished yearly report of Enterprises and Industry Development Department. Arba Minch.

Georgise, F.B.; Thoben, K. D.; Seifert, M. (2011). Supply Chain Modeling and Improving Manufacturing Industry in Developing Countries. A Research Agenda World Academy of Science, Engineering and Technology, 60-61.

Girum, E. (2016). Indigenous Knowledge among Shiro Meda Dorze Community: The case of weaving By National Archives and Library Agency. Addis Ababa: Addis Ababa University.

Harrison, A.& van Hoek, R. (2019). Logistics Management and Strategy: Competing Through the Supply Chain (5th ed.). Pearson.

Hasibuan, Sawarni, Dzikrillah & Nurul. (2018). Supply Chain Performance Measurement and Improvement for Indonesia Chemical Industry Using SCOR and DMAIC Method, Saudi Journal of Engineering and Technology (SJEAT) ISSN 2415-6272, 10.21276/sjeat.2018.3.3.5

Hitesh & Chaudhari. (2020). Supply Chain Management Practices of Weaving Industry.

Hofverberg, H (2010). Dorze Weaving in Ethiopia. A model of education for sustainable325 development?. Uppsala Universitet. Accessed 20 April 2019: [http://www.diva-326

Ivanov, D. (2020). Viable Supply Chain Model: Integrating Resilience and Sustainability*. International Journal of Production Research*, 58(10), 3015-3032.

Japan-Embassy. (2008). Series of Studies on Industries in Ethiopia. The Embassy of Japan in Ethiopia.

Kalyani & Samala. (2017). Impact of supply chain management practices on product quality in indian handloom industry with reference to master weavers.

Kalyani, M. (2021). Supply Chain Management Practices and Production Performance in the Handloom Industry. International Journal of Production Economics.

Kalyani. A. (2021). Examining the Relationship Between Supply Chain Management Practices and Production Performance in Indian Handloom Industry.

Kamarudin, Nurhayati and Izaidin, A. M. (2018). Using the Supply Chain Operation Reference (SCOR) Model to Assess the Potential Impact on Business Management in Malaysia SME Industry: A Conceptual Framework, International Journal of Business Management and Commerce Vol. 3 No. 4; August 2018.

Kedir, G. (2016). Gamo's Artisanship Acument. The Ethiopian Herald /All Africa.

Kothari, C. R. (2006). Research methodology, methods and techniques.

Kusrini, E., Ahmad, A. and Murniati W. (2019). Design Key Performance Indicator for Sustainable Warehouse: A Case Study in a Leather Manufacturer, 2019 IOP Conf. Ser.: Mater. Sci. Eng. 598 012042.

Rodríguez Mañay, L. O., Guaita-Pradas, I., & Marques-Perez, I. (2022). Measuring the supply chain performance of the floricultural sector using the SCOR model and a multicriteria decision-making method. Horticulturae, 8(2), 168. DOI: 10.3390/horticulturae8020168.

Ruamsuke, Thanapong & Ongkunaruk, Pornthipa (2021). Supply chain analysis of import fresh fruit business in Thailand using the supply chain operations reference (scor) model, E3S Web of Conferences 316, 02014 (2021).

Saad, M. J. (2002). A review of the progress towards the adoption of supply chain management (SCM) relationships in construction. European Journal of Purchasing & Supply Management, p.173-183.

Scholten, K., Schilder, S. (2021). The Role of Supply Chain Resilience in Managing Disruptions: A Review and Research Agenda*. *International Journal of Operations Production Management, 41(1), 1-28.

SCOR, http://docplayer.net/18215973-Scor-supply-chain-reference-model.html, Accessed on 12th July 2023.

Statista. (2024). Global Apparel Market - Statistics & Facts. Statista Research Department. (Provides the latest data on China, India, and emerging hubs).

Taplin, I. M. (2021). The restructuring of the global apparel industry. Journal of Fashion Marketing and Management, 25(1), 1–15. https://doi.org/10.1108/JFMM-08-2020-0156.

Temesgen, A. G. (2018). The Art of Hand Weaving Textiles and Crafting on Socio-Cultural Values in Ethiopian (Review). International Journal of Advanced Multidisciplinary, Research, 5, 12 -20.

Thando V. and Anthea P. (2017). Towards the integration of markets: Competition in road transportation of perishable goods between Malawi, South Africa, Zambia, and Zimbabwe, WIDER Working Paper 2017/49, https://www.wider.unu.edu/sites/default/files/wp2017-49.pdf, Accessed on 14th July 2023.

Venkataraman, Ray R., & Demirag, Ozgun C., Supply Chain Management Securing a Superior Global Edge, SAGE, 2022.

Waktole, D. (2016). Cultural Values of Customary Handicraft: Cloth weaving in case of Macca Oromo ethnic group Western Ethiopia, SORTES 4(2).

Witkin, B. R. (1995). Planning and conducting needs assessments: A practical guide. , . Newbury Park: CA: Sage Publications.