

CHAPTER 2

LITERATURE REVIEW

The present work focuses on the current state of handloom sectors of Varanasi city of Uttar Pradesh in India. This sector produces many handloom products, with saree being one of the most important. Weavers in this sector are not able to earn a profit directly, even for a normal livelihood. The present study focuses on such problems and strategies/methodologies /policies to mitigate such issues and improve their conditions. Depending upon the set objectives derived through the literature survey of this chapter of the present study, the literature review is divided into seven sections as follows.

1. Challenges of Handloom Sector Weavers
2. Customer requirements for the handloom sector
3. Omnichannel marketing for the handloom sector
4. Augmented reality for the handloom sector
5. Certification of Handloom products
6. Facility location for Handloom weavers
7. Musculoskeletal Disorder of Handloom weavers

This chapter is written in line with the work due to Naik et al. (2023) and the working paper due to Naik and Bhardwaj (2023).

2.1 Challenges of Handloom Sector Weavers

The handloom sector, which holds important cultural traditions and skills, is facing some major challenges that affect its sector growth in different ways and affect weavers

directly or indirectly. The subsequent subsection will elaborate on the challenges faced by these weavers.

2.1.1 Raw material

The raw material is one of the significant challenges in the handloom sector due to increased prices. The price is following an increasing trend every year. A severe hardship on the weaver's profit (Rao and Rao, 2015; Tanusree, 2015; Varghese and Salim, 2015; Jayachitra and Leeson, 2016; Rao, 2022) is introduced in the business handloom products, weavers used different raw materials with yarn as a basic raw material supplied by the mills. In Varanasi, it is being purchased from Karnataka, Andhra Pradesh, and Tamil Nadu, followed by West Bengal and Jammu and Kashmir (Kumaresan, 2002), while white cocoon silk is imported from China as the Indian silk has a poorer quality due to yellow cocoon (Feng et al., 2009). According to the researcher, the availability of good quality raw materials at the right time and at the right price is an issue that affects the industry's performance (Akter and Ghosh, 2005; Rao and Rao, 2015). Jayachitra and Leeson (2016) have highlighted the proper delivery system, the closure of spinning mills, and the non-fulfillment of the hank yarn obligation by the organized mill sector are some of the reasons for the non-availability of raw materials. A study conducted by Devi et al. (2021) in Societies of the Virudhunagar District in Tamil Nadu state showed that the availability and quality of raw materials are the major problems faced by weavers. Similarly, Kethan et al. (2022) mentioned the adoption of systematic strategies for raw materials/procurement as another reason. A study by Tanusree (2015), the handloom weavers in Varanasi found that lower-quality products were produced due to substandard raw material use. Similarly, no procedure has been adopted to check the quality standards of products (Rao and Rao, 2015).

2.1.2 Finance

No huge capital is required for the handloom sector in comparison to other industries. Still, finance is an essentiality that is highly required for its successful operations. Weavers, weaving houses, and weaving societies face a paucity of funds for smooth operations and maintaining their looms, procuring the required quantity of raw materials, and making new designs for weaving in the handloom sector. The weavers face problems in getting a loan due to i) collateral required by banks/ institutions (Chutia and Bhuyan, 2014), ii) the tedious and time-consuming procedures (Parvin and Birner, 2021) and iii) illegitimate practices adopted for personal gains (Harriss-White,2020; Wani and Irshad, 2021). Any delay in finance like the loan not only increases the transportation cost of the weavers but also decreases the interest of the weavers in approaching such institutions for a loan. In addition, political interference is also among the major concerns in getting financial assistance from government institutions (Khan, 2020). While some weaves to get a quick loan and avoid collateral issues, the Weavers bear higher interest rates as they take loans from traders, money lenders, and family friends (Akter and Ghosh, 2005; Bhuvaneswari and Kannan, 2018; Varghese and Salim, 2015). Another challenge to business development is the long period of return and lower profit from the investment (Malarkodi et al., 2020; Singha and Singha, 2020). Tanusree (2015) study explained that weavers sold the products to traders, who realized higher profits. These traders offer them less of the product through post-dated cheques with a long waiting time. It also highlighted that weavers have to wait long to realize the money of sold items, so the money circulation slows down and throughput reduces.

2.1.3 Lack of Marketing and Outreach

Marketing products can create a higher demand in the domestic and international markets. However, the handloom sector lacks branding for its products compared to power looms and textile mills (Narzary, 2012; Rao and Rao, 2015; Bhuvanewari and Kannan, 2018). Handloom products can be marketed by the products online through e-commerce in order to increase their customers (Varghese and Salim, 2015). According to Jain and Ratan (2017), the E-commerce platform will connect stakeholders and customers. Still, the lack of qualified and educated staff to develop and support the e-commerce platforms is great for operating such platforms, so they are not able to reach local and distant customers (Bortamuly and Goswami, 2015). Another important barrier in this sector is a lack of knowledge about customer preferences (Narzary, 2012; Rao and Rao, 2015). In the lack of such knowledge, weavers cannot produce products according to customers' tastes, which results in unsatisfied customers (Rao and Rao, 2015; Shamitha and Balasubramanian, 2018). Mahapatra et al. (2019) suggested to assess such requirements for product design modifications, which largely depend on customer input, like patterns, color combinations, etc. Moreover, the presence of mediators and traders has widened the gap between the two, and weavers are unable to lag behind too much in order to catch the demands of the customers. Most of the weavers operate in the local market and are unable to break boundaries due to their current condition, so they are facing tough competition from handloom sectors of another state, power looms (Malarkodi et al., 2020; Ahmed et al., 2022; Khatoon and Iffat, 2022) and imported products from China, Bangladesh, etc. (Sivasakthi and Basariya, 2018). However, due to a lack of knowledge, logistics facilities, and financial support, they are unable to export (Narzary, 2012; Rao and Rao, 2015; Gardas et al., 2018). It is the right time to create infrastructure to support this sector and its culture and weavers.

2.1.4 Technology

Varanasi handloom sector still uses inefficient and obsolete technology, which can degrade productivity and quality. In their findings, Dey et al. (2023a) stated that technology could reduce laborious fabric design and production tasks. In Varanasi, the weavers use pit looms for weaving mainly because procurement of new technology is costly and requires a high initial investment for installation and maintenance (Bhuvanewari and Kannan, 2018; Hazarika et al.,2016; Bortamuly and Goswami, 2015). However, some weavers can afford the technology, but they do not have knowledge and awareness about modern technology (Bortamuly and Goswami, 2015; Hazarika et al.,2016), whereas others are unwilling to opt because of their scale of operations and need for skilled technical staff for operating and maintenance and the requirement of continuous electricity. A study conducted by Patra (2019) in the Odisha handloom sector revealed that weavers are afraid of adopting new technology because of uncertainty about the profit of the products manufactured with it. The poor adoption of technology in the industry hampers the expansion of the handloom trade (Bortamuly and Goswami, 2015). So, the full potential of purchasing, advertising, and selling cannot be realized. The handloom weavers need affordable and easy-to-maintain equipment for weaving, but available due to poor research and development (Bortamuly and Goswami, 2015; Hazarika et al.,2016; Bhuvanewari and Kannan, 2018).

2.1.5 Workers-Related problem

Weavers play a crucial role in the production and development of the handloom sector, but their performance is low in this sector. According to Bhowmik (2019), to weave high-quality handloom products, weavers require a higher level of skill, but there is a significant shortage of skilled weavers, and there is a need for a training program for new

weavers (Akter and Ghosh, 2005; Varghese and Salim, 2015; Gardas et al., 2018; Shamitha and Balasubramanian, 2018; Kazancoglu et al., 2022). Another significant challenge with weavers is the level of education. According to Dey et al. (2023b), education is crucial to human and capital resources to affect the efficiency of a firm. Many weavers have only primary education, and they are unable to update their skills with technological change (Boruah and Kaur, 2015; Bhowmik, 2021; Khatoon and Iffat, 2021) as handloom weaving involves numerous activities (Siddiqui et al., 2021), like dyeing, bleaching, jagard card making, and weaving itself. A different skilled set of weavers is required. However, a lack of coordination between the different divisions of weavers can delay the work and quality of the product (Kazancoglu et al., 2022; Khatoon and Iffat, 2021). In the handloom sector, weavers work continuously on the loom for hours for a long duration. Their repetitive work and prolonged sitting at a place in the same posture has been documented as a strong risk factor affecting their musculoskeletal system and their productivity, besides they are also facing psychological health problems while working (Durlav et al., 2014; Chutia and Bhuyan, 2014; Varghese and Salim, 2015; Shamitha and Balasubramanian, 2018). Though they work hard for hours, they do not have job assurance. Most weavers are hired daily under the master weavers at low wages. Because of this, the younger generation is not showing interest in this sector. Highly skilled workers are migrating to other sectors, such as construction workers, rickshaw-pullers, and vendors (Balaji and Mani, 2014; Shamitha and Balasubramanian, 2018; Das, 2021). This has created a serious problem of lack of skilled workers.

2.1.6 Government

Government policy is used to promote the implementation of new technology, but its effective implementation is a challenging task in the handloom sector (Bhowmik, 2021). The Indian government launched schemes and policies to enhance the development of the handloom sector, but due to a lack of proper publicity by the management, they failed to spread amongst weavers (Sivasakthi and Basariya, 2018; Rathinamoorthy and Prathiba Devi, 2021). According to Rao and Rao (2015), the flow of information on “Government policies and schemes under running” to weavers is another challenge. Sometimes, the implementing agencies and the concerned government departments may not possess complete information, resulting in critical gaps in implementation. Another critical challenge in the handloom sector is the violation of the Handloom Reservation Act. The government listed 22 items to be produced only by the handloom, but the power loom is weaving these listed items and selling them in the market as handloom products (Mishra et al., 2016). It is mainly because of the ineffective implementation of stringent laws and policies (Basole, 2015; Mishra et al., 2016). In a study, Prathap and Sreelaksmi (2022) stated that consumers are facing issues in identifying the original handloom products available in the market because traders are mixing them with some other fabric. On the government bodies, Bhushan and Anand (2022) stated, “*There is no legal provision that governs how inspection body’s function which leads to the de Gration of the quality of such products and fails to incentivize the artisans.*”. A research study by Khatoon and Iffat (2022) also highlighted that most sections of the weavers are moved to other professions due to a lack of support and protection. Therefore, there is a need for government to make strict laws to reduce violations.

2.2 Customer requirements for the handloom sector

India is the world's second most significant emerging market in apparel retailing (Jin et al., 2010). As customers wish to get the best clothes, their satisfaction is essential in this handloom sector (Rieke et al., 2016; Seram and Kumarasiri, 2020). Anderson et al. (2005) stated that the study of consumer behavior is a scientific process that satisfies consumers' needs. Women are more concerned about looks and personality and want to be differentiated from others. Therefore, women pay more attention to apparel selection to reflect their identity or due to other reasons (Jan and Abdullah, 2015; Seram and Kumarasiri, 2020). The researchers conducted a survey on customers to identify the purchase intention of different products. Eckman et al. (1990) studied the in-store purchase decision of consumer criteria for women's apparel, and they found that color, pattern, style, and fabric were the most influencing factors for the selection of garments. At the same time, bad fit and poor appearance were important factors in rejecting the garments. Jegethesan et al. (2012) focused on young adults in Australia to explore the importance of functional, hedonistic, and ethical attributes of denim jeans characteristics. The respondents felt fit, fashionableness, and color were the influential attributes in the purchase. Rahman and Koszewska (2020) identified that consumers in Poland would not purchase products if they did not meet aesthetic, functional, and financial needs and were more reliant on garment fit.

Ghalachyan and Karpova (2021) tried to develop an Apparel Product Evaluation (APE) framework that explained how consumers evaluate products when purchasing and using them. Seram and Kumarasiri (2020) revealed that plus-size women were not satisfied with the current garments available in the market due to the inability to find well-fitting, non-availability of variety, trendy, and good-quality clothes. They indicated that the lack

of information about female body dimensions is the main issue in the female garment market.

Hamad et al. (2021) suggested a data-driven semi-supervised approach for Consumer Oriented Sizing Systems in the Clothing Industry. Hsu and Burns (2002) studied the cross-national comparison of consumers using the twelve clothing evaluation criteria and found size/fit was an important criterion for both groups, males and females. Lee (2019) tries to understand the clothing purchase behavior of students and reveals that quality, color, and care are major factors, while size and color are the lowest barriers in selecting clothes. In their study, Castelo and Cabral (2018) found that women had a higher perception of quality than men and purchased products with style at a fair price. Kwan et al. (2004) did a study on young consumers in China, and their study found that style, durability, ease of care, fit, and price were the major criteria among young consumers for their decision. Dhiman et al. (2018) found that the buying behavior in apparel segments depended on i) uncontrollable demographic variables such as income, age, and sex and ii) controlled variables like fit, comfort, durability, and variety.

In India, Jin et al. (2010) studied evaluation criteria for selecting denim jeans. The study finds that the brand name is the more important criterion than price, design, and quality for Indian customers. Therefore, establishing a brand name is vital for successful marketing strategies in India. Similarly, Kumar et al. (2009) conducted a study on Indian college students to find the purchase intention of clothing and accessories and showed that students required unique brands reflecting their own style. Sahay and Sharma (2010) study highlighted that there is a need for research for every product to understand consumer behavior. Arora and Aggarwal (2018) focused on the attitudes of women shoppers in India and explored three essential variables for online shopping: i) price, ii) convenience, and iii)

product variety. Among the customer preferences, variety was considered the most important by Indian women, and the same was affirmed by Sengupta et al. (2022) as Indian consumers are brand conscious and make judicious choices based on their affinity, which was reflected in the brand analyses. Their results supported that Indian consumers' response to the brand analysis components varies among global brands, local brands, and regions. A study by Trehan and Sinha (2020) recommends that the weaver communicate and understand customer requirements so that weavers can modify their process according to their specific needs. Meera and Vinodan (2022) study emphasized that weavers have to observe the customer's taste and preference for fulfilling the requirements of individual market orientation. In the current market, weavers still follow the old customs and overlook the customer's requirements. It is estimated to make an endeavor towards this and fill the gap between customers and weavers. The current study focuses on this issue and finds some strategies/policies to fill the gap and help the weavers. Channeling the products of handloom weavers to meet the customer requirements in the global market can enhance the efforts.

2.3 Omnichannel marketing for the handloom sector

The handloom sector is lagging behind in adopting this approach to selling its products. Such an approach can create direct contact between weavers/ weaving houses and the customers. Thereby increasing profits and, hence, improving their conditions. An effort has been made to find the barriers to adopting omnichannel in the handloom sector.

Omnichannel is an important concept in the present business condition, as it offers value addition to the handloom sector business by integrating online channels/platforms in manufacturing and services. The same can be exercised in Varanasi's handloom sector. The barriers to omnichannel adoption in the handloom sector were identified using keywords

such as "omnichannel," "omnichannel retail," "omnichannel barriers," "omnichannel handloom sector," "omnichannel in India," and "omnichannel textile" from databases like ScienceDirect, Web of Science and Emerald Insights. It is evident from the literature survey that the term omnichannel was first introduced by Rigby (2011). He defined it as *"an integrated sales experience that melds the advantage of physical stores with the information-rich experience of online shopping."* According to Akter et al. (2021), customers are purchasing from several channels simultaneously. Thus, companies are making an effort for omnichannel instead of handling various channels separately. Different researchers studied the adoption of omnichannel in retail. Barbosa and Casais (2022) try to study how omnichannel can be implemented in Portugal's retail companies. De Borba et al. (2020) analyzed the barriers in omnichannel retailing returns for reverse logistics. Hickman et al. (2020) have identified the factors influencing an omnichannel experience in UK customers. Lynch and Barnes (2020) proposed a framework for decision-making customer journeys for the omnichannel for the fashion industry. Ovezmyradov and Kurata (2022) studied the implementation of RFID and omnichannel investments in fashion retailing. Shao and Lasseben (2021) examined the factors that determine consumers' willingness to participate in fast fashion brands' used clothes recycling plans in an omnichannel retail environment. Liu et al. (2018) explored the drivers and barriers to omnichannel retailing in China and attempted to understand how companies formulate their business strategies during their transformations to omnichannel retailing. Mishra (2020) tries to identify the factors influencing omnichannel retailing adoption in Indian apparel firms. Mishra et al. (2022) omnichannel adoption in logistics to overcome the barrier of Indian apparel firms.

2.3.1 *Barriers to omnichannel adoption*

2.3.1.1 lack of understanding and commitment of management (UC)

Adopting and implementing the new business strategy mainly depends on the top-level management commitment and understanding of the use of the new technology (Ajmera and Jain, 2019; Devi et al., 2021). Majumdar et al. (2021) identified barriers in India's textile and clothing industry and showed that lack of understanding is the main barrier to adopting the technology. Similarly, the study of Orzes et al. (2018) highlighted that for small and medium-sized enterprises, the lack of support from top management is the critical barrier to adopting new technology. Sharma and Joshi (2021) also mentioned that low awareness and low support from the high management level are the main driving variables in the industries. Ye et al. (2018) tried to understand the business strategies used during their transformation to omnichannel retailing in China's fashion and apparel industry. Their study revealed that senior-level managers should decentralize control by delegating more decision-making authority to middle-level management. Meanwhile, in the handloom sector, small and middle-level weavers are unaware of digital platforms for their business. So, small retailers and online players can create an omnichannel that can be cost-effective and responsive to customer needs (Chopra, 2016). In addition, in a cooperative society, master weavers who are in the retail business can develop this omnichannel for their business growth.

2.3.1.2 Lack of digital culture (DC)

Digitization is necessary for handloom sector business development with digital technology advancements. Consumers seek to purchase online and offline products using omnichannel behavior (Sharma et al., 2019). However, with the poor digital strategy,

implementing new technology has become the most prominent barrier in developing countries like India (Raj et al., 2020). According to researchers, digitization will save time and cost, develop consumer-manufacturer interconnection, and provide information privacy (Rajput and Singh, 2019; Sharma and Joshi, 2021). Majumdar et al. (2021) claimed that the use of digital technology culture in textiles and clothing is missing. Simone and Sabbadin (2018) suggested that retailers need to connect with customers via social media and mobile technologies. Wang et al. (2021) also reported that digital mobile technologies are the most effective way to develop an omnichannel strategy in integrating channels for seamless customer experiences.

2.3.1.3 lack of qualified /skilled workers (QS)

The lack of skilled employees is a significant barrier to adopting technology in manufacturing organizations (Kamble et al., 2018; Luthra et al., 2020). To adopt a digital workplace, firms need to acquire skilled employees or provide training to the current employees (Devi et al., 2021). According to studies by De Borba et al. (2020) and Ye et al. (2018), the challenge of omnichannel retail is managing different channels with high efficiency and their inventories. Similarly, studies by Liu and Nagula (2020) revealed that retailers face challenges in managing omnichannel because of poor channel integration management and a lack of skills. A study by Kamble et al. (2018) also showed that efficient design and deployment of solutions require skilled workers from both technical and non-technical disciplines. Similarly, Majumdar et al. (2021) reported that the textile and clothing industry does not have a highly skilled workforce in India.

2.3.1.4 High implementation cost (IC)

The technology requires high investment for development during the initial stages (Sharma and Joshi, 2021). Most manufacturing firms are reluctant to invest in technology upgradation in India (Raj et al., 2020). Majumdar et al. (2021) also showed that the high implementation cost of technology upgradation in the Indian textile and clothing handloom sector is a significant barrier. According to researchers, for the conversion of multichannel to omnichannel networks, there is a need for the advancement of technology equipment, stores, advanced warehouse management systems, and staff training (Zhang et al., 2018; Liu and Nagula, 2020). De Borba et al. (2020) conducted a study to identify the barriers to managing omnichannel retail returns, which showed a high investment barrier because of the risk of waste and stock obsolescence in decentralized locations. A similar study on omnichannel retail in China's fashion and apparel industry shows there is a need for last-order fulfillment, which requires high fixed costs for setting up fulfillment centers (Ye et al., 2018).

2.3.1.5 Lack of Internet access and IT infrastructure in rural areas (IT)

It refers to IT infrastructure essential for the omnichannel implementation's support. The internet will help workers to enable a faster, more flexible, and more efficient way to connect inter and across the organizations, and it will provide complete competitiveness for the company (Devi et al., 2021) if the manufacturing industries lack effective communication due to signal coverage. Its infrastructure may act as a significant blockade for various products/ services (Kamble et al., 2018). A research study by Majumdar et al. (2021) also highlighted that most of the Indian textile and clothing industries are located in remote areas, which have limited IT infrastructure and poor signal coverage. Even if the IT infrastructure is sufficient, business investment may hamper their operations.

2.3.1.6 Lack of Integrated distribution Network and Stores (NS)

In the rapid development of marketplaces, it is essential to have a network connected in order to serve the customers (Luthra et al., 2020). The network system helps “capture, classify, store, and retrieve data to improve collaboration” (Majumdar et al., 2021). According to De Borba et al. (2020), organizations must remove the inefficiency and conflict in operations across channels. A research study by Simone and Sabbadin (2018) states that there was a clear distinction between physical and online stores. A similar study by Ye et al. (2018) states that though many consumers visit physical stores, store transactions are still minimal. The omnichannel comprises online and physical stores, web portals, and social network sites (Sharma et al., 2019). According to a study in omnichannel retail in the USA, integrated networks and stores are needed to improve the logistics service quality (Murfield et al., 2017). So, the management of information between channels will result in increasing customer service. Weaving houses are required to such an extent, and the government may be of great help in this regard.

2.3.1.7 Uncertainty in the law and contracts with partners (LC)

The omnichannel integrates the customer with the retailer, and the retailer will depend on several partners to achieve the cross-channel business, like support for technical services, logistics facility, and inventory at various warehouse regions, so that the product can reach the customer at a minimum time. To encourage the use of the omnichannel in business, there is a need for special laws and regulations to deal with uncertainties in interconnection with partners. According to Majumdar et al. (2021), the lack of regulations and forms of certification is the most influencing barrier in Indian firms. A similar study by Rauch et al. (2019) To find barriers to smart manufacturing in small and medium-sized enterprises in four different regions revealed that data security was mentioned as a very

important barrier. So, data security and the binding laws may greatly hinder the adoption of omnichannel systems in the handloom sector.

2.3.1.8 Fear of failing (FF)

The organization's business can fail when there is a mismanagement of financial resources, channels, product management, and human resources (Ye et al., 2018). According to the researcher Majumdar et al. (2021), the lack of established evidence about the success of the implementation of technology in a particular field of an industry can also lead to fear of failure. The use and expansion of omnichannel needs to interact with a vast network of customers with millions of devices, all exchanging information, and will always be concerned about wireless privacy problems. The researcher Rana et al. (2019) say that network threats can cause network damage by interrupting and penetrating individual users' devices or interfering with business operations, leading to a loss of customer trust and a low return on investment.

2.3.1.9 Lack of government support and policies (GP)

Governmental support and related policies are crucial in manufacturing systems to transform from traditional business models to smart and sustainable business models (Luthra and Mangla, 2018; Luthra et al.,2020). According to Majumdar et al. (2021), there is a lack of government guidelines and directions for new technology in industries like textiles. For the omnichannel adoption in the handloom industries in India, Government commitment is essential, and the agencies need to provide directions for converting traditional to omnichannel business model by creating awareness about the technology, providing financial support for initial capital investment, training them in using the technology in their businesses and developing policies linked to the simple and safe business.

2.3.1.10 Payment scams and false claims (PC)

With the rise of the online environment, the internet has become a popular medium for scams, linking fraudsters with a large number of prospective targets. In e-commerce shopping, nonpayment and non-delivery product scams are among the most popular (Maimon et al., 2019). Because of this fear, many minor business persons hesitate to do business online, where information about financial transactions is transferred electronically between customers and retailers. According to Button et al. (2014), Online fraud has become a significant problem in many countries with millions of victims. Maimon et al. (2019) stated that online fraudsters use urgency cues as a major criterion to interact with potential victims for nonpayment. A study by Sangal et al. (2022) tries to conceptualize using blockchain in omnichannel for the healthcare industry to get transparency in payment across the channels. Weaving houses of handloom sectors may become reluctant and face loss due to such market practices, which needs to be addressed accordingly.

2.3.1.11 Privacy and consent issues about the design of the product (PI)

Digital marketing can impact users' trust because of privacy, security, and information transparency (Sangal et al., 2022). According to Sharma et al. (2019), users feel uncomfortable sharing personal information with the agencies (Sharma et al., 2019). In omnichannel adoption in the handloom sector, the weavers are concerned about the privacy of product design. Most designers and weavers spend months designing a saree and choosing color combinations for a saree. If some unauthenticated person accesses their design data to make identical products, it creates a massive loss to the business. On the other hand, a duplicate by power loom may also eat their market with the same design due to low cost.

2.3.1.12 The issue with reverse logistics (RL)

Handloom products are costly compared to power loom products (Tanusree, 2015). Most handloom products are purchased by high-end customers because the cost of the products can vary from thousands to lakhs depending on the design and material used for the product. To deal with customers, there is a need for a forward and reverse logistics system (Sarkar et al., 2019). According to the researchers (De Borba et al., 2020; Murfield et al., 2017; Thiyagarajan and Ali, 2016), reverse logistics is too critical for implementation in the online retail handloom sector and needs a separate warehouse and human resources. Meanwhile, in the handloom sector, weavers face reverse logistics difficulty because they must carefully inspect the product when the customer returns it. The inspection employees should require skills and knowledge of the product, and if employees accept tampered or used products, it will cause considerable losses to the weavers.

2.3.1.13 The issue with forward logistics (FL)

Differentiated logistics is essential for an omnichannel business to work (Mishra,2020). Forward logistics needs prioritized picking options, inventory maintenance, and distribution of goods to the customer at a given time (Sarkar et al., 2019; Mishra,2020). Currently, customers need the product on time, and the delay in logistics can lead to the cancellation of the order (Sun, 2019). When the industry deals with the omnichannel, there is a problem of picking the wrong item in the peak season (Mishra et al., 2022). The handloom sector has to prepare itself for such issues. So, for a seamless customer experience, customers need to be segregated by the nature of purchase, such as new, regular, and premium customers.

2.3.1.14 Withdrawal from purchase (WP)

In online shopping, the customer will get price, variety, and delivery time information. Customers often compare product prices before and after placing an order (Simone and Sabbadin, 2018). At the same time, customers also read online reviews about the product's quality and usability (Ahmad and Guzmán, 2021). So, if the customer changes the purchase decision during the product shipment, the customer may opt to cancel the purchase. The canceled products will be shipped back to the source. According to the study by De Borba et al. (2020), if customers are dissatisfied with the delivered order, they will withdraw from the purchase, impacting omnichannel retailing.

2.3.1.15 Production scalability issue (PS)

Whereas industries also face the issue of inventory invisibility across channels (Mishra et al., 2022), there is a need to maintain warehouse stocks and process inventory to reduce shortage in omnichannel management (Mishra, 2021). To resolve this issue of inventory, there is a need for production scalability, which scalability is a constraint in many manufacturing industries (Thomas-Seale et al., 2018). In the handloom sector, scalability is one of the significant issues because it is an unorganized sector, and most of the weavers work on traditional looms, where the production of sarees is slow. So, to adopt omnichannel, users need to maintain a high quantity of products at different locations so that they can reach the customer within a limited time.

The next dimension for the handloom sector is to market its products to penetrate their products. Augmented reality may be of great help.

2.4 Augmented reality for the handloom sector

The literature review shows that the term augmented reality was first used in 1992 by Preston Caudell, a researcher in Boeing industries (Arena et al. 2022). AR is generally defined as a live view, either direct or indirect, of a real world where computer-generated information has been used to enhance the physical environment by infusing it with the virtual one (Carmigniani and Furht 2011). While explaining AR marketing, Rauschnabel et al. (2022) consider a broader perspective and define it as the strategic integration of AR content, independently or in conjunction with other media or brand information. The aim of such an exercise is not only to create value for its stakeholders by achieving long-term marketing goals but also to consider the ethical and societal implications. Manchanda and Deb (2021) try to study the impact of AR technologies as well as anthropomorphism on the attitude and intention of Indian consumers towards the adoption of m-commerce. Similarly, Baytar et al. (2020) examine the effectiveness of AR on various fronts by studying the shopping habits of US college students. The study focuses on AR's ability to reliably convey product information like fit, size, and performance. Additionally, AR's effect on the customers' attitudes toward the apparel and the purchase intentions was a significant part of this work (Baytar et al. 2020).

2.4.1 Barriers to the adoption of augmented reality business model in the handloom sector

A literature survey revealed no clue of the direct use of AR in the Indian handloom sector and the barriers to adopting the same. The following sections present various barriers identified.

2.4.1.1 Lack of information and knowledge

Augmented reality is a type of technology that, in addition to extensive technological support, requires real-time collaboration between the user and the digital and physical information (Barroso et al. 2019). This technology allows industries to implement new competitive strategies for their business (Dal Forno et al., 2023). However, at present, users have a shallow understanding of this new technology and are unsure about the exact consequences/ implications of technology adoption (Luthra and Mangla 2018). The study conducted by Oke and Arowoiyi (2022) to find the critical barrier to adopting Augmented reality in Nigeria shows a lack of technological awareness. Similarly, Cugno et al. (2021) highlighted that many industries are not embracing technology owing to the scarcity of information about its advantages and drawbacks. A similar assertion can also be made about the shortage of information due to investment support. Gattullo et al. (2020) pointed out that AR is barely implemented in ground-level industrial operations because of a lack of knowledge. So, the industry can collaborate with an academic institution for digital transformation projects (Khin and Kee 2022).

2.4.1.2 Lack of top management commitment

The commitment and vision of the top management is primarily responsible for technology adoption in the industries (De Sousa Jabbour et al. 2018). Similarly, Cugno et al. (2021) state that the primary obstacle to technology adoption is the unacceptability shown by human resources due to the existing cultural or technical environment. Per the study of Raj et al. (2020), significant resistance exists towards any alteration to the current production techniques and tasks by the managers, as they are not ready to deal with complex technology due to a lack of technical skills (Moktadir et al. 2018). According to a study conducted by Majumdar et al. (2021), in the textile industry, top management may resist implementing new technology because they fear that decision-making power will

shift from higher-level management to the lower levels of the organization. Ahmad et al. (2020) conducted a study in the textile industry, revealing that it is difficult to change the attitude of management toward integrating modern technology and quoted it as a significant barrier. According to Luthra and Mangla (2018), top management involvement is needed to transform the industry to develop a skilled workforce, policies, and friendly business culture.

2.4.1.3 Lack of skilled workers

Skilled workers and field experts must be trained to implement new technology efficiently (Ahmad et al., 2020). Simultaneously, Oke and Arowoia (2022) also pointed out that the skill shortage is challenging for adopting AR in business development. According to (Kumar et al. 2021), the non-availability of skilled workers must first be addressed to adopt such digital technology in any organization. Kamble et al. (2018) stated that most of the industrial workforce lacks the adequate skills to cope with the upcoming automation. According to Cugno et al. (2021), adopting AR in the industry's internal skill force is needed to manage the interaction between process and information flows. Alarcon et al. (2020) mentioned that adopting new technology is highly diverse, and most solutions are not user-friendly. So, the existing workforce must be trained to know the essential processes (Luthra and Mangla, 2018), like maintaining or sharing industry data and user details. Moktadir et al. (2018) studied the barriers to implementing the new technology in the leather industry. Their study stated that AR could be used for repair operations to provide instructions to the workers, but this technology implementation strongly depends on skilled personnel.

2.4.1.4 Lack of funds

Emerging technology provides quality and customer satisfaction, but technology is quite costly (Kamble et al. 2018). Alarcon et al. (2020) also highlighted that the high cost is among the most significant challenges facing workplace AR adoption. Failing to overcome this will undoubtedly threaten the smooth and timely introduction of AR. Due to the initial high cost of required hardware, software, and the necessary training for the existing employees, introducing new technologies like AR systems is a particularly costly process (Cugno et al. 2021; Oke and Arowoiya 2022). Alternatively, additional costs may be incurred if the recruitment of skilled employees is needed (Ajmera and Jain 2019).

2.4.1.5 Lack of IT infrastructure and solid internet access

New technologies like AR would require its components to be integrated appropriately (Raj et al. 2020) to collect and share information with different users (Dal Forno et al. 2023). To facilitate this, advanced IT infrastructure is necessary (Ajmera and Jain 2019). According to Kumar et al. (2021), organizations aiming to utilize these systems must have sufficient and capable technological infrastructure like reliable high-speed connectivity, uninterrupted energy supply, and IoT architecture. To establish stable communication and interconnectivity between organizations and consumers (Cugno et al. 2021), a study conducted in India by Luthra and Mangla (2018) shows that internet connectivity is affecting business and is not the same in urban and rural areas. Majumdar et al. (2021) have reported that most textile industries in India are in remote and underdeveloped regions with insufficient IT infrastructure and limited internet connectivity. The study of Iyanna et al. (2022) confirmed that internet connectivity is a crucial infrastructural constraint. Similarly, Kamble et al. (2018) highlighted that a lack of internet facilities is a significant blockade for various services. So, this technology needs a

solid internet connection to avoid discontinuity caused by adverse weather conditions (Oke and Arowoija, 2022).

2.4.1.6 Legal and contractual uncertainty

The transformation of organizations into digital organizations is a long and challenging process, and it has to deal with issues related to legal uncertainties (Cugno et al. 2021). The protection of sensitive information about the consumer and the protection of intellectual property are some of the critical considerations for such organizations (Birkel et al., 2019). AR technology uses various machines, sensors, facilities, and the internet (Luthra and Mangla 2018) to interact with the users to capture and transmit the real data, which can have privacy issues regarding who owns the data and who controls it. Luthra and Mangla (2018) stated that companies must also counteract cyber criminality to protect their own and other users' data linked to them. According to Majumdar et al. (2021), the legal rules regarding standardization, information protection, and data ownership should be considered before deploying a digital strategy in the industry. A study conducted by Iyanna et al. (2022) in the healthcare sector suggested that regulatory bodies must issue precise guidelines and enact the necessary laws for the ever-evolving technological landscape. A study on the manufacturing industry in India by Kamble et al. (2018) revealed that Legal and Contractual Uncertainty is the driving barrier with top priority. Similarly, the handloom sector must also check such types of binding issues.

2.4.1.7 Privacy issues

Today, businesses heavily rely on real-time data analysis, which creates a high demand for data storage facilities (Moktadir et al. 2018). Industries relying on information technologies generate confidential information from the enormous range of sensors and software applications (Ahmad et al. 2020). This information is stored online across a cloud

computing environment (Ajmera and Jain 2019). Organizations use this information to predict customer requirements and interests (Dal Forno et al., 2023). In a digital network, a large amount of generated information flows from one network to another while analyzing real-time data. Different software at various nodes in this network may come from different organizations (Hehenberger et al. 2016), posing a potential data privacy issue (Kamble et al. 2018). Without necessary security measures, there is a risk of losing sensitive information to intermediate third-party software or a competitive service provider in the industry (Raj et al., 2020).

Similarly, Iyanna et al. (2022) stated that the low reliability of computer systems brings more vulnerability to cyber-attacks and can cause customer data loss. Moktadir et al. (2018) highlighted cybersecurity as a significant challenge in adopting information-based technologies. Therefore, industries must use a standard communication protocol. Iyanna et al. (2022) suggested that the government has to control cloud space to share sensitive industry data. Similarly, Dal Forno et al. (2023) suggested some data security techniques to be practiced in textile industries, like data encryption for data privacy, firewall management to restrict access, and Virtual Private Network (VPN) for secure access in intranet and remote locations.

2.4.1.8 Fear of failure

While adopting AR in business has several benefits, its implementation needs high investments, and organizations have to deal with technical complexity and infrastructure deficiencies (Tamvada et al., 2022). As there is no established evidence of success in the organizations, fear of failure prevails (Majumdar et al. 2021). According to Kamble et al. (2018), emerging technologies constantly threaten industries, and in some cases, organizations cannot recover their investments. Other industries fear losing control over

intellectual property (Nagy et al. 2018). On the other hand, the organization fears facing social risks, i.e., a decrease in employees due to the adoption of new technologies and the privacy of the organization's confidential data (Sanchez 2019). However, new technology in industry business cannot be adopted without trying (Birkel et al. 2019). So, the government and industries have to interact to make new policies for the industry to eliminate the fear of failure (Majumdar et al. 2021).

2.4.1.9 Lack of digital culture

Digitalization is changing the business environment (Machado et al., 2019). The new technologies are implemented when the organization as a whole is ready to utilize its potential (Antonsson, 2017). Raj et al. (2020) state that an organization's lack of digital culture can prevent employees and middle management from adopting new technology. In the present era, however, the most required things for employees in the industry are related to hard and soft digital skills (Cugno et al., 2021). According to a study by Majumdar et al. (2021) in the textile and clothing industry, the primary challenge encountered by the industry is the absence of digital culture.

Further, AR technology is interdisciplinary, which requires connecting different network elements (Luthra and Mangla 2018). In the handloom sector, most weavers are in rural areas and rarely use online platforms to communicate with customers (Khatoon and Iffat, 2022). The present government of India provides digital marketing to customers to improve digital culture in business (Khatoon and Iffat, 2022). This can be used to improve digital culture in weavers so they can use AR in their operations.

2.4.1.10 Lack of government support and policies

The government has a crucial role to play during the early stages of adopting any new technology in industries (Toufaily et al. 2021). The government must provide the

essential infrastructure to the industries (Kumar, 2021), especially the rural handloom sector. Similarly, a study by Majumdar et al. (2021) also highlighted that the government is responsible for connecting remote industrial areas containing textile and clothing manufacturing companies with high-speed Internet connectivity. A similar study conducted by Ajmera and Jain (2019) in the health industry suggested that the government has to create uniform standards for exchanging free and secure information at the national and international levels. In addition to ensuring the minimum encryption standards for digital information (Iyanna et al. 2022), the government should also ensure the safety of physical hardware in remote industrial areas. The government, as an impartial entity, should be the one to control the cloud space without breach of ownership data. Müller (2020) stated that conventional industries lack the expertise to deal with new technology challenges. So, industries have to be supported by government institutions.

2.4.1.11 Poor research and development in the sector

An organization's efficient communication and smooth operation necessitate the coordination and collaboration between various organizational units and partners (Moktadir et al. 2018; Majumdar et al. 2021). According to Machado et al. (2019), most companies lack expertise in implementing technology components. Kumar et al. (2021) emphasized the need to improve employees' technical skills concerning these emerging technologies. A similar study by Luthra and Mangla (2018) also showed that business organizations lack accurate decision strategies during this business transformation. Certainly, there is a lack of focused research. This deficiency can be decreased by collaborating with companies and institutions (Müller et al. 2018). Cugno et al. (2021) also suggested that research and development are crucial for any firm to implement technology to fulfill the requirements of the customers. Majumdar et al. (2021) mentioned that the textile industry has to focus on research needs to implement technology in industries.

Therefore, there is a need to collaborate with the service provider and academic institutions, especially for the handloom sector, to fulfill the customer's requirement.

To fulfill the customer requirements, the handloom weavers need to supply authenticated products. Certification of handloom products can greatly help, and the literature survey is presented in the next section.

2.5 Certification of Handloom products

The handloom saree in India is manufactured by gold, silver-coated and copper thread woven on the finest silk. Handloom sarees will take weeks to months, depending upon the design and skill of the weaver (Sinha, 2019). These products are known for their durability, weight, and design (Kumar, 2023). So, the customers who are more interested in purchasing handloom products may want to have genuine products. Traditional handloom apparel customers are largely affected by the issue of identifying the originality of products available in the market that face competition from near to similar products from power looms (Verma and Mishra, 2018). This often puts the consumer in a situation of their inability to identify the genuine product (Prathap and Sreelaksmi, 2022). The invasion of the power loom products has also significantly affected the handloom industries in India. One way of countering this level of competition is to sell the product with a logo or marks (Lalitha and Vinayan 2019).

The Government of India launched the Handloom Mark Scheme to provide assurance to consumers about the authenticity of handloom products. However, it did not cover the aspect of product quality assurance (Vyshnavi and Suja, 2017). However, the adoption of handloom marks is not widespread among weavers due to poor awareness and a lack of quality consciousness at the weavers level (Dhineshkumar, 2018). The Indian government also provided Geographical Indication (GI) tags for handloom products to

provide authentication to product quality and place of origin (Kumar, 2023). In the absence of a GI tag, it was difficult to differentiate the original handloom saree from similar-looking products in the market. Using the recognized marks in the finished product gives the consumers assurance of the quality. According to Prathap and Sreelaksmi (2022), product quality concerns affect a consumer's decision to purchase traditional handloom apparel.

India is the largest consumer of silk in the world, and the tradition of brides wearing silk sarees in marriages is followed in southern parts of India (Sundaram and Prakash, 2014). The government of India also introduced the Silk Mark for the purpose of the identification of genuine handloom products made of pure silk (Dutta et al., 2021). However, most of the customers are unaware of the logos due to a lack of awareness, and sellers are also not providing the tags. The handloom mark (HM), silk mark (SM), and Geographical indication (GI) mark are provided along with a product as a paper tag. They can be easily detached from the handloom product and even placed with the power loom products. This highlights a need to incorporate these tags in handloom products to prove a genuine product. An effort has been made in this work to this extent.

In order to increase customer contact and direct sales, a network of offline and online facilities for handloom products must be developed. Such network design may be of great help, especially to the Varanasi handloom sector, as Varanasi is a great tourist place. The next section presents the literature survey in this regard.

2.6 Facility location for Handloom weavers

The strategic design of supply chain networks heavily relies on decisions concerning facility location (Melo et al., 2009). According to Ahmadi-Javid et al. (2017), facility location theory pertains to a set of problems concerned with the modeling, formulation, and solution methods for identifying the optimal location for facilities within a given space. The research study of Lee and Yang (1997) utilized the analytical hierarchy process (AHP) to locate new facilities or relocate the existing ones. This method facilitated organizations in analyzing location factors, evaluating site options, and ultimately choosing the best location. Similarly, Badri (1999) utilized a combined model of the analytic hierarchy process and multi-objective goal programming for the location problem, incorporating variables such as the political situation of the foreign country, global competition and survival, and government regulations. Kahraman et al. (2003) stated that the conventional approaches to solving facility location problems are less effective in handling linguistic assessment's imprecise or vague nature. So, Fuzzy multi-attribute group decision-making was recommended for solving facility location problems. Ertuğrul and Karakaşoğlu (2008) applied fuzzy AHP and fuzzy Topsis to Turkey's textile company's facility location selection problem to address such linguistic assessments of vague nature. They used decision criteria such as favorable labor climate, proximity to markets, community considerations, quality of life, and proximity to suppliers and resources. Özdağoğlu (2012) chose to use the fuzzy ANP method instead of the AHP model to select a facility location due to its ability to deal with multiple directions of hierarchies. Athawale et al. (2012) recommend using PROMETHEE II as an effective MCDM tool for making decisions about facility locations in the manufacturing environment to tackle complex problems. Dogan (2012) proposed an integrated approach that utilizes Bayesian Networks and the total Cost of Ownership to address the complexities involved in selecting an

international facility for a manufacturing plant. Dantrakul et al. (2014) conducted a study that involved selecting potential sites for setting up facilities and assigning clients to the opened facilities to minimize total transportation and setup costs, using three methods: the greedy method, the p-median method, and the p-center method.

At present, facility location applications can be made more efficient and simpler by implementing machine learning. The machine learning process typically involves three stages: data acquisition, model building, and generalization. Machine learning algorithms are commonly used to tackle complex problems surpassing human capabilities (Durai and Shamili, 2022). The k-facility location problem is a recent algorithm (Zhang, 2007) and is a highly popular clustering technique (Yadav and Sharma, 2013). Its popularity stems from its ability to cluster large quantities of noisy and numerical data swiftly and effectively (Ralambondrainy, 1995). According to Dehariya et al. (2010), k-means, one of the simplest unsupervised learning algorithms, can solve the well-known clustering problem. Hartigan and Wong (1979) proposed the k-means algorithm to partition m objects in n dimensions into k (where $k \leq n$) clusters, aiming to minimize the within-cluster sum of squares.

The k-means has been successfully applied in various research studies, such as consumer segmentation in clothing and apparel shopping in India (Hemalatha et al., 2009). Simić et al. (2016) used the k-mean method in clustering the cotton textile importer's data. Davoodi (2019) used it for solving multiobjective facility locations. Chen and Yang (2020) used to study the behavioral analysis of choice difficulty states during online clothing shopping. Khalid and Herbert-Hansen (2018) used k-means for clustering in the international location decision. Smrithii et al. (2022) used k-means clustering for efficient parking allocation. Ran et al. (2021) used k-means clustering to capture urban noise hotspots.

A k-means clustering approach can be used to design a local or a national network in order to establish direct sales of handloom products. This approach will be very effective for a Varanasi handloom case as the Varanasi city is a tourist destination. In order to have a smooth operation to run such a network effectively, weavers' health is another dimension. The next section is devoted to musculoskeletal disorders of the handloom sector.

2.7 Musculoskeletal Disorder of Handloom weavers

Musculoskeletal disorders (MSDs) are common health problems in working people and a significant cause of disability worldwide, creating economic loss not only at the individual level but also at the organizational level (Naz et al., 2015). Choobineh et al. (2007) mentioned MSDs as one of the most critical problems in the workplace ergonomists are encountering worldwide. In many countries, the prevention of work-related MSDs (WMSDs) has become a national priority. MSDs cause work-limiting pain and fatigue, which many people do not disclose (Bevan, 2015). Musculoskeletal pain increases with the length of exposure to occupation with awkward posture that is pursued with repetitive tasks and forceful exertion (Bori and Bhattacharyya, 2020). The MSD can be dictated by simple instruments such as the Nordic Musculoskeletal Questionnaire (NMQ) (Kahraman et al., 2016). It is an internationally self-administered questionnaire (Gómez-Rodríguez et al., 2020). This instrument allows the study of pain in different regions such as "neck, shoulders, elbows, wrists/ hands, upper back, lower back, hips/thighs, knees, and ankles/feet" (Bazazan et al., 2019). Researchers in different fields use it to analyze the pain in workers such as automotive assembly workers (Nelfiyanti et al., 2021), cleaning workers (Sharma et al., 2022), manufacturing company workers (Moreira-Silva et al., 2021), quarry workers (Njaka et al., 2021), agricultural workers (Momeni et al., 2020), office workers

(Besharati et al., 2020), janitorial workers (Lim et al., 2022), hand block printing industry (Kamble et al., 2022), mine workers (Jeripotula et al., 2021).

Along with other fields, research was carried out to study MSD in handloom weavers. Handloom weavers. Muhamad et al. (2020) conducted a study on women handloom weavers in Indonesia, highlighting that MSD significantly correlates with prolonged sitting. Similarly, a study by Siddiqui et al. (2021) suggested that MSD in the handloom weaves is more in the upper and lower back. Mallapiang et al. (2021) tried to identify the relationship posture working with MSD on Indonesian weavers and revealed that weavers are sitting long, creating fatigue on workers' back. So, there is a need for proper seating arrangements.

The literature review highlights that the handloom sector has many issues/problems to be addressed through various strategies to mitigate these challenges in order to preserve culture and save the handloom sector in Varanasi city. Identified with a literature survey and with expert opinion, research gaps are highlighted in the next section.

Based on the discussion presented in sections 2.1 to 2.7 of the literature review and sections 1.4 and 1.5, it is evident that the handloom industry is encountering various challenges. These challenges encompass issues related to raw materials, finances, marketing and outreach deficiencies, technology adoption such as omnichannel and augmented reality, facility location, certification of handloom products, and musculoskeletal disorders among weavers. Therefore, there is a pressing need to pinpoint the specific challenges that are adversely impacting the Varanasi handloom industry and endeavor to alleviate the barriers' effects. It is imperative to conduct a thorough examination and propose a strategic approach to address these challenges effectively. The literature highlights the efforts of several researchers who have investigated problems within the handloom sector in different regions, as outlined in Table 2.1.

Table 2.1: Previous Studies on the Handloom Industry.

Author/authors	Techniques	Focus area	Findings/results
Varghese and Salim (2015)	Interviews	Study of handloom sector problems in Kerala	Need of special training, need of creating data bank for handloom, building up a reliable information system.
Kumudha and Rizwana (2013a).	Stratified Random Sampling	Study of handloom sector problems in Cooperative society in Erode district	Marketing problem, poor quality of raw material, low number of weavers
Risna and Banu (2021)	structured, and unstructured interviews techniques	Study of handloom sector problems in Maruthamunai Area	Weavers' shortage, fatigue in weavers, financial
Paul (2019)	Interview and group discussion	Analysis of handloom industry and its major problems in Gangarampur block of Dakshin Dinajpur	Supply of yarn and dyes, poor working environment, scarcity of labour
Samadhiya and Agrawal (2022).	Design Thinking (DT)	Design a handloom for weavers in Local villages of Uttarakhand	Designed a handloom for enhanced output quality, higher productivity, and improved ergonomics
Tarai (2020)	Focus group discussion	Entrepreneurial Development in Handloom Sector through Effective	Emphasis on Direct customer link, Cluster Identity, Setting up locally procurement Fabric Hub

		Strategy Formulation in odisha	
Pandit et al. (2013)	Questionnaire based survey and observations	Ergonomic Problems Prevalent in Handloom Units of Guwahati	Identified the areas where ergonomic intervention is required for the weavers
Durlov et al. (2014)	Questionnaire based survey	Evaluating the prevalence of low back pain among the handloom weavers in India	Lumber support and short brakes are required for the weavers for increasing productivity of sector.
Koiri (2020)	Structured questionnaire	Tried to identify occupational health problems of the handloom weavers in Sualkuchi	Suggested to implementation of ergonomic design into weavers work station to reduce effect of work posture
Mishra et al. (2019)	Focus Group Discussions and Brainstorming	Design and development of by using Web based application for handloom industry in India	The platform will increase profit through increase in sales by providing access to global markets
Hazarika et al (2016)	Questionnaire	Adoption of modern weaving technology in Assam handloom micro-enterprises	Study finds that there is a need of training, workshop, better policy framework, marketing.

Table 2.1 and sections 1.4 and 1.5 illustrates that researchers have undertaken various investigations into the dimensions of issues within the handloom and textile sector to enhance its efficacy. A literature survey from 2001 to 2023 reveals that the condition of the handloom sector has been worsening day by day over the years, and weavers are migrating to another profession. It is also visible that limited studies have been devoted solely to Uttar Pradesh, particularly in Varanasi. Hence, this research predominantly concentrates on the Varanasi handloom industry across the aforementioned dimensions, as elucidated in sections 2.1 to 2.7 and as highlighted in sections 1.4 and 1.5. Various methodologies were employed to carry out this research work. The Following section discusses these in brief and in the respective chapter as well.

2.8 Techniques

The methodology employed to identify research problems has been analyzed using methodologies such as AHP, QFD, ISM, and the Nordic questionnaire. The following subsections give relative merits of the various methods.

2.8.1 AHP method:

Analytical Hierarchy Process (AHP) is used by decision-makers grappling with complex scenarios, where multiple criteria and stakeholders need consideration. Ortega and Moslem (2023) argued that AHP stands out among Multi-Criteria Decision Making (MCDM) techniques, such as PROMETHEE, ELECTRE, and TOPSIS, due to its adeptness in handling diverse and intricate decision contexts. Putriani et al. (2023), in a research study for decision-making processes, highlighted AHP's superiority over alternative methods like Simple Additive Weighting (SAW) and Frequency Ratio (FR). Furthermore, Othman et al. (2020) provided empirical evidence supporting AHP's effectiveness, particularly in selection problems, where its overall accuracy surpasses that

of the Weighted Sum Method (WSM). According to Qubaisi et al. (2016), it is an effective tool for dealing with complex decision-making and may aid the decision-maker in setting priorities and making the best decision. By reducing complex decisions to a series of pairwise comparisons and synthesizing the results, the AHP helps capture both subjective and objective aspects of a decision (Puspitasari, 2018). In addition, Puspitasari (2018) mentioned that the AHP incorporates a useful technique for checking the consistency of the decision maker's evaluations, thus reducing the bias in the decision-making process. These collective findings highlight the widespread acknowledgement and adoption of AHP methodology for addressing multifaceted decision challenges across various domains.

2.8.2 QFD method:

Akao (1972) proposed Quality Function Deployment (QFD), one of the most important and widely used methods developed for identifying customer requirements and needs for developing products and services (Sofyalioglu and tunail, 2012). This method is useful in improving customer satisfaction, reducing product development cycle time, and reducing production costs (Ping et al., 2020). According to Haron et al. (2022), for understanding customer requirements, the QFD method is better than traditional methods such as brainstorming, cause and effect diagrams, checklists, and FMEA. Similarly, Kadir et al. (2020) highlighted that the QFD method is preferred over approaches like the SWOT analysis because the QFD approach is more technical and conscientious.

2.8.3 ISM method:

Interpretive structural modeling (ISM) was developed by Warfield (1974) to model contextual relationships between the barriers. The advantage of this approach is that it does

not require any quantitative data and uses only the decision makers' perception, coded with symbols and binary numbers (Majumdar and Sinha 2019). The ISM technique is superior to other interpretive techniques such as Analytic Network Process and Structural Equation Modeling (Srivastava and Dashora, 2022). Similarly, Mangla et al. (2018) highlighted that the ISM method outperforms Graph Theory and Interpretive Ranking Process. Research by Zayed and Yaseen (2021) emphasized that ISM is one of the most robust tools, requiring less data than Delphi or Structural Equation Modeling (SEM), which demand massive data. Raut et al. (2019) also reported that the ISM method does not require the level of dominance in establishing the interrelationship between the factors to be modelled, unlike other MCDM tools like ANP and TOPSIS.

2.8.4 Nordic questionnaire:

The Nordic Musculoskeletal Questionnaire is used to determine whether someone has problems with their locomotion (Chairani, 2020). It was developed within the framework of a project supported by the Nordic Council of Ministers. The questionnaire consists of structured, forced, multiple-choice questions and can be used as self-administered or as part of an interview (Descatha et al., 2007). Gómez-Rodríguez et al. (2020) highlighted that, Nordic questionnaire is internationally self-administered questionnaire designed to evaluate musculoskeletal problems in an ergonomic or occupational health context. Similarly, Serra et al. (2018) also mentioned that, the Nordic questionnaire is internationally used as a standard measurement of MSDs because it is easily to applied and understandable. According to the López-Aragón et al. (2017), researchers developed different methods for evaluating the MSD like “laboratory method of Work Economy and Sociology, known as LEST, the RNUR or profiles in jobs of Renault, the method of the Agence Nationale pour L’Amelioration des Conditions de Travail (National Agency for

Improvement of Working Conditions) known as the ANACT, the mixed method of FREMAP, the FAGOR method, and the Ergonomic Workplace Analysis method known as the EWA”, these are methods identify the, where the problem is but they do not quantify or isolate it with precision.

A comprehensive explanation of these methodologies and their respective steps is provided in the subsequent chapters.

2.9 Identified Research Gaps

Based on the literature survey presented in sections 2.1 to 2.7 and sections 1.4 and 1.5, several significant gaps within the handloom sector, particularly in Varanasi, necessitate further investigation:

- **Limited Understanding of Weavers' Challenges:** Existing literature lacks a comprehensive examination of the distinct challenges encountered by various categories of weavers (structures, namely independent, master, and cooperative society weavers). Targeted research initiatives are necessary to address the specific obstacles faced by each structure.
- **Lack of Insight into Customer Requirements:** Despite the significant influence of consumer preferences on market dynamics, there is a noticeable absence of comprehensive studies exploring customers' specific requirements in the Varanasi handloom sector. Focused research efforts are essential to bridge this knowledge gap and better understand consumer needs.
- **Inadequate Exploration of Technological Adoption:** The Varanasi handloom sector faces barriers to adopting innovative technologies such as omnichannel and augmented reality, which could enhance customer engagement and market competitiveness. However, there is a scarcity of research articles examining the

factors hindering the adoption of these technologies and addressing corresponding customer requirements, indicating a critical research gap in this domain.

- **Lack of Strategic Facility Location Studies:** Despite the significance of proximity between customers and weavers for operational efficiency and market access, there is a lack of comprehensive studies on the strategic design of facility locations in the Varanasi handloom sector. Addressing this gap is essential to optimize the facility's spatial layout and better meet the needs of customers and weavers. This will facilitate the weavers to sell their product directly.
- **Identification of Genuine Handloom Products:** The demand for authentic handloom products necessitates the development of techniques for verifying product authenticity. However, research in this area is insufficient, highlighting a crucial gap in understanding and addressing customer requirements related to product authenticity and quality assurance.
- **Exploration of Work-Related Musculoskeletal Disorders:** Weavers in the handloom sector are prone to work-related musculoskeletal disorders, yet research on this topic is limited. Further studies are required to investigate the prevalence of such disorders among weavers and explore potential ergonomic interventions for designing safer workplace environments. Well designed workplace bring more belongingness in weavers towards their profession and so, reduces migration.

Based in these gaps, various research objectives, as mentioned in Chapter 1, have been framed and are reproduced here in the next section.

2.10 Research Objectives

Based on the gaps identified in section 2.9, the objectives are framed as discussed in section 1.8 and are reproduced as follows.

1. Identification and prioritization of key challenges of handloom weavers
2. Understanding the customers' requirements of and establishing strategies to fulfill their requirements
3. Modelling of Barrier in the Adoption of Omnichannel Marketing
4. Barriers to adopting augmented reality in the handloom sector
5. Authentication of genuine handloom product
6. Facility locations planning for the handloom sector
7. Study of work-related musculoskeletal disorders and Design of seat for handloom weavers.

The tools and techniques with the literature survey that are used towards these objectives are discussed in the respective chapters. The next chapter is devoted to the first objective, i.e., identification and prioritization of challenges of handloom weavers.

