A CONCEPTUAL FRAMEWORK TO REINVIGORATE THE HANDLOOMS SECTOR IN INDIA: MODELLING THROUGH ARTIFICIAL INTELLIGENCE METHODS LEVERAGING SYSTEMS THINKING APPROACHES

by

VENKATA SATYANARAYANA KONE

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VENKATA SATYANARAYANA KONE

APPROVED BY

Hanadi Taher, PhD taherhanadi

<Chair's Name, Degree>, Chair

Saša Petar, Ph.D.

<Member's Name, Degree>, Committee Member

Anna Provodnikova

<Member's Name, Degree>, Committee Member

RECEIVED/APPROVED BY:

<Associate Dean's Name, Degree>, Associate Dean

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Abstract

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Dissertation Chair: <Chair's Name>
Co-Chair: <If applicable. Co-Chair's Name>

This exploratory inquiry intends to uncover and comprehend the problems of the languished handloom industry and impoverished artisans. Further, the study suggests conceptual frameworks for the revival of the Indian Handloom Sector.

Handloom craft is a lasting legacy of great imagination, artistry and aesthetics practised as far back as 4000 BC in India. Until the late 18th century, India was a global hub of exquisite textiles and accounted for over 50% of the worldwide supply.

The sector currently faces headwinds and grapples with multifarious problems, such as low productivity, disrupted supply chain, restricted credit flow, weak marketing, inadequate infrastructure and obsolete technology, among others. Moreover, with the incongruity of government policies and declining support and protection, the handloom industry is further impaired by the predatory competition from powerlooms.

The study adopted mixed methods of data collection and multiple data analytical methods. The quantitative data gleaned from over 11,000 weaver households and a few personal interviews for qualitative insights in the Prakasam district of Andhra Pradesh, India, constituted a big dataset.

The study conceived four models based on disparate influencing factors identified within the three perspectives; productivity and supply chain, human capital, and policy and implementation.

Data were analysed wielding Artificial Intelligence and Machine Learning tools. The results were then scanned and explicated, employing Systems Thinking and Sustainable Livelihoods Approaches for accentuating the interrelations, patterns and trends.

This study revealed a complex web of activities and interactions that resulted in the industry's downswing and consequent marginalisation of weavers.

The study provided significant evidence about how the neglect of economic, social, and policy perspectives engendered structural distortions in the artisanal socioeconomic landscape.

The study established the adverse effects of degraded human capital, eroded productivity factors, and disrupted supply chains. The study further disclosed that the government's claim of support to handlooms is more vaunted than the field-level reality.

This paper provided policymakers and executives with policy and implementation frameworks to address the gaps and inconsistencies.

The dissertation finally suggests long-term investment in human capital, technology and infrastructure associated with sustainable policies and schemes for bolstering productivity and competitiveness.

Key Words: Handloom Industry, Artisans, Conceptual Framework, Mixed Methods, Artificial Intelligence, Machine Learning, Systems Thinking, Sustainable Livelihoods Approach, Human Capital, Productivity.

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CHAPTER I:

INTRODUCTION

1.1 Introduction

Indian handloom is unparalleled in its creativity and versatility and makes up a timeless facet of India's rich cultural and traditional legacy. For over 4000 years, Indian handlooms have been renowned for their craftsmanship.

In human society, hand weaving has been the most valuable and fascinating craft since time immemorial, and the craft is a blend of utility and aesthetics. A person working with hands is considered a labourer, while somebody who works with hands and brain is an artisan. Still, a handloom weaver is an accomplished artist who works with hands, brain and soul, and the cloth he weaves is intertwined with deep feelings and emotions (Das,1986).

UNESCO (2007) describes crafts and artisans:

> Creativity and creative communities may be the remaining enduring resources in the developing world. They represent present cultures and past civilisations which uniquely contribute to the nobility, heritage, beauty and integrity of the human race.

Over several centuries, an extraordinary legacy has nurtured traditional Indian crafts across religious, ethnic and communal borders, exemplifying a mosaic of pluralistic cultures and traditions.

Ranjan (1998) has given an elaborate and convincing definition of a craft:

> Crafts can be defined as those activities that deal with the conversion of specific materials into products, using primarily hand skills with simple tools and employing the local traditional wisdom of craft processes. Such activities usually form the core economic activity of a community of people called craftsmen.

The Textile Policy 2000 (2000) reveals that:

The handloom industry has not only survived but also grown over the decades due to its inherent strengths like the flexibility of production in small quantities, openness to innovation, low level of capital investment and the immense possibility of designing fabrics.

Indian textiles are known for their brilliance of colours and patterns. They have been traded in the past millennium in exchange for a variety of commodities; the crafts flourished on the skill, artistry, and ingenuity of the Indian artisans (Reid, 2009).

In 1500 AD, cotton textile activity was the mainstay and central to the manufacturing ecosystem in the Indian subcontinent. It also led to a wide range of trade activities from India spreading across the globe via land and sea to Indonesia, Japan, Saudi Arabia, Ethiopia, Egypt and West Africa (Roy, 1999).

Till the beginning of the European Industrial Revolution, which started in England in the 18th century, India was the world's hub of textile production (Gillow and Barnard, 2008).

The studies of Parthasarathi (2011) report that during the Mughals' regime of the 18th century India became a major international trade centre for textiles and produced about 25 per cent of the world's industrial output until 1750.

The British established the East India Company in 1600 as a trading organisation and started trade expansion exponentially. The systemic exploitation of British India during the 19th and early 20th centuries engendered far-reaching implications and particularly weakened the handloom and handicraft sectors. (Charlesworth, 1982).

The late 19th century further witnessed the rise of mechanised textile mills and especially the emergence of a new threat in the form of Powerlooms as small business enterprises. As a result, the artisans lost their identity and independence, and the whole handloom business ecosystem was dismantled. By the end of the 19th century, the handloom industry landscape was altered substantially (Wendt, 2009).

1.2 Current Status

The globally renowned Indian handloom industry is a hallmark of India's rich cultural heritage and traditions, with an extensive range of fabrics showcasing intricate designs and patterns.

India has a glorious treasure trove of fabrics and handloom techniques with the most intricate woven patterns and varieties ranging from the Ikkat of Odisha, Kalamkari from Andhra, Rajasthani Sheesha work, Bhagalpuri silks of Bihar, Kosa of Chhattisgarh, Jharkhand's Kuchai, Mysore silks, Paithani of Maharashtra, Telangana's Pochampally, Kashmir's Pashmina, Eri and Muga Silks from north-eastern India, and Lucknow's Chikan and Zardozi work, Gujarat's Bandhani, Goa's Kunbi and many more (Craft Council, 2011).

Currently, this industry is unevenly distributed and highly concentrated in a few states of India, including Tamil Nadu, Andhra Pradesh, West Bengal and the North-eastern States. These states are home to almost 84.5 per cent of India's handloom workforce (Handloom Census, 2019).

Weaving is a highly dispersed and decentralised activity in India, predominantly home-based, with the entire family's participation, including women and children, with absolute role clarity. (Gouse, 2012; Hazarika *et al.*, 2016; Bortamuly and Goswami, 2015; Bortamuly *et al*., 2014; Bhagavatula *et al*., 2010). Mostly women and children undertake pre-weaving processes, and this is the time for the children to learn the techniques from their elders. That is how the tradition continues and transmits from generation to generation.

Indian Handloom industry has the second-largest workforce after agriculture (Annual Report, 2018-19, Ministry of Textile, GOI). About 3.14 million households are engaged in handloom weaving and allied activities, employing over 3.52 million handloom workforce, including weavers and allied workers. About 88.7 per cent of the households are in rural areas, 11.3 per cent are in urban areas, and around 72 per cent of handloom weavers are female (Handloom Census, 2019).

The employment structure in the handloom industry is divided into four categories based on the work they perform and their relation to the other stakeholders. Independent weavers make up about 73.2 per cent and perform all supply chain activities. Weavers working under master weavers account for 19.4 per cent, and they depend on their master weaver for all weaving activities, including credit. While weavers organised into cooperatives are shareholders and account for about 6.3 per cent, those who do not own any looms work under Government Corporations and Boards are about one per cent (Handloom Census, 2019). Moreover, most artisans occupied in the activity are currently from the vulnerable and weaker sections of society (Singh *et al*., 2015; Boruah and Kaur, 2015).

The industry has a substantial production capacity with a firm infrastructure base, including the highest number of looms in the world, with over 2.82 million varied designs and built (Handloom Census, 2019).

The handloom industry in India is less capital-intensive and requires less power. In addition, the handloom industry is environmentally sustainable and has continued for generations (Government of India, 2015). Moreover, the Indian handloom industry has many inherent advantages, including abundant, inexpensive labour and rich resources, low capital investment and unique artistry of the artisans coupled with increasing global demand for handlooms (Hashmi, 2012).

The handloom industry is one of India’s most enormous, decentralised and informal economic activities and provides livelihoods to over 3.52 million people (Government of India, 2015; Bortamuly and Goswami, 2014; Devi, 2013; Ghouse, 2012; Niranjana and Vinayan, 2001).

In India, weavers have been traditionally an integral part of the village economy for ages. The crafts created used to cater to the needs of the people by providing designs and motifs appropriate to the communities. Besides using the craft for personal consumption and satisfaction, the self-expression of weavers intertwined with aesthetic sensibility also facilitated economic activity (Jasleen Dhamija, 1979).

In 2018-19, the Indian Textiles sector contributed about 15 per cent to the total country's exports, and the textiles sector ranks 5th in the global trade with a share of around 6 per cent; however, handlooms fabric accounts for 15 per cent of the total textile production in India. Therefore, India has a sizable share of handloom exports, and the exports stood at USD 315.62 million in FY 2019-20 (Exim Bank, 2018).

Despite several advantages and inherent strengths in the Indian handloom sector, the sector has become a significant concern for the Indian textile economy, afflicted with multiple problems. Besides steadily losing its sheen and share in textile production, the weaving community has been pushed into a profound misery.

1.3 Statement of Problem

India's handloom industry today produces different designs and motifs to suit any setting and context. India is the only country globally with a maximum number of artisans engaged in handmade fashion. However, despite the rich artistry and high production capacity, hand craftsmanship in India is on the wane. The socioeconomic status of the weavers is in deep distress for multiple reasons.

Given the economic and social significance of the Indian handloom industry, the sector is beset with myriad challenges. Low productivity, raw material shortage, exploitation by intermediaries, and insufficient working capital are the major deterrents. In addition, weak marketing networks, weaver's inability to adapt technology, the dominance of mechanised looms (Powerlooms) and competition from the mill sector, and the proliferation of fakes are a few critical challenges among many others that plagued the handloom industry.

The situation is further aggravated by globalisation, changing socioeconomic conditions and rapidly increasing industrialisation.

Adverse government policies and ineffective implementation of the schemes have highly affected the industry. As a result, the weavers face severe livelihood crises and struggle to make ends meet.

1.3.1 Dwindling Number of Artisans

According to the Handloom Census 2019-20, the Indian handloom sector is rapidly shrinking. The number of weavers has been declining compared to the censuses of 1970-71, 2009-10 and 1995-96. Weaver’s numbers decreased by 19 per cent to 3.5 million in 2019-20 from 4.3 million in 2009-10 and 6.5 million in 1995-96, 6.7 million in 1987-88 and 12.4 million in 1970-71 (Handloom Census, 2019).

1.3.2 Declining Production

Handlooms contributed to nearly 33 per cent of total cloth production during the early 1930s; however, there was a shift in the production pattern. By Indian independence in 1947, the handlooms’ contribution shrunk to around 25 per cent (Roy,1996). Nevertheless, handloom production stabilised from the 1960s to 1995 at 23 per cent. However, slippage again started after 1995, and the handloom contribution was estimated at 13 per cent from 2004 to 05 (Kalyani *et al.*, 2017). As a result, the handloom contribution to the total cloth production is hovering around 15 per cent.

1.3.3 Declining Exports

The export of handlooms to total textile exports is insignificant and makes up less than 1.75 per cent. Despite significant global demand for handlooms, India has failed to maintain its position. Moreover, the export of handloom products from India has steadily declined over the last few years. Exports that stood at USD 367.41 in 2014 have declined to USD 315.62 million in FY19-20, registering a negative CAGR. Despite having a robust domestic untapped production capacity, India also imports handloom products, which stand at 2 to 2.64 per cent of India's total imports (Exim bank, 2018).

1.3.4 Meagre Income

The socioeconomic status of the weavers is in disarray, and about 67 per cent of handloom weavers earn less than Rs 5000/month (USD 67), which means Rs 166/day (USD 2.2 per day), and is less than the minimum wage prescribed by the government and further making weaving an unsustainable economic activity.

The grim situation is further intensified by globalisation, changing socioeconomic conditions, and burgeoning industrialisation. As a result, once the most sought-after textile destination, India has been steadily losing the race in international trade to Bangladesh, Sri Lanka, Vietnam, and China.

1.3.5 Lackadaisical Government Support

Despite a slew of support schemes launched by the government to encourage the artisans, the outcomes were quite disappointing. Though the government claims to have done substantially for the welfare of the artisans, the ground-level reality is frightfully different. Furthermore, the actions often reflect a disconnect between the objectives of schemes and the reality at the micro-level such as the absence of weavers' involvement in the decision-making, rampant corruption, shifting markets, and the growth models that are incompatible with the weavers' culture and traditions, among others (Craft Council, 2011).

Adverse government policies and ineffective implementation of the schemes have highly affected the industry. As a result, the weavers are neck-deep into a severe livelihood crisis. The irony is that the government perceives the handloom sector as anachronistic and a sunset industry in the modern world.

Given this deplorable situation and further guided by persuasive social and economic perspectives, this researcher has chosen the Indian handloom sector for in-depth analysis and comprehension to unravel the factors responsible for the crisis.

Therefore, this research attempts to bring forth fresh perspectives that need to be addressed and implemented to reinvigorate the handloom industry while preserving and honing artisans’ livelihoods in India.

1.4 Significance of the Study

The handloom sector is an important economic activity and extends livelihood support to millions of artisans in India; however, the industry is currently in a vexing position. Despite many efforts by several researchers and policy-makers to analyse the problems and offer solutions for redressal, it is noticed that the literature and the proposed redressal methods are found haphazard and noncoherent.

The industry problems were identified and analysed in isolation, disregarding their interconnectedness and interrelationships. Hence, the results are non-comprehensive, lack objectivity, and do not reflect trends and patterns.

Ostensibly, most studies banked on small samples, and there were no attempts made to predict how the situation would be if the issues were not settled and redressed.

This study adopts a unique research methodology to obviate the shortcomings described above by using mixed data collection methods and multiple tools for analysis and prediction, besides employing the Systems Thinking and Sustainable Livelihoods paradigms for interpretation and drawing meaningful and rational conclusions.

This study proposed to collect a larger sample to have greater precision and avoid contradictory findings and conclusions. A larger sample is a key determinant to overcoming larger margins of error and higher standards of deviation and eventually restricts false negatives or false positives (Kaplan *et al*., 2014).

A larger sample leads to a higher volume of data, called big data, which calls for advanced analytics and multiple tools to eliminate bias and derive accurate inferences. Accordingly, the study intends to deploy Artificial Intelligence and Machine Learning techniques to analyse big data to arrive at more informed decisions.

1.5 Purpose of the Study

This research has three major purposes. First, identify and address the critical productivity factors to augment productivity. Second, to understand the complexity of the handloom industry and propose a framework for problem resolution by suggesting a model for the weavers' livelihood support. Last, a deep analysis of the existing schemes and policies for policy-level interventions at the government's end.

The study seeks to understand the deeply entrenched structural problems the industry faces. For example, human capital issues such as gender discrimination, low productivity due to health issues, low education, and low skill levels are believed to affect the artisan's productivity substantially.

In addition, the informal nature of the industry, technological obsolescence, lack of entrepreneurship and opportunities for marketing are premised to be some of the core issues of the low-income generation. Therefore, the study intends to suggest a tangible and sustainable livelihood model for addressing the livelihood concerns of the artisans.

The economic and other external environmental factors would be assessed, analysed and underpinned to build a model for enhanced productivity by infusing efficiency and agility into the production system.

The superficial and sporadic interventions made by the government have failed to yield tangible results since the government has believed that the problem is simple and unitary. However, as revealed by some researchers, the policies and schemes unleashed by the government have added more complexity and chaos.

Therefore, the study takes ingenuity to analyse the policy initiatives to understand the complexity better and unveil a resilient policy framework for correction and reawakening interest in the handloom sector. Given this, the research is expected to develop tangible solutions to quell the distress and propose corrective action to reinvigorate the ailing handloom industry besides predicting the future course.

1.6 Objectives of the Study

Recognising and comprehending the implications of globalisation and fierce competition from mechanical looms and mills, the survival of the handloom industry is on the verge of extinction and the weaving community is pushed into a deep livelihood crisis.

Therefore, it is essential to study the industry's challenges for deeper insights; hence, the possible resolution to tide over the crisis depends on authentic research data.

The key objective of this study is to design authentic modelling frameworks to espouse durable solutions to the issues of the Handloom Industry by scanning under Systems Thinking and Sustainable Livelihood approaches and deploying Artificial Intelligence tools.

The research further builds on the following four primary objectives:

1. Evaluating the factors responsible for the low productivity: To articulate and design a model to assess and analyse the factors of production that contributed to the low productivity growth in the handloom sector.
2. Proposing a conceptual model for supply chain issues: To assess the impact of the various supply chain determinants on productivity and explore reasons for disrupting the supply chain activities.
3. Modelling the livelihoods framework of weavers: To model the artisan's livelihoods with a diagnostic and analytical approach and measure various social, technological, economic, and other relevant elements.

4. Designing policy and implementation frameworks for government intervention: To propose a model or framework to the policymakers for taking appropriate action to better the battered handloom industry and weaver's livelihoods.

The above primary objectives can be further divided into the following secondary objectives:

- To identify and assess the critical vulnerability factors in varied contexts and their interrelations to determine the core roots of the problem.
- To notify and analyse the factors of production (investment, innovation, skills, enterprise and competition) that improve outputs and lead to enhanced productivity.
- To appreciate the supply chain issues and assess their influence on productivity.
- To find practical solutions to the lack of visibility and decent livelihood options for artisans.
- To identify the critical gaps in existing awareness-building and capacity and skill development programmes.
- To uncover the reasons for poor technical, design, financial and handholding support from the designated government institutions.
- To critically evaluate the various government policies, acts, norms, and regulations.
- To identify and analyse the gaps between programme planning and implementation of various government schemes.
- To deliberate and suggest policy-level interventions both long-term and short-term to the government.
- To outline the strategies to improve India's export competitiveness.

1.7 Research Questions

Artisans' livelihoods in the handlooms industry are expected to provide access to basic needs and the opportunity to prosper, besides a sense of identity, dignity and recognition. Nevertheless, unfortunately, the handloom sector is rife with social, economic and financial problems, and even the sustenance of the artisan is hanging under the sword of Damocles.

This study seeks to examine India's handloom industry, alluding to its structural anomalies and other vital factors besetting the growth of the sector and degradation of the livelihoods of weavers by posing the following questions:

1. What deters the weavers from achieving higher productivity growth despite the handloom sector's inherent potential?
2. Whether the business performance in the handloom sector lies in the broader, robust, and resilient supply chain?
3. Is the prevailing livelihood crisis and impoverishment of the weaving community the culmination of centuries-old neglect of human capital assets?
4. Why have government policies and schemes designed to improve the industry's competitiveness and strengthen the artisan's livelihoods failed to make a positive impact?

1.8 Approach to the Study

The proposed research attempts to design conceptual models for analysing the core issues faced by the handloom industry based on the analysis and understanding of the data and empirical evidence collected.

As the chosen field is complex and wicked and afflicted by various issues, the preferred methodology to be adopted could be Systems Approaches. The problems would be examined under the Systems Thinking lens for more viable solutions, leveraging Artificial Intelligence and Machine Learning tools.

The Systems Approach offers solutions when the issues are complex and chaotic and involve multiple stakeholders and agencies with several interacting variables in a real-world setting.

Systems Thinking provides a holistic and logical platform for integrating disparate socioeconomic variables and polarisations, allowing cross-sectional interactions and dependencies and eventually showcasing a big picture. Systems Thinking is thus a process of understanding how various factors in a ‘holon’ influence one another.

Therefore, this author believes that the Systems Thinking approach is the most appropriate methodology to understand and comprehend the problems of the handloom sector in India.

In addition, the Sustainable Livelihood Approach (SLA), a trusted model to analyse livelihoods, is also contemplated to delve into the weaver’s livelihood issues.

1.9 Organisation of the Study

The remainder of the study is organised into five chapters. Chapter 2 deals with the literature review and focuses on some theoretical perspectives and findings of empirical studies of various authors concerning the handloom industry.

Chapter 3 outlines the philosophical background of the study and the methods adopted and further describes the experimental design.

Chapter 4 discloses and describes the study’s results and highlights the study’s major findings.

Chapter 5 presents an analytical narration of the results obtained while referring to the literature and research questions. It also showcases the conceptual models for policy formulation and implementation.

Finally, Chapter 6 presents a summary covering the study’s results and analysis, conclusion, implications, recommendations and limitations.

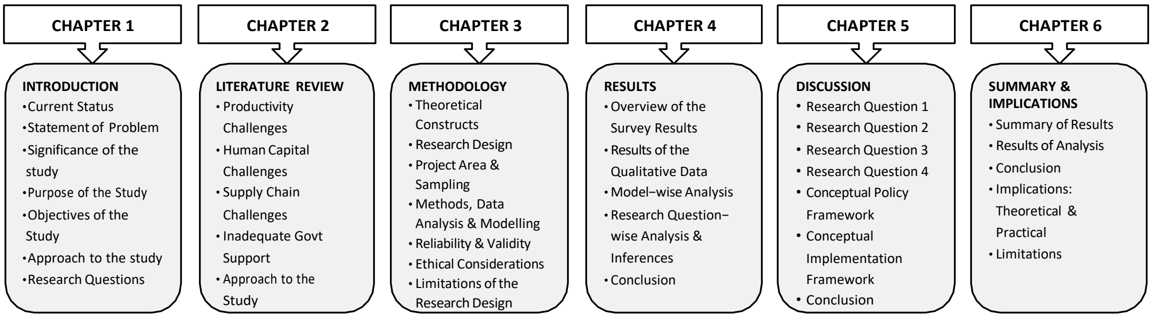


Figure 1
The organisation of the study

CHAPTER II:

LITERATURE REVIEW

2.1 Introduction

Although the government claims to have been extending all support to the handlooms sector with various schemes; however, the Indian handloom sector is in a deep crisis at cataclysmic proportions.

The sector suffers from several inadequacies such as a lack of distribution system for raw materials and marketing, low wages and income, a threat from the mill sector, resulting in increased suicides of artisans, a mass exodus from the industry in search of other livelihood options and many other adverse developments (Craft Council, 2011).

This chapter provides an overview of the existing literature relevant to this paper. The literature review is discussed under five major categories; Production and Productivity Challenges, Human Capital Challenges, Supply Chain Challenges, Inadequate government support and policy, and Approach to the Study.

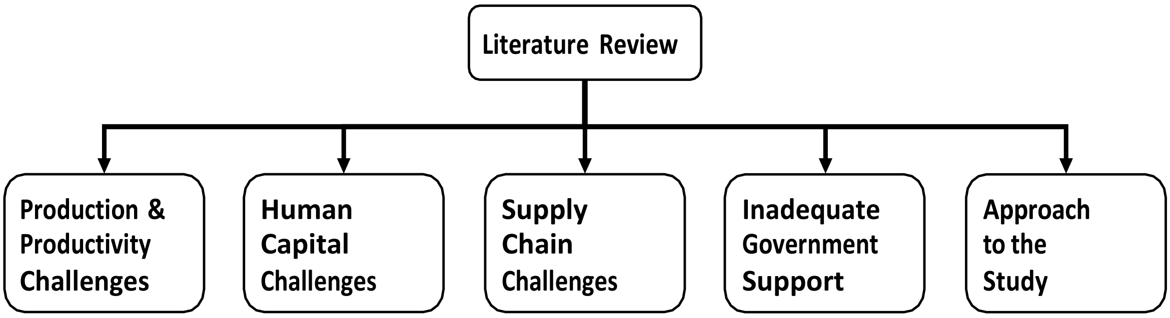


Figure 2
Scheme of Literature Review

2.2 Production and Productivity Challenges

Productivity is reckoned as a major cause of economic growth and competitiveness. It includes both production and efficiency. The act of manufacturing or creating outputs, such as goods or services, is called production. 'Production is the process of creating, growing, manufacturing, or improving goods and services. It also refers to the quantity produced’ (Kotler *et al.*, 2006). The efficient conversion of a given level of inputs, such as labour, capital, and raw materials, into a volume of outputs, is regarded as productivity.

Gordon *et al*. (2015) state ‘Productivity is the measure of production efficiency. At a national level, it captures the economy’s ability to harness its physical and human resources to generate output and income’. Productive efficiency, when the growth of outputs outpaces the existing inputs, leads to more productivity growth. It implies that using the inputs more efficiently results in more productivity.

‘Productivity growth refers to an increase in the value of outputs produced for a given level of inputs, over a given period of time’ (Gordon *et al*., 2015). Therefore, productivity growth suggests an increase in the value of outputs produced for a given level of inputs.

The factors of production are inputs, and their quality and quantum determine the quality of finished goods or outputs. The major determinants of long-term productivity growth include investment, innovation, skills, enterprise and competition (Office for National Statistics, UK).

2.2.1 Decentralised Informal Sector

Business success depends heavily on the organisational structure. An appropriate organisational structure provides a congenial work ecosystem for continuous work, and information flow.

The handloom industry in India is decentralised, unorganised, informal, and rural-based (Hazarika *et al*., 2016; Bortamuly & Goswami, 2015; Bortamuly *et al*., 2014; Bhagavatula *et al*., 2010). The chief manifestations of the unorganised sector are subdued production and poor productivity because of a lack of apt organisational structure and management.

Blunch *et al*. 2001 emphasise the need for an improved understanding of the problems of the informal sector to find solutions to address the workforce’s needs engaged in the handloom sector (Blunch *et al*., 2001). The handloom sector regularly faces challenges as an unorganised sector run by an unorganised workforce, therefore, to overcome such challenges, a deep understanding is needed.

Patil (2012) says that the handloom sector is suffering from many inadequacies because of its informal nature, such as an unorganised and decentralised production system, low and slow output, scarce working capital, limited product range, imitation products from powerlooms, and lack of marketing. All such pitfalls eventually cause low productivity and low sales.

Traders and intermediaries intentionally induce informality to gain business in their favour. Further, informality is a barrier to the flow of knowledge, information, and market trends (Beddig, 2008). In the absence of regulations and controls in an informal setting, the intermediaries and other organised sector enterprises find this as an opportunity to exploit the weavers.

Goswami and Jain (2014) have enlisted various problems that the handloom sector faces, including low sales, lack of scientific market research, insufficient budget, and inadequate infrastructure. Such challenges need apt strategies to tackle, such as overall cost leadership, product differentiation, and others, for improving business gains.

Khatoon (2016) analysed and enumerated a slew of challenges affecting the handloom sector. They include shortage and the high price of yarn and other raw materials, scarcity of quality dyes, less credit availability, lack of market facilities and design support, and an uncongenial work environment. Raw materials scarcity adversely impacts businesses and the handloom activity is further exacerbated by a lack of market and new product range.

Goswami and Jain (2014), Hariharan and Benjamin (1991), and Lubell (1991) opined that the handloom sector in India is a classic example of the informal sector entailed all complexities and inadequacies such as low levels of wages, investment, technology adoption, and many other parameters. The heterogeneous nature and the intricacies of attributes of the informal sector have a lasting effect on the handloom sector.

Charulate and Rajani Gupte (2015) observe that the informal handloom sector has many challenges such as low wages, lack of social security and poor working conditions, lack of investment and lack of infrastructures such as work sheds, and storage facilities for keeping raw materials and finished goods. In addition, Blunch *et al*. 2001) have noticed, insufficient transport and packaging facilities. These observations reveal the implications of informality which increasingly limit the growth prospects of the handloom industry.

The informal handloom sector is ensnared in myriad complex issues and inflicted with several inadequacies such as a lack of proper infrastructures, low wages, lack of market and dominance of intermediaries, among many other challenges and all such inconsistencies undermine productivity.

2.2.2 Low Income and Low Wages

The handloom industry is embroiled with inadequate wages and nonremunerative prices for handloom products. As a result, the collective income of an entire family is not even sufficient for sustenance. Further, it precludes them from meeting their basic needs and leaves them in abject poverty.

Lack of sufficient income and unending poverty have led many artisans to move away from the weaving activity. These critical factors dissuade artisans from continuing the profession (Annapurna *et al.*, 2012). Furthermore, ever-rising raw material prices and consequent production cost rise, competition from the mill and powerloom sector, and eroding social status have further distressed the industry (Planning Commission, 2012).

UNIDO (2008) has conducted a diagnostic study in a weaver's cluster in West Bengal State and identified two intertwined problems; insufficient competitiveness and poverty. In addition, UNIDO's study noticed a culture of scepticism and fear among weavers towards adopting technology and modern management techniques. Lack of education and empowerment weakens the psyche of the artisans and increases vulnerability.

Handloom Census (2019) discloses that about 67.1 per cent of handloom weavers are earning less than USD 67 a month ($2.2 per day), which is less than the mandatory minimum wage prescribed for semi-skilled labourers by the government, and 26.2 per cent earn between USD 68 to 136.

With the reduced income earnings, the overall economic situation of the handloom weavers has further deteriorated since the Handloom Census (2009-10), thus making weaving an unsustainable economic activity (Amit and Nehal, 2020).

The inadequate and nonremunerative wages led to the impoverishment of the artisans and further eroded their social status.

2.2.3 Declining Numbers

The Indian handloom sector is rapidly shrinking, as disclosed by the Handloom Census (2019), and the number of weavers has been declining compared to the 1970-71, 2009-10 and 1995-96 censuses. The numbers decreased by 19 per cent to 3.5 million in 2019-20 from 4.3 million in 2009-10. In comparison, the weaver population stood at 6.5 million in 1995-96, 6.7 million in 1987-88 and 12.4 million in 1970-71. Beddig, 2008 suggests ensuring sustainability and remunerative prices for their products would stop the migration of weavers.

The primary reasons for the declining population of weavers could be cheap machine-made fabrics, low wages, or unfair prices in the handloom sector. Preventing artisans from shunning and giving up the craft and migrating in search of alternative livelihoods is a critical challenge and needs immediate attention.

2.2.4 Demotivated Youth

Handloom art survived for thousands of years in India and has been passed over through generations. However, younger generations of less than 35 years are deterred from continuing the tradition. Instead, they opt for alternate employment because of the uncertainty of the handloom sector, lack of income and dignity of labour. As a result, youth from weaving families are increasingly dissuaded from enduring their family traditions, and this has led to a steady fall in youths engaged in weaving from 26.13 lakh in 2009-10 to 16.07 lakh in 2019-20 (Handloom Census, 2019).

Alexandra Soteriou (1998 cited in Kapur and Mittar, 2014) reveals that weavers are trained on the art forms practised and perfected by their ancestors as a legacy with pride, but not just for the sake of making a product.

However, Kasturi (2005) argues that weavers derive pride in their work and creativity if they are rewarded with recognition, remuneration, and status, and then they would encourage their kin to continue the profession. Moreover, the Handloom Census (2009-10) discloses that in response to a question as part of the census survey, only 23 per cent of the weavers wanted their children to continue the tradition and profession.

The degraded social status of the weavers in society and a disconnect between the importance of traditional crafts and the school curriculum are other reasons for the youth not continuing the family tradition (Annapurna *et al.*, 2012). Being a witness to the struggle and misery undergone by their parents and feeling stunted in the industry, children naturally opt for better opportunities.

2.2.5 Lack of Investment

Investment is one of the critical factors of production. Investment in human capital, physical capital, such as machinery, equipment, and other infrastructure, and technology acquisition plays a vital role in the production process.

Individual knowledge-based competencies, such as education, skill, and knowledge, form part of human capital and call for investment (Gordon et al., 2015). Gaining and

managing knowledge enables manufacturers to produce more efficiently,
called disembodied and invisible technology.

The 12th Plan Steering Committee Report has highlighted the gaps in infrastructure and the need for adopting modern technology. The report reveals that the clusters of handlooms production are devoid of clean drinking water, sanitation, effluent treatment plants, and electricity (Planning Commission, 2012). Social infrastructure enhances the quality of the work environment. The adoption of technologies, more than any other inputs, facilitates business expansion. While acquiring capital inputs, such as machinery, computers make up capital-embodied technology.

The study by UNIDO observed that among the artisans, the fear of losing their livelihood and income is prevalent if they attempt to innovate and change, which rendered weavers obsolete and unable to keep pace with market demands (UNIDO 2008). In addition, Reddy (2010) says that handloom artisans still follow their traditional systems and practices and have not yet integrated modern business and production principles into handloom activity.

Scrase (2003) suggests that modernising local arts leads to changes in the product and the community's socio-cultural fabric. The author further informed that over 0.4 million artisan jobs in weaving and allied activities in Indonesia were lost when the traditional textile industry was modernised into large-scale manufacturing enterprises (Scrase, 2003).

In contrast, Colloredo-Mansfeld *et al*. (2003) observed the revival of traditional textile activity after modernisation by opening new markets and offering multiple opportunities in Otavalo, Ecuador.

The analysis of Jain and Goswami (2011) pinpoints the usage of age-old infrastructure by weavers, where productivity is very low. Given this, production at scale is not attainable and meeting the exacting market demand in terms of quantity, diverse designs and patterns is also allusive.

Globalisation has unveiled fierce competition in the textile sector with an influx of cheap imports; weavers, unaware of the trend and incursion of mill-made cloth that debilitated the weavers' competitiveness, are now entrapped in a severe livelihood crisis (Khateeb *et al.*, 2012).

Using obsolete technology causes low productivity in the handloom activity, due to which artisans cannot achieve economies of scale and adhere to the delivery schedules. As a result, India's global share of handlooms is relatively low, owing to its low productivity (Ghouse, 2012).

Hazarika *et al*. (2016) identify that technological up-gradation in the handloom sector plays a significant role in augmenting business competitiveness. Governments should ensure a policy framework for easy access to credit or capital, market linkages, and technology.

Jain and Yadav (2017) stressed the need to adopt modern technology for smart business returns such as ICT-enabled services. However, Shilpi Jain *et al*. (2018) explain the difficulties and challenges of adopting ICT in India's handloom sector; particularly, the low level of education and social empowerment of weavers restrains them from adopting ICT.

Jain and Yadav (2017) highlighted the need for technology adoption for improved marketing and presence. They add further that the marketing strategy, modern technology and communication tools need to be integrated to achieve business optimisation.

Kalyani (2014) argues that adopting modern technology can envisage improved productivity and better quality. Product diversification driven by technology and design interventions is essential for better marketability, and it caters to diverse segments of consumers across the globe to fetch ultimate business performance.

Kalyani (2014) further suggests that employing different techniques such as applique work draws the attention of middle-class customers, while heavy embroideries with rich handwork products attract high-income group consumers.

Therefore, to harness the potential of the handloom industry, the proper infrastructure with sophistication shall be in place. Exploiting technology and modernity would foster the industry and change the fortunes of the weavers for the best.

Though over 28.2 lakhs of traditional looms are available, their productivity remains low. Hence, modernising the looms is essential for enhancing weavers' overall productivity and achieving zero-defect weaving.

2.2.6 Competition from Powerlooms

Due to inconsistent and fragmented government policies, the powerloom sector has attained monumental proportions, and their share is over 70 per cent in textiles production and supplies.

Naga Raju *et al*. (2014) have confirmed that the competitiveness of handloom sectors is frail because of many inherent challenges, and handlooms can never match the robust powerloom and mill sectors.

Fierce competition with powerlooms and mills severely threatens handlooms (M. Lakshmi Narasaiah, 2004). Currently, powerlooms enjoy unstinted support and patronage from the government, enjoying many sops such as different subsidies and other investments.

Sanjay Sharma *et al.* (2021) observe that the handlooms sector is facing a serious threat from the powerloom sector. The Sivaraman Committee, formed in 1974, underscored the lukewarm government support for the handloom sector and further added that the product reservation originally meant for the handlooms had, in reality, benefitted the powerloom sector. The committee also disclosed that the powerlooms recorded an unprecedented growth rate of 21.94 per cent between 1963 and 1974, and each powerloom established rendered six handlooms inactive. Moreover, every job created in the powerloom sector removed 14 jobs from the handloom sector (Niranjana and Vinayan, 2001).

The study carried out by NIPFP (1992) reported the mushrooming growth of small powerloom units and further disclosed that ‘hank’ yarn diversion to the powerloom sector was substantial and was between 21-53 per cent of the total ‘hank’ yarn (National Institute of Public Finance and Policy,1992).

Satyam Committee (1999) reported that 39 per cent of ‘hank’ yarn produced in the country was in reality used by the powerloom sector (Niranjana and Vinayan, 2001).

Van Engen *et al. (2019)* have disclosed that the country’s unprecedented growth of powerloom units was driven by decades of poorly implemented policies. They further opined that the sectoral contribution of handlooms to the economy could not be estimated objectively.

The threat from powerlooms can be obliterated if the handloom sector comes up with contemporary and unique designs and also high-end niche products catering to different markets globally and tourists, supported by strong government policy and implementation framework.

2.2.7 Knowledge Management Challenges

Organisational knowledge and innovation are significant drivers of productivity growth at the organisation level.

The narratives and findings of some authors and researchers about the need and influence of Knowledge Management are discussed here.

‘Knowledge is power’, as said by Francis Bacon, published in his work, Meditationes Sacrae (1597); organisations can thrive on extensive knowledge and information and gain power when they keep an efficient Knowledge Management System in place. The knowledge management process involves collecting, aggregating, analysing the data and knowledge, and communicating the processed information.

Peter Drucker (1999) views knowledge management as ‘the coordination and exploitation of organisational knowledge resources, in order to create benefit and competitive advantage’. He further elaborates that Knowledge Management is ‘the conscious process of defining, structuring, retaining and sharing the knowledge and experience of employees within an organisation’.

Powell and Snellman (2004) posit that if organisations aspire to become competitive, the key is knowledge acquisition, processing, and optimal utilisation. In a dynamic business environment, being competitive and sustaining a comparative advantage over their rivals is a critical challenge.

Daniel *et al.* (2018) suggest that organisations need to gain up-to-date knowledge to optimise business success in today’s fast-changing business environment. The knowledge inventory and other information resources must be aligned with the business goals and further analysed to draw inferences to take business decisions.

Jelena Rašula *et al.* (2012) empirically tested the impact of knowledge management practices on business performance and showed that organisations could augment their performance by collecting and managing knowledge.

Gonzalez and Martins (2014) have expressed that organisational knowledge is intangible; however, it is regarded as an invaluable asset and imparts a competitive advantage to the organisation. According to Olubunmi (2015), knowledge management is a key driver of organisational performance.

Shruti and Das (2019) argue that accruing knowledge and management are essential to business success to gain an advantage and position with a reasonable market share in the handloom sector. They further add that efficient knowledge management facilitates organisations to overcome fierce competition, uncertainty in the business environment, advances in Industry 4.0, and many other challenges.

In their study, Upadhyay and Kundu (2020) have established a relationship between Knowledge Management practices and business sustainability in the handloom sector. They further believe that an effective Knowledge Management mechanism helps revive handloom enterprises through an effective means of knowledge assimilation and dissemination.

Small-scale handloom enterprises are often constrained in accessing information, knowledge and other resources and cannot secure the advantages of systematic Knowledge Management practices to refine their business procedures. Therefore, knowledge management applications are essential for reviving organisational viability and existence and further enhancing competitiveness and profitability.

2.2.8 Lack of Awareness

Embedding Knowledge Management practices into organisations solely depends upon the awareness levels and ability of the artisans to access and assimilate the information and knowledge. In addition, good communication among artisans mediates identifying opportunities and resource mobilisation.

Bhagavatula *et al.* (2010) observe that the awareness primarily banks on the strengths of weavers' social and human capital, and lack of awareness leads to the inability to recognise opportunities and mobilise resources.

Maureen and Roy (2003) acknowledge that 'vastly asymmetric information and asymmetric capabilities between the artisan and the market operators' are crucial in the handloom sector.

Business success depends on market information, and weavers are predominantly subject to information asymmetries. Information failure or asymmetry sets an imbalance in business transactions, hinders market access, causes adverse changes in business volumes, and eventually results in market failure.

2.3 Human Capital Challenges

Human Capital is an acquired intangible asset that encompasses qualities or abilities such as education, knowledge, training, skill, health, and other attributes. Investment in these attributes enables people to contribute to economic development (Goldin, 2014).

The Human Capital of the workforce in the handloom sector has many gaps and deficiencies. However, the gross neglect of investment in Human Capital has a devastating effect on the lives of the artisans and reverberates throughout their lifespan while limiting their abilities.

The literature on some of these attributes of human capital is discussed here.

2.3.1 Low Education

Bari *et al*. (2015), while explaining the socioeconomic status of the handloom weavers, have summarised that lack of proper education is one of the root causes of their backwardness.

The poor educational attainment among the weavers is a critical factor for their social and economic backwardness. About 23.2 per cent of weavers have never attended school, and a further 32 per cent are below the primary level. Only 3.6 per cent are undergraduates or above (Handloom Census, 2019).

Low educational levels limit their ability to understand and comprehend the intricacies of business management, such as inventory management, access to markets, financial institutions, and information about government schemes (Handloom Census, 2019). Weaving is a family occupation; all the family members, including women and children, are engaged in one or other activity in weaving and processing, which naturally leads to little or no schooling, particularly for the young, especially women.

2.3.2 Inadequate Training and Skill Development

Training is a method of increasing an individual's skills, knowledge, abilities, and attitudes in an organised way.

According to Edwin Flippo 'training is the act of increasing the skills of an employee for doing a particular job'. While Dale S. Beach (1980) defines training as 'the organized procedure by which people learn knowledge and/or skill for a definite purpose' (cited in Gowsalya and Asma, 2017)

According to the Handloom Census (2019), around 52 per cent of handloom weaver households needed training in marketing, packaging, market information and export procedures. However, only sporadic efforts are made for training, design innovations, and other activities. As a result, the success experienced by the artisans has been limited, and the real benefits to the artisans are still elusive.

During their empirical study, Sangeeta *et al.* (2010) noticed a substantial gain in knowledge, change in attitude and skill after undergoing training on handloom weaving and value addition.

Lack of opportunities for formal training and lack of the financial resources to upgrade the technology are major impediments for weavers to achieve economies of scale and quality (Craft Council, 2011). Curriculum related to the handloom sector encompassing its rich cultural heritage, artistry, economic importance and past glory has never been incorporated into the education curriculum at any level in India.

Hazarika *et al.* (2016) believe that institutional training plays a key role in shaping the fortunes of women entrepreneurs to achieve improved earnings. Hazarika et al. (2016) also showed that access to institutional training, educational fulfilment, learning bookkeeping practices, risk aversion attitude, enrolling with SHGs, and employing modern weaving techniques have broader positive implications and influence the income of the micro-entrepreneurs. Moreover, the current practices are labour-intensive and archaic, needing the sophistication to remove drudgery and instil precision (Craft Council, 2011).

Skilling and upskilling artisans all along the value chain are paramount for the positive transformation of the industry; however, the facilities for systematic training in the handloom sector are scarce.

2.3.3 Poor Health Status

The work environment around the weavers is unhealthy, and artisans often work far too long in toxic environments and are exposed to dangerous chemicals, noise, and other hazards.

The study by Sarkar (2016) discloses that weavers suffer from various health ailments, such as back pain, neck pain, foot pain, and joint pain, because of poor ergonomic design in the workplace.

Priyanka Koiri (2020) studied the determinants of occupational health issues among the artisans and allied workers involved in the handloom sector and she demonstrates that about 80 per cent of the workforce in the handloom sector is suffering from health issues in one form or another.

The study further reveals that over 50 per cent of artisans have musculoskeletal disorders because of postural strain, years of stay in the occupation and long working hours. The study further underpins the need to improve the work environment with ergonomic designs to avoid physical injuries (Priyanka Koiri, 2020).

Occupational health implies the workforce’s physical, mental, and social well-being in all occupations (WHO). Occupational health is a preventive and multidisciplinary healthcare system to deal with all aspects of well-being, health, and safety at the workplace. Hence, efforts are needed to improve the workplace ecosystem of artisans.

2.3.4 Women and Gender Disparity

The handloom sector has long been a traditional occupation for women in India and contributes to substantial employment opportunities for rural women providing means of livelihood. However, gender marginalisation has been a common phenomenon in the handloom industry, and women's contribution has never been recognised and rewarded sufficiently.

Women play a more significant role in Indian handloom activity, and the industry engages around 2.54 million (25.46 lakh) women. Women account for about 72.3 per cent of the total workforce (Handloom Census, 2019). However, women and ethnic minorities, besides being inflicted by poverty, also suffer from a lack of education and health. In addition, they do not have any role to play in decision-making, even within the family (UNIDO-Case study 2008).

Alin Borah *et al*. (2014) have observed that many women are associated with handloom micro-enterprises in Assam with low income; however, information about the income gap among self-employed or smaller entrepreneurs is scarce.

Ramanthan *et al*. (2016) inform that the extensive presence of women in the handlooms sector is mainly because of labour-intensive production processes. The empirical evidence shows that women's labour is cheaper than men's, and women will not be rewarded separately when they work as part of a family endeavour.

Despite the more extensive participation of women, their socioeconomic conditions are fragile, with no recognition or reward for their contribution, primarily because of a lack of independence and education (FICCI, 2019).

The gender income gap in wage employment in the Indian handloom industry has been well-established. India Wage Report (ILO, 2018) shows the prevalence of gender-based wage disparity in India. Women workers earning low wages compared to male workers remains a serious challenge to achieving inclusive growth.

In their study, Mishra *et al*. (2021) and Hazariaka (2017) noticed that the average earning of women handloom entrepreneurs is 51 per cent lesser than male entrepreneurs and further observed an increase in the gender income gap with increased income distribution. In addition, they also observed that poor managerial practices have further widened the income gap throughout the income distribution.

Hazarika *et al.* (2016) show that strong social capital through Self-Help Groups (SHGs) has become an excellent source of microcredit for women entrepreneurs who otherwise cannot access institutional credit. Moreover, women entrepreneurs and individuals who get financial assistance from SHGs earn more than those not in the SHG fold. Hazarika *et al.* (2016) further believe that SHG membership infuses confidence to access credit in an informal setting and helps them expand their business, including technology adoption.

In a study conducted in Mubarakpur town of Uttar Pradesh, Tasneem and Munir (2014) found that many women were forced to work in the handloom sector because of poor economic conditions, unemployment, low literacy and low education and large family size.

Baishya (2019), in her empirical study organised in Assam, has found that the lack of credit for women weavers makes them helpless and economically vulnerable. However, microfinance accessed through SHGs in the lower Brahmaputra valley has become a boon to the rural women weavers and enabled them to procure raw materials and earn substantial profits.

Women suffer from secondary status in society and are quite vulnerable to changes in the dynamic world. Because of many socioeconomic and cultural factors, women have been relegated to the second spot in the social hierarchy (Raju, 2014).

Women's capacity development is a crucial facet of any development paradigm. However, Ramanathan *et al*. (2016) have observed that efforts to empower female weavers to understand their problems and prospects are relatively scarce.

Therefore, the glaring gender discrimination is because of a lack of opportunities for education and skill building and compelling societal norms; however, microcredit through SHGs is found encouraging in some areas and hence needs emphasis.

2.3.5 Risk Aversion Attitude

Various categories of risks and uncertainty associated with financial activities and decisions are termed financial risks. Therefore, attitude and responsiveness toward risk are critical predictors of business success (Earle and Sakova, 2000).

The entrepreneurial and financial risks often entail market fluctuations and insufficient resources and are further intensified by the absence of financial literacy and domain knowledge. In addition, lack of access to business intelligence and incompetence to gauge and understand the markets also adds to the associated costs and limitations (Evers and Mehmet, 1994).

In the handloom industry, the financial risk of weavers is involved in investment in raw materials and modern machinery for amplified efficiency of diverse handloom activities (Hazarika *et al*., 2016; Bortamuly and Goswami, 2015).

Financial risk aversion attitude is also a significant determinant and affects handloom activity, particularly among the micro-entrepreneurs in the handloom industry. Female entrepreneurs show more risk aversion than their male counterparts (Goswami, *et al.,* 2017). Success depends on the smartness of the entrepreneur to convert the associated risks into opportunities (Blunch *et al*., 2001).

Literature also suggests that various socioeconomic and personal factors, such as age, gender, occupation, marital status, and income, influence entrepreneurs to take financial risks (Adhikary *et al*., 2011).

2.4 Supply Chain Challenges

The handloom sector suffers from supply chain issues such as the non-availability of quality and adequate raw materials at reasonable prices and lack of product development, designing, branding, marketing and promotional activities. In addition, the dominance of middlemen, traders and powerlooms is also a major detrimental factor for supply chain disruptions.

The supply chain comprises all the activities, people, organisations, information, and resources required from raw materials aggregation to the stage of finished goods reaching the customers. Keith Oliver (1982, cited in Cooper *et al.*,1997) introduced the concept of Supply Chain Management and defined:

> Supply Chain Management (SCM) is a process of Planning, Implementing, and Controlling the Operations of the supply chain with the purpose to satisfy customer requirements as efficiently as possible. Supply chain management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption.

The supply chain in the handloom industry encompasses a series of procedures, suppliers, master weavers, mediators, societies, apex cooperatives and customers; knowledge and product flow are central to the entire flow of goods and services (Kaya, Ö., 2014).

The handloom industry faces several challenges in the supply chain activities, such as inventory management, partnerships, visibility, lead time, technology and logistics (Giri and Shankar, 2013).

Kalyani *et al*. (2017) suggest reinforcing the supply chain's activities by eliminating middlemen, forging market links and supporting designs to make weaving a viable business proposition and protect the weavers' livelihoods.

The adverse impact experienced by the individual weaver is comparatively less severe than that of master weavers and cooperatives. This is because an independent weaver has to fetch all the raw materials for himself, and the steps involved in the supply chain are also limited. However, with cooperatives and master weavers, the impact of disruption would manifest predominantly and hamper the entire production process (Anumala, 2021).

2.4.1 Absence of Supply Chain Management (SCM) Practices

Supply chain activities and effective management have been increasingly gaining relevance and are recognised as important determinants for business gains, particularly in the manufacturing sector.

Christopher and Peck (1992) define supply chain management as 'A network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer'.

SCM practices improve the understanding of the complex nature of diverse operations in a supply chain, and their integration subtly leads to the effective delivery of products, services and information that eventually add value for customers (Cooper *et al*., 1997). Supply Chain Management (SCM) practices include a set of actions started by organisations to promote effective management of their supply chain activities.

The findings of Agus (2015) suggest that suitable SCM practices improve the quality of the products and production performance, besides positively affecting the overall efficiency of the organisational performance.

The results of an empirical study conducted by Arawati (2011) disclose that supply chain management has significant relations with supply chain flexibility, quick reflexes to the changing external environment, and business performance. The results also prove that the adoption of technology and innovation in the production process is closely associated with SCM practices.

The study carried out by Arawati *et al.* (2008) reveals that establishing Strategic Supplier Partnership (SSP) as part of SCM practices enhances product quality and business outcomes.

Inda Sukati *et al*. (2012) find that supply chain management practices have a significant relationship with supply chain performance. Better coordination and long-term relationship with suppliers create value and improve performance.

Zahra Lotfi *et al.* (2013) have found that information sharing in Supply Chain Management has increased the efficacy of organisations in the manufacturing sector.

Anumala (2021) has noticed the absence of Supply Chain Management (SCM) practices and disruptions in the supply chain activities in the handloom industry. She has shortlisted four distinctive sub-constructs for better understanding and measuring SCM practices, and they include Strategic Supplier Partnership (SSP), Customer Relationship (CR), Information Sharing (IS), and Information Quality (IQ).

Anumala (2021) has further established that SCM practices and production performance are interrelated. Therefore, SCM practices with better communication help overcome disruption in the supply chain and improve the production process in the handloom sector.

2.4.2 Raw Material Constraints

Short supply and continuous price rise of yarn are the major glitches in the handloom sector, despite India being a leading cotton producer with a global share of 23.6 per cent

(Exim Bank 2018). The sourcing of raw materials has become a perennial problem for the weaving community, particularly the individual weavers who struggle with procuring quality yarn and dyes. The scarcity and a phenomenal rise in yarn prices have added woes to the languishing handloom industry (Planning Commission, 2012).

In the traditional system, the exchange of goods and services existed between weavers and the rest of the village; and the weavers were enabled to access the community resources for finished cloth. However, of late, with the breakdown of this system, weavers found it challenging to procure the raw materials at an affordable price and were forced to buy from local traders at inflated prices (Planning Commission, 2012).

Niranjana and Vinayan (2001), in a study commissioned by the Planning Commission of India, argue that the de-linking of yarn production from cloth production by the government has brought about a devastating effect on the handloom industry. The cloth production figures are measured considering the yarn output in a country, based on a standard conversion principle.

Reddy (2010) strongly advocated that essential inputs like sufficient raw materials and working capital are mandatory for the long-term development of the handloom sector. The availability of Cotton yarn, the critical input for handlooms, is one of the significant constraints for the industry and hence, improved input levels determine the handloom industry’s growth potential (Reddy, 2010).

Goswami and Jain (2011) have narrated the challenges and issues of production, procurement, production, and distribution of yarn because of globalisation and technological advances.

The Hank Yarn Packing Notification of 1974 enjoins spinning mills to pack yarn in ‘hank’ (coiled) form in a proportion of not less than 50 per cent of total yarn packed by that mill. It was subsequently reduced to 40 per cent in 2003 notification (Ministry of Textile, GoI). Therefore, this notification is a statutory directive to ensure an adequate supply of 'hank' yarn at a reasonable price to the handloom industry.

The government established dedicated cooperative spinning mills to provide 'hank' yarn to the handloom industry. However, these arrangements were unserviceable, as most cooperative yarn mills were closed. Moreover, the 'hank' yarn produced by mills was largely diverted deceitfully to powerlooms (Niranjana and Vinayan, 2001).

Abid Hussain Committee (1989) observed that the 'hank' yarn supply to the handlooms was much less than the obligatory 40 per cent (GoI, 1990), and the statistics from GoI show it was always ranging between 22 to 24 per cent (cited in Mishra and Patnaik,1997).

Abid Hussain Committee (1989) further disclosed that about 64 per cent of the yarn produced in the 20s and 40s count was exported, ignoring the domestic requirement. Further, Noorbasha Abdul (1996) says that after economic liberalisation in 1991, the government intensified the export of yarn in a bid to earn more foreign exchange, disregarding the domestic handloom sectors' needs.

The organised sector uses most of the yarn produced by the mills. However, the 'hank' yarn produced by the mills meant for the handloom industry in compliance with the 'hank' yarn obligation notification is often diverted by the powerlooms in deceitful ways (NIPFP, 1992). Usually, the powerlooms use yarn in cones; however, they buy 'hank' yarn meant for handlooms to avoid taxes and convert 'hank' yarn into cones at minimum cost, creating a shortage for handlooms (NIPFP, 1992).

Weavers face difficulty procuring quality raw materials at an affordable price and cannot compete with powerlooms as their quantity requirement is low and their bargaining capacity is low. Therefore, weavers have to settle for low-quality raw materials. Eventually, the 'hank' yarn shortage leads to the demand-supply gap, and handloom weavers are forced to purchase yarn from private traders at higher prices. In contrast, powerlooms require a higher quantity of raw materials as they produce fabric faster than handlooms and the resultant margins are also higher. Therefore, they can offer higher prices for quality raw materials (Niranjana and Vinayan, 2001).

Access to affordable and quality yarn and other consumables by weavers is a big challenge. Weavers purchase about 76.6 per cent of yarn in the open market at exorbitant prices, and the balance is from cooperative societies and government yarn depots (Handloom Survey 2019-20). The rising input cost increases the price of finished goods and eventually enervates the profit margin and quality.

A study by Chalam (2001) reveals the lapses of the National Handloom Development Corporation (NHDC), a Government of India enterprise. NHDC is required to procure ‘hank’ yarn from mills under Hank Yarn Obligation (HYO) notification but often NHDC defaults to ensure compliance by the spinning mills and forces the weavers and master weavers to buy yarn in the open market or mills directly at exorbitant prices.

Chalam (2001) and Kalyani *et al*. (2017) further reveal that there is no institutionalised mechanism to control and monitor the prices of yarn, dyes, and other chemicals. Priyanka Singh (2012) reports frequent fluctuation in ‘hank’ yarn prices. An increase in yarn prices and an irregular supply of yarn led to the misery of the handloom sector (Kasisomayajula, 2012).

While explaining the reasons for the shortage of yarn, Kalyani *et al*. (2017) explain that yarn prices have also gone up in recent times due to a steep rise in cotton prices globally. In addition, improper delivery mechanism, defunct spinning mills in some States, and violation and non-fulfilment of the Hank Yarn obligation by the mill sector have further exacerbated the yarn availability.

Even though yarn prices are linked to raw cotton, the price fixation of cotton yarn is arbitrary and depends on the trader's discretion. In addition, the vagaries of monsoons and other supply chain issues also stifle the supply of cotton yarn price (IIFT, 2018).

2.4.3 Lack of Credit and Working Capital

Weavers suffer from a lack of adequate working capital. Inaccessibility to institutional finance is a significant constraint to the handloom sector. Hence, to fund their micro-entrepreneurial activities, the weavers often depend on other sources of finance, including their savings, family income, and other informal sources like money lenders (Hazarika *et al*., 2016).

As artisans lack fundamental awareness and even rudimentary financial literacy about financial institutions' operational formalities; as a result, they fail to access credit from banks (12th plan steering committee report, 2012). It is believed that weavers are mostly inclined to use credit for personal consumption needs. Commercial banks also decline loans as they feel weavers have no creditworthiness and divert the credit for other needs if sanctioned.

As a result, weavers are forced to explore alternative sources of financing and eventually approach private moneylenders, who charge a higher interest rate (UNIDO, 2008; Beddig, 2008). Eventually, the higher interest rates levied by private moneylenders increase the financial risk of weavers (Hazarika *et al*., 2016; Bhagavatula *et al.*, 2010).

Since the handloom sector is predominantly informal and decentralised, the traders, middlemen and master weavers always try to exploit the weavers. Besides providing all inputs to the artisans, they act as finance and social security providers in the absence of a systematic mechanism put in place by the Government and Banks, which eventually nudges the weavers into the clutches of the intermediaries and coerces them to depend eternally. Thus, the weavers lose bargaining power (Beddig, 2008).

Handloom Census (2019) reveals that only 23.3 per cent of the weavers have a bank account, and bank penetration in rural areas is just 20.8 per cent, but slightly higher at 41.8 per cent in urban areas. The census data also shows that credit accessibility by the artisans is a meagre 20 per cent, and the rest of the weavers are forced to depend on other sources.

Because of low creditworthiness and low repaying capacity, hardly 1.3 per cent of the weavers have availed credit from other sources. The cost of availing of credit is also exorbitant and likely to drive them into a debt trap (Handloom Census, 2019).

Impeded by the lack of finances, purchasing raw materials and meeting other incidentals are often delayed; therefore, adhering to the supply deadlines becomes challenging.

2.4.4 Dependence on Middlemen and Master Weavers

Low educational attainments impede the weavers from exploring various business success opportunities; instead, they rely on mediators to sell their products, including small traders and master weavers.

While explaining the woes of individual artisans under master weavers, Amit and Nehal (2020) inform that master weavers virtually dictate terms to the individual weavers, grab most of the profit and share little with weavers.

The centralised marketing cooperative societies, too, have failed to come to the rescue of weavers. Most cooperatives primarily suffer from twin challenges of mismanagement and lack of capital, which results in delayed payments to the weavers and concomitantly hampers the production cycle (Planning Commission, 2012).

2.4.5 Absence of Design Interventions

Continuous reinventing and innovative product design are mandatory for keeping the demand alive for the economic sustainability of weaving activity, but this is the biggest challenge of any business.

Ranjan, M.P. (1998) says:

> Design is a complex activity that is influenced by a large number of factors that may be financial, technological, socio-cultural and historical and most of all by the changing perceptions and needs of human user groups and their social actions.

Unfortunately, India's handloom sector lacks such resources for design interventions to enrich design vocabulary with modern design sensibilities to sustainably reach a diverse audience.

Devising innovative designs is a multidisciplinary activity, if successful, brings about far-reaching implications and offers strategic and holistic solutions to the Indian Handloom industry for augmenting competitiveness nationally and globally (Marzia & Beatrice, 2014).

In India, the weavers and designers used to maintain a mutual relationship and bring forth new designs, amalgamating the old and new trends (Sanjeev & Nandini, 2011); however, currently, this interface is shattered over time.

Kapur and Mittar (2014) advocate that design intervention helps produce more new designs and products that revitalise the disintegrating crafts, improve the artisans' livelihoods, and transform the economy into an innovation-driven country.

According to Reubens (2010) design innovation needs to be linked to cultural, economic, ecological and social tenets for achieving sustainability. Therefore, a collaboration between a designer and a craftsperson facilitates innovation and broadens the range of handloom products with new designs that can capture current markets.

Kasturi (2005) enunciates that adopting modern technology and tuning to new contemporary designs is welcome. However, the craftsperson is not involved, nor is his point of view considered in all such propositions; thus, artisans are excluded from technology and design interventions.

An opposite view is, however, held by Mamidipudi and Bijker (2018). They reveal that the commonly perceived view of handloom craft being obsolete, premodern and unsustainable is disproved by Uppada weavers. The weavers demonstrated successfully with ‘Jamdani’, a new labour-intensive and sophisticated technique innovated by the weavers in Uppada of Andhra Pradesh to counter the steep hike in ‘hank’ yarn price.

The authors called it socio-technology and argued that artisans continuously innovate new methods, designs, and techniques without calling them innovation. Therefore, the success of ‘Jamdani’ owes to the creativity of artisans, and with no technology adoption. Thus, the assumption that efficiency comes from mechanisation and adopting technology is contradicted (Mamidipudi and Bijker, 2018).

Amartya Sen (1999) says that the artisans have never been sensitised and empowered to take decisions on their own to mould their future decisively and help each other but remained passive beneficiaries of the decisions of the top-down approach.

Amartya Sen (1999), while emphasising the need for the empowerment of artisans, further argues:

> An adequate approach of development cannot really be so centred only on those in power. The reach has to be broader, and the need for popular participation is not just sanctimonious rubbish. Indeed, the idea of development cannot be dissociated from it.

Kasturi (2005) apprises that the assumption that ‘Good design is good business’ fails to positively affect the artisans’ living standards. Kasturi (2005) concludes that artisans need design support from experts, which is not exploitative and unfair; the designers, governments and training institutions shall consider ‘Design’ as a powerful tool and ensure equality as the key ingredient.

The handloom sector has limited training resources functioning with a vision and long-term strategy and has a dearth of qualified trainers. Therefore, the craft training centres must be modern and on par with corporate offices to provide a congenial learning environment to enthuse the artisans to get empowered, prepare them to face challenges, and shape their destinies (Kasturi, 2005).

2.4.6 Absence of Marketing Strategy

An appropriate marketing strategy is central to achieving business objectives. The lack of a systematic and integrated marketing plan in the handloom sector resulted in less positive sales outcomes with low customer volume. Weavers mainly depend on local consumption, as the Handloom Census (2019) shows that over 64 per cent of the sales happen in the local markets. The inability of weavers to adopt newer marketing techniques, including new marketing tools, apt strategies and digital platforms to suit the needs of the contemporary marketing world, worsened the sufferings of weavers.

'Marketing aims to know and understand the customer so well the product or service fits him and sells itself", Peter Drucker. To achieve this objective, the entrepreneur needs to create, build and maintain a healthy relationship with the customers for the best possible customer satisfaction. Marketing is a process that involves all the activities such as research, designing, pricing, promotion, transportation and distribution to increase sales and profit.

'Sales' is the most extensive business function and remains a challenge to the weavers in the absence of a proper marketing strategy. Weavers sell about 64.1per cent of their products in the local market and 17.6 per cent to the master weavers, from whom they have already received some support, either raw material or finance.

Sales through cooperative bodies account for 8.8 per cent, one per cent in fairs and exhibitions, and the remaining 0.2 per cent happens through e-Commerce portals. Exports account for just 0.4 per cent, while other sources represent 8 per cent of the sales (Handloom Census, 2019).

Craft Council (2011) mentions that both crisis and opportunities coexist. The handloom sector should innovate new marketing strategies to tide over the competition in domestic and overseas markets. To derive benefit from current opportunities, the government must focus on market research, intellectual property rights, branding, merchandising, and entrepreneurial expertise (Craft Council, 2011).

Madhuri and Tejaswini (2012) describe that marketing in the handloom sector is quite feeble, and usually, traders and middlemen manipulate the marketing to their benefit.

Crafts production happens in a scattered way in rural areas, and there is no system of aggregation, quality checks or storehouses for preservation. The middlemen and traders take advantage of this situation and buy craft products directly from the weavers at a lower price and, in turn, sell them at higher prices in bigger markets in urban areas (Mamidipudi and Bijker, 2018).

Since there is no systematic market created for handloom products, artisans' vulnerability to market fluctuations and exploitation by intermediaries increases.

2.4.7 Poor Managerial Resources

Good management practices will have a positive and meaningful impact on business success. However, due to a lack of managerial resources and skills, weavers mostly depend on middlemen, small traders and master weavers for business needs, including credit, raw materials and sales.

Khateeb and Vadakepat (2012) posit that the ailing handloom industry shall pursue strategic marketing approaches to reach global customers before machine-made crafts fully replace them.

2.4.8 Delays in Delivery Schedules

Unable to adhere to delivery deadlines is a major problem in the Indian handloom industry. Indian Institute of Foreign Trade (2018) observes that inordinate delays in meeting delivery deadlines result in loss of business. For example, India's delivery and lead time to the USA are much higher at about 85 to 100 days; however, it is about 70 to 80 days for Europe, while China delivers in just 60 days to the same countries (IIFT, 2018).

Khateeb and Vadakepat (2012) organised a market threat analysis in Kerala, India, to find the marketability constraints of handlooms. The study discloses that response delays by those units will no longer be in competition, and those firms seeking handlooms will then meet their requirement with imported products without waiting for the domestic handlooms.

2.4.9 Lack of Price Realisation and Negotiation skills

Reddy (2010) articulates that arriving at a unit value of the product is a critical issue based on many pre-production and post-production factors. Without a unit value fixed on rational principles, the possible integration of handloom growth plans with modern marketing tools and techniques remains challenging.

The traders have absolute control over the handlooms market, and weavers do not have any say except to surrender meekly to the price offered by the trader or intermediaries. The empowerment of weavers also imparts strong bargaining power to deal with traders to realise viable prices and nullify information asymmetries. (Craft Council, 2011). Hence, empowering artisans with negotiation skills to boost their confidence levels assumes high significance.

The handloom sector is predominantly informal and decentralised. Traders, mediators and master weavers, besides providing all inputs to the artisans, also act as finance and social security providers in the absence of a systematic mechanism put in place by the Government and Banks. This overdependence nudges the weavers into the intermediaries' clutches and coerces them to depend eternally and lose their bargaining power (Beddig, 2008).

Singh *et al.* (2015) have proposed a fifth barrier, 'Social Market Separation', that separates producers and customers and hinders market development at the bottom of the pyramid. This ‘Social Market Separation’ is in addition to the four barriers earlier suggested by Bartels’ (1968) theory of market separations, including Spatial, Economic, Temporal and Informational.

The empirical study of Singh *et al.* (2015) reveals that most handloom weavers are poor and vulnerable and occupy the bottom of the wealth pyramid. Moreover, the social customs and repressive cultural practices deter and debilitate the ability of weavers to market their produce.

2.5 Inadequate Government Support

During ancient times, arts and crafts used to be patronised by kings and rulers; however, in the modern world, governments usually lend support for preserving and promoting these arts, believing the crafts represent a rich and lasting cultural heritage. Over time, arts and crafts survived many threats and, of late, planet-friendly handicrafts and motifs command an overwhelming demand across the globe.

The government is expected to play a vital role in policy formulation and implementation for honing the arts and crafts. However, the literature says that government support for arts and crafts in India is quite limited. Despite a slew of support schemes launched by the government to encourage artisans, the outcomes were disappointing due to a lack of rationality and objectivity.

2.5.1 Lack of Awareness of Government Schemes

While commenting on the performance of the government, the Steering Committee of the Planning Commission (2012), the Government of India (GoI) explains the reasons for the failure of government schemes; the lack of a proper mechanism for information diffusion is the main reason for the poor progress of the schemes and programmes launched by the government. In addition, the implementing agencies are often ill-equipped, do not possess complete information, and further fail to disseminate the information up to the last mile, resulting in serious implementation gaps.

The expositions of Sharma *et al.* (2021) and Kaushik and Jain (2015) reveal the government's failure to create sufficient awareness and galvanise various government programmes and schemes. As a result, weavers could not derive any tangible benefits from all such schemes, be it welfare, marketing or export, which eventually resulted in a livelihood crisis.

Lack of awareness about government schemes and other opportunities to check financial choices, marketing avenues, and others has a magnifying effect. For example, Handloom Census 2019-20 reveals that over 65 per cent of weavers are unaware of existing schemes, training and other enablers.

Only three (3) per cent of artisans know about Weavers Health Insurance Scheme, and about 10.5 per cent are aware of the credit waiver scheme (Handloom Census, 2019).

Lack of information to weavers regarding various government policies and schemes has become increasingly common and is abetted by the inefficiencies of the government system, particularly the laxity and irresponsible attitude of the staff engaged in the government sector. For example, the Handloom Census (2019) reveals that over 65 per cent of the weaver household members are unaware of various schemes, including welfare, housing, credit, training and other welfare schemes, made available by the government.

2.5.2 Failure of Government Schemes

The government's avowed claim of wholehearted support to the languished handloom sector with an umpteen number of schemes is just an ingenious juxtaposition of the reality, as noticed by many researchers.

Integrated Handlooms Development Scheme (IHDS) is a flagship programme of the government, which aims to provide working capital for work shed construction, purchase of accessories, acquiring new computer-aided designs and many other benefits. However, the study of Kaushik and Jain (2015) divulges that only 15 per cent of the target population benefitted from this scheme. The critical reasons for the failure are insufficient financial allocation, delays in funds release, and lack of proper training for operating the computers.

Kaushik and Jain (2015) further find that the scheme meant for Marketing and Export Promotion also had a diminutive impact on the artisans. The social security schemes Mahatma Gandhi Bunkar Bima Yojana (MGBBY) and Health Insurance Scheme were found either ineffective or misused owing to poor implementation and monitoring.

Sehgal and Mir (2014) have examined the implementation of the Weaver Credit Card (WCC) scheme in Jammu and Kashmir and found a lukewarm response from the bankers to extend a loan on the weaver credit card.

2.5.3 Inconsistent Government Policies

Kasisomayajula (2012), who carried out a study in Andhra Pradesh, argues the need for a policy change at the Central and State Government level, as the current policies have miserably failed to bring the weavers out of the crisis.

Devi (2014) also believes that the adverse government policies and ineffective implementation of government schemes are responsible for the severe livelihood crisis of the handloom weavers.

Kasturi (2005) suggests that weavers should not remain passive beneficiaries of the government’s meagre assistance; instead, they should boldly face the challenges on their own by exploring and capitalising on the social opportunities available.

To obviate these persistent policy issues, region-wise customised policies are required instead of a uniform policy for the entire country, as every region is unique. A lack of sufficient budget and improper implementation and monitoring are also critical issues.

2.7 Conclusion

This chapter highlighted the literature concerning various factors that affected the handloom sector. The literature showed that the human capital attributes of artisans are below the expected levels and resulted in poor productivity and eroded livelihoods.

Many researchers have also described the debilitated production capacity of the handloom sector owing to the non-adoption of current trends in designs and technology. In addition, supply chain disruptions were found to have played havoc on the handloom activity, more importantly, the inaccessibility of raw materials and marketing support.

The government's support to facilitate the handloom activity is lukewarm, and inconsistency in policy advancement, lack of monitoring, and improper implementation have further contributed to the industry's downfall.

To summarise, the literature portrayed a grim picture of the handloom industry rife with many problems, including deteriorated industry, reduced productivity, loss of livelihoods and revenue, the apathy and negligence of policymakers and exploitation.

CHAPTER III:

METHODOLOGY

3.1 Introduction

This chapter discusses the proposed research methodology to conduct the study. The perspectives considered in the research design, data collection methods and analytics to carry out the study are illustrated in this chapter in the light of the research objectives and the relevant research questions.

3.2 Theoretical Constructs

Research is a comprehensive and orderly study of the facts, veracities and realities, using different methods of interpretation, assessment and analysis to conclude. The term' business research' refers to 'academic research on topics relating to questions that apply to the field of business and management and have a social science orientation' (Bryman and Bell, 2011).

While Robson and McCartan (2016) define research as 'The theoretical, political and philosophical backgrounds to social research and their implications for research practice and for the use of particular research methods'.

3.2.1 Research Philosophy

The basic construct of research philosophy refers to understanding how data should be gathered, analysed, and utilised. Thus, the harbinger of research methods selection begins with identifying the appropriate research philosophy.

Choosing a philosophical outlook to interrogate the research questions is guided by the specific needs and requirements of the study rather than strictly adhering to a particular philosophy or paradigm.

Mark Saunders *et al*. (2009) define Research Philosophy as 'a system of beliefs and assumptions about the development of knowledge'. Therefore, a profound understanding of research philosophy is essential for developing new knowledge in any field of study (Mark Saunders *et al*., 2009).

The proposed research relies on epistemological (What is reality?), ontological (How do we know something?), and axiological (what are the values and principles?) assumptions. Epistemologically, the current study seeks to acquire acceptable, valid, and legitimate knowledge objectively while differentiating between truth and false (Mark Saunders *et al*., 2009). Ontologically, this study explores the nature of reality as one perceives it. The fundamental axiological principle that guides this research ingrains the values and beliefs of both researcher and the participants. In addition, the axiological and subjectivist assumptions contribute significantly to the triangulation process for data validity.

3.2.2 Philosophical Paradigms

This section summarises the reflection on the philosophical underpinnings of the different research paradigms proposed in this study. The key archetype positioned in this study would be 'pragmatism'; however, some attributes of 'post-positivism' and 'critical realism' may also underlie the philosophy intermittently.

Epistemologically, pragmatism is built on the premise that research should not get entrapped in the debate of truth and reality; instead, it should focus on real-world issues (Patton, 2005).

Primarily, pragmatism aims to answer research questions and contributes practical solutions to complex real-world issues (Morgan, 2007; Feilzer, 2010). Furthermore, pragmatists contend that the research question is the most critical determinant of the three paradigms, epistemology, ontology, and axiology, rather than any other dogma. Therefore, working with all three paradigms comfortably with some modifications is possible (Tashakkori and Teddlie, 1998).

Pragmatism springs from empiricist and experiential vantage points, and it effectively reunites philosophical extremities such as ‘objectivism and subjectivism, facts and values, accurate knowledge and different contextualised experiences’ (Mark Saunders et al., 2009). Moreover, given the flexibility available with pragmatism, the researchers are better equipped to tackle complex and dynamic social issues (Kelly and Cordeiro, 2020).

Positivist philosophy assumes that the social world exists independently of humans and that reality can be measured by objective methods (Guba and Lincoln, 1994). However, post-positivists believe that not everything is wholly seen or perceived because of the limitations of the human senses (Krauss, 2005).

Because of these limitations, critical realists believe that reality is external and independent, and we cannot see actual reality through our empirical observations or senses. Therefore, what we see are only the manifestations of real-world issues but not the original things, and what we cannot see are the underlying causes (Bhaskar, 2008). Ontologically, post-positivism represents critical realism.

This study seeks to examine the big picture to understand the causality, consequent effects, and interrelations among the multitude of factors impinging the handloom sector. However, the visible and perceived reasons alone cannot understand the complex situation. Therefore, as critical realists believe, during the process, this researcher may feel it necessary to carry out historical analyses of phylogenetic events of the handloom sector to unravel the underlying causes of the distress in the handloom sector.

3.3.3 Philosophical Approach

Some argue that observing either a pure deduction or pure induction is daunting; therefore, abduction, which positions at the centre of both approaches, would be the right choice. Abduction also bodes well with pragmatism and critical realism (Mark Saunders *et al*., 2009).

As pragmatism allows combining both positivist and interpretivism positions, a mix of approaches is possible. However, this study begins with a deductive approach, as substantial literature is available and switches to other approaches when the need arises.

Figure 3
Philosophical Framework

3.3 Research Design

A conceptual structure or framework called ‘Research Design’ facilitates the optimal collection of relevant pieces of evidence, insights, and data. Research design is a strategic framework for undertaking research that links research questions and research implementation (Bryman and Bell, 2011).

Kerlinger (1973) posits, ‘Research design is the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and to control variance’.

3.3.1 Research Purpose

This current research intends to identify the credible reasons and causes for the crisis and chaos in the handloom sector in India and also attempts to offer different options for problem resolution; hence, this research is exploratory. An exploratory study seeks to assess and find insights and answers to various queries and happenings (Robson and McCartan, 2016). Furthermore, the artisans’ problems, needs, and aspirations in the project area were assessed using qualitative and quantitative methods. Hence, this work is descriptive and logical (Robson and McCartan, 2016).

Sandhursen (2000) explains that exploratory research is inconclusive, while conclusive research identifies the root of the issue conclusively, offers one ultimate solution, and leaves no room for further research. Since this study focuses on only a few aspects and variables of the handloom sector, the conclusions in this research cannot be final. Moreover, this researcher did change the direction and shifted the focus when new insights or observations were noticed (Mark Saunders *et al*., 2009).

The study is applied research too, where new models and frameworks were developed to understand the problems in the handloom sector, and the study eventually resulted in problem resolution. Moreover, the models designed are replicable and can be adopted by other organisations tackling similar wicked problems.

3.3.2 Research Strategy

In this study, the research strategy is guided by the research objectives, research questions, the extent of literature available, and other resources (Mark Saunders *et al*., 2009).

This study mainly relied on a survey strategy, which typically goes well with the deductive approach and facilitates exploratory and descriptive research. Data collection from a large sample, either physically administering a questionnaire or using an online route, is relatively more accessible than other methods. In addition, the large amount of data collected can be processed statistically to know the interrelations among variables for drawing inferences.

The second strategy would be Action Research; as the proposed study happens in a dynamic real-world situation, repeated cycles of diagnosis and mid-course correction are needed.

A. Methods Choice

This study observed a pluralistic and flexible approach and believed there are disparate ways of understanding and interpreting the world. Accordingly, the research attempted to integrate different research methods, such as qualitative, quantitative, and other observable data, to find answers to the research questions (Mark Saunders *et al*., 2009).

The study started with a basic premise that data resources available for this study are limited, and literature on applying Systems Thinking (ST) approaches and using artificial intelligence tools in the handloom sector is almost negligible. Given this, this researcher relied upon primary data collection that is both quantitative and qualitative.

B. Characteristics of the Study

The overall structure of the study depends on certain underlying principles and methods, such as Iteration, Participatory Approach, Action Research and particularly the Systems Thinking and Sustainable Livelihoods approaches.

Modular Nature: The examination and testing of perspectives were done in a modular way and then iterated. The problem issues were divided into small discrete and independent modules with a well-defined method for each module. However, the interrelations and cyclicality of certain variables among the modules were addressed separately.

Iteration: The research intends to repeat the process through different cycles for the consistency of eventual outcomes. Therefore, though the initial research scope was boundless, the scope was restricted to a few critical aspects during the research process.

Participatory Process: The inquiry was participatory, involving all the stakeholders across the value chain to ensure the participants own and adopt the outcomes and suggestions.

Action Research (AR): The study also embraced Action Research (AR) principles for feedback and midway correction, assuming the social world is dynamic and changing continuously. AR is an evidence-based reflective process that allows the inquiry, enables improvement and refines the inquiry from time to time while capturing the dynamics.

A mix of methods: Qualitative and quantitative methods were adopted to capture insights from social, cultural, and economic inquiries. The data analysis was also done using multiple analytical methods including Artificial Intelligence techniques.

Systems Thinking (ST): The intended modelling was achieved based on the constructs and methods of Systems Thinking, deploying the tools such as causal loops and cause-and-effect diagrams for greater understanding and exposing the interdependence among several factors considered in this study.

Sustainable Livelihoods Approach (SLA): This framework facilitates understanding the nuances of the fragile livelihoods of the poor by examining their assets, risk, vulnerability and institutional structures and processes.

Since the handloom sector is currently in total disarray, afflicted with many social, cultural and economic problems, the present study is social research relying on field studies.

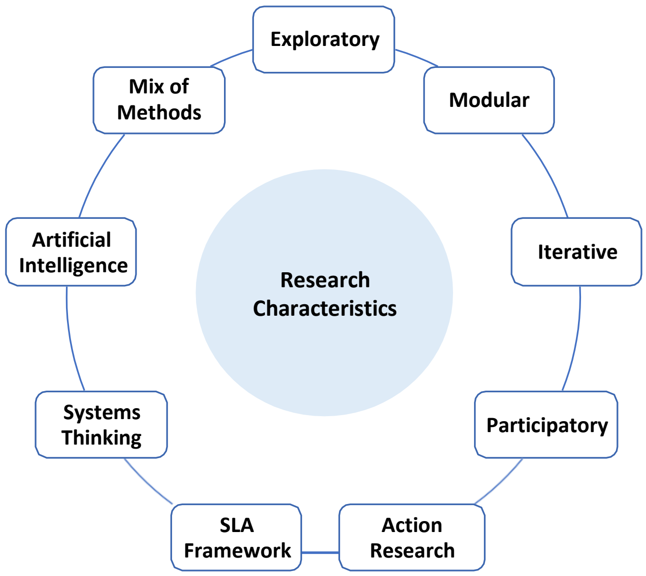


Figure 4
Research Characteristics

3.3.3 Perspectives of the Study

The study demands a detailed examination of diverse and multiple perspectives to understand linear and vertical relations and other cross-sectional interdependencies since the subject chosen is multifaceted and complex. However, to avoid losing focus and given the time frame to complete the dissertation, only three perspectives have been preferred to get the big picture and further answer the four research questions mentioned in the previous chapter.

1) Productivity is the first perspective. Productivity is the ratio between the volume of output and the volume of inputs. It measures how efficiently the inputs, such as men, material, capital, technology, competition, enterprise, innovation, skills, and many others, contribute to the outputs (OECD, 2008). Productivity growth is a vital metric for the growth in living standards, and more productivity growth adds more income to the workers (OECD, 2008).

Paul Krugman (1994), a Nobel Laureate, famously said ‘Productivity isn’t everything, but in the long run, it is almost everything. A country’s ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker’ (cited in OECD,2008).

The heightened concerns of slow productivity growth in the handloom sector were explored and analysed in this study as to the reasons and genesis of key determinants and drivers of productivity growth.

In addition, the issues related to the supply chain were also engrossed in this study. The supply chain entails a series of interdependent activities, from procuring the raw material to the finished product.

2) Second, the Socioeconomic perspective examines variables such as livelihood dimensions, human capital and social capital issues combined with economic factors, including income patterns, exploitation and threat from other sectors, among many

others. In particular, the study focuses on the issues of Human Capital, which embodies disparate investments in education, skills, knowledge, health, and behaviour, among many others, to increase individual productivity (Goldin, 2014). Finally, an investigation is needed as to how all these attributes influence the weaving community's internal and external environment concerning their livelihoods and business performance.

3) The third perspective, 'Public Policy', as defined by Lassance (2020), is 'an institutionalised proposal to solve a central problem, guided by a conception'. Public Policy is usually enacted or conceived by the government to resolve problems faced by the public. It is also expected to create a congenial environment for prospering a specified sector. Public Policy reflects a host of deliberate and conscious interventions by the government, such as laws, norms, regulations, subsidies, support schemes and programmes, which need to be examined and investigated to detect contradictions, inconsistencies and mismatches, if any, in this study. The proposed model for government intervention would be designed after a conscientious analysis of the efficacy and effects of various government schemes and interventions unleashed and implemented by the government during the last decade.

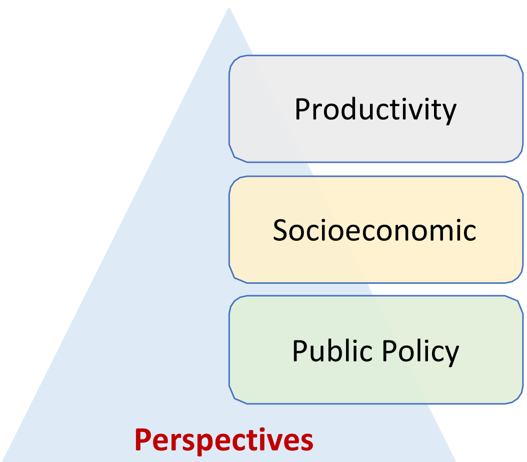


Figure 5
Research Perspectives

To understand and analyse the three perspectives and to propose tangible solutions, the five research questions, as already mentioned in Section 1.8 of Chapter 1, need to be answered.

3.4 Sample Area

The present study occurred in a Mega Cluster of weavers in Andhra Pradesh, India. The mega cluster spreads across Guntur and Prakasam districts, covering over 27,000 households engaged in weaving. This area is one of the country's highly populated locations of weavers, with over 44,000 operational looms.

The Government of India (GoI) identified and funded this mega cluster under the Comprehensive Handloom Cluster Development Scheme (CHCDS), a flagship programme under the Ministry of Textiles.

The data collection was confined to the Prakasam district only in this research. The Prakasam district has been renowned for its most exclusive handwoven fabric from time immemorial. The handlooms in Prakasam earned world fame and manifested the dexterity of innumerable weavers and artisans.

The district occupies an area of 17,626 sq. Kms with a population of around 3.4 million (Census, 2011), and 80.44 per cent of the population reside in rural areas. Administratively, the district is divided into three revenue divisions and further subdivided into 56 Mandals (Detailed demographics in Appendix A).

Weaving is predominantly practised by a particular social group (Padmasali), and the district has about 23,094 weavers' households, which are actively engaged in weaving on over 18,000 handlooms (Handlooms Dept, GOAP). In addition, 74 Primary Weaver cooperative societies are in the district, and 50 are active and functional.

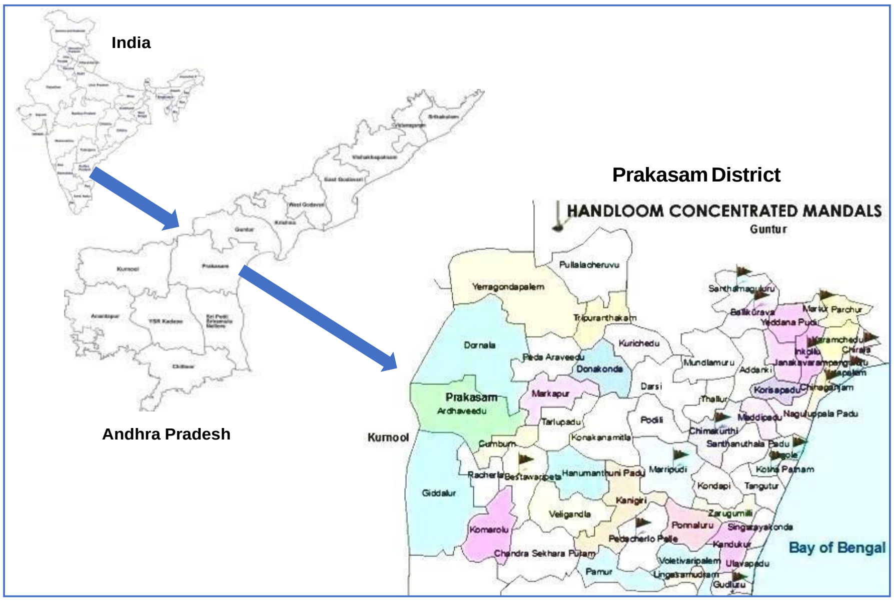


Figure 6
Prakasam district map showing handloom concentrated Mandals

3.5 Sampling

A sample is a smaller portion destined to represent a more significant portion, and the selection process of a smaller segment is called sampling. Bryman and Bell (2011) define a sample as ‘the segment of the population that is selected for investigation, it is a subset of the population’. Therefore, a sample represents the entire population, and the observations of a sample can apply to the entire population.

As Bryman and Bell (2011) described, out of the two sampling methods, the probability sampling technique was preferred to the nonprobability sampling methods in this study because of its unbiased nature. A probability sample ‘uses random selection so that each unit in the population has a known chance of being selected’ (Bryman and Bell, 2011). Moreover, within the probability sampling method, the Simple Random Sampling method was favoured over other methods in this study.

A minimum of 10 to 20 per cent of entities are purported to be selected from the weaving community to minimise sampling error in the project area. However, out of 23,094 weavers’ households available in the Prakasam district, 11,594 households were selected and surveyed. Therefore, almost 50 per cent of the district’s weaving population was covered in this study, and this was possible because the weaving families lived close to each other in smaller geographical areas.

3.6 Data Collection Methods

The data collection began with secondary data in this study, collected from various sources, including Government Departments, voluntary organisations, and relevant websites.

However, the primary standpoint in this study is that due to the lack of sufficient insightful information apart from banking on secondary data, this researcher felt the need to gather primary data to capture perceptions, feelings, and impressions in a real-life situation.

Upon deliberation and analysis, the mixed methods research design was apt in this study and comfortably fitted into the Pragmatism Paradigm (Creswell, 2012). Mixed methods research embraces both quantitative and qualitative methods in a single study (Creswell, 2012); therefore, the present study embarked on mixed research methods. The basic idea behind this methodology is that such conflated methods facilitate a more holistic and synergistic application of data for inferences (Mark Saunders *et al.*, 2009). A mixed-methods strategy enables the researcher to gain a more comprehensive understanding of a complex issue than a singular method of either quantitative or qualitative study.

Usually, the sample size in qualitative studies is limited; hence, generalizability is challenging but provides contextual insights. On the other hand, the quantitative methods provide credible and generalisable insights, where the sample size is always bigger. Combining these two methods absolves each other’s weaknesses and heightens the overall understanding (Creswell, 2012).

This researcher collected the data over four weeks by administering the questionnaire and conducting personal interviews simultaneously with weavers, industry experts and other stakeholders. A database of 11,594 handloom weavers was collected through a close-ended questionnaire, but only 25 persons, including weavers, other stakeholders, and experts, were interviewed; therefore, this study is skewed more towards quantitative methods; hence, it is a quantitatively driven study (QUAN) (Creswell, 2012).

Questionnaire: The questionnaire method efficiently collects data from a large sample (Mark Saunders *et al.*, 2009). Furthermore, a properly designed questionnaire with simple language that correctly conveys the questions' meaning is better than semi-structured or in-depth interviews (Jankowicz, 2005). Therefore, before serving the questionnaire, every effort was made to design it precisely and accurately, including pilot testing, to maintain its validity, reliability, and consistency with the questions (Mark Saunders *et al.*, 2009).

The questions relevant to the research questions and objectives of the study were framed. The questions are simple, unambiguous and easily understandable in a way intended by the researcher to avoid uninformed responses (Foddy, 1993).

The questionnaire was structured into six sections. The first section (A) captures information such as the weaver's name, address, age, education, gender, income, and immovable assets, including housing, while the second section (B) elicits information regarding the family members.

The third section (C) encompasses questions concerning the profession, including functional status and ownership of the looms, skill and training. Finance and productivity-related information, such as debts, productivity and government benefits, was sought in the fourth section (D).

The fifth section (E) deals with the production and market-related issues; in contrast, the sixth and final section (F) includes questions on the professional needs of the weaver (Questionnaire in Appendix B).

All the questions designed in this questionnaire are closed questions (closed-ended questions), except a few in the last section (F), where some are open-ended. With closed questions, the respondents are advised to choose the answer from the given options, whereas, in open questions, the respondents are free to answer as they wish (Foddy, 1993; Dillman, 2007, cited in Mark Saunders *et al.*, 2009).

The questions in this questionnaire fall under three categories (Dillman 2007 cited in Mark Saunders *et al.*, 2009); opinion variables such as feelings and views, behavioural variables like experiences and attribute variables such as characteristics, age, gender and income; however, rating questions and ranking questions did not find a place.

The questionnaire was administered through trained staff and volunteers, and the responses of the weavers were recorded manually.

Before analysing the data, all the responses were grouped, coded, and tabulated on an Excel spreadsheet.

Quantitative data: Besides the quantitative data, the qualitative real-time data was also obtained by conducting 25 individual structured interviews to capture in-depth factual data. The interview schedule was designed predominantly with close-ended questions to ensure consistency and standardised interviewing (Bryman and Bell, 2011). Of course, the data interpretation of qualitative studies is subject to the researcher's bias.

In qualitative methods, only the visible and measurable data can be seen; therefore, if the study entirely banks on the qualitative data, there is a possibility of losing track of trends and patterns resulting from quantitative data. Nevertheless, the qualitative method enabled this researcher to understand deeper underlying complexities.

The data were also compared with the results of quantitative applications for validation (Interview Schedule in Appendix C).

3.7 Systems Thinking (ST) Tools

This researcher proposes to examine the application of Systems Thinking (ST) Approaches to the problems of the Indian Handloom Sector. Flood and Jackson (1991) opined that traditional analysis and assessment methods are usually trial-and-error and long-drawn processes with great uncertainty. Given this, ST applications can reflect the real picture and reduce the time taken for critical analysis; the resultant inferences would be the right choices for understanding complex issues.

Therefore, the principal testing platform positioned in this study was the Systems Thinking methodology. The current study proposes modelling various perspectives to address the Handloom Industry's problems. As Midgley (2015) advocated, a blend of methodologies was embraced in this study, called methodological pluralism, for better results, instead of one methodology to achieve the research objective.

The system's behaviour can be understood and predicted by deploying systems thinking tools such as dynamic thinking tools, structural thinking tools and computer-based tools (Kim, 2000). However, Causal Loops and Cause and Effect diagrams were used in this paper for more nuanced insights.

3.8 Data Analysis and Modelling

Data analysis entails collecting, modelling, and analysing the data. Data Analysis is a vital technique for converting raw data into meaningful and deducible statistics that facilitate detecting insights and drawing logical conclusions.

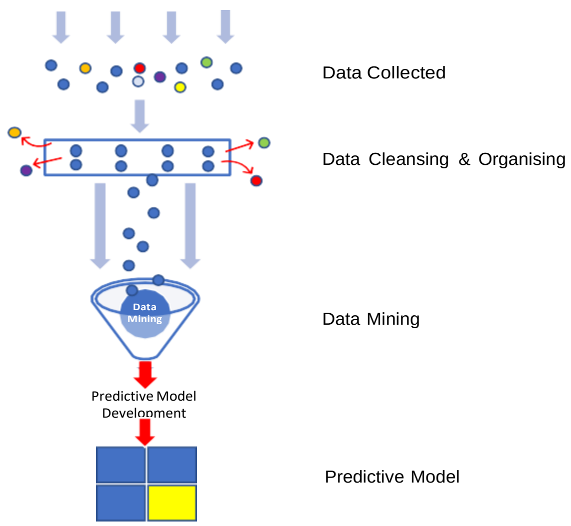


Figure 7
Scheme of data analysis

The qualitative data collected at sight were analysed manually using the content analysis method to identify patterns, trends, and impressions. The quantitative data that was gleaned through questionnaires from primary sources requires sophisticated methods and tools for analysis and consequent conclusions. However, before analysis, the haphazard data was cleaned, pre-processed, wrangled and organised properly for analysis (Figure 7).

Modelling includes various rules, formulas and equations to forecast an outcome upon feeding a set of inputs (IBM®). The detailed analysis and modelling rely on different deterministic approaches, computational techniques and data analytics tools, including Microsoft Excel for initial tabulation, sorting and formal analysis. The analysis also leveraged three different Artificial Intelligence techniques: Multinomial Logistic Regression (MLR), Artificial Neural Networks (ANN) and Decision Trees (DT) for extensive data analysis (Figure 8).

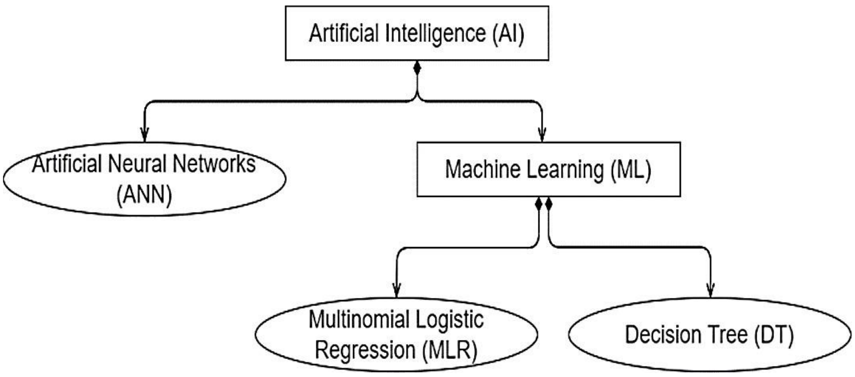


Figure 8
Selected Analytical Tools & Techniques

3.8.1 Analytical Methods and Tools for Quantitative Data

Of different categories of analysis, Predictive Analysis was preferred over other categories such as descriptive, exploratory, and diagnostic analysis since the crisis in the handloom sector is colossal and calls for immediate situation analysis and prediction for resolution.

Predictive Analytics: Among a plethora of Predictive Analytics techniques, two Machine Learning methods have been taken on board in this study, such as the Multinomial

Logistic Regression (MLR) method and Decision Trees (DT). Among the Artificial Intelligence techniques, the Artificial Neural Network (ANN) method has been chosen to analyse the large volume of data gathered in this research to take advantage of these techniques' robust computing and data mining powers.

There are three primary Predictive Analytics methods based on purpose: Predictive Models, Decision Models, and Descriptive Models.

Predictive models, often called Data Mining, analyse the relations of various unit factors in a sample with one or more known attributes. Furthermore, these models assess and measure the probability of performance in a similar unit of a different sample. Predictive models can find patterns and identify relations and interdependencies among the variables, enabling researchers to assess the potential and risk of decision-making (Gkisser, 1993).

On the other hand, decision models are used to describe the relationships among all the elements of a decision encompassing known attributes and predicted results (Regan and Holtzman, 1992). While descriptive models identify and quantify many relationships in data to classify prospects into groups.

Predictive Analytics is a forward-looking and inductive technique to forecast future events and behaviour. These models rummage through the large volume of data and allow the data to identify meaningful relationships and patterns by leveraging past events.

Predictive Modelling or Predictive Analytics encompasses a wide range of business intelligence (BI) technologies, including Statistics, Machine Learning, Robotics, Computational Mathematics, Deep Learning Algorithms and Artificial Intelligence Techniques (Nyce, 2007).

Predictive Analytics does not guarantee accuracy; however, the results depend on the person's experience, domain knowledge, expertise in the intelligent use of the data, and interpretation of the results appropriately.

Machine Learning (ML): Machine Learning (ML) is a popular analytical method that can learn, adapt and convert experience into knowledge. ML is useful for identifying patterns and behaviour with broader applications. Different Machine Learning techniques can find solutions to complex problems (Shalev-Shwartz and Ben-David, 2014).

Machine Learning algorithms are of two types, supervised learning and unsupervised learning. Supervised learning embarks on historical data to train the model for making predictions, while the unsupervised learning model does not use historical data to train its models.

In supervised learning, training or test data is given to a model to teach a machine learning algorithm/model to learn and make predictions. The test data measures the performance, including the algorithm's accuracy and efficiency in training the machine. The training augments the capability of the model to generalise successfully; however, sufficient training data needs to be made available for accurate prediction.

Supervised learning methods include classification, regression, and time-series analysis. Classification finds which group a record in the data fits into, and a classifier is an algorithm that produces classification by mapping input data into a category. Time-series analysis helps predict seasonal variances, while regression examines the relationship between independent and dependent variables. Conversely, unsupervised learning uses descriptive statistics and does not predict a target value.

Regression Techniques: Regression establishes a mathematical formula as a model to represent the relationships between a dependent variable and one or more independent variables.

In regression methods, the features of observations are called independent variables (explanatory variables, predictor variables, regressors, covariates, manipulated variables, exposure variables, risk factors, & input variables). These variables are deemed autonomous and do not depend on any other variable in the current scope of the study. The dependent variable (Outcome Variable, Criterion Variable, Response Variable and Target Variable) is influenced by the values of independent variables when tested and yields an outcome. Therefore, it implies that the dependent variable responds when the independent variable is manipulated.

The regression includes finding out the best fit line or curve. The best fit line transits through all the data points while minimising the distance between the line and each data point.

Regression is useful for determining the strength of predictors and predicting an effect and trend. There are two major categories of regression used in Machine Learning, Linear Regression and Logistic Regression.

Linear Regression (LR) models are used to explicate the relationship between one dependent variable (y) and one or more independent variables (X) (David A. Freedman, 2009). However, the best-suited model would be logistic regression rather than linear regression when the dependent variable is binary, discrete, and not continuous.

Logistic Regression: Logistic regression is helpful to forecast the probability of frequency of an event by fitting data to a logit function, hence called logistic regression, and its output value ranges between 0 and 1.

Logistic regression is an appropriate method for discrete binary and linear classification issues and is used when the dependent variable is discrete, such as Yes or No, 0 or 1; in other words, the dependent variable can have only two values.

Logistic regression also explains the interrelations between one outcome variable (dependent binary variable) and one or more nominal, ordinal, interval or ratio-level predictor (independent) variables. Logit is a binary dependent variable used to model a particular outcome's probability (*p*), such as yes/no, true/false, and pass/fail. The probability (*p*) ranges from 0 to 1. When logits are plotted against an independent *variable* in a graph, it gives a logit curve.

In Logistic Regression, the Logit function is employed to measure the relationship between the dependent and independent variables.

Logit(p) = ln(p/(1-p)) = b0+b1X1+b2X2+b3X3….+bkXk

p = probability of occurrence

p/(1-p) = corresponding odds

Logistic regression is apt when the data is large, with no multicollinearity or correlation among the independent variables.

Logistic regression models a discrete binary (dichotomous) outcome and tries to determine how best a new sample fits into a category. However, in Multinomial Logistic Regression, there are over two possible outcomes (dependent variables) (Edgar and Manz, 2017).

Depending on the need and situation, extensions are available for the Logistic Regression methods.

Multinomial Logistic Regression (MLR): Multinomial Logistic Regression (MLR), a variant of Logistic Regression, can be deployed to predict a nominal dependent variable with one or more nominal or continuous independent variables.

Multinomial Logistic Regression is often known as multinomial regression. It is also considered an extension of binomial logistic regression that facilitates two or more categories of the dependent variable (Kwak and Clayton-Matthews, 2011).

MLR is quite convenient for researchers as it does not assume normality, linearity, or homoscedasticity (Kwak and Clayton-Matthews, 2011).

Multinomial Logistic Regression can deal with diverse situations with many categories. Therefore, the method does not require restricting the analysis to pairs of categories or reducing the categories into two groups to leverage the logit model. Moreover, it uses maximum likelihood assessment to predict the probability of the categorical variables.

Because of these advantages, the Multinomial Logistic Regression method has been preferred in this study.

Artificial Neural Networks (ANN): Neural Networks or Artificial Neural Networks (ANN) originate in Machine Learning, a subset of Artificial Intelligence, and ANN is also one of a variety of Deep Learning Algorithms. ANN works on the analogy of a human brain with a series of algorithms.

ANN is useful in finding solutions to complex problems where the interrelationships and interactions among inputs and outputs are dynamic and not effectively established.

ANN is a mathematical function that collects the data/signals and classifies the information based on the topology or structure of the ANN. It further identifies the patterns and invisible causal relationships in a data set. ANNs can learn from the initial training and subsequent applications and change themselves; hence, ANNs are adaptive.

ANNs have many layers with interconnected nodes (Al-Barqawi and Zayed, 2008). Each node is called a Perceptron, where computation happens; it receives binary inputs and yields binary outputs. A node or Perception is similar to a neuron in the human brain.

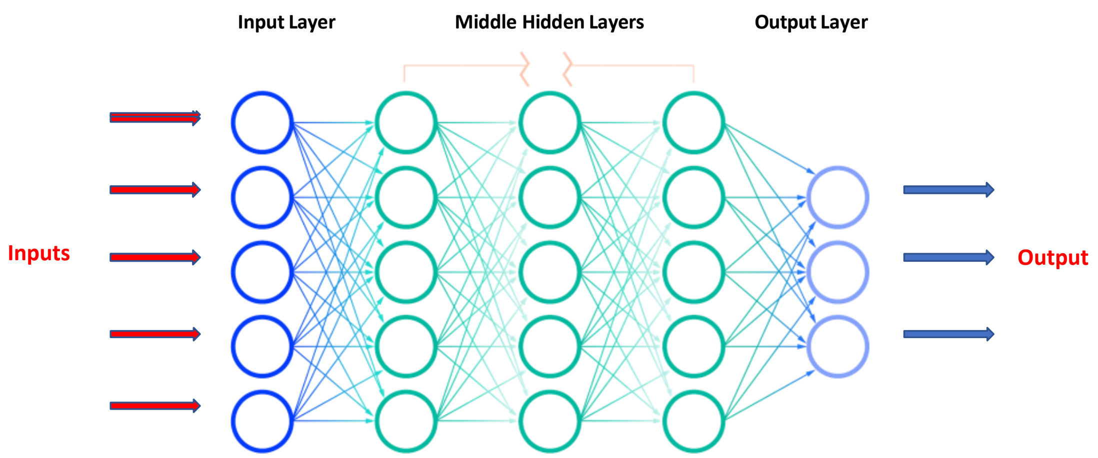


Figure 9
Multi-Layered Perceptron

A simple ANN is a single-layered Perceptron that produces a single output based on inputs. Each Perceptron is a supervised learning algorithm. It has an associated weight and threshold (Bias) and acts as a Linear Binary Classifier (Figure 9).

In a Multilayer Perceptron (MLP), also called ANN, the outer input layer receives the data, and an activation function then processes the data into an output.

If the output of the input layer exceeds a given threshold, it then activates the node and nudges the data to the next layer in the network. The layer next to the input layer receives the processed data as input and passes it on to the next adjoining layer as output (Zayed and Halpin, 2005). In the same way, the data passes through different layers in a neural network in one direction, and such an ANN is called a feed-forward network. One or more middle/hidden layers process the data with a minimal margin of error and deduce features and patterns likely to predict the outputs. Moreover, all inputs will be multiplied by their respective weights or coefficients and then summed (Figure 10).

Then the sum passes through an activation function to determine up to what level the sum or data should pass through the network to affect the final output. Finally, the output layer generates the classified data.

Every node has an associated weight and threshold in determining the given variable's importance. The larger weight and coefficient value's contribution are more significant to the outputs than the smaller ones.

With the input change, the Neural Network generates appropriate output without rewriting the output criteria. As a result, the Neural Networks can differentiate the indefinable nonlinear interdependencies and patterns, which other techniques cannot easily detect.

The prediction accuracy would range from 50 to 60 per cent; however, the success depends on the quality of the input data.

The ANN algorithm of IBM SPSS has been found fit for this study. It offers nonlinear data modelling procedures for understanding the complex relations among the various factors/variables likely to affect the handloom industry.

ANNs achieve greater predictive capability and offer deeper insights when the data is complex. Therefore, the Multilayer Perceptron (MLP) algorithm has been chosen in this study as it provides classification and accurate and effective predictive models or numerical outcomes.

Figure 10
ANN Schematic Representation (Source: McCulloch & Pitts, 1943)

- Net input can be calculated as follows − yin=x1.w1+x2.w2+x3.w3…xm. wmyin=x1.w1+x2.w2+x3.w3…xm.wm
- i.e., Net input yin=∑mixi.wiyin=∑imxi.wi
- The output can be calculated by applying the activation function over the net input. Y=F(yin)Y=F(yin)
- Output = function net input calculated
- Processing of ANN depends upon the following three building blocks:
  - ✓ Network Topology
  - ✓ Adjustments of Weights or Learning
  - ✓ Activation Functions

Decision Trees (DT): Decision trees (DT) are one of the popular machine learning algorithms, given their unambiguousness and simplicity (Wu, X. *et al*.,2008)

The Decision Tree method is a simple classification technique which facilitates a logical way of narrating a decision-making process. It is a sub-set of Supervised Learning techniques in Machine Learning, and one of the predictive modelling approaches usually depends on historical knowledge (Ben-Gal. *et al*., 2014).

A Decision Tree (DT) mimics human thinking for decision-making and classifies cases into groups. It predicts the effects of independent (predictor) variables on a dependent variable. Constructing a decision tree is simple, and the ensuing interpretation is straightforward.

The Decision Tree is a graphical representation that resembles a real tree with the root node, branches, and leaves; internal nodes denote the characteristics of a dataset, and branches symbolise the decision rules (Shalev-Shwartz and Ben-David, 2014) and each leaf node represents the outcome (Figure 11). The test can be done based on a given data set's features, including both categorical and numeric data, to arrive at possible solutions. At every step, a variable is chosen that best classifies the data into two (Rokach and Maimon, 2005).

There are two different Decision Trees, namely classification and regression trees. In the classification tree, the predicted outcome is the distinct class to which the data belongs, while the predicted outcome will be a numeric value in the regression tree.

For forecasting the class of the given dataset, the algorithm sets off from the root node, where the complete data set is available. The algorithm then compares the values of root features with the actual dataset and then hops into the next node. Again, the same process repeats with other sub-nodes and moves forward until it reaches the leaf node of the tree, where further classification is not possible.

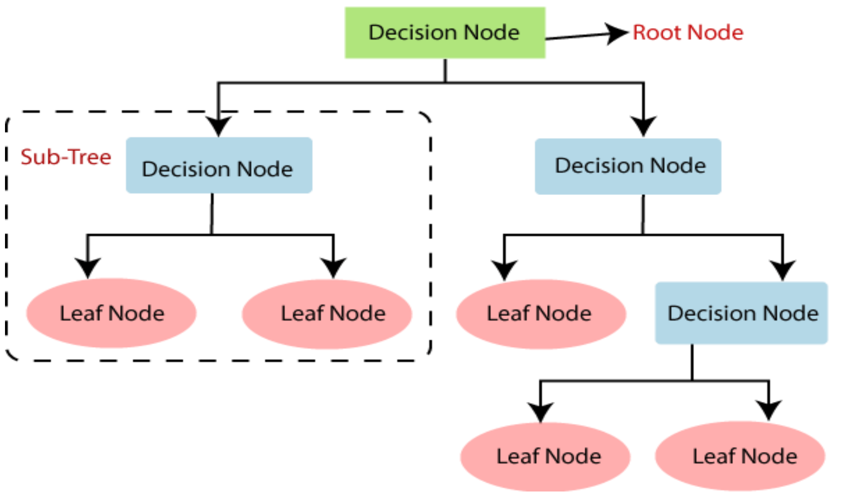


Figure 11
Scheme and structure of a Decision Tree

DTs are adept at solving regression or classification problems, and DTs can map nonlinear relations better than other algorithms. There are many methods of growing a Decision Tree based on the Attribute Selection Measure (ASM): CART, QUEST, ID3, C4.5 and CHAID. Attribute Selection Measure (ASM) is a technique usually adopted to select the best attribute for the nodes to split.

CHAID (proposed initially by Kass in 1980) is compatible with continuous or categorical dependent variables and only categorical independent variables. Therefore, the continuous independent variables need to be converted into categorical ones before feeding them to the CHAID algorithm.

CHAID (Chi-Squared Automatic Interaction Detection) method is based on the values of the Chi-square statistic. By default, the correlation is measured by using the Pearson metric. Then, a Chi-square statistic is computed iteratively for all the predictors in sequence to find the significance of the predictors compared to the dependent variable.

The variable with the biggest Chi-square value takes precedence over the smaller value for a split; hence, the higher the Chi-square value, the higher the splitting efficiency.

The probability yielded by the Qi-square of a variable ranges between zero (0) and one (1). Smaller probability values close to zero indicate a significant difference between the two predictor variables under comparison, while those close to 1 (One) indicate negligible difference or less significance. Usually, the ideal *p*-value for splitting is assumed to be less than 0.05 (0.05) or at a 95 per cent confidence level.

When multiple comparisons are conducted, there is a likelihood of getting more false positives. Thus, to avoid ending up with the wrong significant variables, the Bonferroni Correction method needs to be performed by adjusting the *p*-values. For example, the default *p*-value of 0.05 can be increased up to 0.1 (90% confidence) or decreased to 0.01 (99% confidence) to avoid wrong significant variables and regulate the tree size depending on the need.

The predictor with the smallest value of less than 0.05 (or Bonferroni adjusted *p*-value) will be selected as the first value to perform the first split. The next best *p*-value is then selected for the next split, and the process continues until a stage where no further split occurs when the *p*-value is greater than the ideal *p*-value.

CHAID is suitable for bigger samples, while CART is best suited for smaller samples. Computationally, CHAID is faster than CART. Moreover, CART produces only binary splits, while CHAID can produce multiple splits if needed. Finally, interpreting CHAID is easier and less confounding than CART. In addition, QUEST has many limitations; therefore, given these circumstances, CHAID has been preferred in this test.

To summarise, the data analysis and modelling were performed using SPSS (version 21), Python, R Programming and Venism software.

3.8.2 Modelling

Given the mandate and need, four different models have been conceived to satiate the concerns raised in this study. For all the models dependent and independent variables were identified out of 97 variables available with the dataset and then channelled into different tools and methods for determining the interactions, interrelations, trends, and patterns.

Model 1 focuses on production and productivity-related issues of the handloom sector to answer the first research questions (Table 1).

This model has one dependent variable ‘Production per day’ and was tested against eight independent variables, and the reasons for selecting them are mentioned in the last column of Table 1.

Table 1
Selected Variables of Model 1

	Variables	Reasons for Selection of Variables
Dependent Variable	Production per day	Productivity correlates with income and indicates the standard of living.
Independent Variables	Own Looms (Inside + outside)	Own Looms naturally give more income
	Total Looms	Total Looms including rented and owned by others.
	Total Looms working	More looms in working conditions, more productivity.
	Type of Looms	It shows the technology adoption. For example, pit looms are obsolete with low productivity.
	House with work-shed	Indicates the acquisition of additional infrastructure and further shows the affordability of the weaver for dedicated and improved activity.
	House Ownership	Provides social security and facilitates weaving at home.
	Source of Weaving Knowledge and skill	Weavers naturally come with traditional knowledge; however, additional skill training would enhance productivity.
	Weaver Work for Master Weaver or others	If the weaver works for himself, the income would be more, but working under the master weaver or others would undermine income levels.

While Model 2 answers the second question and attempts to capture insights on supply chain challenges that influence the productivity and income of the weaver. In Model 2 the dependent variable ‘Monthly Income’ was tested against five independent variables.

Table 2
Selected Variables of Model 2

	Variables	Reasons for Selection of Variables
Dependent Variable	Monthly Income	Income level indicates overall well-being.
Independent Variables	Source of Raw Material Supply	Timely & quality raw material availability is a critical factor in productivity.
	Bank Loan Availed- Credit Access	Adequate and timely credit heavily influence productivity.
	Marketing of Final Product	Wider market accessibility improves productivity and income.
	Price Realization & Negotiation	Good price realisation and negotiation opportunities indicate weavers' empowerment.
	Dependence on Middlemen & Master Weavers	Self-reliance on raw material procurement and marketing boosts productivity and income, while dependence on others for everything reduces productivity and income.

Model 3 seeks to answer the third research question by studying the human capital challenges that influence productivity, income, and overall weavers' living conditions.

This model has one dependent variable 'Monthly Income' and was tested against five independent variables identified from human capital assets such as Gender, Education, Skill, Age and Health Status of weavers.

Table 3
Selected Variables of Model 3

	Variables	Reasons for Selection of Variables
Dependent Variable	Monthly income	Income level indicates overall well-being.
Independent Variable	Gender	In India, it is customary for women to earn less than men.
	Education	Higher educational attainments positively influence productivity and income.
	Skill Training Received	Advanced skill sets positively influence productivity and income.
	Age	Economically active age positively influences productivity and income.
	Sound Health	Sound health positively influences productivity and income.

Finally, model 4 answers the fourth research question while critically analysing the sufficiency of the Government Support extended to the handloom sector. The impact of six independent variables was examined against the dependent variable ‘Monthly Income’.

Table 4
Selected Variables for Model 4

	Variables	Reasons for Selection of Variables
Dependent Variable	Monthly Income	Income level indicates overall well-being.
Independent Variable	Bank AC-yes/no	Opening a bank account is the first step toward financial inclusion.
	Bank Loan Availed	Sufficient credit access from formal financial institutions indicates positive Government policy formulation and implementation.
	Loan Purpose	The utilisation of the loan for other consumption purposes indicates the prevalence of poverty due to the Government’s failure of other basic welfare schemes.
	Housing Loan Availed Yes/No	The availing of housing loans indicates the Governments’ positive monetary policies and intention to provide social security.
	Skill Training Received	Skill and entrepreneurship development programmes organised by the Government promote business efficiency, besides traditional and hereditary acquisition of skill and weaving knowledge.
	Type of Looms (New infra/loom/upgraded)	The government launched schemes for providing upgraded looms to increase productivity. Pit Loom usage indicates Government’s failure to educate artisans and upgrade technology.

Each model underwent testing through MLR, ANN, and DT sequentially to identify the best fit model and crosscheck to validate the data.

3.9 Reliability, Validity & Generalisability

The research also ensures comparing and validating the current theories and models for deriving inferences (Ghauri et al., 1995). The research should conform to similar testing results obtained elsewhere; therefore, the study is subject to external scrutiny. Further, the study is expected to get the same result each time it is tested.

Reliability implies getting consistent results from the data collection techniques and analytic procedures deployed. Thus, the reliability of the research stems from the appropriate methodology and its perfect deployment (Bernard, 2011).

Triangulation is a popular strategy to increase the reliability of the research findings (Robson and McCartan (2016). However, Mark Saunders *et al*. (2009) define triangulation as 'The use of different data collection methods within one study'. Triangulation is a combination of methodologies for studying the same subject by verifying and comparing the data obtained from each source separately to maintain neutrality and avoid bias and uncertainty in the research for wider acceptance (Ghauri *et al.*, 1995).

Sarantakos (1998) explains that data triangulation facilitates collecting diverse information on the same subject through different methods for cross-verification and corroboration. In addition, triangulation enables the building of each method's strength. Thus, it overcomes the shortcomings of single-method studies to improve the reliability and validity of the study.

Validity encompasses research design and structure with proper methods and techniques proposed therein. Since a sufficiently bigger sample is proposed in this study with adept research methods and data triangulation to eliminate any possible variance, the inferences drawn would automatically qualify for generalisation.

This research conceived four different models and tested each model by simultaneously deploying MLR, ANN, and DT techniques to identify the best fit model and crosscheck to validate the data.

3.10 Ethical Considerations

The mandate of this research is to ingrain neutrality, fairness, and ethical principles in every stage of the research process to increase certainty and credibility.

The proposed research has been ethically designed to respect human rights and align with human values; the research is further committed to safeguarding the participants' privacy and confidentiality. Therefore, this research endeavour was strictly guided and governed by ethical considerations in consonance with the SSBM.

Mark Saunders *et al*. (2009) define 'Ethics refers to the appropriateness of your behaviour in relation to the rights of those who become the subject of your work or who are affected by it'.

All the recognised values and norms of research ethics and moral principles were embedded in this study right from the topic identification stage to the end.

The self-regulation and ethical behaviour of the researcher are paramount as far as the stakeholders of this study are concerned. Therefore, this researcher was obligated to ensure that the research participants would not be put to any embarrassment, harm, damage, or any other inconvenience (Mark Saunders *et al*., 2009).

3.11 Limitations of the Research Design

Despite efforts to undertake the study comprehensively, there could still be some limitations to the research design and methods adopted.

Usually, earlier research on a specified subject lays an excellent foundation for beginning a new study; however, specific and authentic studies using AI and ML techniques and scanned under the Systems Thinking lenses are absent in the present context.

The broad-based formulation of research aims and objectives may reduce the focus and rigour; given this, the current study attempted to narrow down the research questions, yet there is a scope of losing focus because of the excessiveness of the subject.

The sample size selected in this study may not be adequate to represent the entire artisan population in the country because of variances in the artisans' geographical, cultural, and social backgrounds.

Data collection through questionnaires or interview formats may be subject to limitations due to incorrect understanding and filling.

3.12 Conclusion

The handloom industry is an important economic activity and the second-largest employment provider in the non-farm sector in India. However, the industry is embroiled with multifarious problems and struggling for survival, and the livelihoods of many artisans are under serious threat.

Asymmetric economic development and lack of economic opportunities resulting from inconsistent policies and inefficient implementation affected the handloom industry adversely. Moreover, the race toward globalisation has also unleashed a spate of hardships for the artisans.

The sector is further implicated by many deterrents that are looming large, such as supply chain disruptions, lack of education and training for the artisans, lack of marketing, and obsolete technology. Frequent shifting of government priorities and hinging on the mechanised sector, extending all subsidies to powerlooms, and ignoring the welfare of artisans, are a few challenges among many.

The demand for craft products is alive globally because of the growing concern for eco-friendly products, and the demand for such products is also snowballing. However, despite the growing demand for handlooms internationally, the inaction of the government is causing serious concern. Hence, urgent corrective action is needed to revive the industry and protect artisans’ livelihoods.

CHAPTER IV:

RESULTS

This chapter delves into the survey's findings obtained through the questionnaire, personal interviews, and subsequent analysis.

The first section begins with an overview of the results of the data gained through the questionnaire, while the subsequent sections throw light on a detailed model-wise and research question-wise analysis and findings. The analysis of qualitative data was presented in section 4.2. The quantitative data was analysed by deploying three different analytical tools; Multinomial Logistics Regression (MLR), Artificial Neural Network (ANN) and Decision Tree (DT) and presented in section 4.3.

4.1 Overview and Summary of Survey Results

The study was carried out in the Prakasam district of Andhra Pradesh. In the district, 54 villages were selected purposefully for the data collection where the concentration of wavers was high. About 11.594 households were surveyed, making up over 50 per cent of the weaver households of the district (Table 5).

Table 5
Summary of the survey

Survey Summary	Number
Total Households Available	23,094
No of the Households Surveyed	11.594
No of the Weavers Surveyed	11.594
No of the Villages Covered	54
Per Cent of Households Surveyed	50.2%

Among the artisans' households, about 76.30 per cent of the weavers take up weaving as the mainstay, and the remaining 22.69 per cent undertake allied/ancillary activities as the chief occupation. About 92 per cent of the weavers work under the control of Master Weavers, and only 5 per cent of the weavers practise independently.

The age profile of the weavers shows that about 70 per cent of the weavers fall within the age group of 31 to 60 years, and around 19 per cent are above 60 years old.

About 54.58 per cent of the artisans are illiterates, and another 40 per cent have below 10th grade. Illiteracy among women weavers stands at 68 per cent compared to 46 per cent of male artisans.

Concerning skill development and training, about 93.24 per cent of the artisans gained the weaving skill from their parents and siblings; however, a measly 6.76 per cent of the weavers received skill training arranged by the government.

The survey also divulges that about 89.16 per cent of the weavers suffer from different health problems.

Weavers have inadequate social and professional infrastructures, over 81 per cent of the weavers have their own houses; however, only 60 per cent of the houses are permanent structures (RCC roof). In addition, only 39.50 per cent of artisans had access to safe drinking water, and only 53 per cent had proper sanitation facilities.

Even though 66 per cent of the weavers have bank accounts; however, only 32.96 per cent of the weavers accessed Bank Loans, and over 52 per cent got loans from private moneylenders. Furthermore, only 10 per cent of the weavers could get a house loan from banks.

Regarding productivity, over 73 per cent of the weavers produce less than 2 yards of fabric per day, while another 20 per cent produces 2 to 4 yards per day, and only 4.5 per cent are in the 4 to 6 yards production category.

About 90 per cent of the weavers earn a monthly income of less than Rs 6000 (USD 80) with the productivity of fewer than 4 yards of fabric a day. Women earn less than their male counterparts in all income categories.

The survey reveals that 91.54 per cent of artisans source ‘hank’ yarn from master weavers, and 92 per cent sell their finished product to the master weavers.

About 79.25 per cent of weaver households had looms; however, around 98 per cent of the looms were Pit Looms, and only 80 per cent were functional and cramped in a small workspace below 100 sq ft.

The survey also made a needs assessment to find the requirements and expectations of the weavers. Over 64 per cent of the artisans wanted alternate power to illuminate the house and workplace. The work-shed provision for a dedicated weaving activity was the next priority for over 43 per cent of the weavers. Close to 23 per cent of artisans needed an individual dwelling unit. Over 20 per cent have felt the need for training, capacity development and marketing support. The weavers expressed many other requirements concerning raw material supply, new designs and patterns, and loom accessories (Detailed survey statistics in Appendix D).

4.2 Results of the Qualitative Data

The structured interview was undertaken in person in the sample area. The views and opinions expressed by the artisans were recorded manually using a voice recorder and noted down on the written interview schedule for all the close-ended questions (Appendix C).

The analysis mainly focused on the frequency of certain words and phrases to identify the patterns and trends (Amaratunga, *et al*., 2002). After coding the text, the data were categorised based on the interview schedule and computed quantitatively.

Most of the artisans interviewed were in the age group of 40 and above, with sufficient professional experience. They strongly opined that weaving was not only a livelihood option and provided employment but also an income generator for the country if honed and appropriately supported due to the increasing global demand for handmade products.

Many participants have confirmed the pathetic socio-economic condition and ordeals of the artisans. The weavers felt that the industry was waning slowly because of a lack of support from the government, and youth particularly were demotivated and not inclined to continue the family tradition.

Availability of timely credit, quality and affordable raw materials supply, and marketing continued to be major deterrents. Failure to implement the Handloom Reservation Act and flooding the market with cheap imitations made of power looms and mills are some of the major impediments debilitating the artisans.

Although artisans have realised the importance and adoption of modern technology for augmented production and eCommerce methods for marketing, the necessary support from the government is lacking.

As the elderly weavers do not have any other skills for livelihood support except weaving, they were forced to continue the activity despite low wages and recurring health issues. Owning a house is still a dream for many artisans and having a dedicated work-shed is beyond their imagination.

The weavers demanded uninterrupted support from the government in terms of financial assistance, raw material supply, training and skill-building, design interventions and marketing to improve the weaving activity and emancipate the poor artisans from poverty.

4.3 Results of the Quantitative Data Analysis

As narrated in section 3.8 of chapter 3, four different models were conceived to analyse the concerns raised in this study.

Each of these four (4) models was tested by employing three different Artificial Intelligence and Machine Learning algorithms to get probability outputs; Multinomial Logistic Regression (MLR), Artificial Neural Network (ANN) and Decision Trees (DT).

All analyses were performed using SPSS (version 21), Python, R Programming and Venism software.

4.3.1 Model 1 and Research Question 1

Model 1 focuses on production and productivity-related issues in the handloom sector and attempts to answer the first research question.

What deters the weavers from achieving higher productivity growth despite the handloom sector's inherent potential?

And this model was run with one (1) dependent variable and Eight (8) independent variables to uncover the interactions, interrelations, trends, and patterns (Table 6).

Table 6
Model 1 – Selected Variables

Dependent Variable	Production Per Day (Yards)
Independent Variables	Own Looms (Inside + outside) Total Looms Total Looms working Type of Looms House with work-shed House Ownership Source of Weaving Knowledge and skill Weaver Work for Master Weaver or others

Table 6 shows the variables derived from the productivity perspective and the literature review. The dependent variable (Production per Day) has five different scales of productivity ranging from less than 2 yards per day to 10 yards per day. Out of the 11594 weavers who participated in the survey, about 73 per cent produced <2 (less than 2) yards/day, and only 20 per cent were in the productivity category of 2 to 4 yards/day; however, only minuscule of weavers were in the other higher categories.

4.3.1.1 Multinomial Logistic Regression (MLR) - Model 1

The first analytical method adopted in this study was Multinomial Logistic Regression (MLR). The theoretical details of MLR are mentioned in Section 3.8 of chapter

III. Next, the questionnaire data was analysed to model the potential factors related to the weaver's productivity. The results of MLR are shown below.

Table 7 shows the Case Processing Summary with details of the data fed and analysed. The N in the middle column represents the number of observations fitting the 'Production per Day' category. The last column, Marginal Percentage, refers to the percentage of weavers belonging to a particular productivity range category. All the 11594 records were found valid, and there are no missing records.

Table 7
Case Processing Summary

		N	Marginal Percentage
Production_Per_Day (yards.)	<2	8467	73.0%
	2 to 4	2334	20.1%
	4 to 6	521	4.5%
	6 to 8	144	1.2%
	8 to 10	128	1.1%
Valid		11594	100.0%
Missing		0	
Total		11594	
Subpopulation		226[a]	

In Multinomial Logistic Regression (MLR), there are three essential ways of assessing and evaluating the data for inferences: Goodness of Fit, Model Fitting, and Pseudo R-Squared.

A fit in regression refers to how well a model approximates (estimates) a target function and observes further whether the differences between observations and predicted outcomes are minor and well-composed.

A 'model' in Machine Learning essentially refers to an output of an algorithm that was trained with a selected dataset. The model is then used to predict an event or an outcome with the same dataset. Models are usually employed in Machine Learning to make predictions about the target variables (dependent variables) for better understanding and decision-making.

Generalisation in machine learning primarily refers to the model's ability to adapt and respond appropriately to previously unseen new data, and then the system makes accurate predictions on being trained.

Therefore, a model is considered 'good' or 'well-fitted' in machine learning if it appropriately generalises any new input data from a similar problem field. Hence, this further facilitates an accurate prediction of future data that was never seen by the model before.

Model Fitting Information: Model Fitting measures how well a Machine Learning algorithm learns from trained data and generalises to similar new input data.

In the Intercept-only model, all the parameter coefficients are 0 (Null), which means no variables are added; however, in the final model, selected variables are added, and they converge and give rise to some *p*-values. The *p*-value is considered statistically significant if it is less than 0.05 (alpha level indicates an error rate of 5% or less)), and it further adduces stronger evidence against the Null Hypothesis. In contrast, higher than 0.05 *p*-values show inaccurate predictions. *p* =< 0.05 (less than) is statistically significant and fits the data well, showing that the final model significantly improves over the baseline Intercept-only model and predicts the dependent variable better than the Intercept-only model alone.

- *p* => 0.05 (more than) is statistically insignificant, so it does not fit the data well and indicates that the final model does not significantly improve over the baseline Intercept-only model.
- df stands for 'degrees of freedom' and indicates the number of predictor variables in the Chi-square statistic deployed to test the LR (Likelihood Ratio).

In Model 1, the results of Model Fitting Information are as follows (Table 8):

- The Chi-square statistic is the difference between the -2 log-likelihoods of the Null and final models; therefore, one of the variables is not equal to zero; hence, at least one of the independent variables is relevant and predicts the outcome.

- The LR Chi-square can be computed using the formula -2*L (null Model) – (-2*L (fitted model)).
    - LR Chi-square = 2254.567 - 1885.689 = 368.878
    - df (Degree of Freedom) = 32 groups
    - Sig = significance = .000

Table 8
Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood	Chi-square	df	Sig.
Intercept Only	2254.567			
Final	1885.689	368.878	32	.000

In this regression, the final model had a significantly reduced -2 Log-Likelihood compared to the 'Intercept', suggesting a variance in the outcome and an improvement in model fit. Furthermore, the resultant Sig (Significance) was less than the standard 0.05 and is, therefore, statistically significant and establishes that the final model is an improvement over the Intercept-only model (Null).

The statistically significant static does not necessarily reflect the real-world implications and does not mean practically or meaningfully significant in absolute terms.

Goodness of Fit: The Goodness of Fit is a measure to estimate how well the approximation of the function goes well with the target function. The Goodness of Fit indicates the model's suitability, where the observations are summarised to find any discrepancies between the observed and expected values.

This test determines whether the independent variables come from an identified population and represent the entire population. The test further facilitates deciding if the data values are a Good Enough Fit for the proposed model.

The Goodness-of-Fit table has two different Chi-square statistics, Pearson's Chi-square and Deviance Chi-square, and they aim to test whether the model exhibits a good fit to the observed data and is consistent with the fitted model. Higher values (over 0.05) of Pearson's Chi-square and Deviance R2 show a better fit (Allison, 2014).

In this Model 1, the results generated by the SPSS are presented in Table 9. However, both Pearson and Deviance test values are less than < 0.05 (standard value), showing that the model does not suit the data. Conversely, the Chi-square values are higher and more significant, but the *p*-value is less than the standard value; therefore, there is an incongruity; hence, complete reliance on Goodness-of-Fit is not warranted under this paradoxical situation.

Table 9
Goodness-of-Fit

	Chi-square	df	Sig.
Pearson	1645.050	868	.000
Deviance	1241.728	868	.000

In order to overcome such a chaotic situation, this researcher has also adopted other testing methods, such as Artificial Neural Networks (ANN) and Decision Trees (DT), for accuracy and validation.

Pseudo R-Square: The equivalent of standard R^2 as in ordinary linear regression is not available in Multinomial Logistic Regression (MLR). The R^2 (coefficient of determination) in linear regression provides the proportion of variance influenced by the independent variables; however, computing R^2 is ruled out in Multinomial Logistic Regression. Therefore, three tests have been included in Pseudo R-Squared (p^2) model to overcome the absence of R^2.

1. **Cox and Snell's Pseudo R^2** compares the Log-Likelihoods of the entire model (tested model) with an Intercept-only model (Null) that fits the same data (Allison, P. D., 2014). Cox and Snell's R^2 = 1–[(Likelihood (Intercept-only Model) / (Likelihood (Specified Model)] 2/N (N is the number of observations). Smaller ratios show an improvement over the Intercept-only model. However, the value is less than one (1), even

for the perfect model. Therefore, Cox and Snell's R^2 is computed as 1-*L (M Intercept)2/N.*

2. **Nagelkerke's Pseudo R^2** approach is a modified version of Cox and Snell's R^2. In Cox-Snell's R^2 model, the upper limit is not 1 (one); therefore, to overcome this, Nagelkerke's R^2 has adjusted the scale to cover from 0 to 1 by dividing the Cox and Snell R^2 by its highest possible value, 1- L(Intercept) 2/N.

   When the full Model (with covariates) predicts the outcome correctly and has a likelihood of 1, then Nagelkerke's $R^2 = 1$.

   When *L (M full) = 1*, then $R^2 = 1$

   When *L (M full) = L (M Intercept)*, then $R^2 = 0$.

3. **McFadden's Pseudo R^2** is usually employed to compare different specifications of the same model (nested models).

   McFadden's R squared simultaneously calculates the Log-Likelihood ratio for the specified model with maximised likelihood values and an Intercept-only (Null) model without covariates and subtracts this ratio from 1.

   McFadden's Pseudo R-Squared (p^2) = 1–(Log-Likelihood (Tested Model)/Log-Likelihood (Intercept-only Model)

   L c = Maximized likelihood value

   L null = Corresponding value of Null

When the full (tested) model fits the data well, McFadden's Pseudo R-Squared (p^2) will be close to 1, and the ratio of Log-Likelihoods will be smaller. Similarly, when the Intercept-only model fits the data well, McFadden's Pseudo R-Squared (p^2) will be less than or close to zero, and the ratio will be close to 1 (one).

According to Daniel McFadden (1977), a Pseudo R-Squared value between 0.2 to 0.4 shows excellent fit; therefore, larger p^2 values are better suited than smaller ones.

Table 10 provides Pseudo R^2 estimates; Cox and Snell's R^2 was estimated to be.031; since a smaller value of less than 1 (one) indicates an improvement over the Intercept-only model, the value of.031 proves the suitability of the model.

In Nagelkerke's Pseudo R^2, the value .039 shows an improvement over the null. However, McFadden's Pseudo R^2 value of.02 was much smaller than the ideal range of 0.2 to 0.4 for a fit, hence not suitable.

Therefore, there was an inconsistency and contradiction in the results; however, such aberrations are common in Pseudo R^2 estimates; given this, many authors, including Hosmer and Lemeshow (2000), advocate using Pseudo R^2 estimates for model building only.

Table 10
Pseudo R-Square

Cox and Snell	.031
Nagelkerke	.039
McFadden	.020

In most empirical studies, it is rare to get powerful predictors that predict probabilities close to 0 or 1. However, a good p^2 value depends on the nature of the outcome and independent variables (predictors or explanatory variables). Therefore, Pseudo R-Squared is not a lead indicator, as the interpretation is difficult and often gives contradictory conclusions.

Likelihood Ratio Tests (LR Test): Likelihood ratios are ratios of probabilities of every independent variable (Table 11). The Likelihood Ratio Test (LR Test) is usually employed to judge the overall model fit while comparing Intercept-only and final models.

When the Log-Likelihoods of the two models are compared in the LR Test, the effect of each independent variable is computed independently and checked for their impact on the dependent variable (Tabatchnick & Fidell, 2007).

Table 11
Likelihood Ratio Test for Independent Variables

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood of Reduced Model	Chi-square	df	Sig.
Intercept	1943.120	57.431	4	.000
Total_Looms_Own	1962.856	77.167	4	.000
Total_Looms_Working	1917.306	31.617	4	.000
Total_Looms	1893.038	7.349	4	.119
House_Ownership	1912.569	26.880	4	.000
House_with_Workshed	2017.131	131.442	4	.000
Source_of_Weaving_Knowledge	1901.570	15.881	4	.003
Type_of_Looms	1906.793	21.104	4	.000
Weaver_work_for	1901.572	15.883	4	.003

The Chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

The -2 Log-Likelihood is calculated for the reduced model (Intercept/Null) without the effect. However, in the final model (tested model with variables), the effect of the variables will be measured. As a result, the difference between the -2 Log-Likelihoods of the reduced model and the final model yields the Chi-square statistic (Bing Li and Jogesh Babu, 2019).

Table 11 provides the values of likelihood ratios and significance in the last column of all the independent variables. Except for the Sig value of 0.119 recorded against the variable Total Looms, the rest of the values were found statistically significant.

Parameter Estimates: Parameter estimates (coefficients, β) predict the log odds of the dependent variable and further reveal the relationship between the outcome and the independent variables. The parameter estimates find values for the coefficients that maximise the likelihood function and find the set of coefficients that constitutes data most likely.

The core strength of MLR lies in the Parameter Estimates (Table 12) because all the independent variables of a particular category of a dependent variable are grouped, and estimates are computed for all the paired groups to find the different effects of a specified variable within every group. When the MLR is conducted, SPSS automatically assigns the last category of the independent variable as the reference category, or the researcher also has the option to choose the reference category.

A coefficient defines the strength of the contribution of that predictor (independent variable). The larger the magnitude of the coefficient value, the stronger the influence on the probability estimation of that outcome. Zero or near-zero coefficients have very little influence. The negative coefficients would decrease the likelihood of that outcome; however, the positive significant coefficients increase the likelihood.

Column B - Parameter Estimates β (coefficients).

Std. Error (SE) refers to Standard Errors of the individual parameter estimates (coefficients), and lesser values indicate strong influence; therefore, the Standard Errors of greater than 2 need to be checked.

Wald – It is the squared ratio of the Parameter Estimates to the Standard Error of the respective independent variable (explanatory/predictor variable).

Wald Chi-squared = (Parameter Estimate (coefficient)/standard error) ^2

Wald Chi-squared = (B/SE)2

Wald Chi-squared Test is a parametric statistical technique to find the significance of the independent variables and their influence, collectively or separately, in a model (Bewick et al., 2005). A variable becomes significant only when it adds some value to the model. Therefore, only the independent variables having a coefficient value of over zero can be kept, while removing others as they do not add any value to the model.

The Wald Chi-squared Test rejects the null hypothesis if the relevant coefficient is not zero. If the significance of the *p*-value of the corresponding Wald is less than 0.05, then the coefficient differs from 0; hence, the variable is significant and improves model fit (Maddala, G. S. 1992).

Table 12
Parameter Estimates

Production Per Day (yards)[a]		B	Std. Error	Wald	df	Sig.	Exp (B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
<2	Intercept	3.267	1.602	4.159	1	.041			
	Total_Looms_Own	-.760	.298	6.517	1	.011	.468	.261	.838
	Total_Looms_Working	.755	.325	5.391	1	.020	2.127	1.125	4.023
	Total_Looms	-.214	.119	3.230	1	.072	.807	.639	1.020
	House_Ownership	-.500	.209	5.745	1	.017	.606	.403	.913
	House_with_Workshed	-.015	.185	.007	1	.934	.985	.686	1.415
	Source_of_Weaving_Knowledge	-.067	.468	.020	1	.886	.935	.374	2.340
	Type_of_Looms	1.013	.598	2.864	1	.091	2.753	.852	8.896
	Weaver_work_for	-.058	.220	.069	1	.793	.944	.613	1.454
2 to 4	Intercept	.072	1.661	.002	1	.965			
	Total_Looms_Own	-1.279	.301	18.006	1	.000	.278	.154	.502
	Total_Looms_Working	1.095	.329	11.105	1	.001	2.990	1.570	5.694
	Total_Looms	-.166	.122	1.857	1	.173	.847	.667	1.075
	House_Ownership	-.226	.213	1.128	1	.288	.798	.526	1.211
	House_with_Workshed	.526	.189	7.718	1	.005	1.692	1.167	2.451
	Source_of_Weaving_Knowledge	.428	.483	.784	1	.376	1.534	.595	3.957
	Type_of_Looms	.688	.623	1.219	1	.270	1.990	.586	6.752
	Weaver_work_for	.138	.224	.378	1	.539	1.148	.739	1.782
4 to 6	Intercept	1.949	1.776	1.204	1	.272			
	Total_Looms_Own	-.642	.322	3.965	1	.046	.526	.280	.990
	Total_Looms_Working	.881	.359	6.029	1	.014	2.413	1.195	4.875
	Total_Looms	-.314	.144	4.782	1	.029	.730	.551	.968
	House_Ownership	-.357	.236	2.286	1	.131	.700	.440	1.112
	House_with_Workshed	-.284	.204	1.935	1	.164	.752	.504	1.123
	Source_of_Weaving_Knowledge	.312	.549	.322	1	.570	1.366	.465	4.010
	Type_of_Looms	-.229	.638	.129	1	.720	.795	.228	2.777
	Weaver_work_for	.119	.242	.241	1	.623	1.126	.701	1.810
6 to 8	Intercept	-30.668	1.884	265.088	1	.000			
	Total_Looms_Own	-.655	.374	3.056	1	.080	.520	.249	1.083
	Total_Looms_Working	.682	.416	2.693	1	.101	1.979	.876	4.470
	Total_Looms	-.083	.168	.246	1	.620	.920	.662	1.279
	House_Ownership	-.266	.291	.840	1	.360	.766	.433	1.355
	House_with_Workshed	.175	.254	.475	1	.491	1.191	.725	1.957
	Source_of_Weaving_Knowledge	1.013	.852	1.412	1	.235	2.754	.518	14.635
	Type_of_Looms	14.086	.000	.	1	.	1311141.244	1311141.244	1311141.244
	Weaver_work_for	.336	.278	1.464	1	.226	1.400	.812	2.415

a. The reference category is 8 to 10.

Exp (B) or exponential value of B shows the odds ratios for the predictors. An Odds Ratio (OR) is a metric of association between an exposure and the resultant outcome. It compares the odds of two different outcomes, the first when exposed to specific situations/conditions and the other without such exposure. A less than one (1) OR shows less probability of the event/condition happening; in contrast, the higher OR values of greater than one (1) show more chances of that event/condition happening (Douglas G Altman. 1994).

95% Confidence Interval (CI) for Exp (B) is calculated to assess individual predictors' contribution and determine whether the output value is significant. However, unlike the p-value, the 95% CI does not indicate statistical significance but is used as a substitution (Katz, 2011).

If a standard alpha is assumed to be 0.05, then the confidence interval is 95% (1–alpha), which means the true Odds Ratio (OR) of the overall population is within range. In other words, a large CI points to a low level of precision of the OR, while smaller CI values show higher precision; however, a CI value cannot be equated with a *p*-value (Szumilas, M. 2010; Hosmer & Lemeshow, 2000).

The SPSS software identified the category 8 to 10 as the reference category (Table 12).

The category-wise detailed analysis follows:

Category <2 (less than 2): When perusing the category of less than 2, only three variables, 'Total Looms Own', 'Total Looms Working' and 'House Ownership', were found to have statically significant *p*-values. The detailed analysis is as below:

Variable: Total Looms Own:

- 'Total Looms Own' did not have a positive B value (-.760), hence less influential.
- The Std Error of .298 was found to be less than 2; hence, it goes well with the model.
- The Wald had a value of 6.517 and was also associated with a significance of .011; hence, it is statistically significant and rejects the null hypothesis.

- Exp (B) value of .468 indicates a 53% lower (1 minus 0.468= .532 or 53%) likelihood of the variable 'Total Looms Own' to influence the productivity within the range of '<2 yards' than the same variable in the reference category of 8 to 10.

Variable: Total Looms Working:

- In the <2 (less than 2) category, the independent variable 'Total Looms Working' had an overall significant effect with a positive coefficient of .755.
- The Std Error of .325 was found to be less than 2; hence does not require any check.
- The Wald had a value of 5.391 and was also associated with a significance of .020; therefore, it is statistically significant and rejects the null hypothesis.
- Exp (B) value of 2.127 shows 2.1 times (2.1x100=210%) more likelihood of the variable 'Total Looms Working' to influence the productivity within the range of '<2 yards' than the same variable in the reference category of 8 to 10.

Variable: House Ownership:

- 'House Ownership' did not have a positive B value (-.500); hence, less effective.
- The Std Error of .209 was less than the benchmark value of 2; hence, it complies with the model.
- Besides having a value of 5.745, the Wald was also associated with a significance value of .017; hence, it is statistically significant and rejected the null hypothesis.
- Exp (B) value of .606 shows a 39% lower (1 minus 0.606= .394 or 39%) likelihood of the variable 'Total Looms Own' on influencing the productivity within the range of '<2 yards' than the same variable in the reference category of 8 to 10.

Among the three variables found with a significance of less than 0.05, the variable 'Total Looms Working' is more likely to have a decisive positive influence than the remaining two.

The other variables with negative or non-significant values are less likely to influence.

Category 2 to 4: In the category of 2 to 4, the variables ‘Total Looms Own’, ‘Total Looms Working’ and ‘House with Work-shed’ were significant. However, the remaining variables appeared to be insignificant predictors.

Among the significant variables, the variable ‘Total Looms Working’ was found with 2.9 times (2.9 x100=290%) stronger likelihood and the ‘House with Workshed’ variable closely followed with an Odds Ratio of 1.692, which implies a likelihood of having the outcome 1.7 times higher. On the other hand, the third variable, ‘Total Looms Own’, had a .278 Odds Ratio or 72% lower likelihood.

Category 4 to 6: In the category 4 to 6, the variables ‘Total Looms Own’, ‘Total Looms Working’ and ‘Total Looms’ were significant. However, the remaining variables seemed insignificant predictors with higher *p*-values.

The significant variable ‘Total Looms Own’ had an OR of .526 or 47% lower likelihood. On the other hand, another significant variable, ‘Total Looms Working’ carried an Odds Ratio of 2.413 or 2.4 times more likelihood, and the third significant variable, ‘Total Looms’, had an OR of .730 or 27% lower likelihood than the reference range of 8 to 10 category.

To summarise, out of eight (8) independent variables (predictor variables), only five (5) variables ‘Total Looms Own’, ‘Total Looms Working’, ‘House Ownership’, ‘House with Workshed’ and ‘Total Looms’ were found as good predictors in respective categories.
The other two (2) variables had *p*-values larger than 0.05 and are, therefore, insignificant.

Category 8 to 10 (Reference Category): Using the reciprocal calculation, the values of the category 8 to 10 can also be measured.

Confusion Matrix (CM)/ Classification: Confusion Matrix (CM) is a supervised machine learning technique used to measure the performance of a problem classification (Machine Learning algorithm), where the output is of two or more classes. It is a trusted method to assess how often the classifier is accurate.

CM enables gauging the accuracy and precision of a classifier by comparing the actual and predicted classes. Therefore, CM helps evaluate how well the model predicts and what kind of errors it makes. CM summarises total predictions for a given set of test data with known true values, presented in a table matrix containing predicted and actual values.

A Confusion Matrix is a table of 4 different combinations, like True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN) of actual values and predicted values of a dataset (Figure 12).

1. True Positive (TP): The classifier correctly predicts the positive class as positive.
2. True Negative (TN): The classifier correctly predicts the negative class as negative.
3. False Positive (FP): The classifier incorrectly predicts the negative class as positive.
4. False Negative (FN): The classifier incorrectly predicts the positive class as negative.

		Predicted Values	
		Positive	**Negative**
Actual Values	**Positive**	True Positive (TP)	False Negative (FN)
	Negative	False Positive (FP)	True Negative (TN)

Figure 12
Schematic diagram of Confusion Matrix

All the diagonal cells represent good predictions, and an ideal model should have a high rate of True Positives (TP) and True Negatives (TN) along with a low rate of False Positives (FP) and False Negatives (FN).

The Confusion Matrix results are presented in Table 13 and explicated elaborately. However, such elaboration was avoided in the subsequent Confusion Matrix Tables.

Table 13
Confusion Matrix/Classification

Observed	Predicted					
	<2	2 to 4	4 to 6	6 to 8	8 to 10	Percent Correct
<2	[1] 8465	[2] 2	[3] 0	[4] 0	[5] 0	99.9%
2 to 4	[6] 2334	[7] 0	[8] 0	[9] 0	[10] 0	0.0%
4 to 6	[11] 521	[12] 0	[13] 0	[14] 0	[15] 0	0.0%
6 to 8	[16] 144	[17] 0	[18] 0	[19] 0	[20] 0	0.0%
8 to 10	[21] 128	[22] 0	[23] 0	[24] 0	[25] 0	0.0%
Overall Percentage	100.0%	0.0%	0.0%	0.0%	0.0%	73.0%

(Cell numbers for predicted values are shown in tint for greater clarity but avoided in subsequent tables)

Classifier <2 (Less than 2) is explained below:

- <2 (Less than 2) classifier correctly predicted 8465 weavers to have fallen in the category of <2 as True Positives (TP), where the actual value and predicted value are the same. All the correctly classified values (TP) are along the table's upper-left to lower-right diagonal.
- Two (2) weavers were incorrectly identified as falling in the 2 to 4 category, called False Negatives (FN). These are omission errors, defined as the fraction of values that belong to a class but were predicted to be in a different class. Errors of omission represent False Negatives.
- However, 2334, 521, 144 and 128 weavers were incorrectly identified as category <2, hence, called False Positives (FP). These are commission errors, where these numbers were predicted to be in a class but do not belong to that class and are a measure of False Positives.
- True Negative (TN) is the sum of values of all columns and the row except the class values that are calculated.

- In this test, there are no True Negatives (TN).
- Classifiers 2-4, 4-6, 6-8 & 8-10:
- The other categories from 2 to 4, 4 to 6, 6 to 8 and 8 to 10 have no True Positives (TP); hence, no weavers were predicted.
- Similarly, there are no False Negatives (FN), False Positives (FP), and True Negatives (TN) in this classifier.

The overall accuracy of the model can be calculated by summing the number of correctly classified values and dividing them by the total number of values through the following formula:

$$= \frac{TP+TN}{(TP+TN+FP+FN)}$$

= 8465+0/8465+0+3127+2 = 0.73 or 73 %

In this present test, the overall accuracy (correctness) of the model is 73 per cent; however, it is 99.9 per cent accurate with a productivity classifier <2 (Less than 2), which happened to be the largest group with over 73 per cent of weavers falling in this category. The largest groups (categories) of the dependent variable have the strongest prediction in MLR (Hosmer & Lemeshow, 2000).

For other categories, the prediction is poor. However, the model's overall accuracy of 73 per cent is because of a low volume of data in the Productivity categories of 4-6, 6-8 & 8-10 yards/per day (Table 13).

4.3.1.2 Artificial Neural Network (ANN) – Model 1

In this test, the ANN was initially trained and fed data from about 11594 records of weavers with fixed weights and biases. Then, the data input passed through many multiplication layers and underwent a complex and non-linear transformation to make predictions. The process was iterated until the input was optimised and reduced the error.

In this model (Table 14), approximately 69 per cent of the data were assigned for training and 30.2 per cent for testing.

Table 14
Case Processing Summary

		N	%
Sample	Training	8089	69.8%
	Testing	3505	30.2%
Valid		11594	100.0%
Excluded		0	
Total		11594	

Network Information in Table 15 shows the layer-wise details of the multi-layered Perceptron.

Table 15
Network Information

Input Layer	Covariates	1	Total_Looms_Own	
		2	Total_Looms_Working	
		3	Total_Looms	
		4	House_Ownership	
		5	House_with_Workshed	
		6	Source_of_Weaving_Knowledge	
		7	Type_of_Looms	
		8	Weaver_work_for	
	Number of Units[a]			8
	Rescaling Method for Covariates		Standardized	
Hidden Layer(s)	Number of Hidden Layers			1
	Number of Units in Hidden Layer 1[a]			5
	Activation Function		Hyperbolic tangent	
Output Layer	Dependent Variables	1	Production_Per_Day (yrds.)	
	Number of Units			5
	Activation Function		Softmax	
	Error Function		Cross-entropy	

a. Excluding the bias unit

The input layer was fed with data from 8 selected independent variables. The hidden layer chose one dependent variable, ‘Production Per Day’ (yards) and contained five unobservable units with some values showing the function of the predictors.

The model summary (Table 16) shows the ANN’s predictive accuracy. The incorrect predictions were 26.9 per cent for the training data and 27.2 per cent for the testing data. The diagrammatic representation of ANN is depicted in Figure 13.

Table 16
Model Summary

Training	Cross Entropy Error	6313.632
	Percent Incorrect Predictions	26.9%
	Stopping Rule Used	1 consecutive step(s) with no decrease in error[a]
	Training Time	0:00:00.55
Testing	Cross Entropy Error	2767.067
	Percent Incorrect Predictions	27.2%

Dependent Variable: Production_Per_Day (yards.)

a. Error computations are based on the testing sample.

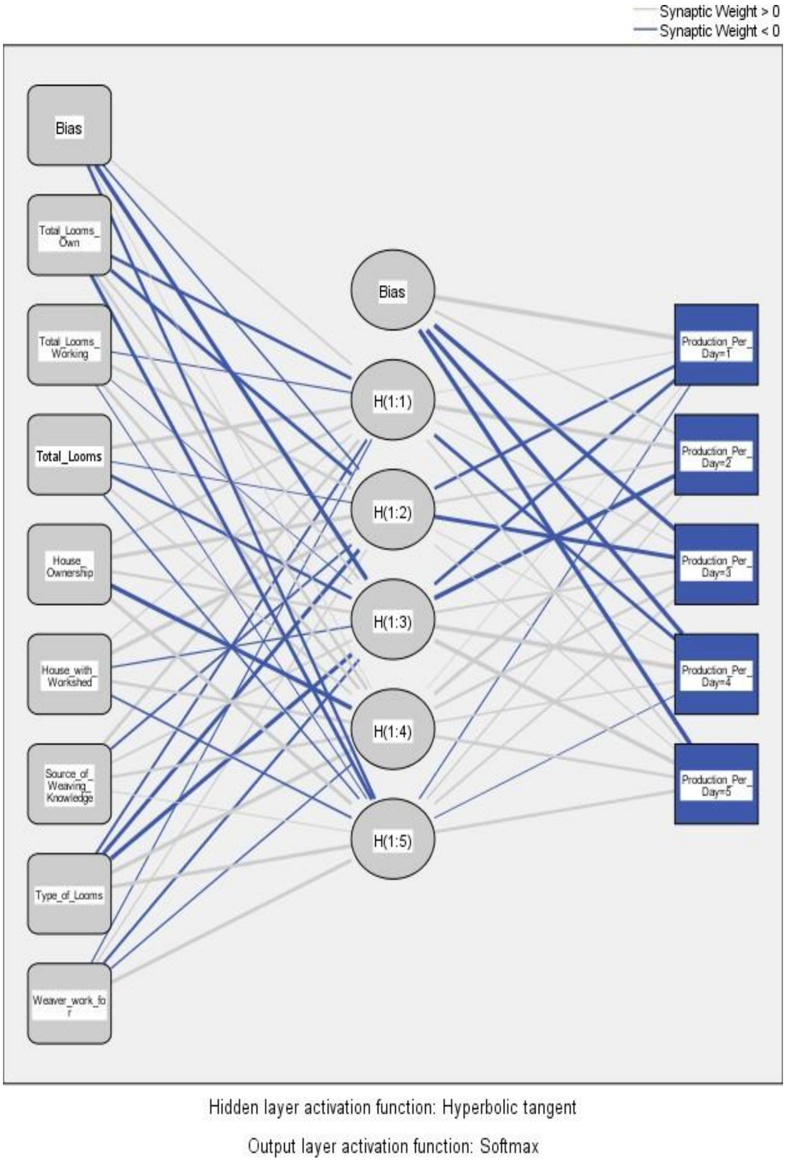


Figure 13
ANN output – Model 1

The confusion matrix of ANN is shown in Table 17. In this model, the overall correctness of the model is 72.8 per cent; however, it is 72.8 per cent accurate with a productivity classifier <2 (Less than 2). For other categories, the prediction is poor.

Table 17
Confusion Matrix/ Classification

Sample	Observed	Predicted					
		<2	2 to 4	4 to 6	6 to 8	8 to 10	Percent Correct
Training	<2	5915	0	0	0	0	100.0%
	2 to 4	1628	0	0	0	0	0.0%
	4 to 6	350	0	0	0	0	0.0%
	6 to 8	106	0	0	0	0	0.0%
	8 to 10	90	0	0	0	0	0.0%
	Overall Percent	100.0%	0.0%	0.0%	0.0%	0.0%	73.1%
Testing	<2	2552	0	0	0	0	99.9%
	2 to 4	706	0	0	0	0	0.0%
	4 to 6	171	0	0	0	0	0.0%
	6 to 8	38	0	0	0	0	0.0%
	8 to 10	38	0	0	0	0	0.0%
	Overall Percent	100.0%	0.0%	0.0%	0.0%	0.0%	72.8%

Dependent Variable: Production_Per_Day (yards.)

Classifier <2 (Less than 2) is explained below:

- <2 (Less than 2) classifier correctly predicted 2552 weavers who have fallen in the category of <2 as True Positives (TP).
- However, 706, 171, 38 and 38, totalling 953 weavers, were incorrectly identified as category <2, called False Positives (FP).
- No True Negatives (TN) or False Negatives (FN) exist.
- Classifiers 2-4, 4-6, 6-8 & 8-10:
- The other categories from 2 to 4, 4 to 6, 6 to 8 and 8 to 10 have no True Positives (TP); hence, no weavers were predicted.
- Similarly, there are no False Negatives (FN), False Positives (FP), and True Negatives (TN).

Sensitivity and Specificity: Sensitivity, also called Recall, measures the share of actual positive cases predicted correctly as True Positive (TP). Higher values of Sensitivity indicate higher accuracy.

Sensitivity = True Positive (TP)/True Positive (TP) + False Negative (FN)

$$\text{Sensitivity} = \frac{TP}{TP+FN}$$

In contrast, Specificity shows the share of actual negatives predicted correctly as True Negatives (TN). Therefore, higher values of Specificity indicate more accuracy.

Specificity = True Negative (TN)/True Negative (TN) + False Positive (FP)

$$\text{Specificity} = \frac{TN}{TN+FP}$$

Specificity and Sensitivity analysis gauge the model's performance by leveraging Receiver Operating Characteristics Curves (ROC). The Area Under the ROC Curve (AUC) determines the model's performance, and therefore, AUC is the ratio between Area Under the ROC curve and the total area (Table 18). Hence, the higher the value (area), the more the accuracy.

Table 18
Area Under the Curve

		Area
Production_Per_Day (yards.)	<2	.635
	2 to 4	.642
	4 to 6	.617
	6 to 8	.599
	8 to 10	.566

Specificity (TN) rates on the X-axis and Sensitivity (TP) rates on the Y-axis are plotted to generate ROC. The test is considered good if the intersection of both Specificity and Sensitivity falls above the black diagonal line as in Diagram (Figure 14).

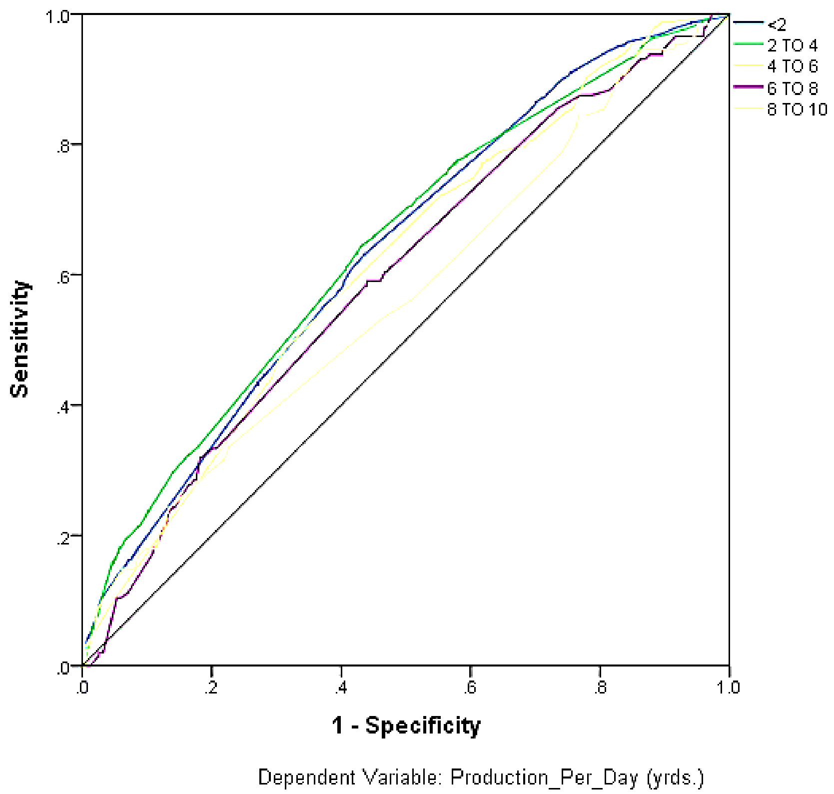


Figure 14
Showing Sensitivity and Specificity – Model 1

Gain Chart and Lift Chart: The Gain Chart and Lift Chart are visual aids to measure the performance and benefits of a classification model. The Confusion Matrix determines the performance of the model generated with the entire dataset. Whereas, Gain and Lift charts measure the models' performance in portions (deciles) of the entire population or dataset. Gain and Lift charts compute the performance of each variable and rank the probabilities in decreasing order.

The ratio between a cumulative number of positive observations within a particular decile and the total number of cumulative positive observations of all the deciles in the entire data set indicates Gain. The predicted probabilities obtained from ANN are arranged in the decreasing order of their prediction. The entire ranked dataset is divided into ten (10) equal subsections called deciles.

Gain values are plotted on the Y-axis, and the total number of positive responses from the entire ranked data split into deciles is plotted on the X-axis (Figure 15).

The diagonal baseline indicates a random response without the model, which is equal to one (1). Any Gain larger than one (1) or, in other words, a larger area between the Gain and diagonal baseline shows that the predictive model is better than the random one.

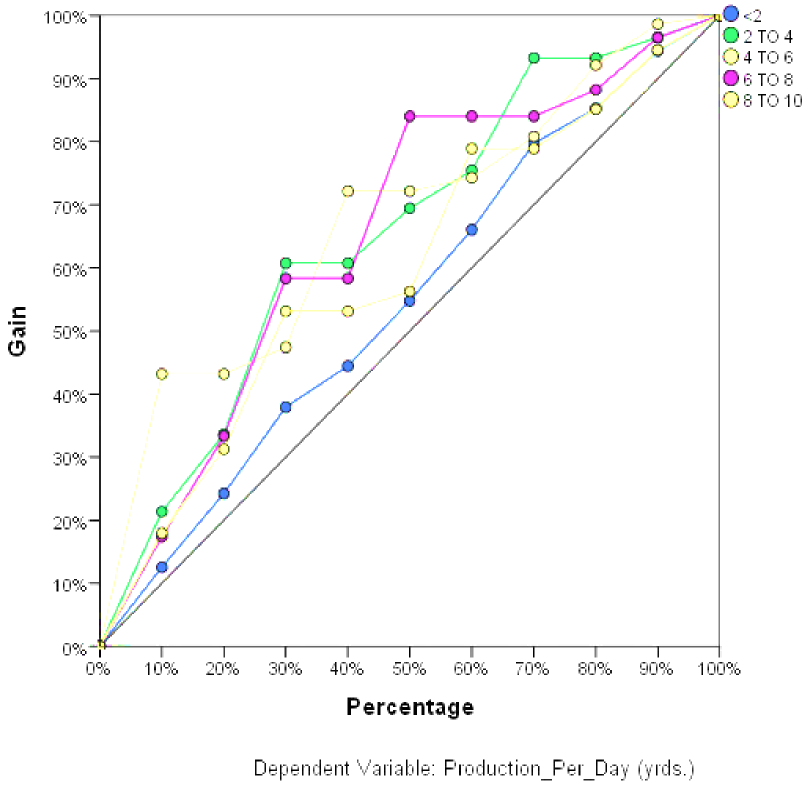


Figure 15
Gain Chart – Model 1

A Lift chart illustrates the improvement brought about by a model compared to the predictions without a model, and the improvement is referred to as Lift.

Therefore, the Lift is a ratio between the cumulative number of positive observations from the model up to a particular decile and the expected cumulative number of positive observations without the model of the same decile.

Lift values are plotted on the Y-axis, and the total number of positive responses from the same decile is plotted on the X-axis. The Y-axis is at level one (1) and represents the baseline, and any gain above one (1) indicates an improvement over the random model (Figure 16).

A greater area above the horizontal baseline in the diagram indicates a better model.

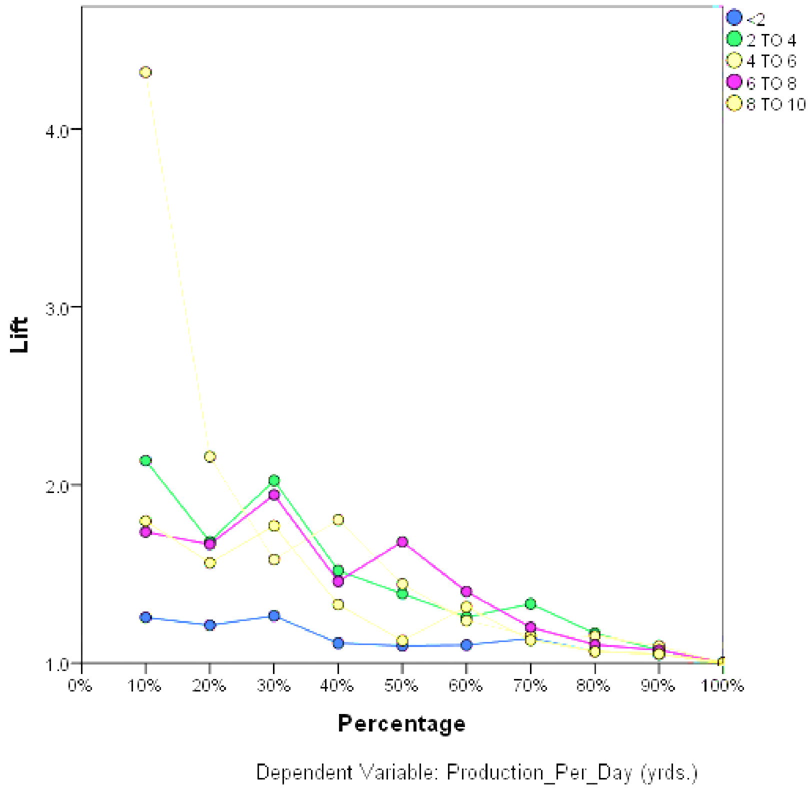


Figure 16
Lift Chart – Model 1

Independent Variable Importance: The relative importance and strength of each Independent Variable that influences the dependent variable is presented in Table 19.

Table 19
Independent Variable Importance

	Importance	Normalized Importance
Total_Looms	.120	47.8%
Total_Looms_Own	.252	100.0%
Total_Looms_Working	.226	89.6%
House_Ownership	.052	20.6%
House_with_Workshed	.051	20.1%
Source_of_Weaving_Knowledge	.077	30.7%
Type_of_Looms	.123	48.8%
Weaver_work_for	.100	39.7%

As such, the predictor's importance does not indicate the model's overall accuracy; however, they play a relative role in making a prediction, regardless of the overall model's accuracy or otherwise. Therefore, all values are equal to 1.0 since they are relative.

Figure 17 shows the normalised importance of all the independent variables.

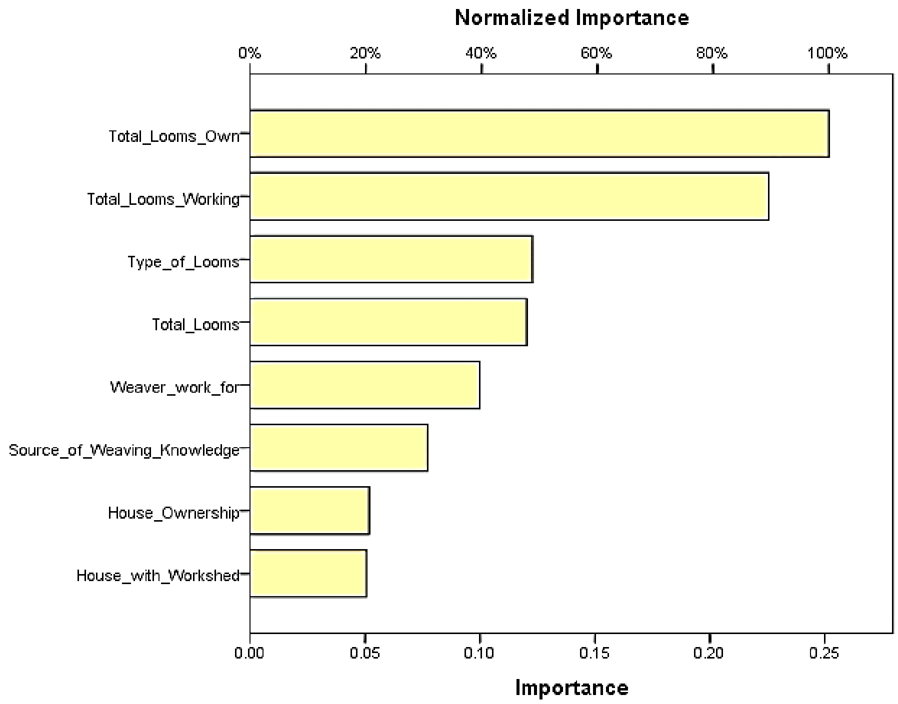


Figure 17
Showing the normalised importance of predictors

Among them, 'Total Looms Own' has the maximum influence, followed by 'Total Looms Working', and a distant third is 'Type of Looms'. Normalized importance can be computed by dividing the importance value of a variable by the variable having the largest importance value.

4.3.1.3 Decision Tree (DT) - Model 1

A Decision Tree (DT) is a visual aid with categorical results for classification and regression problems. The Decision Tree, a supervised learning algorithm, is built in two steps. The system gets trained with the input data and develops a model in the first step. In the second step, the testing data is leveraged to measure the performance of that model and come up with a prediction by comparing it with the actual values.

This study used CHAID (Chi-squared Automatic Interaction Detector) algorithms to grow the Decision Tree (DT).

CHAID gauges the statistical significance between the sub-nodes and the parent node. The DT algorithm runs the Chi-square test repeatedly and identifies the predictors that strongly relate to the target and eventually influence the outcome. The higher Chi-square values of a field indicate the higher statistical significance and are accompanied by smaller *p*-values of less than 0.05. The results of a DT depend on certain parameters such as the depth of the tree, accuracy of classification, number of Leaves (Pure Node) and the number of decision nodes (Any node that splits into further sub-nodes).

Figure 18 shows the DT generated in Model 1. It has a depth of three (3) with one root node and 21 other nodes, including 13 leaf nodes (Terminal Nodes).

The DT begins with the root node, which shows the dependent variable ‘Production per Day’. Then, depending on the statistical significance and relation with the target variable, the predictor splits the data. The split happens concerning the strength and order of a predictor’s importance. The predictors with higher Chi-square values with corresponding *p*-values of less than 0.05 perform the split.

Here in this model, the best predictor with strong relation was found to be ‘Total Looms’ with a big chi-square of 233, which divided the root node into four (4) child nodes classifying the artisans based on the number of looms in their possession.

The first row of nodes, including the first, second and fourth child nodes, is again subdivided based on the number of looms owned by the weavers with chi-square values between 71 and 198.

However, the third node was divided based on the variable ‘House with Workshed’ with a chi-square of 77. Therefore, the next best predictors reckoned are ‘Total Looms Own’ and ‘House with Work-shed’.

In the second row of nodes from 5 to 11, the variables ‘House with Workshed’, Type of Looms and ‘Total Looms Own’ are found to be significant predictors with Chi-square values ranging from 12 to 61. All the nodes in the third row from 12 to 21 are leaf nodes (pure nodes).

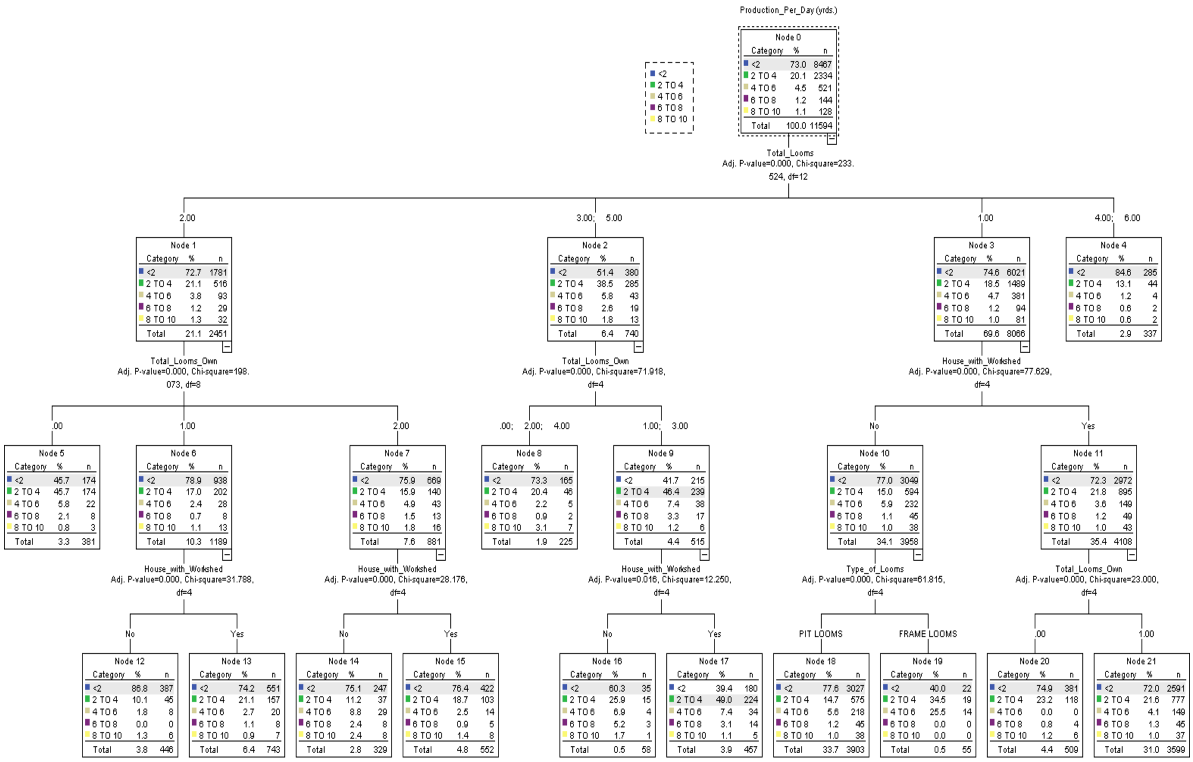


Figure 18
Decision Tree of Model 1

The Confusion Matrix generated by the DT algorithm shows the accuracy levels of different productivity scales (Table 20).

Table 20
Confusion Matrix/Classification

Observed	Predicted					
	<2	2 to 4	4 to 6	6 to 8	8 to 10	Percent Correct
<2	8287	180	0	0	0	97.9%
2 to 4	2110	224	0	0	0	9.6%
4 to 6	487	34	0	0	0	0.0%
6 to 8	130	14	0	0	0	0.0%
8 to 10	123	5	0	0	0	0.0%
Overall Percentage	96.1%	3.9%	0.0%	0.0%	0.0%	73.4%

Growing Method: CHAID
Dependent Variable: Production_Per_Day (yards)

The Classification (Confusion Matrix) Table 20 shows the number of predictions classified correctly and incorrectly for each category of the dependent variable.

Classifier <2 (Less than 2) is explained below:

- <2 (Less than 2) classifier correctly predicted 8287 weavers to belong to the category of <2 as True Positives (TP).
- 180 weavers were incorrectly identified as falling in the category 2 to 4, called False Negatives (FN).
- However, 2110, 487, 130 and 123 weavers, totalling 2850, were incorrectly identified as <2 category and hence called False Positives (FP).
- There are 277 True Negatives (TN) in this test.
- The accuracy stands at 97.9%.
- Classifiers 2-4, 4-6, 6-8 & 8-10:
- For classifier 2-4, the TP stands at 224; however, other values are nil; therefore, the accuracy for classifier 2-4 stays at 9.6%.
- The other classifiers from 4 to 6, 6 to 8 and 8 to 10 have no True Positives (TP), False Negatives (FN), False Positives (FP), and True Negatives (TN), and hence no weavers were predicted in these categories.

In this present case, the overall accuracy (correctness) of the model is 73.4 per cent; however, it is 97.9% accurate with productivity classifier <2 (Less than 2) and 9.6% for the classifier 2 to 4. For other categories, the prediction is poor.

The overall prediction accuracy of 73.4 per cent is because of the low volume of data in the ‘productivity categories’ of 4-6, 6-8 & 8-10 yards/per day.

The results of MLR, ANN and DT are analysed and summed up below with reference to the first research question.

4.3.1.4 Research Question 1 – Review and Inferences

The first research question explores the reasons for handloom weavers’ low productivity, despite tremendous industry potential.

What deters the weavers from achieving higher productivity growth despite the handloom sector's inherent potential?

It is pertinent to recall the Sec 3.3.3 of Chapter III, wherein three perspectives were visualised. The first perspective of productivity seeks to know the factors that led to low productivity in the weaving community.

It is to reiterate that India currently has the largest population of handloom artisans globally, with the most extensive infrastructure and abundant raw materials. However, their productivity levels are not commensurate with the available potential, and the consequent earnings are also abysmally low.

On comparing the prediction results of MLR, and DT methods, out of the 11594 weavers who participated in the survey, about 98 per cent of the artisans produce less than 2 yards/day; however, the ANN indicated slightly lesser artisans of about 73 per cent to be in this category of production. All three analytical methods show that all the variables considered in this model are relevant and impactful; however, at varying levels (Table 21).

Table 21
Model 1- Comparative Performance of all 3 Methods

	Predicted		
Observed Range	Multinomial Logistic Regression	Artificial Neural Network	Decision Tree
<2	99.9%	72.8%	97.9%
2 to 4	0.0%	0.0%	9.6%
4 to 6	0.0%	0.0%	0.0%
6 to 8	0.0%	0.0%	0.0%
8 to 10	0.0%	0.0%	0.0%
Overall Percentage	73%	72.8%	73.4%

The enumeration results show that over 73% of weavers produce less than 2 yards of fabric per day. About 20 per cent of weavers account for 2-4 yards of productivity per day; however, very few can produce over 4 yards per day. On witnessing these results, many questions will emerge.

- Why did most artisans fail to realise the need for higher productivity for income gain?
- What factors of production particularly impeded productivity growth in the handloom sector?
- Why have the formal and informal agencies, including the government, not attempted to address these issues?

Therefore, it is imminent and imperative to know what factors of production have adversely affected and imperilled the productivity of artisans.

Accordingly, Model 1 was designed to find answers to some of these questions, with eight (8) predictor variables which were believed to affect productivity.

In the current artisanal economy, the artisans work too hard and get too little. So what makes an artisan more productive and earn more?

Productivity is a measure to estimate the ratio of inputs vis-à-vis outputs. A higher output level against a minimum level of inputs indicates an efficient production system. The difference between growth in inputs and growth in outputs estimates productivity growth.

The higher the productivity growth, the higher the increased individual income and higher living standards (OECD, 2008). Currently, the handloom sector is operating far below the optimal level compared to its inherent capacity due to many inconsistencies.

Multifarious factors affect productivity. The inefficiency of production factors, such as men, material, capital, technology, competition, enterprise, innovation, and skills, undermines productivity (OECD, 2008).

In addition, the informal nature of the handloom sector, the declining number of weavers, and the low participation rate of youth contribute substantially to the declining production of handloom products.

Regarding the first research question, a detailed analysis was carried out while embarking on multiple analytical methods, such as MLR, ANN and DT.

Based on the literature on the handlooms sector, certain factors that were believed to impact weaver's productivity have been selected as far as practicable. These factors have been considered as independent variables and tested against the dependent variable 'Productivity per Day'. All three methods of analysis have yielded tangible and similar results.

The analysis shows that all the variables employed are relevant and impactful but at varying levels, depending on the productivity range envisaged in the test.

The survey carried out in the project area reveals that independent weavers make up just 5 per cent of the total weavers; however, close to 92 per cent work under the control of Master Weavers and depend on them for all their professional and personal needs, including finance, raw materials, and marketing. The relationship between Master Weaver and Weaver is exploitative and is similar to master and slave.

The predictor 'Weavers Working For' is found to be less significant and a poor predictor in MLR analysis, since most weavers eternally depend on master weavers, as there are no viable alternatives available. Complete subordination to the master weavers makes weavers vulnerable and feeble.

The survey also discloses the uncongenial work environment in which weavers usually work. A pleasant work environment is a morale booster and improves productivity and business success. Water and sanitation are essential parameters for a healthy and productive life; unfortunately, 60 per cent of artisans in the project area do not have safe drinking water access, and 47 per cent are away from toilet facilities and still practice open defecation.

Owning a house is a fundamental need and provides social security that imparts self-confidence and respect in society. The survey reveals that only 56 per cent of the weavers have permanent houses. The remaining stay in semipermanent and thatched houses with inadequate and dilapidated infrastructure. ANN shows that the variables ‘House Ownership’ (20.6%) and ‘House with Work-shed’ (20.10%) exhibited considerable impact.

Notably, over 91.45 per cent of weavers have a cramped workspace of fewer than 100 sq ft within the house, which hardly accommodates the professional infrastructure such as looms and other accessories. Only 57.43 per cent of weavers have a dedicated workshed for carrying out the weaving activity. The Chi-square value of the Likelihood Ratio Test (LRT) showed that the variable ‘House with Work-shed’ was identified to be the most impactful, with over 40 per cent weightage among others, and the DT algorithm also confirmed the same.

Investment is one of the critical factors of production. Investment in technology acquisition and physical capital, such as machinery, equipment, and other infrastructure, plays a vital role in production.

The DT algorithm shows that the variable ‘Total Looms’ is a strong predictor. Around 79.5 per cent of the weavers possess their own looms, and about 67 per cent of looms are located in their households, and the balance of looms was either available with Master Weavers or PWCs or others.

The survey also reveals that about 80 per cent of the looms are in working condition, and 97.8 per cent of artisans have only one loom. All three methods predicted the <2 yards/day category to be the dominant productivity range.

The Wald value, in percentage, for each independent variable was plotted to show the influence and strength against the target variable. The income group-wise analysis gives a holistic understanding of the degree and intensity of the effect of every variable (Figure 19).

MLR analysis shows (Figure 19) that among the category of <2 yards/day (less than 2 yards/day), all the variables have a low impact; however, ‘Own looms’ and ‘Total Looms Working’ are slightly better influencing variables with 23% and 21% impact, respectively.

The low impact of all variables in this category establishes artisans' passive and compromised attitudes developed over time due to a lack of motivation and reward.

The same variables, 'Own looms' and 'Total Looms Working', were found more effective in the 2 to 4 yards/day category with 43% and 26% impact. The influence was relatively stronger in the weavers' 4 to 6 yards category at 29% and 23%, respectively. However, none of the variables substantially impact the higher categories.

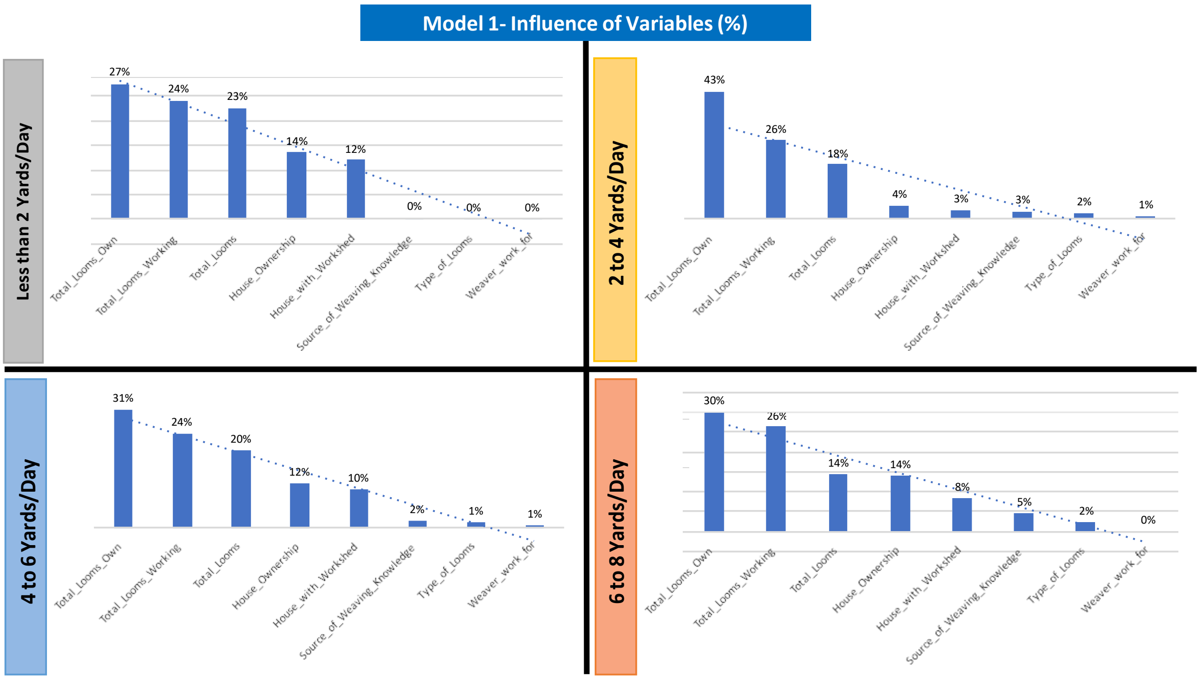


Figure 19
Comparative influence of predictors- Income group-wise

The ANN (Table 22) also confirms the impact of variables' 'Own Looms' and 'Total Looms Working', and both carry relevance of over 90%.

Table 22
Variables Importance generated by ANN

	Normalized Importance
Total_Looms_Own	100.00%
Total_Looms_Working	89.60%
Type_of_Looms	48.80%
Total_Looms	47.80%
Weaver_work_for	39.70%
Source_of_Weaving_Knowledge	30.70%
House_Ownership	20.60%
House_with_Workshed	20.10%

DT has also signified the importance of the variable ‘Total Looms Own’. These results prove that ownership of the looms and their working condition are significant factors of production.

The DT indicates the significance of ‘Type of Looms’. Over 97 per cent of the looms owned by the artisans are Pit Looms, which are considered obsolete, less productive and un-ergonomic. Inefficient workplace infrastructure is a liability and increases drudgery, lethargy and passive attitude in the long run.

The survey reveals that about 96.67 per cent of the weavers automatically inherit the basic weaving knowledge and skill from their parents and other siblings as they grow up in an environment where the entire family is engaged in weaving. Moreover, the survey says that only 3 per cent have received skill up-gradation training arranged by government departments. In the absence of skill up-gradation, productivity is usually low; therefore, in all three analytical approaches, the variable ‘Source of Weaving Knowledge’ remains a poor predictor.

Over 94.39 per cent do not have substantial educational attainments, and 55 per cent are illiterate. General management, market intelligence and supply chain management practices, often regarded as vital for any business success, are absent in the handloom economy due to a lack of awareness and sufficient education. The weavers rely upon Master Weavers for everything.

The findings of the qualitative data obtained through personal interviews are in tune with the observations of quantitative data analysis.

In conclusion, it is established that many interrelated production factors influence a weaver’s productivity. Over time, the enhanced rate of productivity growth determines economic growth and improves living standards. Therefore, higher productivity implies higher income for artisans and a higher standard of living.

4.3.2 Model 2 and Research Question 2

Model 2 focuses on supply chain challenges influencing productivity and weaver's revenue earnings. This model is expected to answer the second research question.

Whether the business performance in the handloom sector lies in the broader, robust and resilient supply chain?

One Target (dependent) variable, 'Monthly Income' of the weaver, was tested with five (5) independent variables that are believed to influence the weaver's income and productivity (Table 23).

Different Machine Learning and AI approaches were sequentially employed to test this model using the same data.

Table 23
Model 2- Selected Variables

Dependent Variable	Monthly Income
Independent Variables	Source of Raw Material Bank Loan Availed (Credit Access) Marketing of Final Product Price Realization & Negotiation Dependence on Others (Middlemen)

4.3.2.1 Multinomial Logistic Regression (MLR) – Model 2

The Case Processing Summary reveals that the dependent variable (Monthly Income) has five different scales of income ranging from less than Rs 3000 per month to above Rs 12000 per month.

Out of the 11594 weavers enumerated, about 48.5 per cent were in the Rs 3000 to 6000 group. Another 41.2 per cent were in the less than Rs 3000 category. Therefore, almost 90 per cent of the weavers were categorised as belonging to the less than Rs 6000 income group. However, a fraction of weavers were in the other high-income groups.

Model Fitting Information: Model fitting demonstrates the machine learning algorithm's learning ability from a labelled dataset and replicates the same efficiency with the new input data to make predictions (Table 24).

The model fitting test shows the Model Fitting criterion, which relies upon -2 Log-Likelihood and Likelihood Ratio tests. The Chi-Square statistic is the difference between the -2 log-likelihoods of the Null and Final models. Therefore,

LR Chi-Square = -2*L (null Model) – (-2*L (fitted model)).

LR Chi-Square = 550.828 - 439.779= 111.050

df (Degree of Freedom) = 20 groups

Sig = significance = .000

Table 24
Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood	Chi-Square	df	Sig.
Intercept Only	550.828			
Final	439.779	111.050	20	.000

In this test, the final model had a -2 Log-Likelihood value of 439.779 (Table 53) and was also found to be significantly less than the Intercept, suggesting a variance in the outcome and an improvement in model fit.

In addition, the resultant Sig was less than the standard *p*-value of 0.05 and is statistically significant. The Sig value also shows that the final model is an improvement over the baseline intercept-only model and predicts the dependent variable better than the Intercept-only model.

Goodness of Fit: The Goodness-of-Fit indicates the model's suitability, where the observations are summarised to find any discrepancies between the observed and expected values.

Table 25 shows that higher Chi-square values (212.464 & 222.823) of Pearson's and Deviance models indicate a better fit. However, the *p*-values are less than the ideal range of >0.05 (more than 0.05), showing that the model does not suit the data. Therefore, there was an inconsistency in the Goodness of Fit results.

Table 25
Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	212.464	100	.000
Deviance	222.823	100	.000

Pseudo R-Square: In Logistic Regression, three different indicators, Cox and Snell's, Nagelkerke's and McFadden's R^2, represent the Pseudo R-Squared. Table 26 shows the following results:

1. Cox and Snell's Pseudo R^2 was estimated to be .010; since smaller values of less than 1 indicate an improvement over the Intercept-only model, the value of .010 confirms the model's suitability.

2. Nagelkerke's Pseudo R^2 had a value of .011 and showed an improvement over the null.

3. However, McFadden's Pseudo R^2 had an insignificant value of .005, which is much smaller than the desired range of 0.2 to 0.4 for a fit, hence found unsuitable.

Among the three designated Pseudo R-Squared tests, Cox and Snell's and Nagelkerke's tests showed model ft. In contrast, McFadden's Pseudo R^2 test was found below the prescribed range; given these mixed results, reliance on Pseudo R^2 is inadequate.

Table 26
Pseudo R-Square

Cox and Snell	.010
Nagelkerke	.011
McFadden	.005

Likelihood Ratio Tests (LR Test): Likelihood ratios indicate the probabilities of every independent variable. The Likelihood Ratio Test (LR Test) is usually employed to judge the overall model fit.

As mentioned earlier, the difference between the -2 log-likelihoods of the reduced model and the final model yields the Chi-square statistic. Therefore, the final model is considered statistically significant if the difference between these two models is minimal.

In addition, less than 0.05 significant values of the final model also indicate the statistical significance and positive contribution to the model.

Table 27
Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	447.277	7.498	4	.112
Source_of_Raw_Material	444.179	4.400	4	.355
Marketing_of_Final_Product	459.427	19.648	4	.001
Price_Realisation_Negotiation	442.068	2.290	4	.683
Dependence_on_Others	452.405	12.626	4	.013
Bank_Loan_Availed	499.787	60.009	4	.000

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

Table 27 provides the values of likelihood ratios and the significance of all the independent variables. Only three variables were found to show statistically significant values; ‘Marketing of Final Product’, ‘Dependence on Others’ and ‘Bank Loan Availed’. The remaining variables were found not to have statistically significant values.

Parameter Estimates: Parameter estimates (coefficients, β) unveil the relationship between the outcome and the independent variables. Different testing criteria were computed for all the independent variables within a group to identify the impact of a specified variable (Table 28).

Table 28
Parameter Estimates

Monthly Income [a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound
< Rs. 3,000	Intercept	-8.843	2.356	14.091	1	.000			
	Source_of_Raw_Material	.062	.172	.131	1	.718	1.064	.760	1.490
	Marketing_of_Final_Product	-.122	.517	.056	1	.814	.885	.321	2.441
	Price_Realisation_Negotiation	11.372	.904	158.122	1	.000	86853.250	14756.916	511183.172
	Dependence_on_Others	.027	.561	.002	1	.961	1.028	.342	3.089
	Bank_Loan_Availed	.382	.136	7.904	1	.005	1.465	1.123	1.912
> Rs. 12,000	Intercept	-9.986	1025.244	.000	1	.992			
	Source_of_Raw_Material	-.024	.342	.005	1	.945	.977	.500	1.910
	Marketing_of_Final_Product	1.582	.572	7.655	1	.006	4.863	1.586	14.911
	Price_Realisation_Negotiation	2.866	1025.240	.000	1	.998	17.572	0.000	.[b]
	Dependence_on_Others	1.168	.738	2.508	1	.113	3.216	.758	13.650
	Bank_Loan_Availed	-.067	.329	.042	1	.838	.935	.491	1.781
Rs. 3,001 to 6,000	Intercept	-10.417	2.319	20.186	1	.000			
	Source_of_Raw_Material	.092	.172	.284	1	.594	1.096	.783	1.534
	Marketing_of_Final_Product	.010	.512	.000	1	.984	1.010	.370	2.758
	Price_Realisation_Negotiation	11.693	.901	168.483	1	.000	119778.056	20490.617	700163.531
	Dependence_on_Others	.488	.557	.766	1	.381	1.628	.547	4.851
	Bank_Loan_Availed	.503	.135	13.792	1	.000	1.653	1.268	2.156
Rs. 6,001 To 9,000	Intercept	-13.273	2.193	36.642	1	.000			
	Source_of_Raw_Material	.236	.185	1.626	1	.202	1.267	.881	1.822
	Marketing_of_Final_Product	.265	.534	.246	1	.620	1.303	.457	3.713
	Price_Realisation_Negotiation	12.501	0.000		1		268570.740	268570.740	268570.740
	Dependence_on_Others	.580	.587	.977	1	.323	1.786	.566	5.641
	Bank_Loan_Availed	.013	.148	.008	1	.929	1.013	.758	1.355

a. The reference category is Rs. 9,001 to 12,000.
b. Floating-point overflow occurred while computing this statistic. Its value is therefore set to system missing.

Positive and larger coefficient values strongly influence the probability of an outcome. Besides the impact of the coefficients, the other indicators, such as higher Odds

Ratio (Exp (B)), Wald values associated with significant *p*-values, and Std Error of less than two (2) would steer more probability and enable accurate prediction.

If a standard alpha is assumed to be 0.05, then the Confidence Interval (CI) is 95% (1– alpha), which means the true Odds Ratio (OR) of the overall population is within the range. In other words, a large CI indicates a low level of precision of the OR, while smaller CI values specify higher precision of the model.

In the group < Rs. 3,000, only two (2) variables, 'Price Realisation & Negotiation' with a substantial likelihood and 'Bank Loan Availed' with 1.4 times likelihood, were associated with significant *p*-values, while the remaining three predictors have non-significant *p*-values.

In this group > Rs. 12,000 (More than Rs 12000), only one (1) variable, 'Marketing of Final Product' with 5 times more Likelihood was associated with a significant *p*-value, while the remaining three predictors had non-significant *p*-values.

In the group Rs. 3,001 to 6,000, two (2) variables, 'Price Realisation & Negotiation' with very high likelihood and 'Bank Loan Availed' with 1.6 times higher likelihood were associated with significant *p*-values, while the remaining three predictors had non-significant *p*-values.

The category 'Rs. 6,001 to 9,000', does not have any significant values; therefore, the variables of that group appeared to be poor predictors.

To summarise, for the low and middle-income groups (< Rs. 3,000 and Rs 3001 to 6000), 'Price Realisation & Negotiation' and 'Bank Loan Availed' seemed to be significant determinants. However, for the high-income group, a single variable, ' Marketing of Final Product', was noticed to have a more decisive and positive influence than the remaining variables.

Confusion Matrix/Classification: Table 29 shows the results of the Classifier-wise Confusion Matrix.

Table 29
Confusion Matrix/Classification

Observed	Predicted					
	< Rs. 3,000	> Rs. 12,000	Rs. 3,001 to 6,000	Rs. 6,001 to 9,000	Rs. 9,001 to 12,000	Percent Correct
< Rs. 3,000	409	0	4371	0	0	8.6%
> Rs. 12,000	6	0	39	0	0	0.0%
Rs. 3,001 to 6,000	349	0	5271	0	0	93.8%
Rs. 6,001 to 9,000	71	0	849	0	0	0.0%
Rs. 9,001 to 12,000	23	0	206	0	0	0.0%
Overall Percentage	7.4%	0.0%	92.6%	0.0%	0.0%	49.0%

Classifier < Rs. 3,000 (Less than Rs. 3,000) correctly predicted 409 weavers as True Positives (TP) and another 4371 were incorrectly identified, called False Negatives (FN). In addition, 449 (6, 349, 71, and 23) weavers were incorrectly identified as category < Rs. 3,000 and hence called False Positives (FP). Therefore, the overall accuracy of the classifier stands at 8.6%.

The classifier Rs. 3,001 to 6,000 correctly predicted 5271 weavers to fall in this category as True Positives (TP). Accordingly, the accuracy was estimated to be 93.8%. The other categories from Rs 6001 to 9000 and 9001 to 12000 have no True Positives (TP); hence, no weavers were predicted. Classifier > Rs. 12,000 had no True Positives (TP), and no weavers were predicted. Therefore, the Accuracy is Zero.

To summarise, the category Rs 3001 to 6000 showed a maximum accuracy of 93.8 per cent, while the accuracy recorded against the category < 3000 stood at a meagre 8.6 per cent. Similarly, the other categories had zero accuracies and zero prediction. The model's overall accuracy (correctness) is low at 49 per cent because of a low volume of data in the income categories of < Rs 3000, Rs 6001 to 9000, Rs 9001 to 12000, and above Rs 12000.

4.3.2.2 Artificial Neural Network (ANN) – Model 2

The ANN algorithm generated shows that 69.7 per cent of the data were used up for training and 30.3 per cent for testing, and no invalid records existed.

The ANN's predictive accuracy shows that the incorrect predictions are 51.4 per cent for the training data and 49.9 per cent for the testing data. Figure 20 shows the visual representation of ANN of Model 2.

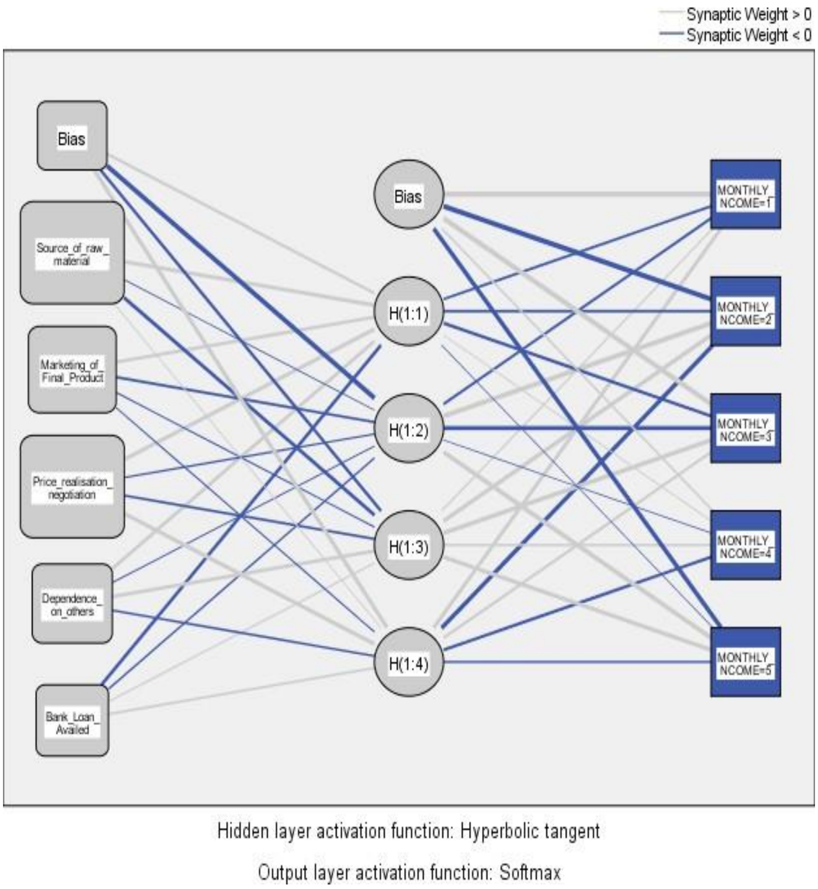


Figure 20
ANN output – Model 2

Confusion Matrix/Classification of ANN: The confusion matrix of the ANN algorithm exhibits an overall accuracy of 48.5 per cent. The low accuracy appeared to have resulted from the unequal distribution of weavers among the five income groups envisaged in the survey (Table 30).

Of the 11594 weavers who participated in the survey, 41.22% belonged to the less than Rs 3000 category. Another 48.47% were in the income group of Rs 3000 to 6000;

therefore, about 90% of the weavers happened to be in the income group of less than Rs 6000, and only a small portion of weavers belonged to other income groups.

The Classifier < Rs. 3,000 correctly predicted 95 weavers as True Positives (TP) and also registered a meagre accuracy of 6.5%.

While classifier Rs. 3,001 to 6,000 appropriately predicted 1606 weavers as True Positives, and the accuracy is estimated to be 94.2%.

The classifiers > Rs. 12,000, Rs. 6,001 to 9,000 and Rs. 9,001 to 12,000 did not have any True Positives (TP) and resulted in zero prediction.

Table 30
Confusion Matrix/Classification

Sample	Observed	Predicted					
		< Rs. 3,000	> Rs. 12,000	Rs. 3,001 to 6,000	Rs. 6,001 to 9,000	Rs. 9,001 to 12,000	Percent Correct
Training	< Rs. 3,000	243	0	3067	0	0	7.3%
	> Rs. 12,000	5	0	29	0	0	0.0%
	Rs. 3,001 to 6,000	280	0	3636	0	0	92.8%
	Rs. 6,001 to 9,000	44	0	611	0	0	0.0%
	Rs. 9,001 to 12,000	16	0	158	0	0	0.0%
	Overall Percent	7.3%	0.0%	92.7%	0.0%	0.0%	48.0%
Testing	< Rs. 3,000	95	0	1375	0	0	6.5%
	> Rs. 12,000	1	0	10	0	0	0.0%
	Rs. 3,001 to 6,000	98	0	1606	0	0	94.2%
	Rs. 6,001 to 9,000	24	0	241	0	0	0.0%
	Rs. 9,001 to 12,000	4	0	51	0	0	0.0%
	Overall Percent	6.3%	0.0%	93.7%	0.0%	0.0%	48.5%

Dependent Variable: ‘Monthly Income’

Sensitivity and Specificity: Predictor variables’ impact on the target variable and the models’ Sensitivity to the changes in predictors can be gauged by conducting a Sensitivity Analysis and inferring Receiver Operating Characteristics (ROC) Curves.

A larger Area Under the ROC Curve (AUC), with higher values, validates the model’s fit (Table 31).

Table 31
Area Under the Curve

		Area
Monthly Income	< Rs. 3,000	.518
	> Rs. 12,000	.473
	Rs. 3,001 to 6,000	.541
	Rs. 6,001 to 9,000	.562
	Rs. 9,001 to 12,000	.564

The Specificity, as shown in Figure 21, establishes the model's accuracy and further reveals that the test carried out is 'good' since the intersection of specificity and sensitivity curves of all variables were positioned above the diagonal line.

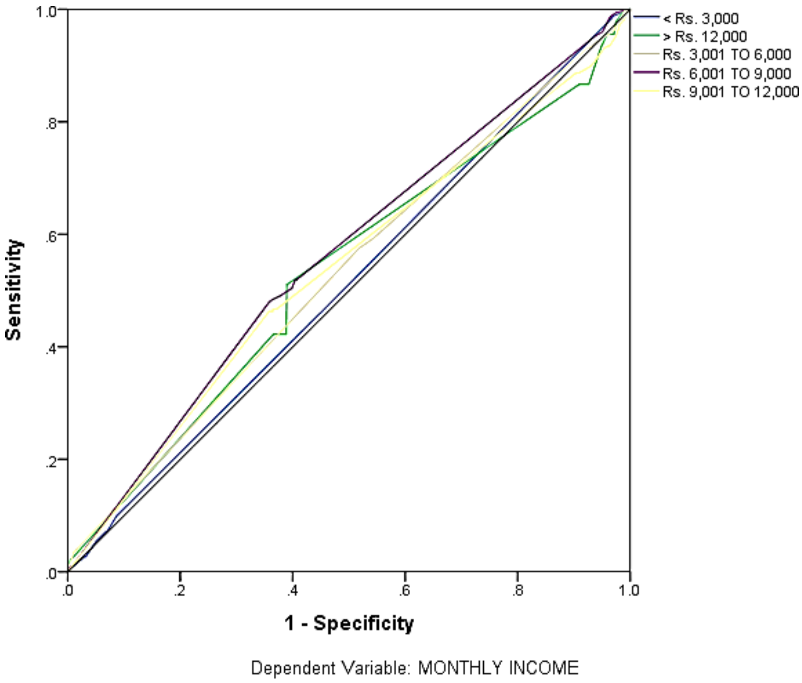


Figure 21
Sensitivity and Specificity Chart – Model 2

Gain Chart and Lift Chart: Gain and Lift charts are visual aids to measure the model's performance in deciles (10 equal portions) of the entire dataset.

Gain is the ratio between a cumulative number of positive observations within a particular decile and the total number of cumulative positive observations of all the deciles in the entire data set. The larger area between the Gain and diagonal baseline (Response without a model) indicates that the predictive model is better than the random one (Figure 22).

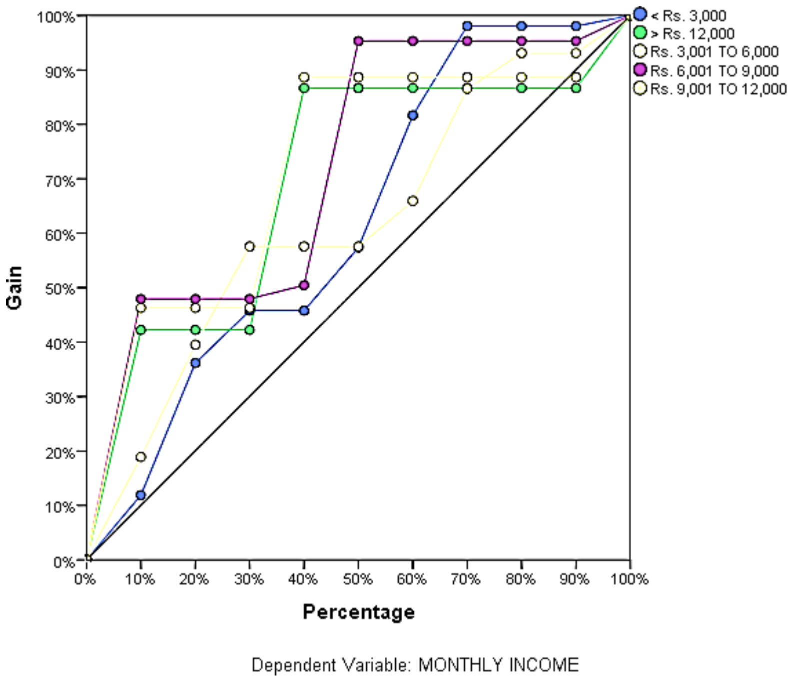


Figure 22
Gain Chart – Model 2

A Lift chart (Figure 23) explains the improvement brought about by a model compared to the predictions without a model, and the improvement is denoted as Lift.

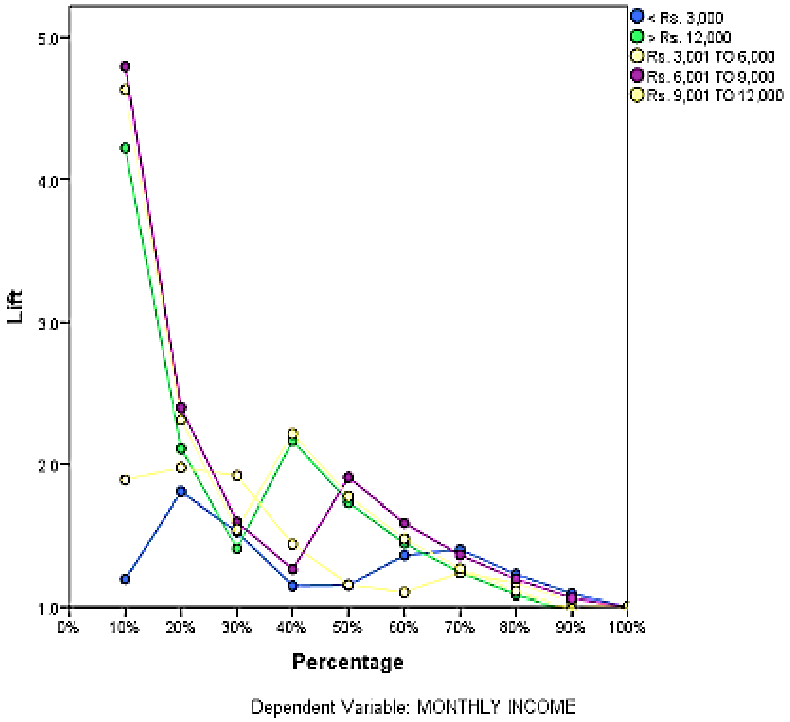


Figure 23
Lift Chart – Model 2

The baseline on the Y-axis is at level one (1), and any gain to one (1) indicates an improvement over the random model. A larger area above the horizontal baseline (X-axis), indicates that the model is good and the predictions are better than the test without a model.

Independent Variable Importance: The normalised importance and strength of each predictor (Independent Variable) are shown in Table 32. The relative strength of these predictors determines the overall models' accuracy.

Table 32
Independent Variable Importance

	Importance	Normalized Importance
Source_of_Raw_Material	.252	99.7%
Marketing_of_Final_Product	.193	76.6%
Price_Realisation_Negotiation	.252	100.0%
Dependence_on_Others	.166	65.7%
Bank_Loan_Availed	.137	54.4%

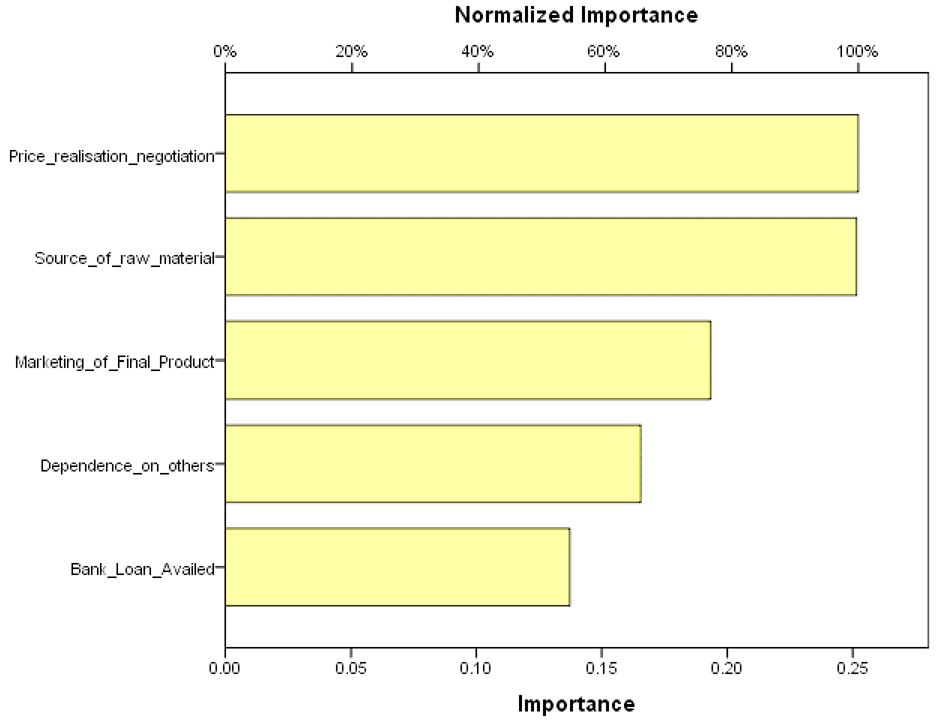


Figure 24
Independent Variable Importance

Among the predictors, ‘Source of Raw Material’, ‘Marketing of Final Product’, and ‘Price Realisation & Negotiation’ have a relative strength of over 75% within the model. In contrast, other variables have slightly lower strength (Figure 24).

4.3.2.3 Decision Tree (DT) - Model 2

This study used the CHAID (Chi-squared Automatic Interaction Detector) algorithm to grow the Decision Tree (DT).

The Decision Tree (DT) was constructed with one target variable (Dependent Variable) and five predictor variables (Independent Variables). The DT algorithm calculates the Chi-square and *p*-value at every node for identifying the best split point while determining the strength of the predictor (Figure 25).

The higher Chi-square values and lower *p*-values of less than 0.05 indicate the higher statistical significance of the predictors and decide the splitting efficiency.

Here in this model, the best predictor with strong relation was found to be ‘Marketing of Final Product’ with a big chi-square of 95, which then divided the root node into three (3) child nodes classifying the artisans based on the source of marketing.

The first and the third nodes are pure and predicted a small number of weavers selling their produce to the ‘Local Traders & Others’ and ‘PWCs’ (Primary Weavers Cooperative Societies).

The second node predicts that over 92 per cent of the artisans sell their produce to the ‘Master Weavers’ and the node further splits into two sub-nodes signifying the predictor ‘Bank Loan Availed’, which carries a strong Chi-square value of 80.

The artisans who do not avail of bank loans constitute 37 per cent of node five (5) and end as leaf nodes. In contrast, the artisans, who avail of bank loan makes up 55 per cent in node four (4), are further divided, duly identifying the ‘Source of Raw Material’ as the significant variable with a Chi-square of 67.

The sixth and seventh nodes of the third row are homogenous leaf nodes without further splitting.

The accuracy of the model's performance was computed using the Sensitivity (Recall) method. Accuracy implies the number of correct predictions against the total number of predictions.

Sensitivity = True Positive (TP)/True Positive (TP) + False Negative (FN)

This model has a depth of three (3) with 8 (eight) nodes, including 5 (five) leaf nodes.

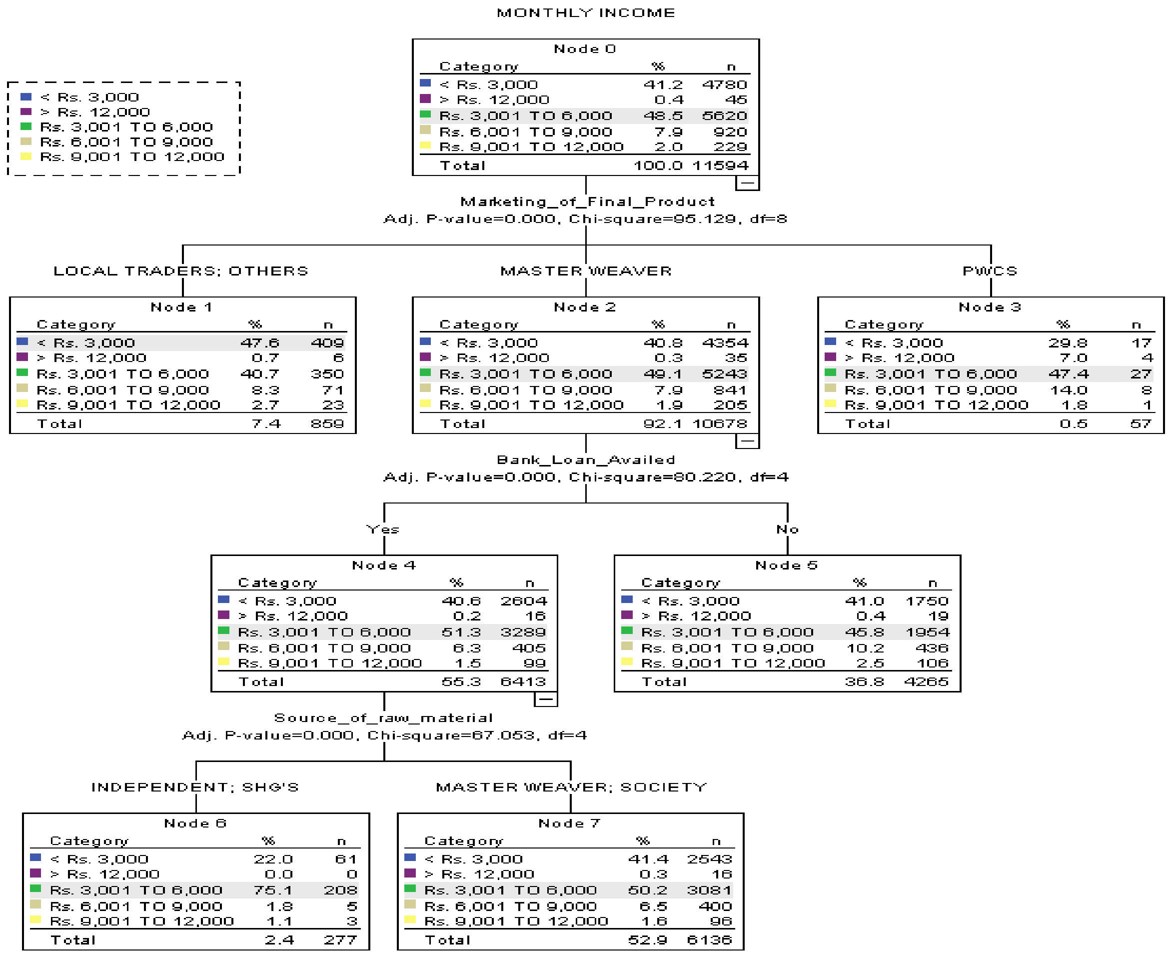


Figure 25
Decision Tree of model 2

Confusion Matrix/Classification: The Confusion Matrix in Table 33 presents the number of correct and incorrect predictions for each category of the dependent variables.

The Classifier < Rs. 3,000 made 409 correct predictions and account for an accuracy of 55.8%.

While the classifier Rs 3,001 to 6,000 correctly predicted 5270 weavers with an accuracy of 93.8%. The other classifiers did not have any True Positives (TP); hence, no weavers were predicted in these categories.

The overall correctness of the model remained at 49 per cent, and for other categories, the prediction was poor.

Table 33
Confusion Matrix/Classification

	Predicted					
Observed	< Rs. 3,000	> Rs. 12,000	Rs. 3,001 to 6,000	Rs. 6,001 to 9,000	Rs. 9,001 to 12,000	Percent Correct
< Rs. 3,000	409	0	4371	0	0	8.6%
> Rs. 12,000	6	0	39	0	0	0.0%
Rs. 3,001 to 6,000	350	0	5270	0	0	93.8%
Rs. 6,001 to 9,000	71	0	849	0	0	0.0%
Rs. 9,001 to 12,000	23	0	206	0	0	0.0%
Overall Percentage	7.4%	0.0%	92.6%	0.0%	0.0%	49.0%

Growing Method: CHAID
Dependent Variable: ‘Monthly Income’

The overall accuracy of 49 per cent is because of a low volume of data in the other income categories.

4.3.2.4 Research Question 2 – Review and Inferences

The second research question intends to comprehend the reasons for the low productivity of handloom weavers affected by supply chain disruptions.

Whether the business performance in the handloom sector lies in the broader, robust, and resilient supply chain?

Model 2 was built with one Target (dependent) variable, the ‘Monthly Income’ of the weaver and five (5) independent variables, which form part of supply chain activities.

In any manufacturing ecosystem, efficient and timely supply chain activities are vital to the business's success. In the entire process of goods and services flow, finance, knowledge, and product are essential prerequisites to be adhered to in a time frame.

Some of the supply chain components where the data could be obtained have been considered as independent variables and tested with the dependent variable 'Productivity per Day'.

All three analysis methods show that all the variables reckoned are found relevant and impactful but at varying levels.

Out of the 11594 weavers surveyed, about 90 per cent of the artisans earn less than Rs 6000/month. The analysis of all three methods, MLR, ANN and DT (Table 34), also confirms that over 95 per cent of the weavers are predicted to be in the income category of less than Rs 6000/Month.

Table 34
Model 2 Comparative Performance of all 3 Methods

Observed Range	Predicted		
	Multinomial Logistic Regression	Artificial Neural Network	Decision Tree
< Rs. 3,000	8.6%	6.5%	8.6%
> Rs. 12,000	0.0%	0.0%	0.0%
Rs. 3,001 to 6,000	93.8%	94.2%	93.8%
Rs. 6,001 to 9,000	0.0%	0.0%	0.0%
Rs. 9,001 to 12,000	0.0%	0.0%	0.0%
Overall Percentage	49.0%	48.5%	49.0%

The survey carried out in the project area reveals that independent weavers make up just 5 per cent of the total weavers; however, close to 92 per cent work under the control of Master Weavers and depend on them for all their professional and personal needs, including finance, raw materials, and marketing.

Table 35
Normalised Importance

	Normalized Importance
Price_Realisation_Negotiation	100.00%
Source_of_Raw_Material	99.70%
Marketing_of_Final_Product	76.60%
Dependence_on_Others	65.70%
Bank_Loan_Availed	54.40%

The Likelihood Ratio Test shows the relevance of the variable 'Dependence on Others', thus establishing the relation between the target and predictor variables. The ANN has also revealed normalised relative importance of 65.70%; hence, this variable is considered a key determinant of the supply chain (Table 35).

Continuous price-rise and short supply of yarn and other consumables cause extensive consternation to the weavers and eventually harm their productivity. Over 91.54 per cent of weavers source raw materials, including chemicals and dyes, from master weavers since over 90 per cent of the weavers pursue the weaving activity under the control of the master weavers.

As the artisans do not have any facilities for the aggregation and preservation of raw materials, they bring raw materials daily from the master weavers. So, perhaps, it could be the reason for the lower level of significance shown by MLR. Nevertheless, its normalised importance was shown to be over 99 per cent in ANN analysis (Table 35), and the DT has also identified the 'Source of Raw Material' as a significant variable (Figure 25).

The survey reveals that with a low educational base and associated customary dependence on master weavers for all needs, the artisans did not adopt any management practices for handling the supply chain or marketing for higher sales outcomes and higher price realisation. So, over 90 per cent of the artisans sell their finished products to the master weavers in the absence of other options.

The Likelihood Ratio Test (LR Test) establishes the significance of 'Marketing of Final Product'. The parameter estimate also points to the relevance of five times more Likelihood in the higher-income group of over Rs 12,000 (Figure 38). The ANN analysis also proves that the variable 'Marketing of Final Product' has a relative normalised importance of over 76.6 per cent (Table 35).

The DT identified 'Marketing of Final Product' as the best predictor with a strong influence (Figure 25).

Figure 26
Comparative influence of predictors- Income group-wise

The survey discloses that 99.8 per cent of the weavers do not have a say in price realisation and negotiation due to their intimate and submissive association with master weavers.

As the dominance of the master weavers prevails, there is no systematic and rational mechanism for unit price fixation of the handloom product. As a result, the master weaver will have the last laugh.

The parameter estimates of MLR show that the variable ‘Price Realisation and Negotiation’, was found relevant in only two income groups of < Rs. 3,000 and Rs. 3,001 to 6,000, with a very high probability of occurrence.

The Wald values in percentage (Figure 26) show that all the predictors have relevance to the target variable. However, the variable ‘Price Realisation and Negotiation’ recorded the highest strength across different income categories. More importantly, in the income category of **<** Rs 3000/month, the strength of the variable stands at 87.7 per cent, thus indicating a strong influence.

The findings of the ANN are also in conformity with the MLR and show 100% importance (Table 36). These results prove that ‘Price Realisation and Negotiation’ is an essential factor.

Artisans continuously need adequate working capital to meet the market demand; however, out of 11594 weavers, only 66 per cent have an account in a public financial institution. Furthermore, about 8704 artisans availed of loans from different sources. Over 52 per cent (4549) got loans from private money lenders, usually at higher interest rates, but only 24 per cent could access finance from a public bank.

The Likelihood Ratio Test (LR Test) shows the relevance of the factor ‘Bank Loan Availed’ with a statistically significant value. This variable is significant in the income groups of < Rs. 3,000 and Rs. 3,001 to 6,000, with a strong likelihood, as shown by the parameter estimates of MLR (Figure 26). Normalised importance also portrays the variable’s importance but is slightly lower at 54.40% (Table 367). However, the DT proves its strength with a strong Chi-square (Figure 25).

The enumeration further shows the absence of innovative product design and branding. Without applying creativity and innovation, the artisans bode well for the designs given by their master weavers.

Thus, the facts and insights derived from the qualitative data confirm the observations of quantitative data analysis.

To sum up, the analysis established that business performance relies on efficient supply chain activities. The handloom industry, a household informal industry, is further impaired by the lack of supply chain activities. Timely raw materials supply and credit play an essential role in meeting the market demand and adhering to delivery schedules. As most weavers are in the master weaver's fold, marketing is not pursued actively and is left to the choice of the master weavers. Since there is no mechanism to fix the product's unit cost, the price unilaterally offered by the master weaver is final and binding.

Therefore, regardless of the business size, all supply chain elements must be addressed for higher returns.

4.3.3 Model 3 and Research Question 3

Model 3 seeks to answer the third research question by studying the human capital challenges that influence productivity, income, and overall weavers' living conditions.

Is the prevailing livelihood crisis and impoverishment of the weaving community the culmination of centuries-old neglect of human capital assets?

Model 3 was made with one dependent variable, 'Monthly Income' of the weaver and five (5) independent variables; Gender, Education, Skill Training Received, Age and Sound Health, which are predominant components of human capital that are presumed to affect the weaver's income (Table 36).

Table 36
Model 3 - Selected Variables

Dependent Variable	Monthly Income
Independent Variable	Gender Education Skill Training Received Age Sound Health

The variables in this model have undergone MLR and were further tested with ANN and DT.

4.3.3.1 Multinomial Logistic Regression (MLR) - Model 3

The Case Processing Summary shows that the dependent variable (Monthly Income) has five different scales ranging from less than Rs 3000 per month to above Rs 12000 per month. Out of the 11594 weavers surveyed, about 48.5 per cent was in the category of Rs 3000 to 6000, and 41.2 per cent belonged to the less than Rs 3000 category; therefore, almost 90 per cent went with less than Rs 6000 income group; however, a small portion of weavers was in the other higher-income groups.

Model Fitting Information: Model fitting demonstrates how well a machine learning algorithm learns from a trained dataset and generalises to similar new input data.

The model fitting test (Table 37) depicts Model Fitting criteria that bank on -2 Log-Likelihood and Likelihood Ratio tests. The Chi-Square statistic is the difference between the -2 log-likelihoods of the Null and Final models. Therefore:

LR Chi-Square = -2*L (null Model) – (-2*L (fitted model)).

- LR Chi-Square = 3824.285 – 2751.242= 1073.043
- df (Degree of Freedom) = 20 groups
- Sig = significance = .000

- In this test, the final model had a -2 Log-Likelihood value of 2751.242, which is significantly less than the Intercept value of 3824.285 and hence suggests a variance in the outcome and an improvement in model fit.
- In addition, the resultant Sig was less than the standard p-value of 0.05 and is statistically significant. The Sig value also shows that the final model is an improvement over the baseline Intercept-only model and predicts the dependent variable better than the Intercept-only model.

Table 37
Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood	Chi-Square	df	Sig.
Intercept Only	3824.285			
Final	2751.242	1073.043	20	.000

Goodness-of-Fit: The Goodness-of-Fit results in Table 38 show the Model's suitability, where the observations are summarised to find any discrepancies between the observed and expected values.

Higher values (over 0.05) of Pearson's chi-square and Deviance R2 show a better fit. However, Table 40 shows that both Pearson and Deviance test *p*-values are less than < 0.05 (standard value), showing that the model does not suit the data since the desired range is >0.05 (over 0.05). Nevertheless, the chi-square values are higher and found significant; therefore, the test yielded mixed results.

Table 38
Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	1852.031	1032	.000
Deviance	1535.522	1032	.000

Pseudo R-Square: Cox and Snell's Pseudo R^2 was estimated to be .088; since smaller values of less than 1 (one) show an improvement over the Intercept-only model, the value of .088 shows the model's suitability (Table 39).

1. Nagelkerke's Pseudo R^2 had a value of .102 and showed an improvement over the null.
2. McFadden's Pseudo R^2 had an insignificant value of .046, much smaller than the desired range of 0.2 to 0.4 for a fit, hence found unsuitable.

To infer that among the three designated Pseudo R-Squared tests, Cox and Snell's and Nagelkerke's tests showed the model's fit.

However, in contrast, McFadden's Pseudo R^2 test was found below the standard range. Therefore, given these mixed results, complete dependence on Pseudo R^2 is not justified.

Table 39
Pseudo R-Square

Cox and Snell	.088
Nagelkerke	.102
McFadden	.046

Likelihood Ratio Tests (LR Test): Likelihood ratios (Table 40) indicate the independent variables' probabilities. The Likelihood Ratio Test (LR Test) is usually employed to judge the overall models' fit.

Table 40
Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	2843.490	92.247	4	.000
Skill_Training_Received	2760.781	9.539	4	.049
Age	2978.473	227.231	4	.000
Gender	3230.379	479.137	4	.000
Education	2928.791	177.549	4	.000
Sound_Health	2799.976	48.734	4	.000

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

The difference between the -2 log-likelihoods of the reduced model and the final model yields the chi-square statistic.

The final model is considered statistically significant if the difference between these two models is minimal. Given this, less than 0.05 significant values of the final model are statistically significant and contribute to the model.

Table 40 provides the values of likelihood ratios and the significance of all the independent variables. In this test, all the Sig values were found statistically significant and have less than a .05 *p*-value.

Parameter Estimates: Parameter estimates (coefficients, β) disclose the relationship between the outcome and the independent variables. Different testing criteria were computed for all the independent variables to identify the impact of a specified variable within the group (Table 41).

Table 41
Parameter Estimates

Monthly Income[a]		B	Std. Error	Wald	df	Sig.	Exp (B)	95% Confidence Interval for Exp(B) Lower Bound	95% Confidence Interval for Exp(B) Upper Bound
< Rs. 3,000	Intercept	3.905	.729	28.715	1	.000			
	Skill_Training_Received	.699	.311	5.058	1	.025	2.013	1.094	3.702
	Age	-.158	.029	29.448	1	.000	.854	.806	.904
	Gender	-1.293	.165	61.217	1	.000	.275	.199	.380
	Education	.154	.037	16.791	1	.000	1.166	1.083	1.255
	Sound_Health	.086	.211	.165	1	.684	1.090	.721	1.647
> Rs. 12,000	Intercept	-1.571	1.659	.897	1	.344			
	Skill_Training_Received	-.323	.669	.233	1	.629	.724	.195	2.687
	Age	.029	.071	.167	1	.683	1.030	.895	1.184
	Gender	.342	.445	.591	1	.442	1.408	.589	3.368
	Education	-.111	.090	1.513	1	.219	.895	.750	1.068
	Sound_Health	.127	.484	.069	1	.793	1.135	.439	2.934
Rs. 3,001 to 6,000	Intercept	3.498	.723	23.422	1	.000			
	Skill_Training_Received	.614	.307	3.994	1	.046	1.848	1.012	3.375
	Age	-.044	.029	2.358	1	.125	.956	.904	1.012
	Gender	-.527	.165	10.194	1	.001	.590	.427	.816
	Education	.011	.037	.082	1	.775	1.011	.940	1.087
	Sound_Health	-.354	.211	2.819	1	.093	.702	.465	1.061
Rs. 6,001 to 9,000	Intercept	1.075	.799	1.811	1	.178			
	Skill_Training_Received	.291	.341	.726	1	.394	1.338	.685	2.612
	Age	-.018	.032	.336	1	.562	.982	.923	1.045
	Gender	-.110	.180	.369	1	.544	.896	.629	1.277
	Education	-.010	.041	.058	1	.810	.990	.915	1.072
	Sound_Health	.064	.228	.079	1	.779	1.066	.682	1.666

a. The reference category is Rs. 9,001 to 12,000.

The larger the magnitude of the coefficient value, the stronger that parameter's influence on the probability of an outcome. The conditions such as higher odds ratio (Exp

(B)), Wald values with significant *p*-values, and Std Error of less than 2 (two) are favourable for more probability and accurate prediction.

In the group < Rs. 3,000, except the variable ‘Sound Health’, all four (4) other variables, ‘Skill Training Received’, ‘Age’, ‘Gender’ and ‘Education’, were found to have statically significant *p*-values (less than 0.05) rejecting the null hypothesis.

The variable ‘Skill Training Received’ has a positive B value with a Standard Error of less than 2 and further has two times more likelihood, hence the variable is influential and goes well with the model.

The independent variable ‘Age’ had a significant effect with a lowered coefficient strength with less than 2 (two) Std Error. Further, the Exp (B) value of .854 shows a 14 per cent lower (1 minus 0.854= .146 or 14%) likelihood to influence the ‘Monthly Income’ than the reference category of Rs. 9,001 to 12,000.

The variable ‘Gender’ did not have a positive B value (-1.293); hence, less dominant. However, its Std Error was less than the benchmark value of 2 (two); hence, it goes well with the model with a 72% lower (1 minus 0.275= .725 or 72%) likelihood.

The variable ‘Education’ had a positive B value with an Std Error within the range and also had 1.1 times more (1.1x100=101%) likelihood to influence the variable ‘Monthly Income’ than the reference category of Rs. 9,001 to 12,000.

Among the four significant variables, the variable ‘Skill Training Received’ is more likely to have a positive influence than the remaining three because of its positive coefficient and two times more likelihood of affecting the dependent variable.

In the category Rs. 3,001 to 6,000, the variables’ Skill Training Received’ and ‘Gender’ were found significant, and the remaining variables appeared to be insignificant predictors.

The variable 'Skill Training Received' had a positive coefficient value of .614 and a Sig of .046. This variable also had an odds ratio of 1.848; hence, its influence would be 1.8 times more.

The other significant variable, 'Gender', had a negative coefficient (-.527); however, other parameters were amiable. The *p*-value stands at .001, while the odds ratio recorded was .590 indicating (1- .590= 0.41 or 41%) 41 per cent lower impact.

Other categories, Rs. 6,001 to 9,000 and > Rs. 12,000, do not have any significant values; therefore, they seemed to be poor predictors.

Confusion Matrix/Classification: The Confusion Matrix in Table 42 shows the results of the Classifier-wise predictions.

The classifier < Rs. 3,000 correctly predicted 2720 weavers as True Positives (TP), and the classifiers' overall accuracy remained at 56.9 per cent.

The classifier > Rs. 12,000 had no True Positives (TP), therefore the accuracy automatically reduced to zero. While the category Rs. 3,001 to 6,000 made 3872 correct predictions as True Positives (TP), and the resultant correctness stood at 68.9 per cent.

The other categories from Rs 6001 to 9000 and 9001 to 12000 have no True Positives (TP); hence, no weavers were predicted.

Table 42
Confusion Matrix/Classification

Observed	Predicted					
	< Rs. 3,000	> Rs. 12,000	Rs. 3,001 to 6,000	Rs. 6,001 to 9,000	Rs. 9,001 to 12,000	Percent Correct
< Rs. 3,000	2720	0	2060	0	0	56.9%
> Rs. 12,000	6	0	39	0	0	0.0%
Rs. 3,001 to 6,000	1748	0	3872	0	0	68.9%
Rs. 6,001 to 9,000	216	0	704	0	0	0.0%
Rs. 9,001 to 12,000	48	0	181	0	0	0.0%
Overall Percentage	40.9%	0.0%	59.1%	0.0%	0.0%	56.9%

To sum up, the category-wise results of the Confusion Matrix showed an accuracy of 56.9% against the category '< 3000' and 68.9 per cent with the Rs 3001 to 6000 category; however, prediction and accuracy concerning other categories were poor.

The model's overall predicted accuracy (correctness) stands at 56.9 per cent. The low percentage is because of the low volume of data in the income categories < 3000, Rs 6001 to 9000, 9001 to 12000, and above Rs 12000.

4.3.3.2 Artificial Neural Network (ANN) - Model 3

The ANN test was conducted iteratively in the development of this model 3 with 'Monthly Income' as the dependent variable (Target Variable) and five (5) input variables as predictors, including 'Age', 'Gender', 'Education', 'Skill Training Received', and 'Sound Health' to identify the factors that influence the income levels of the weavers.

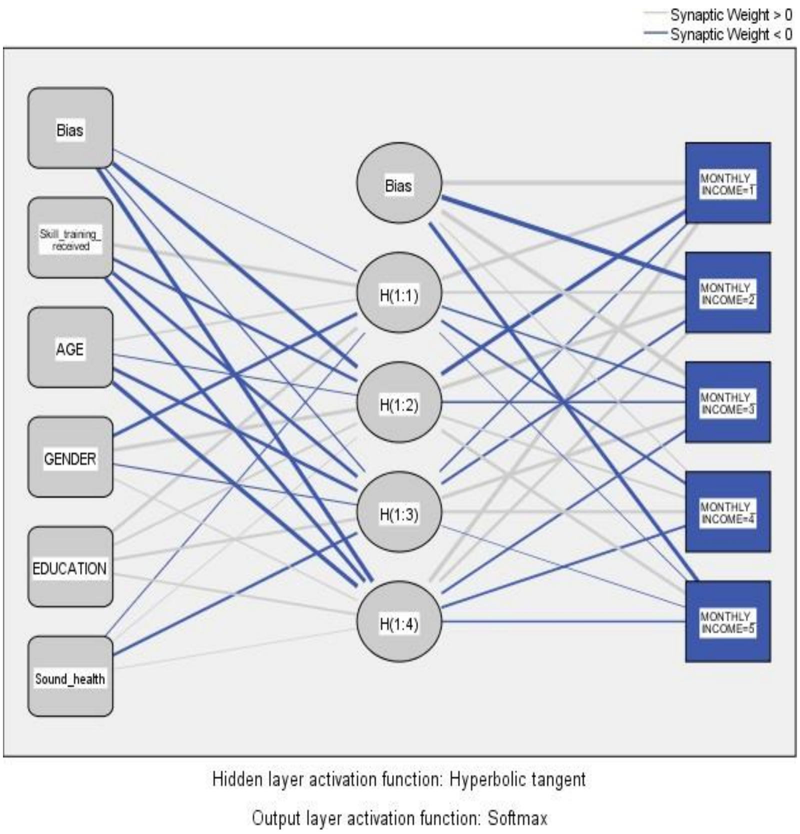


Figure 27
ANN output-Model 3

The Case Processing Summary shows that approximately 70% of the data were assigned for training and 30% for testing, and there were no invalid values. Figure 27 shows the diagrammatic representation of ANN.

Confusion Matrix/Classification: Table 43 shows the details of the Confusion Matrix.

Table 43
Confusion Matrix/Classification

Sample	Observed	Predicted					
		< Rs. 3,000	> Rs. 12,000	Rs. 3,001 to 6,000	Rs. 6,001 to 9,000	Rs. 9,001 to 12,000	Percent Correct
Training	< Rs. 3,000	1758	0	1553	0	0	53.1%
	> Rs. 12,000	3	0	25	0	0	0.0%
	Rs. 3,001 to 6,000	993	0	2950	0	0	74.8%
	Rs. 6,001 to 9,000	102	0	556	0	0	0.0%
	Rs. 9,001 to 12,000	21	0	140	0	0	0.0%
	Overall Percent	35.5%	0.0%	64.5%	0.0%	0.0%	58.1%
Testing	< Rs. 3,000	731	0	738	0	0	49.8%
	> Rs. 12,000	4	0	13	0	0	0.0%
	Rs. 3,001 to 6,000	440	0	1237	0	0	73.8%
	Rs. 6,001 to 9,000	33	0	229	0	0	0.0%
	Rs. 9,001 to 12,000	9	0	59	0	0	0.0%
	Overall Percent	34.8%	0.0%	65.2%	0.0%	0.0%	56.3%

Dependent Variable: Monthly_Income

The classifier, < Rs. 3,000 correctly predicted 731 weavers who belonged to the category of < Rs. 3,000 as True Positives (TP) and also registered an accuracy of 49.8%.

While the classifier, Rs. 3,001 to 6,000 correctly predicted 1237 weavers as True Positives, and the accuracy is estimated to be 73.8%.

However, the classifiers, > Rs. 12,000, Rs. 6,001 to 9,000 and Rs. 9,001 to 12,000 have no True Positives (TP); hence, no weavers were predicted in these categories.

The overall correctness of the model is 56.3 per cent; however, the prediction is poor for other categories. The low overall accuracy is because of the unequal distribution of weavers among the five (5) income categories and about 99 per cent of the data was shared between two income categories < Rs. 3,000 and Rs. 3,001 to 6,000, only a meagre volume of data was recorded in the other productivity categories (Table 43).

Specificity and Sensitivity Test: Sensitivity analysis assesses the model's performance and finds the model's sensitivity to changes in the predictors. The model's performance can be judged through ROC curves More Area Under the ROC Curve, as indicated by higher values, fits the model well (Table 44).

Table 44
Area Under the Curve

		Area
Monthly_Income	< Rs. 3,000	.699
	> Rs. 12,000	.624
	Rs. 3,001 to 6,000	.629
	Rs. 6,001 to 9,000	.659
	Rs. 9,001 to 12,000	.646

The Specificity (FP) (Figure 28), reveals that the test conducted is good since the intersection of Specificity and Sensitivity is above the diagonal line.

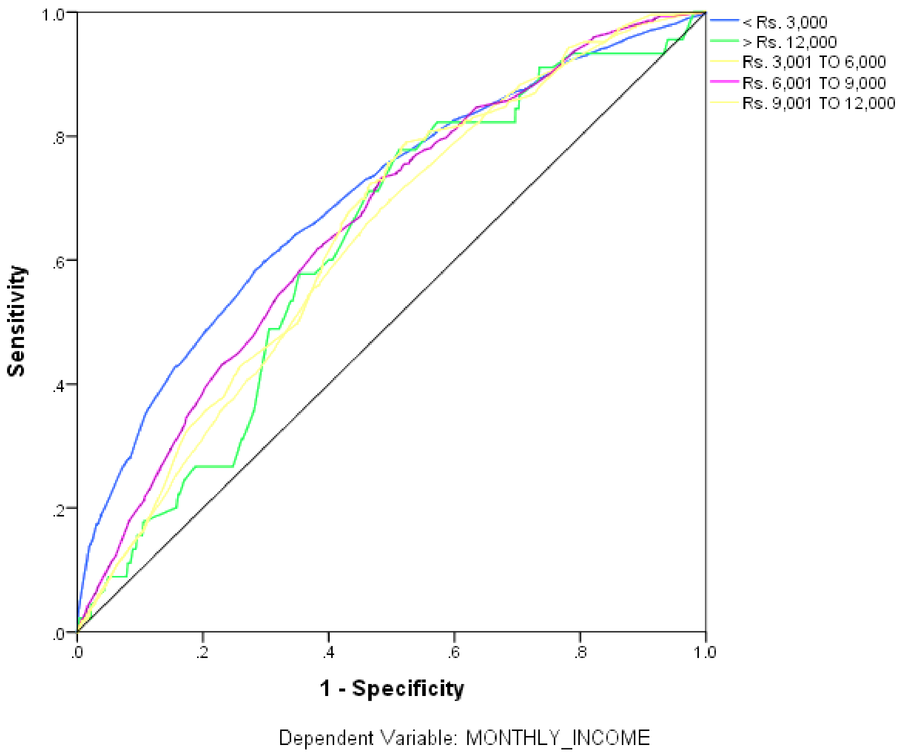


Figure 28
Sensitivity and Specificity Chart – Model 3

Gain Chart and Lift Chart: They measure the Models' performance in portions in portions (deciles) of the entire dataset.

Gain is the ratio between a cumulative number of positive observations within a particular decile and the total number of cumulative positive observations of all the deciles in the entire data set.

The graph in Figure shows a larger area between the Gain and diagonal baseline, indicating that the predictive model is better than the random one (Figure 29).

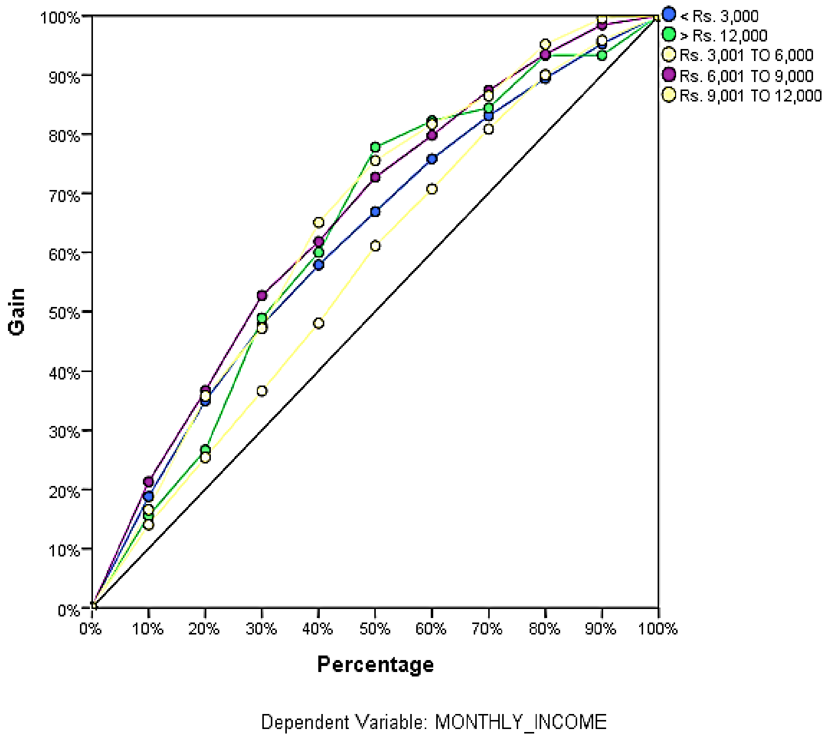


Figure 29
Gain Chart- Model 3

A Lift chart illustrates the improvement brought about by a model compared to the predictions without a model, and the improvement is referred to as Lift.

Figure 30 shows a greater area above the horizontal baseline (X-axis), indicating that the model suits well and predictions are better than the test conducted without a model.

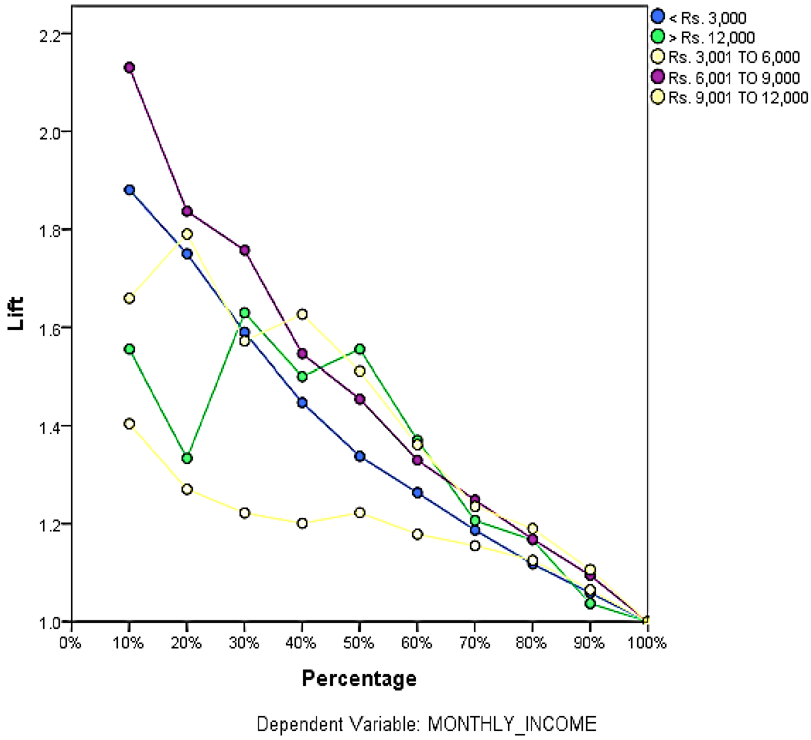


Figure 30
Lift Chart - Model 3

Independent Variables' Importance: The relative importance and strength of each predictor (Independent Variable) are shown in Table 45. These predictors play a relative role in making a prediction, regardless of the overall model's accuracy.

Table 45
Independent Variable Importance

	Importance	Normalized Importance
Skill_Training_Received	.095	30.7%
Age	.310	100.0%
Gender	.255	82.3%
Education	.218	70.3%
Sound_Health	.121	39.0%

Figure 31 shows the normalised importance of all the independent variables, and among them, Age, Gender, and Education have a relative strength of over 70%, while other variables have a relatively low influence.

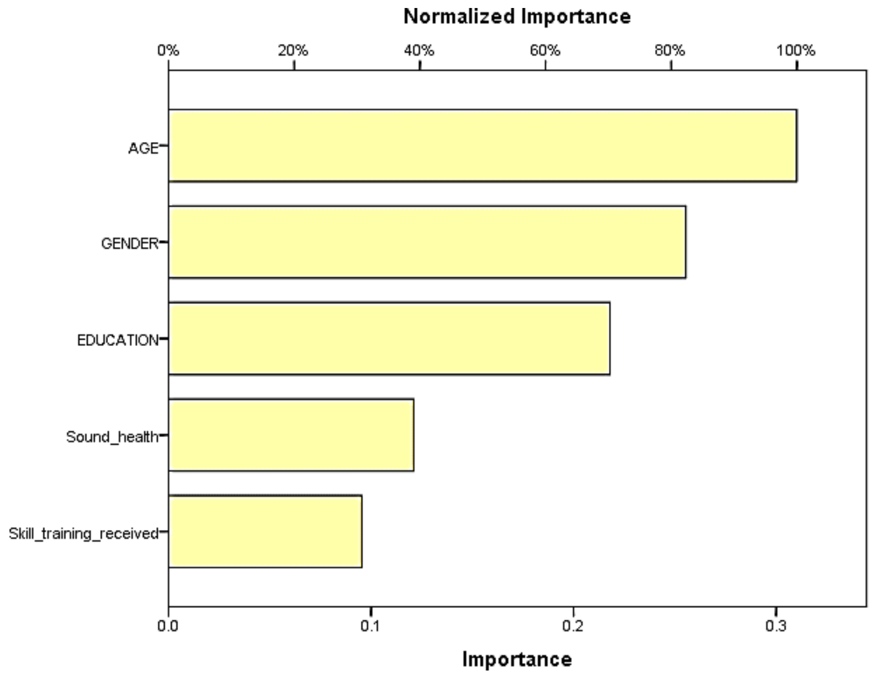


Figure 31
Normalised Importance - Model 3

4.3.3.3 Decision Tree (DT) - Model 3

A Decision Tree (DT) was built for classification purposes with five independent (predictor) variables using the CHAID (Chi-squared Automatic Interaction Detector) algorithm (Figure 32).

The Decision Tree algorithm travels down to the terminal node (Leaf Node) to predict the target variable 'Monthly Income'. After comparing and assessing the strong statistical significance among the predictors, the CHAID algorithm picks a predictor with a strong relationship with the target for a split.

The splitting continues in order of importance and strength until the leaf node. The strength of the predictor is determined by the large Chi-square values and smaller *p*-values of <0.05 (Adjusted *p*-value).

The best predictor in this model was found to be 'Age' with a big chi-square of 873 and an adjusted *p*-value of 0.000, and this variable divided the root node into four (4) child nodes classifying the artisans based on the age groups.

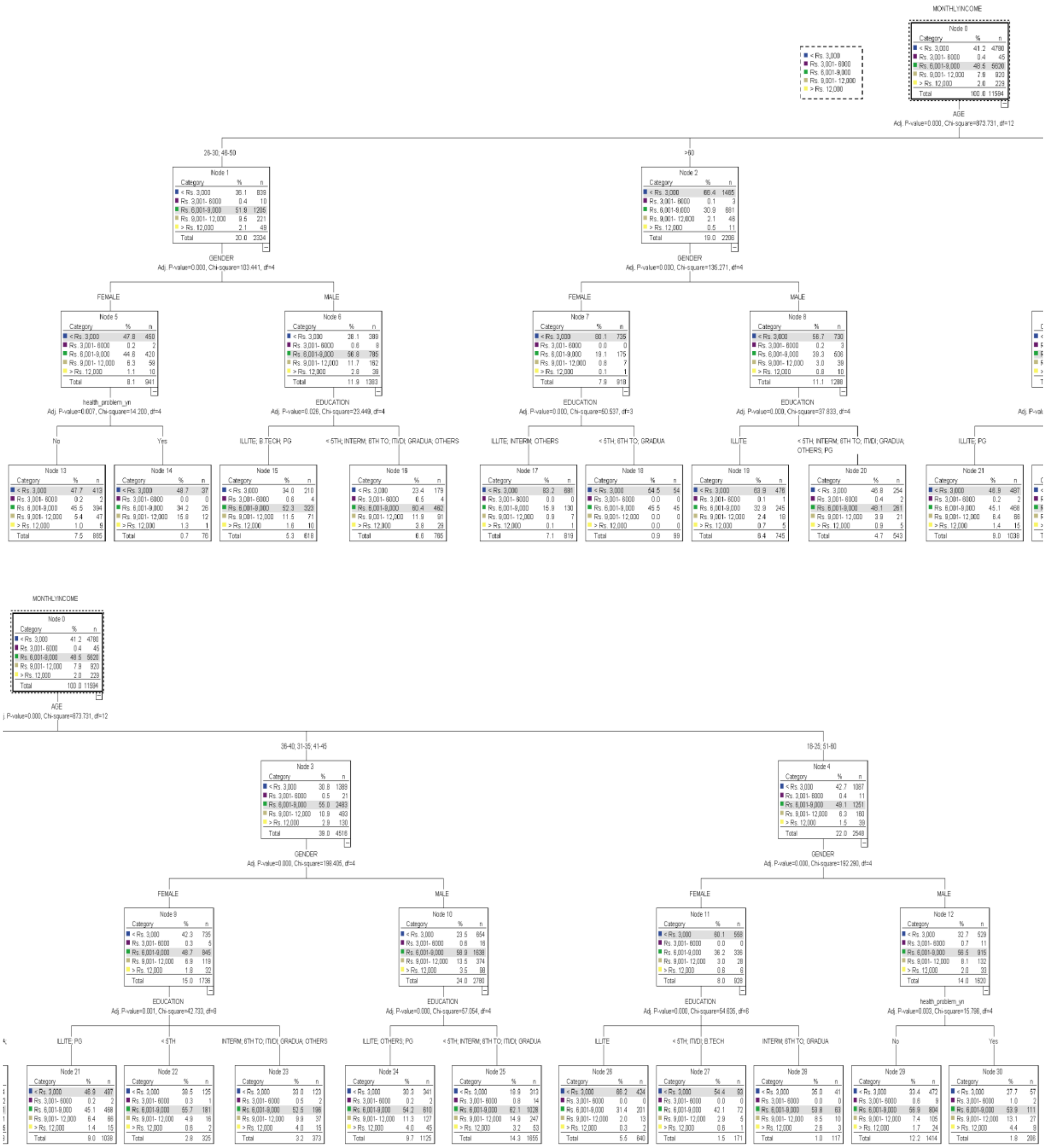


Figure 32
Decision Tree - Model 3

The first row of all four nodes is again divided based on the ‘Gender’ criterion into male and female. Hence, the next more significant predictor is ‘Gender’ with Chi-square values of 103 to 198.

In the second row of nodes from 6 to 11, except nodes 5 and 12, the variable ‘Education’ was noted to be the predominant predictor, with Chi-square values ranging from

23 to 57. However, the fifth and twelfth nodes are signified by the predictor' Sound Health' with low Chi-square values of 15.7 and 14, respectively, showing a lower significance level.

All the nodes in the third row from 15 to 28 are leaf nodes divided based on educational qualification; however, nodes 13,14, 29 and 30 are classified on health status. This model has a depth of three (3), with 30 nodes, including a root node and 18 leaf nodes.

Confusion Matrix: Table 46 shows the confusion matrix detailing the predictions of different income groups.

The classifier < Rs. 3,000 correctly predicted 2665 weavers with an accuracy of 55.8%. While the classifier Rs 6001 to 9000 correctly predicted 4039 weavers (True Positive) with an accuracy of 71.9%.

Whereas the other categories Rs. 3,001 to 6,000, 9001 to 12000 and > Rs. 12,000 have no True Positives (TP); hence, no weavers were predicted in these categories.

Table 46
Confusion Matrix/Classification

Observed	Predicted					
	< Rs. 3,000	Rs. 3,001-6000	Rs. 6,001-9,000	Rs. 9,001-12,000	> Rs. 12,000	Percent Correct
< Rs. 3,000	2665	0	2115	0	0	55.8%
> Rs12,000	5	0	40	0	0	0.0%
Rs. 6,001 to 9,000	1581	0	4039	0	0	71.9%
Rs. 9,001 to 12,000	168	0	752	0	0	0.0%
Rs. 3,001 to 6000	34	0	195	0	0	0.0%
Overall Percentage	38.4%	0.0%	61.6%	0.0%	0.0%	57.8%

Growing Method: CHAID
Dependent Variable: 'Monthly Income'

The overall correctness of the model stays at 57.8 per cent, and the prediction for other categories is poor. The overall lower accuracy is because of a low volume of data in the other income categories.

4.3.3.4 Research Question 3 – Review and Inferences

Model 3 seeks to answer research question number three (3) by reviewing the human capital challenges that influence productivity, income, and overall weavers' living conditions.

Is the prevailing livelihood crisis and impoverishment of the weaving community the culmination of centuries-old neglect of human capital assets?

This model has one dependent variable (Target Variable), the 'Monthly Income' of the weaver and five (5) independent variables (Predictors), which are predominant components of human capital that are purported to affect the weaver's income. The predictor variables include 'Age', 'Gender', 'Education', 'Skill Training Received', and 'Sound Health'.

When Model 3 was tested with MLR, ANN and DT parallelly, the outcomes were almost analogous (Table 47). All three methods predicted that almost 50 to 56% of weavers are likely to fall into the income group of < Rs. 3,000. While another dominant category predicted was Rs. 3,001 to 6,000, with an expected weaver population between 69 to 74%, the remaining income categories have poor predictions.

Table 47
Model 3- Comparative Performance of all 3 Methods

Observed Range	Predicted		
	Multinomial Logistic Regression	Artificial Neural Network	Decision Tree
< Rs. 3,000	56.9%	49.8%	55.8%
> Rs. 12,000	0.0%	0.0%	0.0%
Rs. 3,001 to 6,000	68.9%	73.8%	71.9%
Rs. 6,001 to 9,000	0.0%	0.0%	0.0%
Rs. 9,001 to 12,000	0.0%	0.0%	0.0%
Overall Percentage	56.9%	56.3%	57.8%

Human capital is the most valued intangible asset, with enormous economic value. Both human capital and economic growth are interdependent and inseparable entities.

However, human capital issues remain a serious challenge, and the weaving community across the country is facing severe human capital crises. Low levels of education, health and skill, lack of managerial abilities and entrepreneurship qualities are some critical factors that undermine productivity.

Model 3 conducted a detailed analysis of the impact of human capital factors on productivity by deploying AI and ML techniques.

The sample survey shows that 76 per cent of the participants have weaving as their principal occupation, and the remaining are engaged in ancillary and allied activities. As is known, over 92 per cent of artisans work under master weavers.

Among the weavers, the dominant gender group is men who constitute about 60.98 per cent of the weavers in the sample, and around 39 per cent are female. About 86 per cent of the male artisans adopted weaving as the principal occupation and only 13 per cent focussed on ancillary activities; however, more women, about 38 per cent, preferred ancillary activity as the mainstay; despite that, around 61 per cent took up weaving as the primary profession.

Gender discrimination is still a significant concern, as revealed by the survey.
In terms of educational attainments, artisans lag behind the general population and women artisans are much more backward than their men counterparts. Women are inflicted with illiteracy and low education levels, and their inability to read and write stands at a whopping 67.57 per cent compared to 46 per cent of men.

The overall income levels among artisans are quite deficient; particularly, women artisans earn less than their men counterparts. Nearly 55 per cent of women earn a monthly income of less than Rs 3000, a higher number in the lowest income category; in contrast, only 32.56 per cent of men fall in this income group. On the other hand, more men, about 54 per cent, earn an income of Rs 3000 to 6000; however, fewer women, at 39.27 per cent, belong to this category.

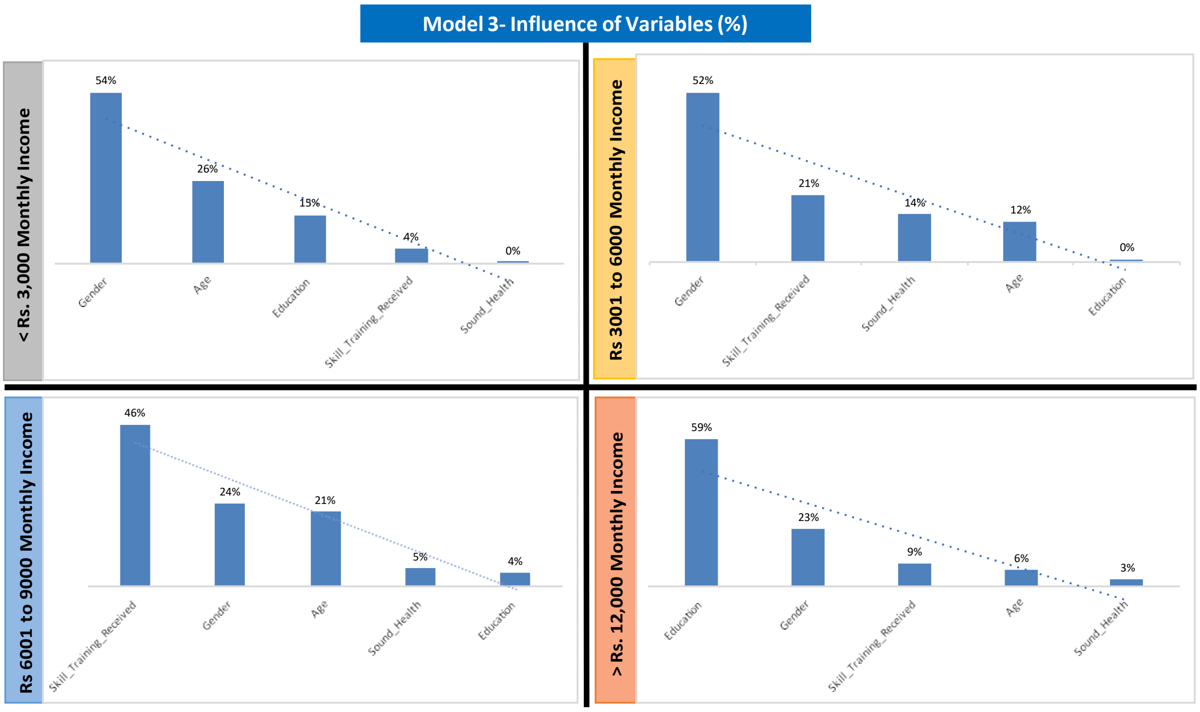


Figure 33
Comparative influence of predictors - Income group-wise

The Likelihood Ratio Test (LR Test) of MLR shows that all the variables are relevant and statistically significant with less than .05 *p*-values (Figure 33).

Concerning ‘Gender’, the LR Test values show a lower level of significance across the income categories; however, the Wald values establish that ‘Gender’ is a decisive variable with 54% weightage in the less than Rs 3000 category and 52% in the Rs 3000 to Rs 6000 category and around 23 per cent in above Rs 6000 income groups (Figure 33).

Table 48
Normalized Importance generated in ANN

Variable	Normalized Importance
Age	100.0%
Gender	82.3%
Education	70.3%
Sound_Health	39.0%
Skill_Training_Received	30.7%

Similarly, the normalised importance value of ‘Gender’ also proves the variable’s strength at 82.3% in terms of prediction within the model (Table 48). The DT has predicted ‘Gender’ to be the second-best predictor.

The survey reveals that over 54 per cent are illiterates, and another 40 per cent are less than 10th grade; it implies that over 94 per cent do not have good educational attainments.

The LR Test shows that ‘Education’ is proved to be an effective indicator with a positive coefficient value and is further associated with a likelihood of over 100% (Figure 33).

The normalised importance of ‘Education’ at 70.3% also proves its strength. Specifically, the Wald value of 59% in the category ‘above 12000’ implies that higher educational attainments are mandatory for getting higher income (Figure 33). Good educational attainments trigger business success in terms of value and contribution, as confirmed by the DT, and this finding conforms to other analyses.

Over 97 per cent of the artisans have traditionally gained weaving knowledge and skill within the family, and only 3 per cent have received external skill-building training. Therefore, the paramountcy of the variable ‘Skill Training Received’ is recognised in all the categories.

In the income categories up to Rs 6000, the variable ‘Skill Training Received’ comes with strong coefficient values and over 180% likelihood. The Wald values are also of considerable strength; however, the normalised importance has a weightage of 31% about ‘Skill Training Received’.

More than 89 per cent of weavers suffer from various health problems, 54% have diabetes, and 41 per cent have blood pressure and diabetes.

The Wald value accorded less weightage to ‘Health’, ranging between 0 to 14%; however, the normalised importance offers a weightage of 39%. It is because over 90 per cent have a productivity of fewer than 2 yards /day and an income of less than Rs 6000/month almost uniformly regardless of their health status. Since the low productivity of artisans is limited by many other factors, the prediction of MLR and DT regarding health is tepid.

The LR Test shows the significance of ‘Age’ across all the income groups, and the Wald values are also significant in all the income categories. The normalised importance value of the ANN has provided the highest importance to ‘Age’ among all the variables. Similarly, DT has also accorded the highest significance to the ‘Age’ with a high Chi- and an adjusted *p*-value of 0.000.

Since over 90 per cent of the weavers are 35 or above, and only 22 per cent are 35 years or below. As a result, youth participation is meagre in the weaving activity. Perhaps this could be one of the potent reasons for the low productivity.

The observations of qualitative data conform to the revelations of quantitative data analysis.

To summarise, this analysis has proved that the attributes of human capital are highly influencing the functionality and productivity of the weavers; however, artisans failed to keep these vital assets intact and honed due to various reasons.

The main reason could be low investments in human capital, which impinges on productivity growth and income growth. Sustained and holistic economic development remains a far-reaching cry among weavers if human capital inadequacies are not addressed.

4.3.4 Model 4 and Research Question 4

Finally, model 4 critically analyses the extent, efficiency and reach of government support to strengthen and sustain the weaver’s livelihoods and professional support to bolster the weaving activity in a bid to promote holistic artisanal activity leading to income rise and consequent exports.

Why have government policies and schemes designed to improve the industry's competitiveness and strengthen the artisan's livelihoods failed to make a positive impact?

Five (5) independent variables were tested against a target variable, 'Monthly Income', to assess the influence and interrelations in this model (Table 49).

Machine Learning and AI approaches were sequentially employed to test this model using the same data. This model is expected to answer the fourth research question.

Table 49
Model 4 - Selected Variables

Dependent Variable	Monthly Income
Independent Variable	Bank AC-yes/no Bank Loan Availed Loan Purpose Housing Loan Availed yes/no Skill Training Received Type of Looms (New infra/loom/upgraded)

4.3.4.1 Multinomial Logistic Regression (MLR) - Model 4

The Case Processing Summary shows that the dependent variable (Monthly Income) has five different scales of income ranging from less than Rs 3000 to above Rs 12000 per month. Over 90 per cent of the weavers earn less than Rs 6000 per month.

Model Fitting Information: Model Fitting is when the algorithm initially learns from the input data and generates a model. The model, in turn, makes predictions concerning the testing data. The outcomes are then verified with the original dataset for accuracy. If the model does not fit the data, the outcomes or predictions will be erroneous.

The Model Fitting test (Table 50) relies on -2 Log-Likelihood and Likelihood Ratio tests. The Chi-Square statistic is the difference between the -2 log-likelihoods of the Null and Final models. Therefore:

LR Chi-Square = -2*L (null Model) – (-2*L (fitted model)).

LR Chi-Square = 1371.068 - 1068.406 = 302.661

df (Degree of Freedom) = 24 groups

Sig = significance = .000

Table 50
Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood	Chi-Square	df	Sig.
Intercept Only	1371.068			
Final	1068.406	302.661	24	.000

Table 51 showed that the final model had a -2 Log-Likelihood value of 1068.406 and was also associated with a significant *p*-value of .000, proving that the final model is an improvement over the Intercept-only model and predicts the dependent variable better than the Intercept.

Goodness of Fit: The Goodness-of-Fit seeks to examine whether the observed data is in tune with the model generated by the algorithm after training. Therefore, the Goodness-of-Fit shows the model's suitability, where the observations are summarised to find any discrepancies between the observed and expected values.

Table 51 shows that higher Chi-square values (623.973 & 480.230) of Pearson's and Deviance models show a better fit; however, the *p*-values are less than the ideal range of >0.05 (over 0.05), showing that the model does not suit the data. In other words, one result is consistent, while the other is not.

Table 51
Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	623.973	384	.000
Deviance	480.230	384	.001

Pseudo R-Square: In Logistic Regression, there are three different indicators, Cox and Snell's, Nagelkerke's and McFadden's R^2, representing the Pseudo R-Squared. Table 52 shows the following results:

1. Cox and Snell's Pseudo R^2 was estimated to be .026; since smaller values of less than one (1) show an improvement over the Intercept-only model, the value of .026 confirms the model's suitability.

2. Nagelkerke's Pseudo R^2 value of .030 was an improvement over the null.

3. However, McFadden's Pseudo R^2 had a value of .013, which is much smaller than the desired range of 0.2 to 0.4 for a fit, hence found unsuitable.

Among the three designated Pseudo R-Squared tests, Cox and Snell's and Nagelkerke's tests showed model's ft. In contrast, McFadden's Pseudo R^2 test was found below the prescribed range; given these mixed results, reliance on Pseudo R^2 is inadequate.

Table 52
Pseudo R-Square

Cox and Snell	.026
Nagelkerke	.030
McFadden	.013

Likelihood Ratio Tests (LR Test): The Likelihood ratios determine the probabilities of all the independent variables. Therefore, the LR Test is usually employed to gauge the overall model fit.

The difference between the -2 log-likelihoods of the reduced model and the final model produces the Chi-square statistic. Therefore, the final model is deemed suitable if the difference between these two models is nominal.

In addition, less than 0.05 *p*-values of the final model also specify the statistical significance and positive contribution to the model.

Table 53 provides the likelihood ratios and significance of all the independent variables. Only two variables, 'Skill Training Received' and 'Housing Loan Availed Y/N' did not have significant *p*-values; however, the remaining four had statistically significant values.

Table 53
Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	1085.658	17.252	4	.002
Bank_Account_Y_N	1250.577	182.171	4	.000
Skill_Training_Received	1073.883	5.477	4	.242
Type_of_Looms	1085.843	17.437	4	.002
Loan_Purpose	1097.253	28.847	4	.000
Housing_Loan_Availed_Y_N	1073.085	4.678	4	.322
Bank_Loan_Availed	1133.796	65.389	4	.000

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

Parameter Estimates: Parameter estimates (coefficients, β) bring about the interrelations between the outcome and the independent variables. Different testing criteria were wielded for all the independent variables to determine the effect of a specific variable within a designated income group (Table 54).

Positive and larger coefficient values bring forth a strong impact on the probability of the outcome. Besides the effect of the coefficients, the other indicators such as higher Odds Ratio (Exp (B)), Wald associated with significant *p*-values, and Std Error of less than two (2) would cause greater probability and enable accurate prediction.

In the group < Rs. 3,000, only three (3) variables,' Bank Account Y/N', 'Loan Purpose' and 'Bank Loan Availed', were associated with significant *p*-values, while the remaining three predictors have non-significant *p*-values.

The variable 'Bank Account Y/N' having negative B value (-.373) is less influential, however, its Std Error was less than 2 and therefore fits the model with 31% (1 minus 0.689= .311 or 31%) lower likelihood.

Table 54
Parameter Estimates

Monthly_Income[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound
< Rs. 3,000	Intercept	3.799	2.148	3.128	1	.077			
	Bank_Account_Y_N	-.373	.144	6.650	1	.010	.689	.519	.914
	Skill_Training_Received	.507	.308	2.703	1	.100	1.660	.907	3.036
	Type_of_Looms	-.536	1.016	.278	1	.598	.585	.080	4.291
	Loan_Purpose	-.140	.044	10.320	1	.001	.869	.798	.947
	Housing_Loan_Availed_Y_N	-.217	.217	1.000	1	.317	.805	.527	1.231
	Bank_Loan_Availed	.459	.138	11.117	1	.001	1.582	1.208	2.072
> Rs. 12,000	Intercept	-24.044	1.658	210.394	1	.000			
	Bank_Account_Y_N	-.003	.347	.000	1	.994	.997	.505	1.969
	Skill_Training_Received	-.247	.667	.137	1	.711	.781	.211	2.889
	Type_of_Looms	12.167	.000	.	1	.	192432.291	192432.291	192432.291
	Loan_Purpose	-.203	.111	3.367	1	.067	.816	.657	1.014
	Housing_Loan_Availed_Y_N	-.583	.637	.838	1	.360	.558	.160	1.946
	Bank_Loan_Availed	-.017	.330	.003	1	.959	.983	.515	1.877
Rs. 3,001 to 6,000	Intercept	3.968	2.135	3.455	1	.063			
	Bank_Account_Y_N	.148	.144	1.044	1	.307	1.159	.873	1.538
	Skill_Training_Received	.539	.307	3.090	1	.079	1.714	.940	3.127
	Type_of_Looms	-1.226	1.010	1.473	1	.225	.294	.041	2.124
	Loan_Purpose	-.087	.044	3.971	1	.046	.917	.842	.999
	Housing_Loan_Availed_Y_N	-.122	.215	.321	1	.571	.885	.580	1.350
	Bank_Loan_Availed	.544	.137	15.738	1	.000	1.723	1.317	2.254
Rs. 6,001 to 9,000	Intercept	1.103	2.328	.225	1	.636			
	Bank_Account_Y_N	.282	.160	3.111	1	.078	1.325	.969	1.813
	Skill_Training_Received	.282	.341	.682	1	.409	1.325	.679	2.585
	Type_of_Looms	-.256	1.099	.054	1	.816	.774	.090	6.669
	Loan_Purpose	-.060	.048	1.606	1	.205	.941	.857	1.034
	Housing_Loan_Availed_Y_N	-.027	.236	.013	1	.909	.973	.613	1.545
	Bank_Loan_Availed	.025	.150	.028	1	.868	1.025	.764	1.376

a. The reference category is Rs. 9,001 to 12,000.

The variable ‘Loan Purpose’ had a negative coefficient of -.140 and was accompanied by an Std Error of .044 and a 13% lower likelihood.

The independent variable ‘Bank Loan Availed’ had a significant effect, with a positive coefficient and permissible Std Error and also shows 1.5 times higher likelihood.

In the category Rs. 3,001 to 6,000, only two (2) variables, ‘Loan Purpose’ and ‘Bank Loan Availed’, were associated with significant *p*-values.

The variable ‘Loan Purpose’ had a negative B value (-.087), hence less significant. The Std Error was limited and complies with the model. While it had a 0.8% (1-

.917= 0.083 or 0.8%) lower likelihood of influencing the ‘Monthly Income’ than that of the reference category.

The variable ‘Bank Loan Availed’ had a significant effect, with a positive coefficient strength of .544. Further, it had a 1.7 times higher likelihood with manageable Std Error.

The categories Rs. 6,001 to 9,000 and > Rs. 12,000 do not have any significant values; therefore, the variables of that group appeared to be poor predictors.

To summarise, for the low and middle-income groups (< Rs. 3,000 and Rs 3001 to 6000), the variables ‘Bank Account Y/N’, ‘Loan Purpose’ and ‘Bank Loan Availed’ seemed significant determinants. However, none of the variables was found important for the high-income groups.

Confusion Matrix/Classification: The Confusion Matrix results generated by MLR are presented in Table 55. The classifier < Rs. 3,000 correctly predicted 1889 weavers as True Positives (TP), however, 2891 weavers were incorrectly identified as category Rs. 3,001 to 6,000, called False Negatives (FN).

Table 55
Confusion Matrix/Classification

Observed	Predicted					
	< Rs. 3,000	> Rs. 12,000	Rs. 3,001 to 6,000	Rs. 6,001 to 9,000	Rs. 9,001 to 12,000	Percent Correct
< Rs. 3,000	1889	0	2891	0	0	39.5%
> Rs. 12,000	15	0	30	0	0	0.0%
Rs. 3,001 to 6,000	1550	0	4070	0	0	72.4%
Rs. 6,001 to 9,000	237	0	683	0	0	0.0%
Rs. 9,001 to 12,000	75	0	154	0	0	0.0%
Overall Percentage	32.5%	0.0%	67.5%	0.0%	0.0%	51.4%

In addition, 1877 (15, 1550, 237, and 75) were incorrectly classified as category < Rs. 3,000 called False Positives (FP). Therefore, the overall accuracy of the classifier stands at 39.5%.

Classifier > Rs. 12,000 had no True Positives (TP), and no weavers were predicted. Therefore, the Accuracy is Zero.

Classifier Rs. 3,001 to 6,000 correctly predicted 4070 weavers to have fallen in this category as True Positives (TP). Accordingly, the accuracy was estimated to be 72.4%.

The other categories from Rs 6001 to 9000 and 9001 to 12000 have no True Positives (TP); hence, no weavers were predicted.

To summarise, the category Rs 3001 to 6000 showed a maximum accuracy of 72.4 per cent, while the accuracy recorded against the category < 3000 stood at 39.5 per cent. Similarly, the other categories had zero accuracies and zero predictions.

The model's overall accuracy (correctness) is low at 51.4 per cent because of a low volume of data in the income categories of < Rs 3000, Rs 6001 to 9000, Rs 9001 to 12000, and above Rs 12000.

4.3.4.2 Artificial Neural Network (ANN) – Model 4

The pictorial representation of the ANN generated in Model 4 is shown in Figure 34.

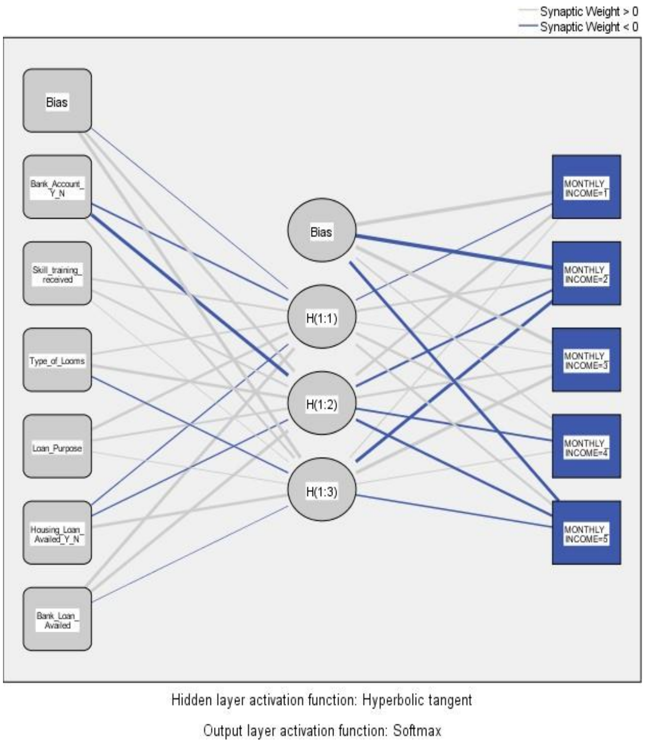


Figure 34
ANN output

After taking the input data, the ANN algorithm yielded the output, and the results show that 70 per cent of the data were used up for training and 30 per cent for testing, and there are no invalid records.

Confusion Matrix/Classification of ANN: The confusion matrix of the ANN algorithm displays an overall accuracy of 53.2% (Table 56).

The classifier < Rs. 3,000 correctly predicted 414 weavers with an accuracy of 29.2% since only a small number of weavers were observed in this group. While the classifier Rs. 3,001 to 6,000 correctly predicted 1458 weavers as True Positives with a computed accuracy of 84.1%. Whereas, the classifiers Rs. 6,001 to 9,000 and Rs. 9,001 to 12,000 and > Rs. 12,000 did not show any True Positives (TP) and hence resulted in zero prediction.

Table 56
Confusion Matrix/Classification

Sample	Observed	Predicted					
		< Rs. 3,000	> Rs. 12,000	Rs. 3,001 to 6,000	Rs. 6,001 to 9,000	Rs. 9,001 to 12,000	Percent Correct
Training	< Rs. 3,000	988	0	2373	0	0	29.4%
	> Rs. 12,000	7	0	27	0	0	0.0%
	Rs. 3,001 to 6,000	683	0	3204	0	0	82.4%
	Rs. 6,001 to 9,000	98	0	525	0	0	0.0%
	Rs. 9,001 to 12,000	33	0	139	0	0	0.0%
	Overall Percent	22.4%	0.0%	77.6%	0.0%	0.0%	51.9%
Testing	< Rs. 3,000	414	0	1005	0	0	29.2%
	> Rs. 12,000	4	0	7	0	0	0.0%
	Rs. 3,001 to 6,000	275	0	1458	0	0	84.1%
	Rs. 6,001 to 9,000	52	0	245	0	0	0.0%
	Rs. 9,001 to 12,000	11	0	46	0	0	0.0%
	Overall Percent	21.5%	0.0%	78.5%	0.0%	0.0%	53.2%

Dependent Variable: Monthly Income

Sensitivity and Specificity: Sensitivity Analysis is a method to assess the model's overall performance by interpreting Receiver Operating Characteristics (ROC) Curves. In addition, Sensitivity Analysis aims to measure the impact of independent variables (predictors) on the dependent variable (Target variable) and further identifies the changes in the predictors.

Sensitivity (Recall) denotes True Positives and estimates the number of actual positive cases predicted correctly as True Positives. Sensitivity (Recall) indicates True Positives and estimates the number of actual positive cases predicted correctly.

Larger values show high accuracy, and a larger AUC authenticates the model's fit (Table 57). While Specificity shows the share of actual negatives predicted correctly as True Negatives (TN). Therefore, higher values of Specificity indicate increased accuracy.

Table 57
Area Under the Curve

		Area
Monthly_Income	< Rs. 3,000	.572
	> Rs. 12,000	.591
	Rs. 3,001 to 6,000	.561
	Rs. 6,001 to 9,000	.570
	Rs. 9,001 to 12,000	.545

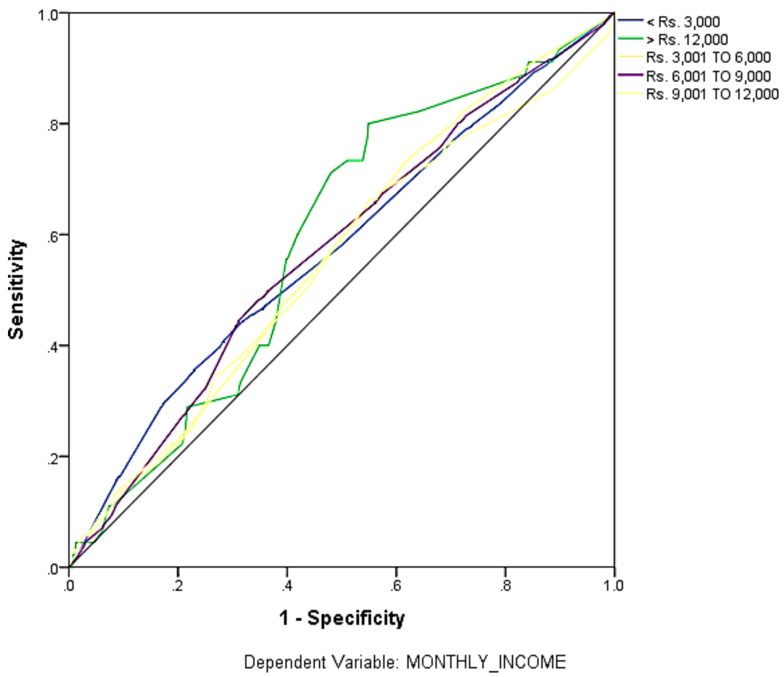


Figure 35
Sensitivity and Specificity Chart – Model 4

The Specificity, as depicted in Figure 35 corroborates the model's accuracy. The figure also shows that the intersection of specificity and sensitivity curves of all variables has fallen above the diagonal line, thus, proving the goodness of the test conducted.

Gain Chart and Lift Chart: Gain is the ratio between a cumulative number of positive observations within a particular decile and the total number of cumulative positive observations of all the deciles in the entire data set.

In Figure 36, a larger area was seen occupied between the Gain and diagonal baseline, showing the predictive model's suitability over the random one. The diagonal baseline, however, represents the random response without a model.

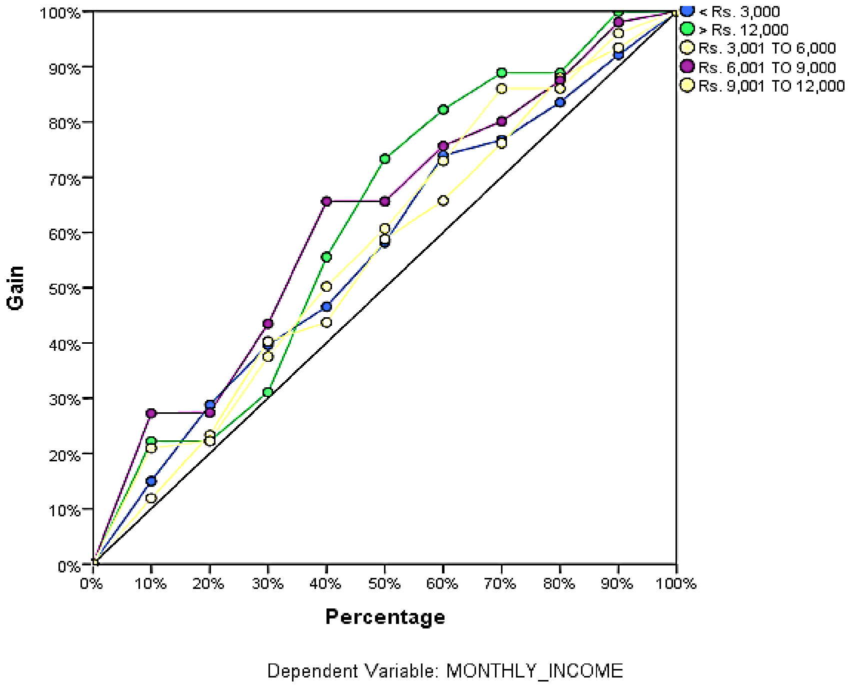


Figure 36
Gain Chart – Model 4

A Lift chart portrays the improvement brought forth by a model compared to the predictions without a model, and the improvement is called Lift.

The baseline on Y-axis is at level one (1), and any gain above one (1) indicates an improvement over the random model. A larger area above the horizontal baseline (X-axis), as in Figure 37, demonstrates the models' accuracy and further proves the soundness of the test.

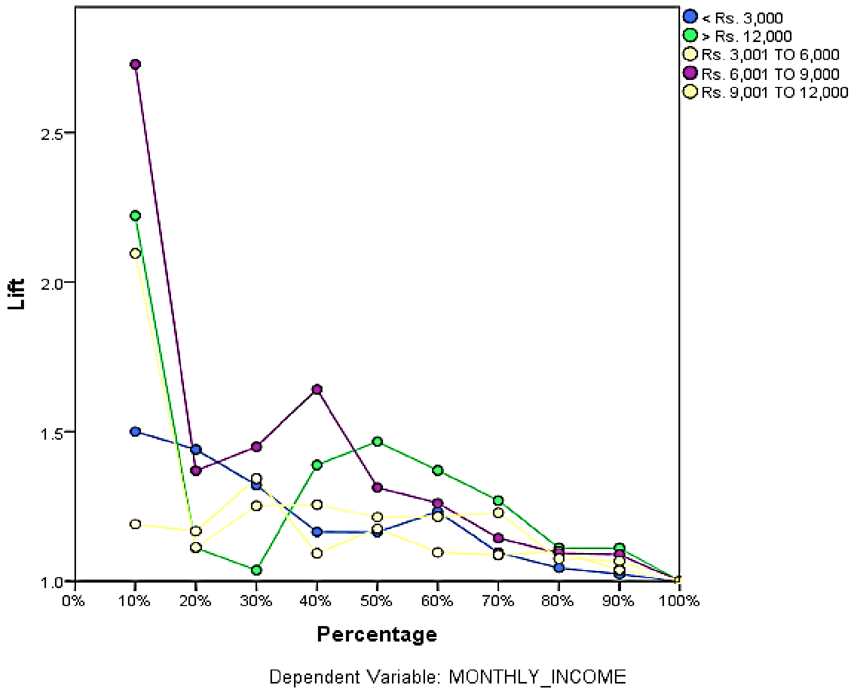


Figure 37
Lift Chart – Model 4

Independent Variable Importance: Table 58 shows the normalised importance and weightage of each predictor (Independent) Variable. The relative strength of these predictors determines the overall model accuracy.

Among the predictors, 'Skill Training Received' has the highest relative strength, followed by the remaining variables, ranging from 41% to 55% (Figure 38).

Table 58
Independent Variable Importance

	Importance	Normalized Importance
Bank_Account_Y_N	.126	43.4%
Skill_Training_Received	.289	100.0%
Type_of_Looms	.160	55.3%
Loan_Purpose	.120	41.6%
Housing_Loan_Availed_Y_N	.140	48.3%
Bank_Loan_Availed	.165	57.0%

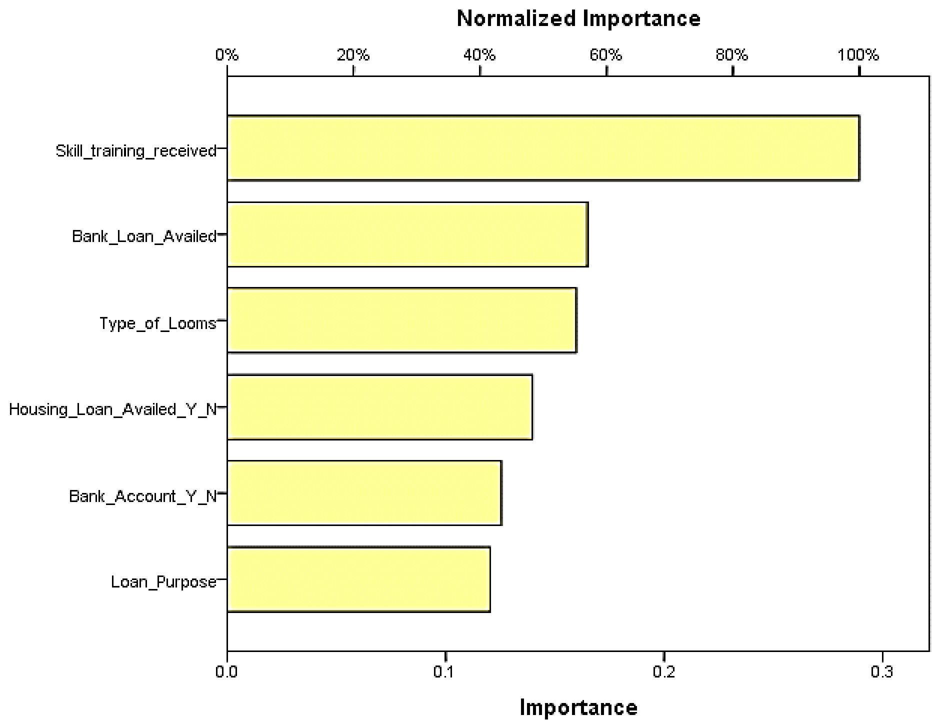


Figure 38
Independent Variable Importance

4.3.4.3 Decision Tree (DT) - Model 4

The Decision Tree (DT) was created using the CHAID algorithm with one target variable and five predictor variables. Monthly income is the target variable present in the root/parent node. The DT algorithm calculates the Chi-square and the corresponding *p*-value at every split point to determine the strength of the predictor variable against the target variable.

The Decision Tree algorithm starts at the root node, moves swiftly, splits at specified points, and ends in leaf nodes, where no further splitting occurs.

The CHAID has selected the predictor ‘Bank Account Y/N’ as the best predictor in the parent node since it has the highest Chi-square value of 184 and lowest *p*-value of 0.000 for the first split (Figure 39).

The first node having artisans without a bank account is again subdivided into four child nodes, including two leaf nodes, based on the purpose of the loan’s utilisation.

Therefore, the variable ‘Loan Purpose’ is identified as the next best predictor with a Chi-square value of 108.

The second node, embodying artisans with a bank account, has further divided into two child nodes depending on the strength of the variable ‘Bank Loan Availed’, implying whether the artisans have availed of a bank loan. This variable ‘Bank Loan Availed’ is found influential with a Chis-square value of 56.

The second row of nodes has been further divided, relying on the strength of variables ‘Skill Training Received’ and ‘Loan Purpose’.

The leaf node (terminal node) is homogenous and considered pure, and the Gini is almost zero.

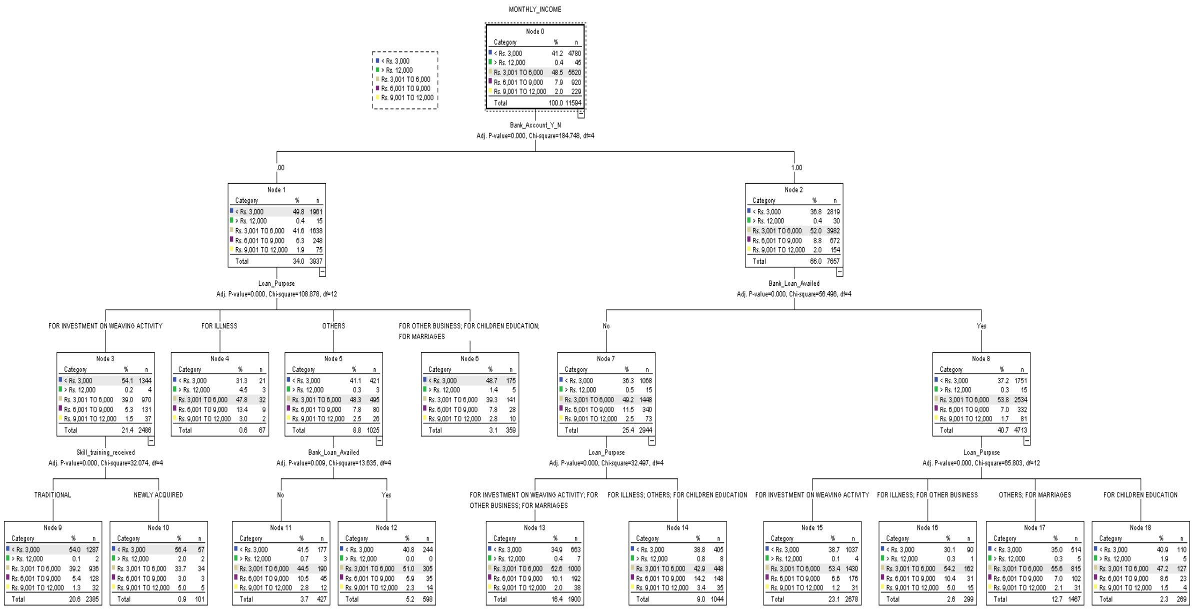


Figure 39
Decision Tree - Model 4

The accuracy of the model’s performance was computed using the Sensitivity (Recall) method. Accuracy implies the number of correct predictions against the total number of predictions.

Sensitivity = True Positive (TP)/True Positive (TP) + False Negative (FN)

This model has a depth of three (3) with 19 nodes, including the root node and 12 leaf nodes.

Confusion Matrix: The Confusion Matrix in Table 59 presents the number of correct and incorrect predictions for each category of the dependent variables.

The classifier < Rs. 3,000 predicted 1519 weavers in the category of < Rs. 3,000 as True Positives (TP), and this classifier shows an accuracy of 55.8%. While the classifier Rs 3,001 to 6,000 correctly predicted 4509 weavers (True Positive) with an accuracy of 93.8%.

Whereas the other classifiers did not have True Positives (TP), hence, no weavers were predicted in these categories.

Table 59
Confusion Matrix/Classification

Observed	Predicted					
	< Rs. 3,000	> Rs. 12,000	Rs. 3,001 to 6,000	Rs. 6,001 to 9,000	Rs. 9,001 to 12,000	Percent Correct
< Rs. 3,000	1519	0	3261	0	0	31.8%
> Rs. 12,000	9	0	36	0	0	0.0%
Rs. 3,001 to 6,000	1111	0	4509	0	0	80.2%
Rs. 6,001 to 9,000	159	0	761	0	0	0.0%
Rs. 9,001 to 12,000	47	0	182	0	0	0.0%
Overall Percentage	24.5%	0.0%	75.5%	0.0%	0.0%	52.0%

Growing Method: CHAID
Dependent Variable: Monthly Income

The overall correctness of the model remained at 52 per cent, and for other categories, the prediction was poor. The overall accuracy of 52 per cent is because of a low volume of data in the other income categories.

4.3.4.4 Research Question 4 – Review and Inferences

The government claims to have extended its holistic support to the handloom sector incessantly. However, the narratives of the literature and historical account project a different picture. Therefore, to find the truth and explore the causes of low productivity and low income, this model was built with relevant factors as independent variables and tested against 'Monthly Income'.

Why have government policies and schemes designed to improve the industry's competitiveness and strengthen the artisan's livelihoods failed to make a positive impact?

Table 60 shows the comparative performance of all three techniques, MLR, ANN and DT, and they all showed similar results and predicted that 31 to 39 per cent of weavers are likely to be in the < Rs. 3,000 income group. However, a larger artisanal population of around 72 to 84 per cent may fall into the category of Rs. 3,001 to 6,000 income group. Hence, over 90 per cent of the weavers would be in an income group of less than Rs 6000. Had the government support been substantial, the most dominant income group would be over Rs 12,000.

Table 60
Model 4- Comparative Performance of all 3 Methods

Observed Range	Predicted		
	Multinomial Logistic Regression	Artificial Neural Network	Decision Tree
< Rs. 3,000	39.5%	29.2%	31.8%
> Rs. 12,000	0.0%	0.0%	0.0%
Rs. 3,001 to 6,000	72.4%	84.1%	80.2%
Rs. 6,001 to 9,000	0.0%	0.0%	0.0%
Rs. 9,001 to 12,000	0.0%	0.0%	0.0%
Overall Percentage	51.4%	53.2%	52.0%

Model 4 intends to critically analyse the extent and extensiveness of the government's support to the weaving activity by examining the following five (5) variables: 'Bank Account Y/N', 'Bank Loan Availed', 'Loan Purpose', 'Housing Loan Availed Y/N', 'Skill Training Received' and 'Type of Looms'.

Bank Account availability in a public bank indicates an opportunity to access financial services and eventually amounts to financial inclusion.

Artisans regularly need adequate working capital to buy raw materials and meet other incidentals; however, out of 11594 weavers, only 66 per cent have an account in a public financial institution (Survey in Appendix D).

The LR Test establishes the importance of the variable ‘Bank Account Y/N’ with statistically significant *p*-values (Figure 40). Moreover, in parameter estimates, it was also identified as a significant indicator in the group < Rs. 3,000, and the Wald value has further confirmed its importance. Finally, the Decision Tree analysis identified the predictor ‘Bank Account Y/N’ as the best predictor associated with the highest Chi-square value.

Bank Loan Availed is another significant predictor. Timely access to credit from formal financial institutions reflects a favourable Government Policy and efficient policy implementation. Nevertheless, out of 8704 artisans who got loans from various sources, over 52% availed of loans from private moneylenders, and only 33% got from formal institutions.

The LR Test shows the variable’s significance (Figure 40). Among all the parameter estimates, the variable ‘Bank Loan Availed’, particularly in the group < Rs. 3,000, was strongly associated with a 1.5 times higher likelihood. The Wald value also showed the highest relevance in the <Rs 3000 category. Similarly, in the Rs. 3,001 to 6,000 group also, the variable strongly correlates with a higher likelihood of 1.7 times. The DT algorithm also found this variable to be highly influencing.

Loan Purpose is an important indicator. Utilising loans for other than professional purposes indicates the failure of the government’s welfare schemes. For example, the survey shows that only 14% of weavers utilised loans for weaving; however, 96% used loans for activities not related to weaving (Survey Statistics in Appendix D).

The LR Test reveals the statistical significance of the indicator ‘Loan Purpose’. In the groups < Rs. 3,000 and Rs. 3,001 to 6,000, this variable was noted to have had its influence. The Wald value further showed relevance in the category <Rs 3000, and the variable was also

found highly effective in the above Rs 12,000 group. The DT also proved the relevance of the variable ‘Loan Purpose’.

Housing Loan Availed Y/N is a critical influencing element of the model. Offering liberal housing loans indicates a favourable government policy toward extending social security. However, the enumeration reveals that only 57 per cent have permanent houses. In comparison, others live in semipermanent or thatched dwelling units. Moreover, only 10.7% (1246) of artisans could get a house loan from the banks, and the remaining 89.3% (10348) were denied.

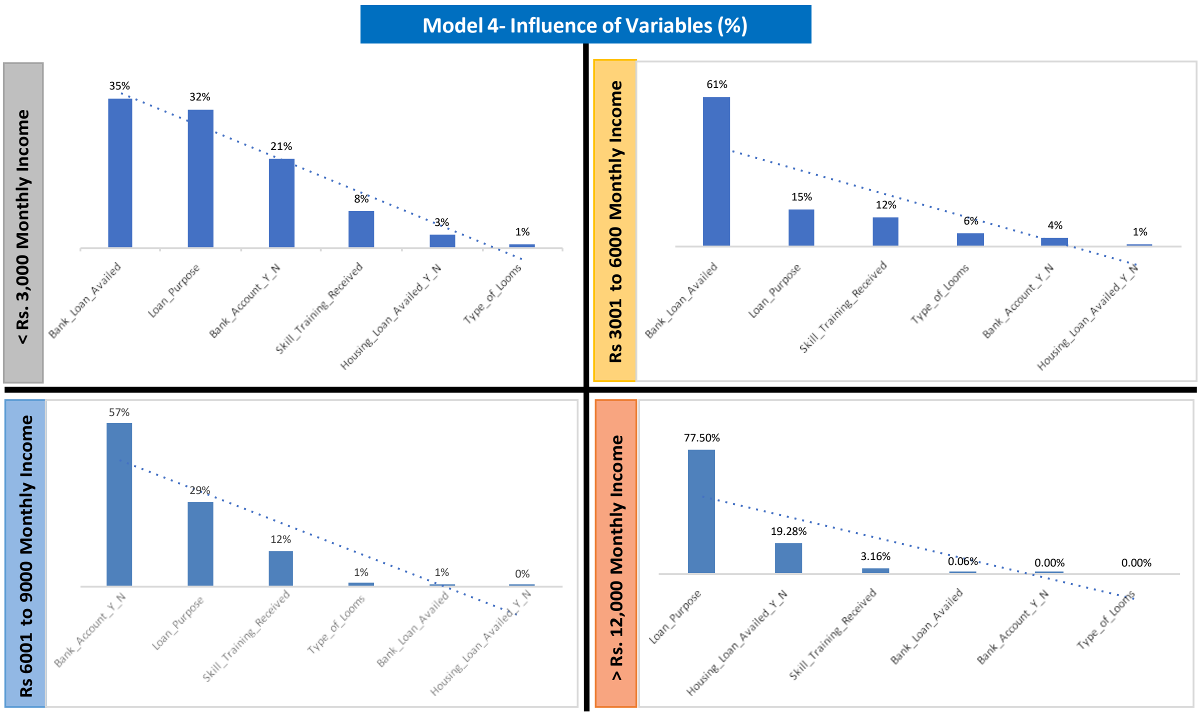


Figure 40
Comparative influence of predictors- Income group-wise

The Likelihood Ratio Test (LR Test) does not show any significance; however, the Wald value shows considerable strength in the above Rs 12000 group (Figure 40).

Besides the traditional and hereditary acquisition of skill and weaving knowledge, artisans are required to upgrade skills to augment productivity and product range to withstand the competition. Incidentally, just 3 per cent of the weavers could receive skill up-gradation training organised by the government. As a result, this variable is noticed to be a poor predictor because of the low volume of data.

It is a non-significant variable according to the Likelihood Ratio Test (LR Test) and remains a poor predictor among all the categories.

Continued usage of Pit Looms shows government's failure to educate the artisans to switch to improved looms and upgrade technology. However, the survey discloses that over 99 per cent of the looms used by the weavers are outdated Pit Looms with lower productivity and higher drudgery.

The Likelihood Ratio Test (LR Test) shows the significance of 'Type of Looms'; however, it remains insignificant across all categories in parameter estimates.

Table 61 Normalised Importance

	Normalized Importance
Skill_Training_Received	100.00%
Bank_Loan_Availed	57.00%
Type_of_Looms	55.30%
Housing_Loan_Availed_Y_N	48.30%
Bank_Account_Y_N	43.40%
Loan_Purpose	41.60%

As generated by ANN, the normalised importance of predictors shows that 'Skill Training Received' has the highest relative strength among the predictors. The remaining variables have a relative strength ranging between 41% to 57% (Table 61).

The analysis of all three methods exposes the shallowness of the government's support to the artisans. For example, the timely credit linkage for weavers to have working capital is meagre, and the technology introduction and up-gradations appeared to be out of the government's agenda. Moreover, the Government grossly neglected individual needs, which make a vast difference in their living conditions and contribute substantially to productivity. A long list of professional and personal needs and aspirations expressed by the artisans in response to the questionnaire further corroborates the findings of the analysis.

A systematic occupational needs assessment was carried out as part of the survey to determine the gaps in the government schemes and identify the artisans' priorities and professional aspirations by asking them what would strengthen them (Table 62).

As in Table 62, housing and work-shed requirements become the top priorities and immediate necessities since most artisans live in unprotected and congested dwelling units. An affordable and decent house makes a real difference in the quality of life of poor artisans; however, it is unrealisable and out of their reach. Most weavers wanted to acquire improved looms and accessories such as Jacquard and dobby.

About 65 per cent wanted an alternative lighting system due to frequent and unscheduled power cuts, and around 22 per cent felt the need for skill up-gradation in weaving, dyeing, designing and value addition.

Table 62
Needs assessment of the weavers

Needs of Weavers and Family Members			Number	%
Training and Capacity Building				
a	Weaving	482	2,666	22.30
b	Dying	336		
c	Printing	916		
d	Designing	863		
e	Garmenting / Value addition	69		
House			2,743	22.95
Work Shed			5,253	43.94
Improved Handlooms			1,861	15.57
Alternate Lighting System			7,742	64.76
Handloom Parts / Accessories			1,409	11.79
Repairs / Replacement of Old Loom			841	7.04
Design Interventions			114	0.95
Group Work Shed			165	1.38
Dobby			413	3.45
Jacquard			1,394	11.66
Yarn Supply			1,963	16.42
Dyeing Facility			276	2.31
Printing Facility			317	2.65
Value addition			47	0.39
Market Linkages			2,457	20.55

Therefore, it is construed that most artisans realised the need for a robust and modern infrastructure with a workspace conducive to the weaving activity.

Although over 90 per cent of the weavers depend on Master Weaver for raw materials supply and marketing, about 17 per cent want timely and quality yarn supply, and over 20 per cent look forward to marketing linkages.

With all its unmet needs and aspirations, the weaving community has become feeble and vulnerable and remains in impoverished conditions. The insights obtained from qualitative data concur with the observations of quantitative data analysis.

4.4 Conclusion

Handlooms, a tormented sector, has been confronting many challenges; as a result, the weavers are struggling for survival.

This study seriously attempted to make a candid assessment and unravel the true picture of the handloom industry, leveraging advanced analytical tools. Based on insights from the literature and other empirical evidence, many factors influencing the handloom sector have been considered. They have been found effective and significant against the target variables in the tests conducted in this study.

This study posed four research questions and devised four different models to answer them. These models were subjected to three different analytical tests sequentially; MLR, ANN, and DT. The results of all three tests are almost similar and prove the model's fit.

Model 1 attempted to understand the reasons for the low productivity among the weavers, duly identifying and examining various elements of productivity. Given the current situation, this model predicted that over 99 per cent of weavers would produce less than 2 yards of fabric per day.

As disclosed by the survey results, productivity is low among the artisans, and it is plausible to believe that the artisans are not able to exploit the key drivers of productivity growth in their favour due to multiple reasons.

The analyses of MLR. ANN and DT have brought out stark revelations that the artisans are precluded from accessing technological advancements such as improved infrastructure like advanced looms and dedicated work-shed and even owning a functional dwelling unit, a fundamental social security asset. Moreover, the necessary support from the government to facilitate such critical services to the weaving community to impart a competitive advantage is seriously missing, the survey revealed.

The wavers' enthusiasm and propensity to learn and innovate were held back by the government's tepid response. Despite the interest shown by most weavers to receive skill training, only a handful could actually get trained.

Dependence on others, particularly on master weavers, for professional and personal needs, kept them away from achieving self-actualisation.

The absence and exility of entrepreneurship qualities and management practices further undermined productivity.

Model 2 predicted that over 99 per cent would earn less than Rs 6000/month (USD80/month). In addition, this model identified and underlined the gaps in the supply chain activities that adversely affected handloom productivity.

Efficient supply chain management is mandatory to augment the business performance, however small an entity is. However, unfortunately, the handloom industry is beleaguered with many inadequacies, such as timely credit, prompt raw materials supply and eventual marketing support.

It is observed that weavers are growing more reliant on master weavers for the raw materials supply and marketing in the absence of government support and other alternatives.

Effective price management reduces price leakage and enables artisans to earn more margins. However, due to the inextricable association of the weaver and the master weaver, the scope for price realisation and negotiation is remote.

As part of the informal sector, handloom units are more susceptible to financial difficulties, and the absence of timely and adequate financial support makes the units adverse and sick. The survey results have already shown that credit access from public financial institutions is meagre, and alternatively, the artisans approach either master weavers or moneylenders.

Model 3 probed into human capital issues and elicited reasons for the below subsistence levels of artisan income. The model foresaw that all the weavers would earn an income of less than Rs 6000/month (USD 80).

This model endeavoured to understand the causality and impact of different livelihood dimensions on weavers' livelihoods and business performance.

This study considered only age, gender, education, health, and skill from many human capital attributes. The analysis also noted them to be impactful at varying scales. The research further established the existence of profound gender discrimination in the sample area. Though men outnumber women in the weaving activity, women's income and educational levels are lower than men's.

The skill the artisans acquired is a natural inheritance, and the outreach of skill up-gradation and other empowerment programmes and measures remained obscure. Youth participation in the handloom activity is increasingly declining because of a lack of certainty, reward and recognition, and only older adults clung to the activity. The incidence of health-related issues was found prevalent and also noticed to be a strong determinant of productivity.

Model 4 forecasts over 99 per cent of weavers in less than Rs 6000/month ($80/month) income group. This model has studied and analysed the utility and impact of various government policies and schemes.

It is customary to expect Governments to play a catalytic role in promoting traditional crafts. However, the Indian Government's policies and schemes were mainly found bereft of any rational purposes and were mostly populist in nature and short-lived. The Governments are expected to play a catalytic role in promoting the crafts. However, the Government policies and schemes were found largely bereft of any rational purposes and were mostly populist in nature and short-lived.

The critical inputs for achieving higher productivity include timely credit, technology promotion and infrastructure up-gradation are rarely made available to the needy weavers.

The government's recital of universal financial inclusion remained far-fetched, and credit access for weaving activity and housing purposes is hardly fulfilled by public credit organisations.

Crafts usually thrive on extensive knowledge and improved skill base; however, the low skill levels among artisans due to lack of opportunities to pursue proved costly and limited the productivity and product range.

The overwhelming demand by the artisans for several services and support shows the ineffectiveness of the government support schemes.

The results eventually warn that the foreseeable prospects of the artisans look grim, and the socioeconomic fallout will be much worse than before if the government fails to embolden the sector with apt and timely interventions.

CHAPTER V:

DISCUSSION AND CONCEPTUAL FRAMEWORKS

This chapter builds on the results and analysis described in the previous chapters and comes up with the suggested conceptual implementation and policy frameworks.

This chapter is divided into five sections. The first section introduces the discussion by recapitulating the issues of the handlooms sector and perspectives underscored in the current study.

Subsequent sections narrate the research question-wise analysis of the findings referring to the sample area and the observations underpinned in the literature and National Handloom Census 2019-20 while drawing parallels.

The fifth section, while explaining the fourth research question, also elucidates the inconsistencies in the policies and programmes of the government. Finally, the next sub-section highlights the need for an exclusive policy for the handloom sector and projects the proposed Policy Framework.

5.1 Introduction

The handloom industry is an important economic activity in the non-farm sector and employs rural artisans. The handloom sector is skill-intensive with minimum infrastructure, which is a hand operative and does not require any power source. Weaving is a community activity confined to a specific group or caste in a particular geographical area. The production process is inclusive and primarily a family affair and easily merges with the social life of artisans.

Based on market demand by the trader, or a master weaver, the future designs and quality are decided beforehand. Although men predominantly take up the weaving, women also take part.

Marketing is done through different channels, including local markets, master weavers, traders, Primary Weaver Cooperative societies (PWCs), and apex cooperative societies. However, the primary source of marketing is the master weaver.

Issues Discussed: Artisanal activity during ancient times provided livelihood and elevated the weaving community's social status and respect in contemporary human society. However, because of the far-reaching implications of globalisation and a shift in human orientation, the handloom industry started retrogression after 1947.

The weaving community, once the pride of India, was pushed into a cataclysmic crisis; now, over 70 per cent of the weavers belong to vulnerable sections.

The sector is implicated by many deterrents, such as frequent changes in government priorities, hinging more on the mechanised sector, and extending subsidies to powerlooms on par with handlooms.

In addition, ignoring the welfare of artisans, and muted response to the violation of the Handloom Reservation Act and Hank Yarn Obligation Acts, are a few more glaring examples, among many others. Moreover, the race toward globalisation has also unleashed a spate of adversities for the artisans.

In conclusion, the asymmetric economic development and lack of economic opportunities resulting from inconsistent policies and inefficient implementation have devastated the handloom industry and pushed the artisans into abject poverty.

Perspectives Considered: The study considered a detailed examination of three perspectives to understand cross-sectional relations and interdependencies to visualise the big picture and uncover the reasons that sneak under the radar.

The First perspective, 'productivity', explains why artisans are unable to exploit various key determinants and drivers of productivity growth affirmatively, such as men, materials, capital, technology, competition, enterprise, innovation, and skills. Furthermore, two research questions have been posed to comprehend this perspective, and both have been examined under the Systems Thinking lens.

Second, the Socioeconomic perspective attempts to understand the causality among livelihood dimensions, human and social capital issues and economic factors and their impact on weavers' livelihoods and business performance. Research question three was modelled to find answers to this perspective and has been examined under the Sustainable Livelihoods Approach alongside the Systems Thinking approach.

The third perspective, ostensibly the Public Policy formulation, followed by a slew of government schemes and interventions unleashed in India, was marked by many upheavals and inconsistencies. The secondary data from various sources have been collated and analysed to gain intelligible and candid insights.

All four research questions have been analysed concerning the research and secondary data findings and expounded in the forthcoming sections.

5.2 Research Question 1:

What deters the weavers from achieving higher productivity growth despite the handloom sector's inherent potential?

Despite India's tremendous potential of having the largest artisanal population, massive infrastructure and abundant raw materials, the productivity levels are quite deficient. The survey in the sample area has shown that over 73% of weavers produce less than 2 yards of fabric per day, and their income earnings are less than USD 80/month.

Model 1, designed in this study (Chapter IV) to find gaps in the productivity factors, has categorically identified and analysed the impact of multiple factors responsible for low productivity. As a result, the model has made a stark prognosis on the industry's prospects.

The informal nature of the handloom sector, the low-income and low wage-earning of the artisans, the declining number of weavers and demotivated youth to continue the looming profession, and non-adoption of technology and modernisation have led to the decreased production of the handloom products.

The handloom industry in India is a decentralised economic activity that broadly supports rural livelihoods (Hazarika *et al*., 2016; Bortamuly and Goswami, 2015; Bortamuly *et al*., 2014; Bhagavatula *et al*., 2010; Beddig, 2008).

The weaving in the sample area is a significant source of livelihood for the weavers. However, their economic productivity and income levels are low, confirming the findings of the Handloom Census (2019) and the observations of various authors cited in the literature.

Production and Productivity: The historical data show that the production volume of handloom fabric has increased initially; however, it stagnated at around 7 billion sq m(m^2) over the years because of the dereliction of productivity factors.

Quality and quantum determine the quality of finished goods or outputs. The significant determinants of long-term productivity growth include investment, innovation, skills, enterprise and competition (Office for National Statistics, UK) (Figure 41).

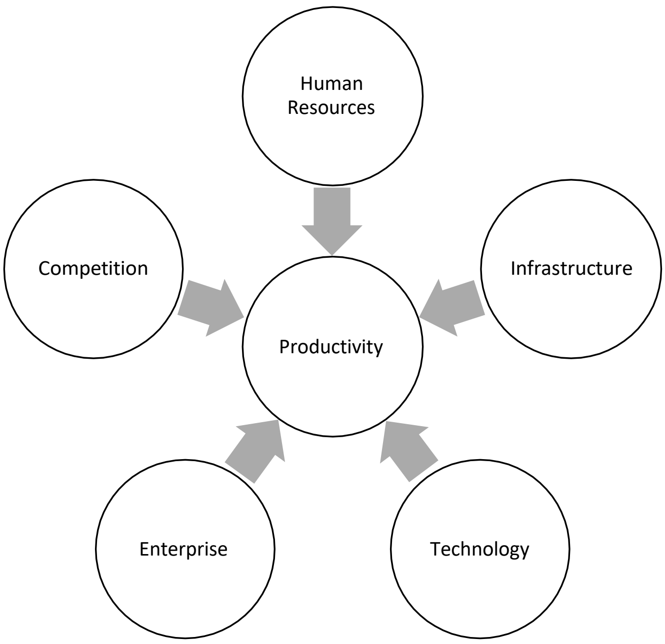


Figure 41
Factors of productivity

Productivity stands out to be the key driver of economic growth and competitiveness (Figure 42). As is known, over time, an economy's enhanced rate of productivity growth determines economic growth and improves living standards (OECD, 2008).

Figure 42
Scheme of Productivity

The efficient conversion of a given level of inputs, such as labour, capital, and raw materials, into a volume of outputs, is productivity (Figure 42). When the growth of outputs is more than the growth of inputs, more productivity growth results (Gordon *et al.*, 2015).

$$\text{Productivity} = \frac{\text{Output (O)}}{\text{Input (I)}}$$

However, this research has noticed that many interrelated factors influence an enterprise's productivity. Furthermore, it is well documented that the handloom sector is not operating at total productive efficiency because of gaps in the factors of productivity growth.

Declining Number of Weavers: The Handloom Census (2019) has reported that the Indian handloom sector is rapidly deteriorating, and the weavers' population has been showing a downward trajectory since the 1970s (Figure 43).

The Handloom Census (2019) further reveals that the number of active weavers has contracted to the current level of 3.5 million from 12.5 million in 1970, and youth participation in the weaving activity is also waning (Annapurna *et al.*, 2012).

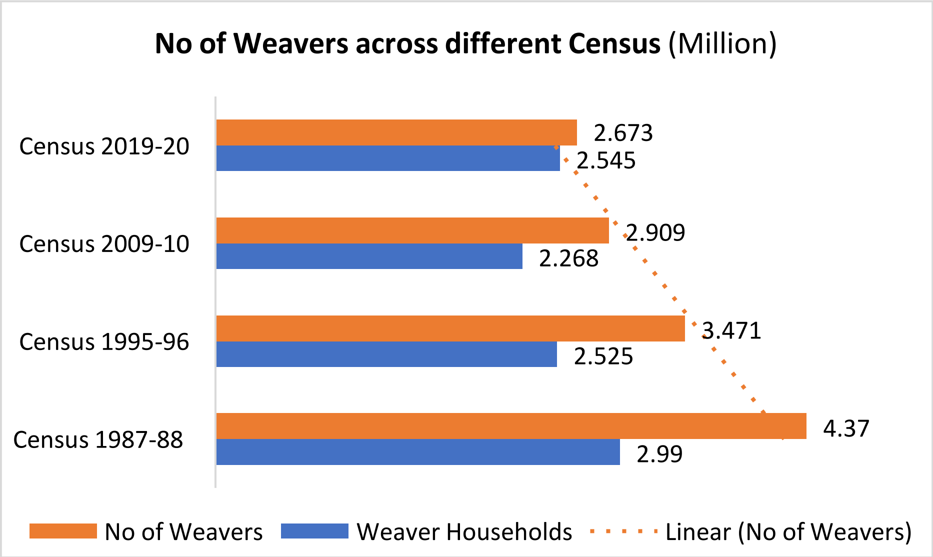


Figure 43
Declining number of weavers across Handloom Censuses

The number of operational looms has also declined, from 3.61 million in the 1987-88 Census to 2.3 million in the 2019-20 Census. On the other hand, during the same period, non-operational or idle looms have gone up from 0.28 million to 0.48 million (Figure 44).

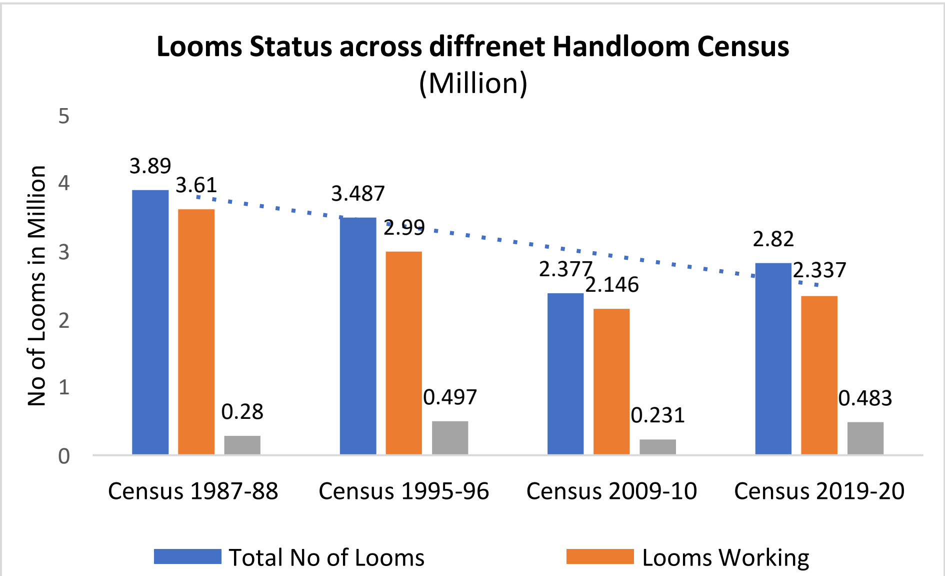


Figure 44
The declining number of Looms across different Handloom Censuses

In the sample area, the historical data also exhibits a similar declining trend, as shown by the Handloom Census data. Nevertheless, more importantly, the participation of youth below 30 is just 10 per cent.

Low Wages: The Handloom Census (2019) shows that about 67 per cent of handloom weavers earn less than USD 67 a month ($2.2 per day). This study also portrays such a grim picture and reveals over 90 per cent of weavers in the Prakasam District get a monthly income of Rs 6000/month (USD 80) which is far below the subsistence level and the minimum wage prescribed.

Gender Discrimination: This research reveals that gender discrimination has manifested in women artisans' income and educational levels. Illiteracy among women is about 68 per cent; however, it is 46 per cent in men artisans. Around 55 per cent of women fall within the lowest income range of below Rs 3000 per month (USD 40), compared to 32 per cent of men.

In India, women are highly respected and regarded as mother Gods; however, the traditional societal norms preclude them from enjoying equal socioeconomic status, particularly regarding access to educational and economic resources.

Social exclusion in India usually operates across socioeconomic and cultural dimensions, and these dimensions interact and mutually buttress the exclusion process while engendering varying degrees of vulnerability and disadvantage.

Eroded Human Capital: Investment is one of the critical factors of production. Investment in human capital, technology acquisition and physical capital, such as machinery, equipment, and other infrastructure, plays a vital role in production.

The human capital attributes such as education, health, innovation, skills, and enterprise are vital intangible success factors for productivity and businesses. Effective empowerment of the organisations through investment in quality education and skill training, coupled with robust transformational initiatives, would engender artisans' sense of self-worth and confidence.

However, it is well established in the study that the government's efforts to expand the weavers' knowledge base and skill sets to accelerate transitions and create high-performance workplaces were seriously missing and only three per cent of weavers received skill training in the sample area. The much-required need for disembodied and invisible technology, which seeks to leverage and amalgamate knowledge acquisition and management, was overshadowed by the irrational welfare schemes with feeble implementation mechanisms.

Dearth of Knowledge: This study has categorically exposed the dearth of organisational knowledge and innovation, which are inextricably linked and considered significant drivers of productivity growth at the organisation level.

Access to qualitative information is an indispensable input to business enterprises; however, among weavers, lack of awareness is widespread and is impelled by the inability of individuals to access, seek and assimilate the information and knowledge because of a lack of literacy, low-level of education, and cultural context.

The survey reveals that over 70% of the weavers are not educated enough to show quick reflexes to the dynamic changes taking place locally and globally in technology, design interventions, and trends, and they still follow the traditional mode of functioning, pinning hope on the master weaver for everything.

Information lag between weavers and the government is a regular phenomenon in the handloom sector. As a result, traders and middlemen dominate the transactions and fix the price in their favour as they are equipped with updated market information and better awareness.

Lack of Knowledge Management Practices: The handlooms sector, at large, is devoid of Knowledge Management practices at every level; the government departments and cooperative societies have of late started such practices to some extent; however, the performance is far from satisfactory.

Many authors and researchers have empirically proved that systematic knowledge management practices help achieve business objectives in different milieus; however, small is the organisation (Upadhyay and Kundu, 2020; Shruti and Das, 2019; Daniel *et al.*, 2018); Olubunmi, 2015; Gonzalez and Martins, 2014; Jelena Rašula *et al.*, 2012; and Powell and Snellman, 2004). The dependence of 92% of weavers on master weavers made them passive and mechanical in the absence of viable alternatives.

Weak Physical Capital: The expositions of Khatoon (2016); Charulate and Rajani Gupte (2015); Goswami and Jain (2014); Patil (2012); Planning Commission (2012); and Blunch *et al*. (2001) have revealed the shallowness of the infrastructure in possession of weavers. The survey in the sample area Most of the weavers do not have own houses of sound quality, safe drinking water, worksheds and modern looms.

Raw Materials Constraints: As described by Khatoon (2016), the handloom sector in the sample location was found seriously debilitated by the shortage of raw materials and frequent cost escalation of yarn and other consumables and further exacerbated by the inability to access institutional finance, marketing and design support.

Lack of Technology Support: The experience elsewhere shows that the units that do not maintain pace in technology up-gradation, innovation and inclination towards digital transformation with the fast-changing technologies will soon become unviable.

The inability of the handloom sector to garner the advantage of the eCommerce platforms, modernisation and failure to extend the marketing network across and link up directly with international markets demonstrates the callous and passive attitude of the weavers. The lack of financial resources, knowledge and handholding support has held them back; therefore, handloom units need the required help to transform.

Unfair Competition from Powerlooms: As if emulated from the philosophy of Schumpeter's Creative Destruction, India experienced mass destruction of traditional industries and business activities, exemplified by an unprecedented expansion of powerlooms trampling upon handlooms. Powerlooms, contributing to over 70% of Indian textiles, have systematically destroyed the handlooms. The imitation products of powerlooms are cheaper because of economies of scale. As a result, the weavers have lost their ability to compete with cheap imitations.

In 1930, the handlooms' contribution to the total cloth production stood at 33 per cent in quantity and 48 per cent in value (Table 63). However, subsequently, the domination of the handlooms started deteriorating, and by 1937 the powerlooms made a beginning and had a share of 1.9 per cent in the total cloth production (Fact Finding Committee,1942).

Table 63
Fabric production - Mills, handlooms, imports & powerlooms - 1930 to 1937

Year	Mills Share %		Handlooms Share %		Imports Share %		Powerlooms Share %	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1930-31	51.5	35.1	33	48.3	15.2	16.5	--	--
1937-38	56.95	36.9	30.7	48.6	10.5	9.2	1.9	5.3

From 1942 onwards, the growth of powerlooms was phenomenal, and the number of registered powerlooms rose from 15000 to 0.45 million by 1974 (Figure 45).

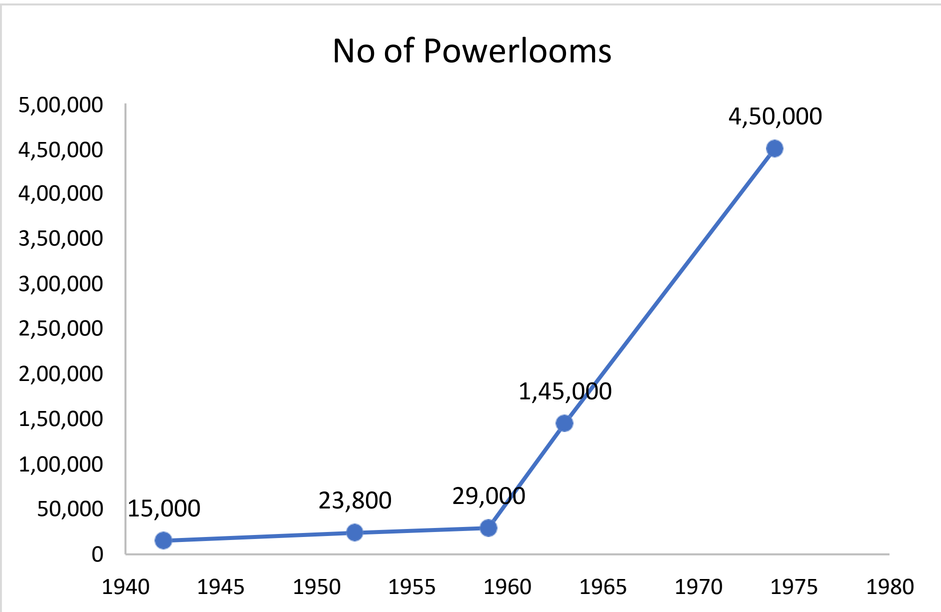


Figure 45
Accelerated growth of powerlooms between 1940 to 1974

After the 1970s, the growth of powerlooms was exponential (Figure 46). By 2012, the number went up to 23 million from 4.5 million in 1974, and now as of 2017-18, the number stands at 27.77 million (Figure 46).

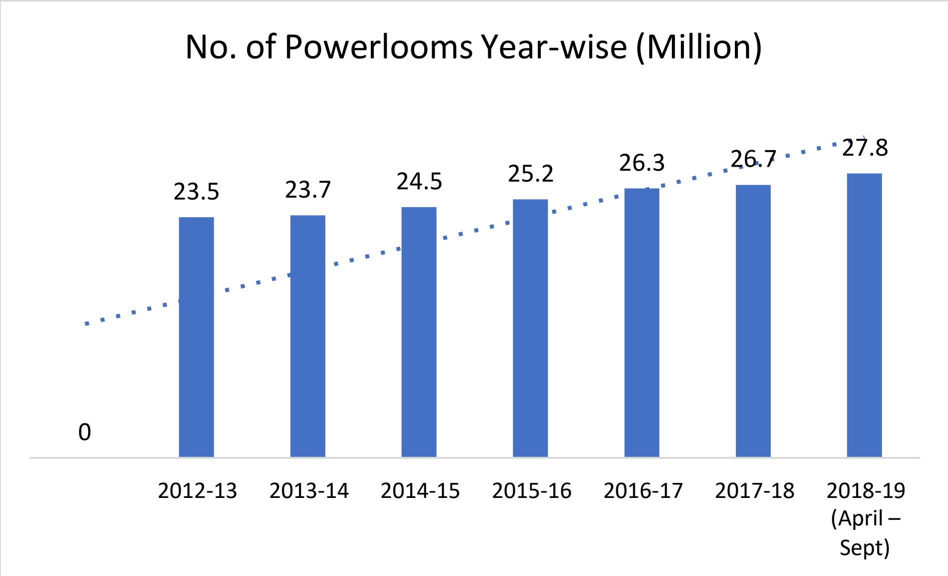


Figure 46
Growth of Powerlooms from 2012-13 to 2018-19

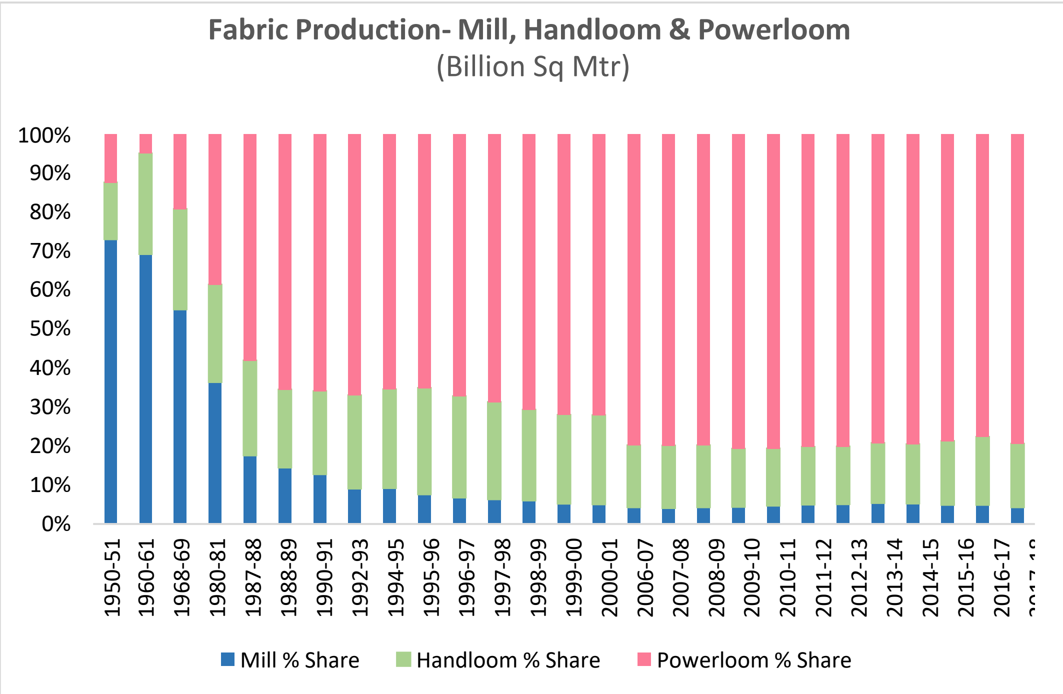
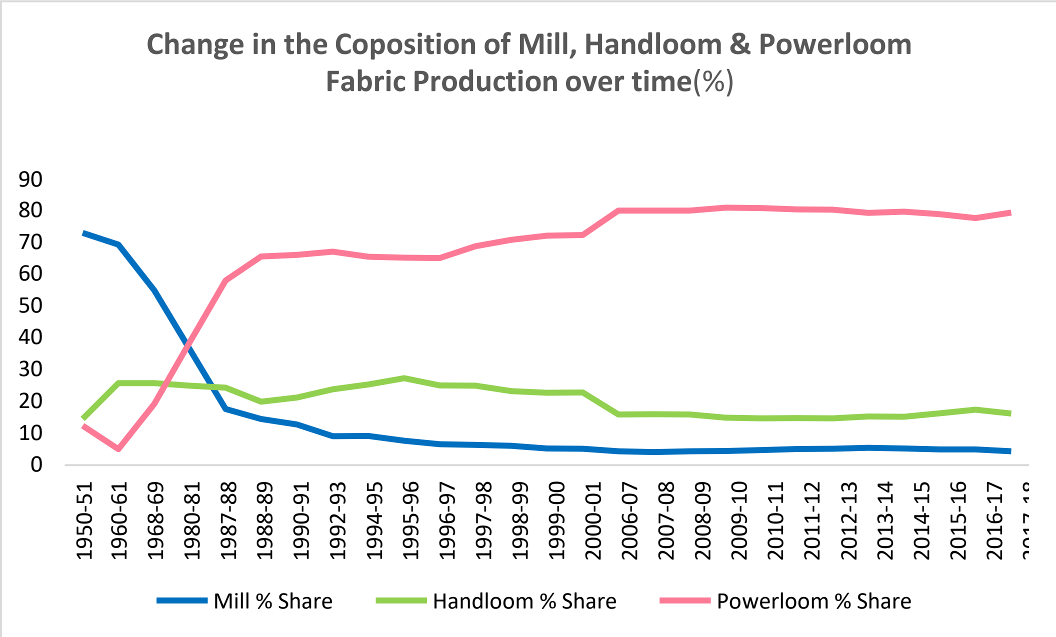


Figure 47
Share of fabric - Mills, Handlooms and Powerlooms from 1950 to 1918



(All values: Excluding Hosiery, Khadi, Wool and Silk)
Source: Textiles Ministry, GoI, Exim Bank, & Handlooms Statistics Compendium
Figure 48
Change of composition of fabric - Mills, Handlooms and Powerlooms

Up to the early 1980s, the mill sector was dominant and contributed over 60 per cent of the country’s cloth production; however, gradually, it was overtaken by the powerloom sector. Within a short period, the powerlooms started reigning supreme, relegating the handloom sector. Currently, powerlooms contribution peaked with a whopping share of over 70 per cent and handlooms were restricted to below 15 per cent (Figures 47 and 48).

The Sivaraman committee also disclosed that the powerlooms recorded an unprecedented growth rate of 21.94 per cent between 1963 and 1974, and each powerloom established rendered six handlooms inactive. Moreover, every job created in the powerloom sector removed 14 jobs from the handloom sector (Niranjana and Vinayan, 2001).

NIPFP (1992) study reported the mushrooming growth of small powerloom units. The report further disclosed that ‘hank’ yarn diversion to the powerloom sector was substantial and was between 21-53 per cent of the total ‘hank’ yarn (National Institute of Public Finance and Policy,1992).

Satyam Committee (1999) reported that 39 per cent of ‘hank’ yarn produced in the country was actually used by the powerloom sector (Niranjana and Vinayan, 2001).

Weak Policy Formulation and Implementation: The household units of weaving make up one of the largest unorganised sectors of the country after agriculture. As these units are unregistered and unregulated, most of the services, benefits and exemptions offered by the government to the corporate sector do not apply to the handloom sector.

Given this, the government has unveiled a slew of schemes, subsidies and other benefits for the handloom sector’s welfare. However, due to several operational issues and insufficient monitoring, most weavers remained vulnerable to exploitation by the master weavers and traders and continued to be impoverished (Beddig, 2008).

Production and productivity are complex processes with several influencing factors showing interdependencies and interconnectedness. Therefore, to understand the dynamic and systemic nature of the system, Systems thinking, particularly causal-loop diagrams, comes in handy.

5.2.1 Systems Thinking Approach

The Systems Thinking perspective sees the system as a whole (one entity) instead of a congregation of isolated parts. As Peter Senge mentioned, ‘A whole is a web of interconnections that creates emerging patterns.’ This approach helps to find the most appropriate places for interventions to address the issues.

Several interconnected parts form a system, and any change in one part automatically changes other parts. Therefore, the system’s behaviour is always dynamic and challenging to predict due to continuous changes and evolution in the parts/components of the system under divergent situations. However, the system’s behaviour depends on the overall compatibility and cohesiveness of the parts.

The pattern of behaviour, as noticed in this study, is complex and wicked. It has multiple adverse narratives such as low productivity, low income, debilitated livelihoods and degraded social status, among many other adverse outcomes in the current handloom sector. Therefore, a holistic approach such as Systems Thinking is apt and plausible to eliminate the problem permanently by rectifying the system structure's shortcomings.

This study has investigated certain variables of interest to find their impact on the artisan's performance. To identify further nuances, deployed systems thinking tools such as the Cause-and-Effect diagram and Causal Loop diagrams using those variables identified.

Causal Loop Diagram is a visual representation that explains the causality of events or happenings in a system and further illustrates how one thing leads to another in a dynamic ecosystem (Figure 61).

The tool provides feedback for holistic and easy understanding, which is otherwise difficult to describe verbally since the system is complex and embodies a web of multiple nonlinear interactions among the factors (Kirkwood, 2013).

Causal Loop Diagrams help researchers visualise a big picture of a system encompassing all its influencing factors (Figure 49). Further, Causal Loop Diagrams facilitate understanding the interrelations and interdependences of various components, factors, or events within a system. These factors influence each other and are eventually responsible for creating a pattern of behaviour or effect in a system (Kirkwood, 2013).

There are two types of feedback loops; Reinforcing Loop (R) and Balancing Loop (B). The elements in the Balanced Loop regulate the system by neutralising or resisting a change and maintaining a steady state and balance.

In contrast, the Reinforcing Loop increases or exponentially aids the effect of a change, both positive and negative. Often, some elements act as barriers or delays in effecting the desired change, called gaps or delays. However, once these gaps are identified and addressed, the process can be expedited toward the desired change.

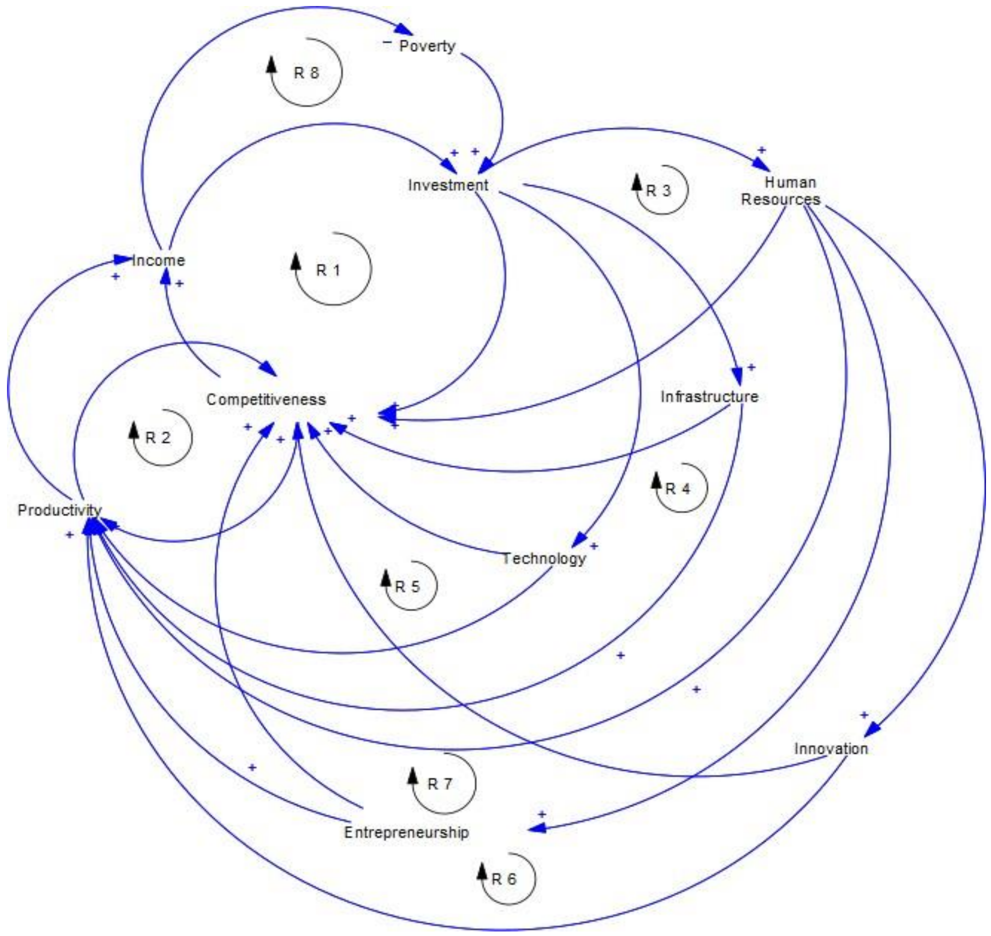


Figure 49
Interconnectedness among the factors of production

A '+' sign or 's' (same) at each arrowhead or on the arrow bar indicates a positive change, while a '–' sign or 'o' (opposite) points to a negative change. A sign of (||) conveys the Delay.

Investment is a crucial determinant that causes long-term positive production outcomes. Investment in human capital, technology, and modern infrastructure creates congenial conditions for enhanced productivity and competitiveness.

Maintaining pace with the changing global business needs by adopting new technologies, acquiring sophisticated infrastructure and practising modern marketing methods will have a multiplier effect on the production process (R 2, R 4, R 5 & R 7).

Investment in human capital in a production system directly affects competitiveness by increasing an individual's skill level, innovation and entrepreneurship abilities (R 3, R 6 & R 7)). In addition, higher productivity and less competition increase overall income and decrease poverty (R 8).

In addition, many external factors, like government policies, tax policies, and market demand, significantly influence productivity. The Government has defaulted from its commitments announced repeatedly and failed to galvanise those announcements into strategic actions securely.

An artisan who achieves higher productivity and gains optimal business is regarded as a successful entrepreneur. However, it is possible only when the artisan efficiently combines all the factors of production (all inputs).

5.3 Research Question 2:

Whether the business performance in the handloom sector lies in the broader, robust, and resilient supply chain?

Supply Chain entails a series of upstream and downstream activities, including the flow of goods and services right from the source of the raw materials, through the manufacturing process and eventually to the delivery of the final goods or services to the end user. In this process, many stakeholders are involved, like individuals, organisations, traders and others. This process is further facilitated by information, finance and other services (Keith Oliver,1982, cited in Cooper *et al.*,1997).

A value chain is the sequence of various business activities in making a final product. For example, in the handloom sector, the value chain begins with procuring raw cotton balls harvested from the fields.

India is the world's largest cotton producer, with an annual production of around 6.1 million tons, and India is projected to produce 27.5 million bales in 2022-23 (James Johnson *et al.*, 2022). The processibility and quality of the fibre depend on the fibre length, colour, strength and reflectance. However, because of certain quality issues, India also imports 0.5 to 0.6 million bales of Extra Long Staple (ELS) cotton annually.

Figure 50 shows the activities of value chain. Raw cotton, after harvest, undergoes two critical processes. The first is ginning, in which the fibre is removed from the seeds and in the second process, the fibre is twisted into yarn called spinning. Both activities are predominantly in the corporate sector.

The yarn is made into a hank (coiled) form to facilitate handloom weaving. Next, artisans initiate weaving using warp and weft to make fabric after processing the yarn with chemicals and dyes.

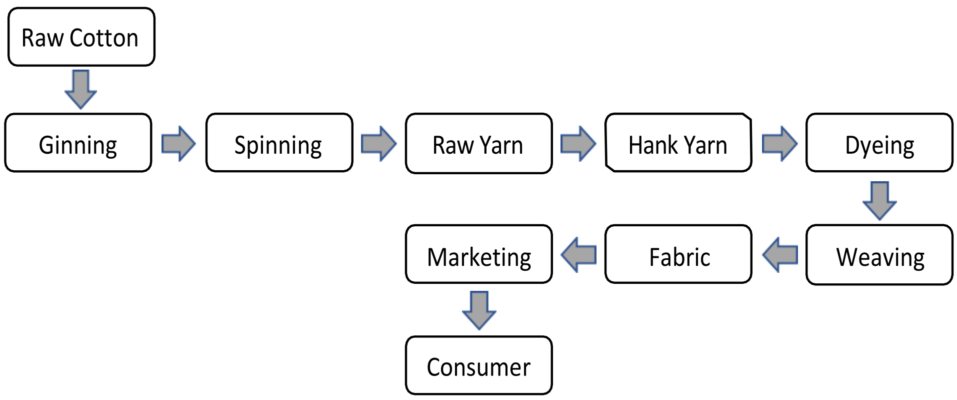


Figure 50
Value Chain of Handloom

Yarn is converted into hank form (coiled) exclusively for the sake of handloom weaving and supplied with a subsidy; however, the exploitation by the powerloom units by diverting and utilising the hank yarn to grab the subsidy is going on unabated and unchecked. As notified by many authors, the handloom industry suffers from serious supply chain interruptions (Anumala, 2021; Kalyani *et al.*, 2017; Giri and Shankar, 2013).

The survey conducted in this study has disclosed that about 92 per cent of weavers work under the master weaver's fold and depend on the master weaver for all the weaving requirements, including raw materials, chemicals and dyes, finance, and marketing.

Therefore, any supply chain disruption immediately affects the master weaver and the weavers under him and eventually affects productivity (Anumala, 2021; Amit and Nehal, 2020).

Absence of Supply Chain Management (SCM) Practices: The survey also revealed that the artisans are not practising any Supply Chain Management (SCM) practices for the promotion and increased efficiency of the production process, as already opined by authors such as Anumala (2021); Agus (2015); Zahra Lotfi *et al.* (2013); Inda Sukati *et al*. (2012); Arawati (2011) and Arawati *et al.* (2008).

Raw Material Issues: As many researchers have uncovered the challenges and issues of production, quality, price, procurement, and distribution of yarn, this study has found that raw materials' availability is still a significant concern. (Kalyani *et al*., 2017; Kasisomayajula, 2012; Goswami and Jain, 2011; Reddy, 2010; Niranjana and Vinayan, 2001; Chalam, 2001; Noorbasha Abdul, 1996; NIPFP, 1992; Abid Hussain Committee, 1989).

Raw material made available under hank yarn regulation through mills is mostly an elusive source. The weavers are therefore compelled to source yarn from the open market at exorbitant prices. The semi-skilled workers engaged in pre-loom and post-loom activities in villages have also given up the activity in search of other non-farm activities. Lowering dependence on agriculture and dwindling local markets have also made a dent in local economies. Thus, the economic activity once predicated in the rural areas has been traumatised and upended the artisans’ fortunes.

Inadequate supply, erratic price escalation, diversion of 'hank' yarn by the mills and powerlooms and failure to implement the Hank Yarn Obligation (HYO) act have increasingly caused hardships to the weavers. The survey and personal interviews with the artisans in the sample area disclose that uncertainty in yarn and chemicals supplies squeezed their efficiency, productivity, and income.

The primary problem lies in the procurement of raw materials. Most of the yarn purchased by weavers (approximately 76 per cent) is from the open market, and the remaining is from government and cooperative societies (Handloom Census, 2019).

Lack of Credit and Working Capital: National Handloom Census (2019), 12th Plan Steering Committee, Hazarika *et al*. (2016) and several others have exposed the shallowness in institutional finance to the weavers.

For any business activity, adequate and timely working capital availability is paramount. However, weavers usually receive a disproportionately small share of credit from banks.

It is noticed in this study that over 36 per cent of weavers have no bank accounts, and hardly 33 per cent could avail of institutional credit, which ultimately pushed the majority into the money lender's clutches.

Often, the artisans face a problem with lengthy verification processes and longer timelines for loan approval than outright rejection.

Moreover, the lack of financial literacy, low educational attainments among the artisans, sparse banking density in rural areas, and apathy of banking personnel to lend have further debilitated the weavers from accessing credit from formal sources.

In the absence of adequate social security schemes, about 78 per cent of the loans availed have been spent on marriage celebrations of their children and siblings.

Absence of Design Interventions: For sustainable customer demand, continuous innovative product designing is crucial, as held by Marzia & Beatrice (2014); Sanjeev & Nandini (2011); and Kapur and Mittar (2014).

However, the lack of proper skill enhancement programmes and a lack of regular interface with designers and customers have made the weavers obsolete in terms of new designs and patterns.

Currently, weavers' interaction is mostly confined to the master weavers, and they do not have any direct exposure to market trends and customer needs.

Absence of Marketing Strategy: A systematic and integrated marketing plan using technology and management strategies would enhance the reach of the artisans and, ultimately, sales outcomes (Khateeb and Vadakepat, 2012; Craft Council, 2011; Madhuri and Tejaswini, 2012; Mamidipudi and Bijker, 2018).

However, the major marketing source of handloom products remains master weavers; about 92 per cent rely on master weavers for their marketing needs. A smaller extent is marketed through cooperative societies (PWCs), apex weaver's organisations, and local traders.

With the government's lackadaisical attitude in imparting proper training and empowerment, artisans tended to lean towards master weavers for all their professional needs. In addition, technology adoption and use of social media for publicity and leveraging eCommerce platforms in tune with fast-changing global dynamics are beyond a weaver's imagination and reach.

5.3.1 Systems Thinking Approach

The supply chain challenges identified in this study and taken from the secondary data have been studied under the Systems Thinking lens using the Double -Q diagram (Cause-and-Effect diagram, or Fish Bone diagram). A double-Q diagram (Figure 51) is a visual representation that manifests the causal links of main categories with an outcome or effect.

The Fishbone diagram is a quality tool to comprehend the perspective of causality and understand how one event or episode leads to another in a dynamic situation. The diagram recognises and classifies many possible causes or factors of an adverse event or problem while depicting the interconnectedness and influence.

The major categories of underlying causes of the problem are shown on the major branches that emerged from the main arrow. In contrast, detailed causes are drawn on the branches that originated from the appropriate category.

In the system's structure, the primary pattern or problem identified in this study was Low Productivity, which is shown on the right side of the diagram under effect.

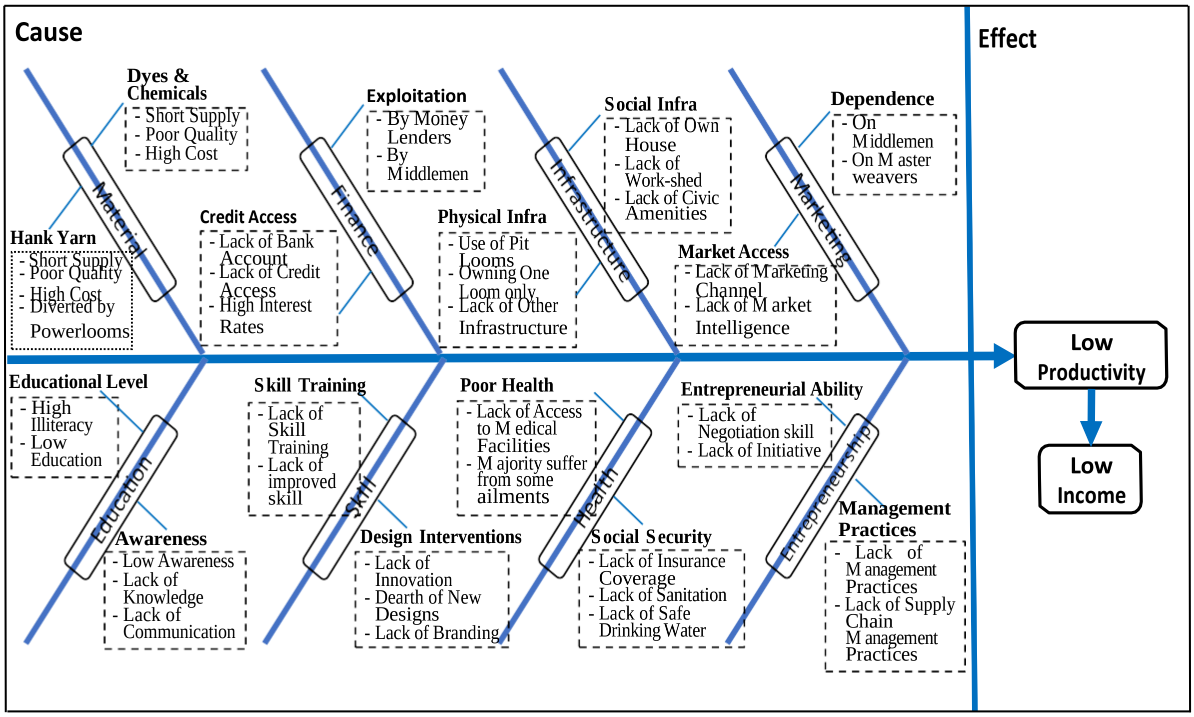


Figure 51
Fish Bone Diagram showing supply chain issues in the handloom sector

The major categories of factors that have caused low productivity are classified into hard or visible factors and soft factors or invisible factors.

The major visible or physical factors are shown on the upper side of the main arrow, which includes Materials, Finance, Infrastructure and Marketing. These factors are again subdivided and mentioned on the side branches.

In the same way, the factors of human capital or soft factors are mentioned on the main branches of the lower portion of the main arrow. These factors comprise Education, Health, Skill and Entrepreneurship. Finally, the details of each of the subcategories are mentioned on the side branches.

5.4 Research Question 3:

Is the prevailing livelihood crisis and impoverishment of the weaving community the culmination of centuries-old neglect of human capital assets?

Weaving is the mainstay for many artisans in rural areas; however, the handloom sector is currently beleaguered with multifarious problems and has posed enormous challenges to the survival of artisans.

Research carried out in this study has documented and highlighted the severity and magnitude of various factors which are associated with socioeconomic distress among individual artisans and families. Furthermore, these factors are known to bring about cascading and intersecting effects creating spin-off crises on artisans' livelihoods.

Unfair competition from the powerlooms, lack of assured market and credit, inadequate investment in human, social and physical capital assets, and lackadaisical attitude of the government are a few constraints which have resulted in the present crisis.

Poverty is surmised as a complex multifactorial situation, and currently, the artisans are beset with multiple problems and reeling under extreme poverty. However, empirical evidence shows that livelihood perspectives profoundly influence the development thinking of rural communities and provide deep insights into the complex and dynamic activities and interactions across disparate sectors.

Therefore, it is felt appropriate to view and analyse the misery of the handloom weavers under the Sustainable Livelihoods Framework lens, besides applying the Systems Thinking approaches. Hence, the Sustainable Livelihoods Approach can be effectively used as a checklist to understand rural artisans' complex and multisectoral development questions.

5.4.1 Sustainable Livelihoods Framework

Chambers and Conway (1992) define livelihoods as:

> A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation, and which contributes net benefits to other livelihoods at the local and global levels and in the short and long run.

The livelihoods are those basic needs that support sustainable living and usually encompass human capabilities, assets and activities required for survival and progress. The Department for International Development (DFID), a Government Department of the United Kingdom, designed a people-centric approach called the Sustainable Livelihoods Framework, which explains various dimensions of poverty, including their complexity and interrelationships (Scoones, 2009).

SLA is a popular and trusted model in vogue to integrate insights and interventions for poverty reduction strategies worldwide. SL framework banks on the five dimensions, including the context of vulnerability, livelihood assets, transforming structures and processes, and livelihood strategies and outcomes (Figure 52).

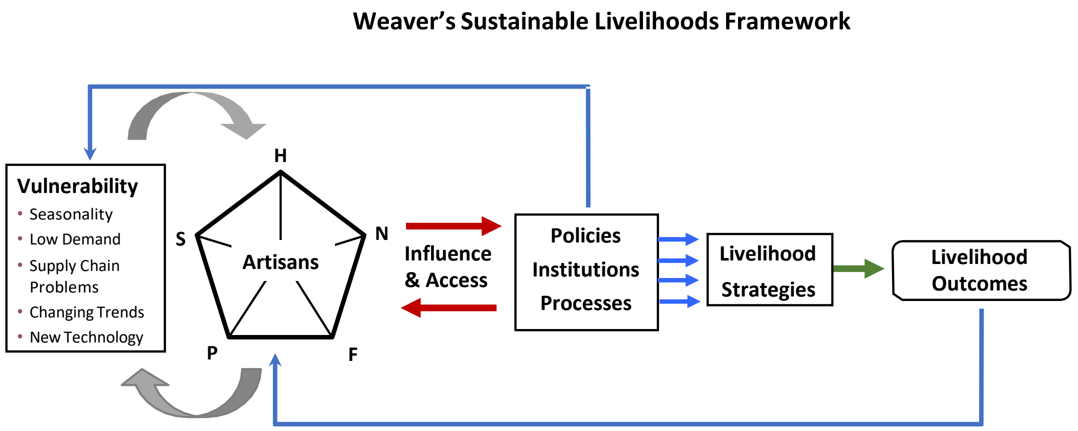


Figure 52
Artisans' Sustainable Livelihoods Framework

The Indian artisans predominantly work in an informal setting. The typical constraints they face include a lack of a reliable source of raw materials, poor infrastructure and inadequate working capital. Moreover, inefficient delivery mechanisms and weak enforcement of the statutes and rules have rendered weavers incapacitated to avail of the reservations and other sops announced by the government.

Lack of opportunity to participate in the policy formulation process, under-investment in livelihood assets, lack of resources for social protection and absence of risk and vulnerability prevention and reduction mechanisms have made artisans vulnerable and poor.

The poor are often incapable of accessing the fundamental building blocks of livelihood assets, also called capitals, and fall into deep impoverishment (Carney *et al*.,1999; Scoones, 1998). These assets entail Human Capital (H- Education, health, skills, knowledge); Social Capital (S- Associations, social networks, community-based organisations); Physical Capital (P- Houses, roads, schools, agricultural land); Financial Capital (F- Wages, savings, credits); and Natural Capital (N- Aquatic resources, land, flora, water resources, air quality).

This paper is mandated to identify the challenges the weavers face, the risks they are exposed to, the effects of various drivers of vulnerability and how those factors influence artisans' livelihoods and lead to impoverishment. This study has already revealed that all the assets that the artisans purported to possess are degraded and feeble. However, they will be analysed once again under the SLA framework.

Human Capital: An artisan's ability to work and motivation is usually modulated by human capital factors, such as education, skill, health status, sanitation and many other similar factors (Bari *et al*., 2015). The dearth of entrepreneurial abilities among artisans, compounded by the lack of knowledge and skill to meet the contemporary demand of consumers, is the culmination of the monumental neglect and lack of focus on human capital components over time (Figure 53).

This study has divulged that over 97 per cent of the weavers in the sample area are either illiterate or with low educational levels, which is higher than the national average, as reported in Handloom Census (2019).

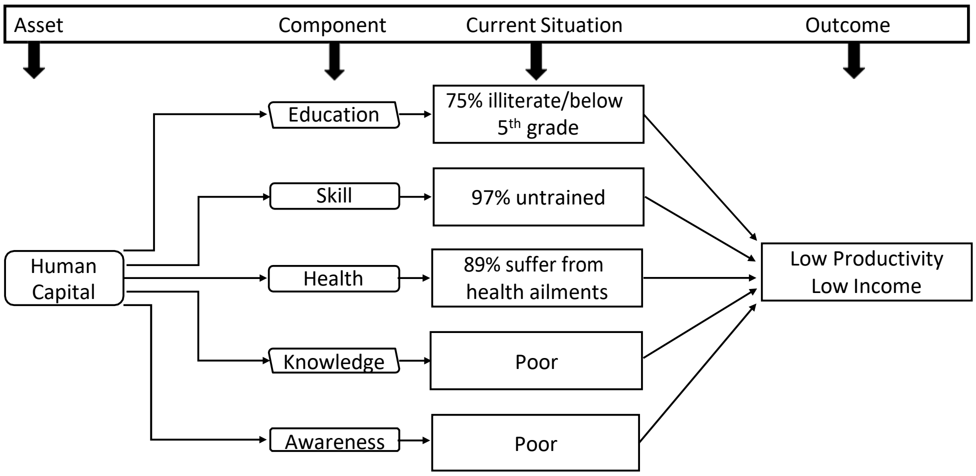


Figure 53
Artisans' Human Capital Assets

Sangeeta *et al.* (2010) and Hazarika *et al.* (2016) have noticed the low coverage of skill training among artisans and highlighted the need for skill development for higher productivity. Only about 3 per cent of the weavers in the sample area have received formal skill development training.

In conformity with the observations made by Sarkar (2016) and Priyanka Koiri (2020), this study also reveals that around 90 per cent of weavers suffer from various health ailments with weakened abilities.

Social Capital: This research has also found that a lack of own house and operating on a single pit loom per family, either own or rent are the key influencing factors of production and seriously impeding productivity (Figure 54). In addition, most households lack clean drinking water and sanitation facilities, as exposed in the 12th Plan Steering Committee report (Planning Commission, 2012). Furthermore, the coverage under various social security schemes is meagre. The insurance penetration, both life and health, among weaver households is 3.8% only (Handloom Census, 2019).

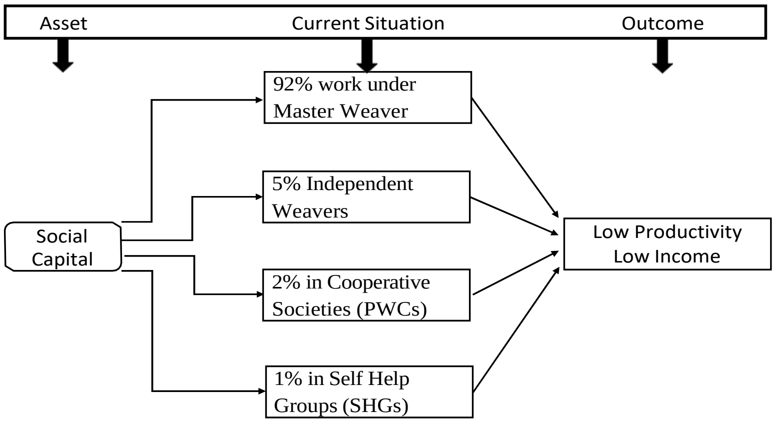


Figure 54
Artisans' Social Capital Assets

Physical Capital: The fragmented handloom units are characterised by many inadequacies and deficiencies, including outdated looms and insufficient infrastructures such as a lack of work sheds, modern tools, value edition equipment, storage facilities for raw materials and finished goods, transport and packaging facilities and many others (Khatoon, 2016; Charulate and Rajani Gupte, 2015; Goswami and Jain, 2014; Patil, 2012; Planning Commission, 2012; and Blunch *et al.*, 2001). Moreover, most of the weavers work on old pit looms in the sample area, with less productivity (Figure 55).

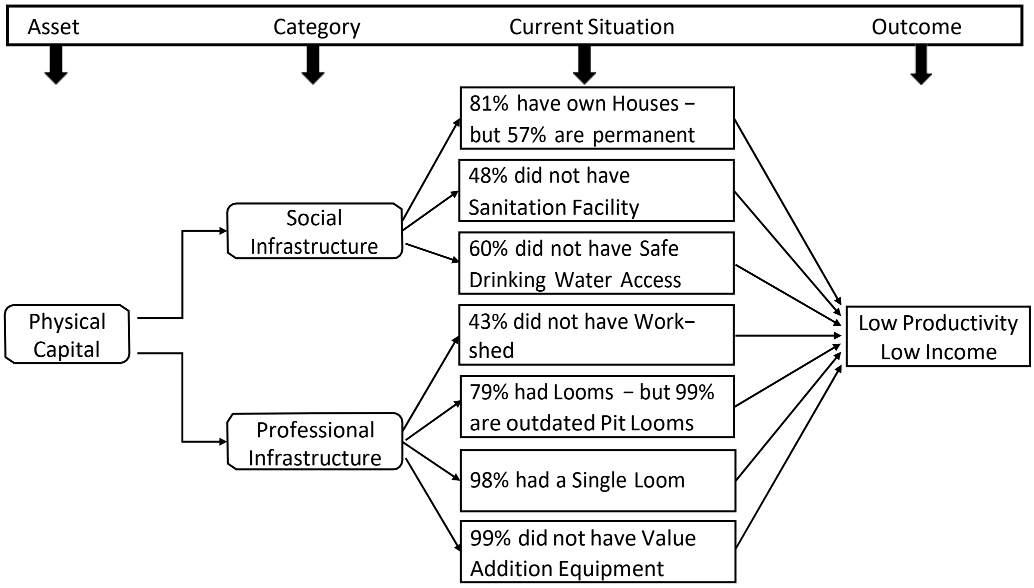


Figure 55
Artisans' Physical Capital Assets

This research has also found that a lack of own house and operating on a single pit loom per family, either own or rent are the key influencing factors of production and seriously impeding productivity. In addition, most households lack clean drinking water and sanitation facilities, as exposed in the 12th Plan Steering Committee report (Planning Commission, 2012).

Financial Capital: It is observed that over 90 per cent of weavers in the Prakasam District earn a monthly revenue of less than Rs 6000 (USD 80), which is slightly higher than the national average of Rs 5000 (USD 67) a month (Handloom Census, 2019); nevertheless, less than the standard minimum wage prescribed by the government (Figure 56).

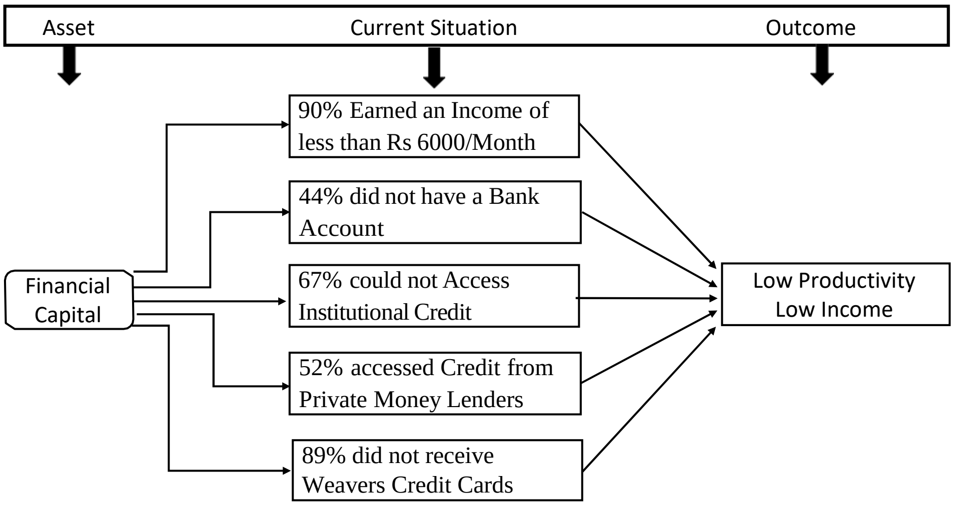


Figure 56
Artisans' Financial Capital Assets

The price the weavers get is not commensurate with their effort and hard work. Hence, it results in low wages below subsistence and nonremunerative prices for handloom products.

The survey showed that about 44 per cent of weavers did not have bank accounts, only 33 per cent could access credit from banks, and most weavers relied on private money lenders for working capital. The income and wages, education, skill, health and other social parameters are found to be comparatively low among women artisans, as mentioned by Hazariaka (2017) and Mishra *et al*. (2021).

Natural Capital: The natural assets, once used to provide alternate livelihoods to the rural inhabitants, have become scarce and no longer support the rural people. In addition, land degradation, soil erosion, the decline in soil health, water pollution, and loss of vegetation because of climate change or human interference have significantly changed the natural ecosystem and undermined the aquatic and soil productivity levels (Figure 57).

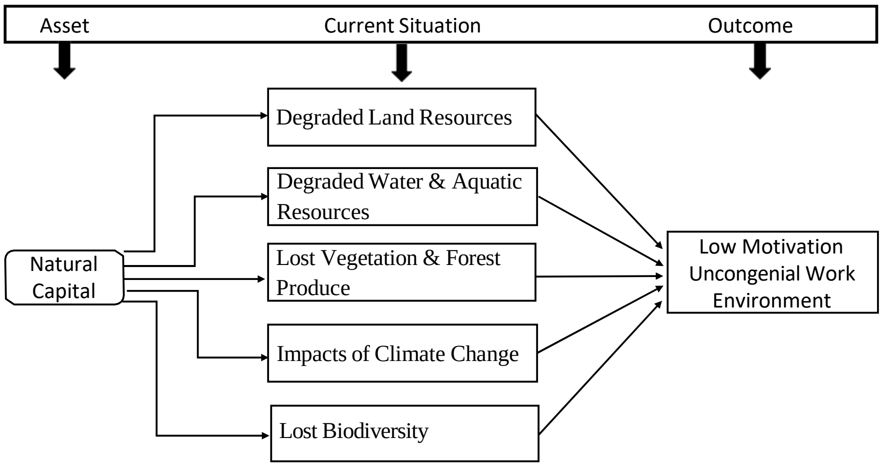


Figure 57
Artisans' Natural Capital Assets

Vulnerability and Risk: The above expositions concerning the diminished capacity of different factors have proved to cause the current livelihood crisis and vulnerability.

Vulnerability is a crucial dimension that reflects the weakened capacities of an individual, a group, or a community to prevent or face and manage the debilitating impact of a hazard or an adverse event that suddenly hits them.

Vulnerability is due to certain unforeseen and uncontrollable natural events, such as drought, floods, epidemics or economic disasters like economic depression and recession.

In addition, many structural weaknesses cause vulnerability and are often identified by a lack of access to essential services such as education, health, fragile infrastructure, inability to access institutional credit, lack of alternative livelihoods and exposure to other socioeconomic risks (Figure 58).

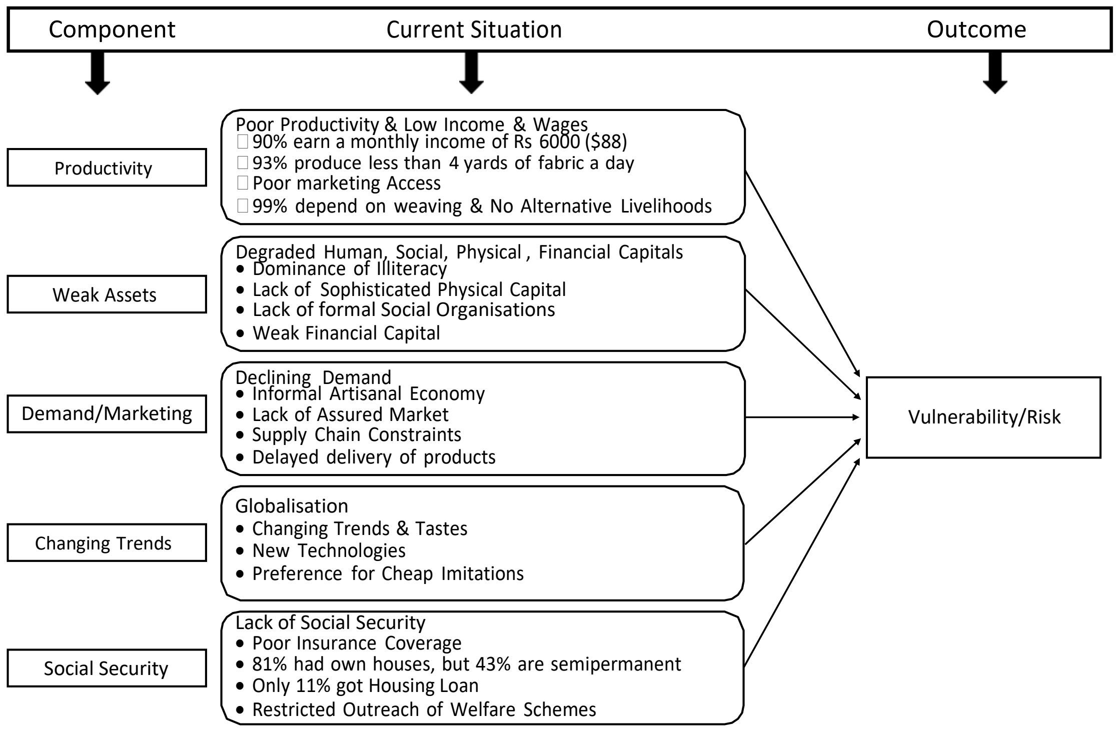


Figure 58
Components causing Vulnerability

Often weavers experience a sudden surge in raw materials prices due to local or global changes. Conversely, a shift in customers' tastes and needs may cause an unexpected fall in demand. Similarly, supply chain disruptions may seriously affect the weavers because of natural calamities or other reasons.

Transforming Structures and Processes: It is imperative to protect, preserve and promote the livelihood assets to reduce vulnerability and risk and eventually enable the weavers to attain reasonable and decent living standards, which is achieved by deploying appropriate livelihood strategies, channelling through the transforming structures and processes (Figure 59).

The transforming structures and processes as in figure 59 include the institutions and the systems in place. Usually, they include government policies, schemes and machinery for implementing and monitoring various interventions. However, the survey and analysis have shown that most of the interventions made by the government are futile and bore no fruits.

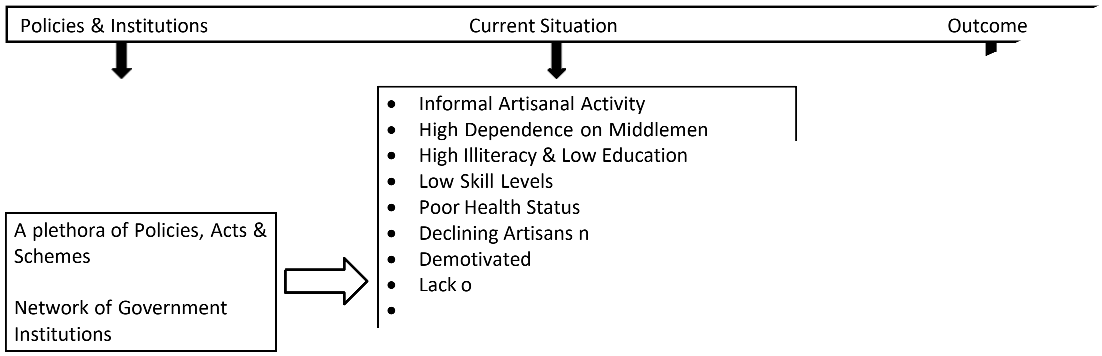


Figure 59
Transforming structures, processes and outcomes

The government must empower the artisans to increase their overall resilience and capacities to address any challenges through policy and intervention.

This approach stems from three (3) goals: Strengthen Livelihoods assets, create sustainable enterprises by integrating with supply chains and value chains, and lastly, risk reduction and mitigation embedded with social safety nets.

The challenge of ending the pervasive poverty among artisans is a daunting task that requires a strong will accompanied by policies, structures, and processes.

5.4.2 Systems Thinking Approach

A causal loop diagram is constructed within the boundaries of Human Capital attributes while verifying the consistency of the literature and the observations made in this study.

The interconnectedness among the factors of human capital is shown in Figure 60. The diagram starts with the positive effects of education (R 1). It is already established that the higher the education level, the higher the knowledge and awareness. Then, improved awareness drives an individual to undergo training in various aspects of the profession (R 4) to improve the skill sets; however, it happens with some delay (||). Enhanced skill, in turn, leads to innovation, new designs, new products and overall higher productivity (R 6 & R 3) and eventually cause higher income (R 5).

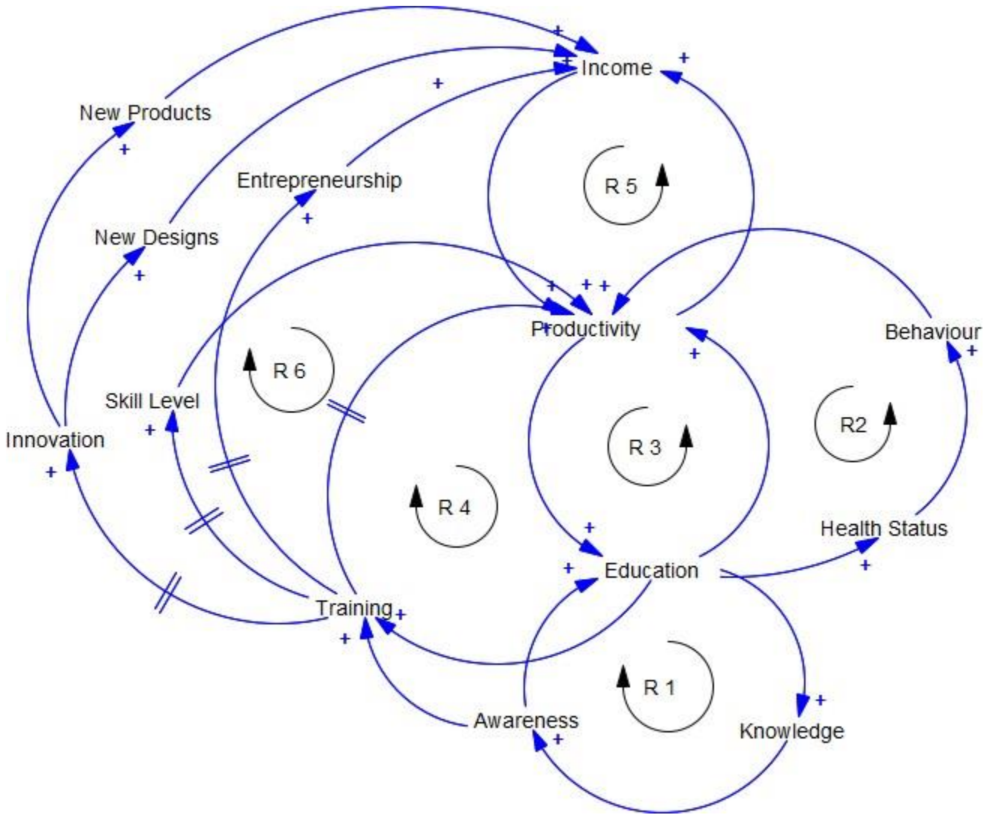


Figure 60
Interconnectedness among livelihood factors

Elevated levels of education (R 2) also impart hygiene and a health-seeking attitude, leading to improved health status and, ultimately, higher productivity (R 3).

5.5 Research Question 4:

Why have the government policies and schemes designed to improve the industry's competitiveness and strengthen the artisan's livelihoods miserably failed to make a substantial positive impact?

The handloom sector has been continuously confronting inconsistencies in government policies and ill-conceived schemes launched for the benefit of weavers. Moreover, the gaps in their implementation have exacerbated the crisis in the sector.

Policies that are noncoherent and inconsistent with previous policies can be challenging and also useless in achieving societal goals (Van Engen *et al*., 2019). Hence, there is a need to identify the critical areas of policy formulation, continuation, and implementation to find the gaps between the intended policy objectives and actual results in the field to explore possible solutions. Therefore, this sub-section predominantly relied on secondary data.

Addressing complex issues requires an in-depth understanding of whether the current policies are in the right direction with proper planning, budget, and implementation mechanisms. Therefore, this study attempts to dive deep to analyse the intricacies and impacts of the policies and schemes with a focus on:

- Identifying critical areas where existing policies and programmes are not delivering results and finding gaps in the implementation process.
- The policies led to the powerloom sector's ascendency at the cost of handlooms.
- Identifying reasons for India’s failure to exploit the existing potential to boost productivity growth and gain a substantial share in the global handloom trade.

This section examines the government’s behaviour regarding policy formulation, different schemes, and implementation across three periods; Pre-Independence (Before 1947), Post-Independence (After 1947) and Post-Industrial Revolution/Liberalisation (After 1991).

Until the invasion of imperial rulers, India used to be a leading exporter of textiles. India’s export of cotton goods to Europe, the Far East, Persia and Central Asia was estimated at 50 to 60 million yards per annum (Leadbeater, 1993).

Britain ended the trade dominance of the East India Company by 1813, and slowly, British cloth imports to India witnessed a steep increase. However, still, India managed to remain a net exporter (Dutt, 1906). To counter Indian exports, Britain started observing protectionist policies, such as levying additional tariffs on Indian textile imports into Britain, which resulted in a sharp fall in Indian exports to Britain.

After the 1857 mutiny by Indians against the British Government, the British crown took complete control over India, which led to further deterioration of handlooms.

At the beginning of the twentieth century, Indian handlooms had to face twin challenges of unfair competition from British mill-made cheap cloth and a severe shortage of quality yarn due to the First World War. As a result, Indian handlooms had to settle with coarse cloth; however, the mill sector got a substantial share of cloth production at the expense of local handlooms and imports (Dutt, 1906).

The yarn crisis led to severe unemployment in the country; recognising the crisis, the Royal Commission on Agriculture in 1928 suggested introducing subsidised yarn to handlooms and forming handloom cooperatives. To develop handlooms, the government announced a grant of Rs 5 lakhs to the Provincial Governments in 1934 (Mazumdar, 1984).

The discriminatory and exploitative British colonial rule encouraged mill-made cloth and yarn imports from England. No significant measures were taken until 1935 to correct the anomalies in the draconian textiles policies of British India. However, in 1935, the government started a subvention scheme for the handloom sector and provided Rs.5 lakhs to each state as a subsidy for five years.

The Fact Finding Committee, formed by the government in 1942 to find the reasons for the crisis in the handloom industry, suggested that certain fabrics be reserved for the handloom sector and further advised setting up an All India Handloom Board (GoI, 1942).

In compliance, the All India Handloom Board was set up in 1945 with limited scope. However, it was restructured with a broader scope in 1951 for supporting artisans, including financial and technical help (Leadbeater, 1993).

During the Second World War, with the increase in demand for uniform cloth for the army, yarn demand also went up; to accommodate the handloom sector with adequate yarn supply, the Cotton Cloth and Yarn (Control) order was taken out in 1943.

After the war, the 1943 Order was renewed through the Textile Industry (Control of Production) Order 1947; however, it was withdrawn in 1948. As a result, cotton and yarn prices shot up exorbitantly, and the government was forced to bring out a new Cotton Textiles (Control) Order in August 1948 (Leadbeater, 1993).

Handlooms witnessed greater turbulence in policy formulation in the post-independent era. Across all Five-Year Plans, emphasis was laid on cottage industries, especially developing the handloom industry, and the major push was on bringing the handlooms into the cooperative fold.

In 1947, inspired by Gandhi's Swadeshi Movement, the government emphasised the need for cottage industries and artisans and included handicrafts and cottage industries in the National Planning Framework.

The Government of India convened the Industries Conference in December 1947 to identify the industrial sector's prospects and challenges, including the handloom sector. The conference identified many challenges regarding the cottage and small-scale industries, such as a lack of finance, ancient techniques of manufacturing, flawed marketing techniques, scarcity of raw materials and competition from mill-made goods, both imported and locally made (Jalal, 1991).

As a result, in 1947, India heralded many interventions for preserving and honing the handloom sector, mainly focusing on creating handloom cooperatives.

The country's first Industrial Policy Resolution (1948) emphasised the role of cottage industries while alluding to the handloom sector. The Industrial Policy Resolution of 1948 expected the textile industry to complement the handloom industry but not as a competitor (Leadbeater, 1993). The same philosophy was reflected in the Industries (Development and Regulation) Act 1951.

In 1948, the government regulated the operation and procuring of powerlooms. The Government also banned the production of certain cloth varieties by the mill sector by enacting the Cotton Textile (Control) Order in 1948. Subsequently, in 1949, the government also imposed excise duty on mill cloth.

Even though the Cotton Textile (Control) Order (1948) ensured reservation of dhoties, sarees, lungis, chaddars, bed sheets, towels, handkerchiefs and other similar articles exclusively for the handloom sector, however, by the 1950s, there was a partial relaxation.

The government later extended the reservation of 5 items to the small-scale powerloom enterprises with 4 or 5 powerlooms on par with the handloom sector, rendering the reservation for handlooms ineffective. Thus, failure to implement reservations originally meant for handlooms led to the bourgeoning growth of power looms.

Before 1950, the decentralised centre was synonymous with the handloom sector; however, afterwards, the composition of the decentralised sector changed with a sharp rise in powerlooms. As a result, powerlooms occupied and accounted for over 70 per cent of the decentralised sector (Mazumdar, 1984).

The dominance of powerlooms led to a surge in unemployment among weavers. To probe into the crisis and make recommendations, the government appointed a commission headed by Nityanand Kanungo in 1952. The committee’s recommendations in favour of powerlooms further influenced the government to facilitate the installation of over 35,000 powerlooms during the 2nd Five-Year Plan (1956 to 61). As a result, the number of powerlooms, around 15,000 at the time of independence, rose to a phenomenal 4,50,000 by 1974 (Mazumdar, 1984).

The All India Handloom Board was restructured in 1952 to augment the production and marketing of handloom products while adopting cooperative principles. In addition, in 1952, the government introduced Handloom Rebate Scheme.

In 1952, the Reserve Bank of India (RBI) launched a scheme to supply yarn with a buy-back arrangement of finished fabric to benefit the handloom weavers. Parallelly, the government imposed curbs on the production of dhotis in mills up to 60% of their monthly production. The RBI has further widened its schemes to revitalise the handloom sector.

In 1952, the RBI expanded working capital support to weavers' cooperative societies. In 1956, RBI introduced the Ninety Percent Loss Guarantee Scheme to cover the irrecoverable losses incurred by the cooperative banks.

In 1953, Khadi and Other Handloom Industries (Additional Excise Duty on Cloth) Act was passed to levy additional excise duty on mill-made cloth for promoting the sale of khadi and other handloom cloth. Furthermore, the revenue proceeds realised therein were proposed to be utilised to develop the khadi and the handloom industry.

Under the Excise Act, the powerloom units with less than five looms were also made eligible for duty exemption along with handlooms until 1955. Powerloom units exploited this rule, showed their units as dispersed, and claimed to be small-scale to garner the benefit.

Subsequently, many studies revealed that large-scale Mills themselves set up many individual powerloom units with less than five looms in each centre to exploit the benefit given to small-scale units. Moreover, at times, the Mills also subcontracted the work to powerlooms; thus, over 90 per cent of powerloom units fell under the small-scale powerloom category and whisked the benefits away from the handloom sector.

Most powerloom units did not even get the required registration and licence to operate. To combat the menace of illegal powerlooms the government took out contravention of Textile Control Orders in 1961, but to no avail as the implementation was an utter failure (Mazumdar, 1984).

The study carried out by NIPFP (1992) reported the mushrooming growth of small powerloom units and further disclosed that 'hank' yarn diversion to the powerloom sector was substantial, between 21-53 per cent of the total ‘hank’ yarn supply (NIFPP-National Institute of Public Finance and Policy,1992).

The study of Srinivasulu (1998) discloses that the Reliance industry had a powerloom unit that produced a whopping 93 million metres and was yet classified as a small-scale powerloom; thus, powerlooms reaped the maximum benefit of reservation rather than handlooms (Chandrasekhar, 2001, cited in Niranjana and Vinayan, 2001).

Multiple Commissions and Committees: After 1952, the government appointed a series of commissions from time to time to understand and take policy decisions as to the development of Handlooms.

The first committee appointed in 1953 by the government, the Kanungo Commission, contrary to the earlier thinking, felt that handlooms had grim prospects due to their inefficient production process and inferior quality compared to mills. Therefore, the commission recommended the conversion of all handlooms into powerlooms within fifteen to twenty years (Niranjana and Vinayan, 2001).

In contrast to the recommendations of the Kanungo Commission, the Karve Committee constituted in 1955 on Village and Small-Scale Industries took an opposite stand completely and strongly advised the government to impose curbs on further expansion of both powerloom and mill production beyond the existing levels to protect handlooms. The Karve Committee also recommended freezing spinning capacity in the mill sector to promote hand spinning.

While accepting the recommendations of the Karve Committee, the government included some of them in the Industrial Policy Resolution of 1956. The Industrial Policy Resolution (1956) enunciated support for the cottage and village and small-scale industries through different measures, such as limiting the production volumes in mills and powerlooms and imposing additional taxes in the centralised large-scale sectors.

In 1955, the government set up the All India Handloom Fabrics Marketing Cooperative Society to encourage handlooms produced in handloom cooperatives. In addition, in 1956, the All India Institute of Handloom Technology was established in Salem and Varanasi to promote research, innovation and technology. Weavers Service Centres (WSC) were also set up in all major locations to promote research, modernisation and design interventions in 1956 (Mishra and Patnaik, 1997).

The Asok Mehta Committee, made up in 1964, while supporting the views of the Kanungo Commission, questioned the sustenance of handlooms' viability in the long run and further urged relaxing all curbs imposed earlier on the powerlooms. In response, the government accepted the recommendations partially and decided on the progressive and systematic expansion of the powerlooms (Niranjana and Vinayan, 2001).

The Sivaraman Committee, formed in 1974, underscored the lukewarm government support for the handloom sector and further added that the product reservation originally meant for the handlooms had, in reality, benefitted the powerloom sector. The committee also disclosed that the powerlooms recorded an unprecedented growth rate of 21.94 per cent between 1963 and 1974, and each powerloom established rendered six handlooms inactive. Moreover, every job created in the powerloom sector removed 14 jobs from the handloom sector.

The committee also pointed out the differential tax policy, which made powerlooms highly cost-effective than mills because of low excise duty, even though both are mechanically operated with the same technology. In addition, the low establishment cost of powerlooms further imparted cost benefits over the handlooms; as a result, powerloom products became relatively cheaper. Given this, the Sivaraman Committee urged the government to scrap the differential tariff between powerlooms and mills and provide fiscal incentives to the handlooms to narrow the price difference. The Sivaraman Committee also suggested setting up the National Handloom Finance and Development Corporation with a specific mandate of ensuring supplies of ‘hank’ yarn and other raw materials (Niranjana and Vinayan, 2001).

In 1976, Janatha Cloth Scheme was launched to employ weavers and make cloth available to the public at affordable prices; however, this scheme was withdrawn as it failed to fulfil its objectives due to poor implementation and lack of monitoring (72nd Report, P. A. **C.** 1994). The withdrawal led to the liquidation of thousands of looms across the country and made weavers jobless (Noorbasha Abdul. 1996).

In 1978, the Janata Government announced its unequivocal support for the handloom sector, which was reflected in the Textile Policy (1978). As a result, the government decided to freeze the production of powerlooms and mills at existing levels. However, the decisions could not be implemented because of political instability, and the incumbent Congress Government subsequently put this policy on hold in 1980.

During the 1980s, the approach to the handlooms stemmed from the Industrial Policy 1980. The 1980 policy regulated the growth of powerlooms such that the growth should not exceed five per cent by 1984-85. During this period, the National Handloom Development Corporation (NHDC) at the national level and a new Indian Institute of Handloom Technology at Gauhati were set up. The policy also proposed the modernisation of looms, strengthening infrastructure in other IIHTs and Weavers Service Centres (WSC), and the revival of dormant looms. In 1980, the government fixed a production target for the powerlooms under the decentralised sector for the first time. By 1985-86, the powerlooms got higher production targets from the government; thus, the ascendency of powerlooms was complete.

In 1985, The Handlooms (Reservation of Articles for Production) Act 1985 was passed to provide the reservation of 22 articles for exclusive production by handlooms while making some changes to the Cotton Textiles (Control) Order, 1948. The Sushma Swaraj Committee, formed in 1994 to review the 1985 Act, recommended downsizing the number of articles reserved. This Act was not implemented till 1993 due to pending lawsuits filed by the mills and powerlooms' lobby, thus causing severe damage to the handloom sector (Srinivasulu, 1996).

In 1993, the Supreme Court pronounced a landmark judgment, upholding the reservation. However, meanwhile, powerlooms attained an indubitable dominance and contributed almost 75 per cent of the total fabric produced in the country. After the Supreme Court's judgement, the government constituted a high-power advisory committee to examine the need for such a reservation to the handlooms afresh instead of paving the way for strict implementation of the Act, thus reflecting the government's insensitivity towards the languished handloom sector. Even afterwards, the Act was never implemented effectively despite serious concerns expressed by the weavers over the frequent violations of the Act (Srinivasulu, 1996).

The new textile policy was launched in 1985 without due processes like stakeholder engagement and public hearings. The policy departed from the earlier traditional and ideological considerations to modern, efficient and liberalised free-market economic thinking (Srinivasulu, 1996). The policy pronounced the liberalisation of the textile economy from any curbs and controls. The government also recognised and acknowledged the potential of the powerloom and mill sectors as growth engines and decided not to regulate the powerloom sectors' expansion and production (Mishra and Patnaik,1997).

The 1985 policy also arbitrarily categorised weavers into two; those who weave high-quality cloth and command a higher price and those who settle with coarse cloth with low earnings. In addition, the policy advocated that low-wage earners either shift to powerlooms or quit the profession.

Many researchers and activists argued that the 1985 textile policy would cause a critical unemployment problem in rural areas (Srinivasulu, 1996) and completely decimates the handloom industry (Jain, 1985).

Though the policy rightly identified the issues of the handloom sector and proposed many initiatives, such as technology up-gradation, fiscal support, raw material supply, credit and marketing and social protection, among many others, there was an abject failure of those recommendations at the implementation level.

Two schools of thought emerged after the 1985 textile policy. One school says only the fittest will survive, and the weak ones will be eliminated naturally. This implies that the handlooms sector will disappear automatically unless competitiveness and modernity are not acquired. The second school inadvertently reveals the government's indifference and lack of political will to protect the weavers' livelihoods.

In 1989, the Government of India introduced Market Development Scheme in place of Rebate and Share Capital Contribution Schemes. In compliance, the State and Central Governments would meet the expenditure on a 50:50 basis.

In 1989, the Abid Hussain Committee was set up to review the Textile Policy of 1985. Besides classifying the weavers into three categories based on skill level and volume of earning, the committee also advised the government to focus on the welfare of the weavers, an area-based approach to boost productivity and income, and enhanced institutional support (Mishra and Patnaik,1997).

The Government of India, in exercise of its powers under Section 3 of the Essential Commodities Act, 1955, issued Cotton Textile Control Order, 1986, asking the spinning mills to pack 50% of the yarn produced as 'hanks' (coiled) to ensure the availability to handlooms (Exim Bank, 2000).

Abid Hussain Committee also noticed a shortfall in the 'hank' yarn supply by the mills. The committee noticed that the supplies never exceeded 40 per cent against a mandatory provision of 50 per cent as per Hank Yarn Obligation Order, 1986 (GoI, 1990); however, the factual data from 1988 onwards showed it was in the order of 22 to 24 per cent only (Srinivasulu, 1996).

To protect handlooms from unfair competition from powerlooms and mills, Abid Hussain Committee recommended the inclusion of Handlooms (Reservation of Articles for Production) in the Ninth Schedule of the Indian Constitution. However, this recommendation was never considered by the government seriously (Noorbasha Abdul. 1996). Similarly, the other key recommendation to establish Handloom Weaver's Rehabilitation Schemes was also ignored.

During the 1990s, the Handloom sector experienced a severe crisis that resulted in the mass suicides of hundreds of weavers across the country. To understand the causes of the crisis and come up with a tangible solution, the Mira Seth Committee was appointed in 1995. The committee advised the government to arrange timely credit, marketing, skill development, designing and modernisation to augment the weavers' income and improve their global competitiveness for exports. The committee further recommended abridging the number of articles reserved for handlooms from 22 to 11, which was implemented in 1996 through an amendment (Srinivasulu,1997; Ministry of Textiles, 2001).

In 1999, in formulating a new textile policy, the government appointed a committee headed by S. Satyam. However, the committee's recommendations never saw the light in the wake of severe criticism due to its anti-handloom stance. The significant recommendations include removing the Handloom Reservation Act and Hank Yarn Obligation Notification of mills since 39 per cent of 'hank' yarn is utilised by powerlooms. Other recommendations comprise phasing out of excise duty exemption provided to the handlooms, termination of weaver welfare schemes and many other deleterious recommendations (Niranjana and Vinayan, 2001).

The Textile Policy 2000 was unveiled in November 2000 amid new challenges and opportunities aiming to improve the competitiveness of the textile sector. Regarding the handlooms sector, the policy concurred with the views of the Satyam Committee and reiterated the backwardness of handloom technology; however, it mentioned the need to sustain and strengthen the traditional knowledge and skills of Indian artisans (National Textile Policy- 2000, 2000).

The Tenth Five-Year Plan Approach Paper (2002-07) suggested phasing out the reservation as it was uneconomical in the backdrop of growing globalisation and liberalisation.

Recent Policy Developments: The government has brought out a slew of Welfare Schemes for the benefit of weavers over time; however, their conception and implementation were flawed. For example, the modernisation of the looms scheme, introduced in 1991, was enervated, and the scheme was subsequently transferred to the State Governments.

Similarly, the scheme ‘loom to loomless’ introduced in 1993 to assist loomless weavers added more idle looms to the already existing idle looms. Thus, the scheme remained a failure because it was conceived without realising that many weavers had already shunned the activity and switched to other livelihood options. (Srinivasulu, 1996).

With an investment of Rs 849 crores, the government planned to set up 300 Handloom Development Centres and 500 Quality Dyeing Units. However, the scheme was watered down as only half the units could be established with a paltry sum of Rs 80.92 crores, just 10 per cent of what was budgeted (Ministry of Textiles, 1999).

Handloom Export Development, a scheme unleashed in 1996 to promote handloom exports did not yield any positive outcome.

The scheme conceived in 2001, Deen Dayal Hathkargha Protsahan Yojana, is just a replica of an earlier scheme called the Project Package Scheme. Most of the welfare schemes made applicable to the weavers in the cooperative fold are also proved to be ill-conceived. Thus, launching multiple and duplicate schemes has further tormented the handloom sector.

The Geographic Indication Act (GI) enacted in 2003 did not offer any premium to the weavers, as the artisans mainly depend on a third party for marketing.

The Handloom Mark scheme, launched in 2006 to assure consumers of the genuineness of the handwoven nature of the fabric and distinguish it from look-alike imitations, has miserably failed to get any premium position in the market or to make any discernable change in handloom weavers' lives.

The Handloom Reservation Act (1985) was never implemented thoughtfully, and the Act failed to prevent replicas' growth. In 2012, the government attempted to change the definition of handloom to erase the difference between a handloom product and a powerloom product based on the recommendation of an advisory sub-committee on the Handloom Reservation Act, 1985. In 2014, based on a Draft Consultation Paper on Handlooms released by the Planning Commission, an attempt was made to alter the Handloom Reservation Act.

The India Handloom Brand is an initiative launched in 2015 to guarantee the quality of the handloom product with zero defects and zero effect on the environment. Nevertheless, this scheme also proved to be a futile exercise and failed to improve the handloom sector.

The government has budgeted Rs 485 cr under NHDP to benefit 8.9 lakh weavers over three years from 2018 to 19 to 2020–21; however, it ended up with only Rs 345 cr.

Recent Controversial Decisions: In 2020, undertaking an extensive rationalisation exercise, the government disbanded the All India Handloom Board (AIHB), Handicrafts and Handlooms Export Corporation of India Ltd (HHEC) and British India Corporation. Further, the government wound up five advisory boards and withdrew officers from industry bodies, Textile Research Associations (TRAs) and Export Promotion Councils.

The AIHB was established in 1992 to advise the government on the comprehensive development of the sector. The AIHB is purported to be a cardinal link between the government and weavers, offering a direct interface for exchanging ideas and suggestions. The AIHB has played a vital role in designing many programmes, such as The Handloom Weavers Comprehensive Welfare Scheme, National Handloom Development Program (NHDP), Handloom Marketing Assistance, Weaver MUDRA and Yarn Supply Scheme.

The Handicrafts and Handlooms Export Corporation of India Ltd (HHEC) is a profit-making organisation to promote the export of Indian handlooms. The British India Corporation is a loss-making 100-year-old Government Undertaking to produce textiles for the armed forces.

The recent decision of the government in December 2021 to raise the Goods and Services Tax (GST) on handloom products from the present 5 per cent to 12 per cent from January 2022 has attracted widespread criticism and led to serious protests from industry and various organisations.

Poor Performance in Exports: Businesses are fast transforming and acclimatising to the ever-changing global business environment to pursue optimal business gains. Businesses are now borderless and barrier-free. Robust exports are proved good for maintaining the trade balance and improved-economic growth. The more rapid growth of exports leads to higher economic growth.

Shirazi and Manap (2005) empirically established a direct correlation between economic growth and exports, confirming the export-led growth hypothesis (ELGH).

The Indian handloom industry has vast growth potential, including employment generation. Every USD 1 billion increase in exports or domestic sales increases employment directly and indirectly in the entire value chain of handloom by 1 billion (IIFT, 2018, Challenges and Strategies to Promote India as a Sourcing Destination).

In 2018-19 Indian Textile Sector contributed about 7 per cent to industrial production and 2 per cent to the GDP. The country's exports made up 15 per cent and had a share of around 6 per cent in the global textile trade.

India is a leading cotton producer and yarn exporter; however, its fabric production is low compared to its rivals. In contrast, China and Bangladesh import cotton yarn from India and export qualitative fabric at prices below India's, whereas Vietnam has improved production of both yarn and fabric.

Globally, China ranks first with a 36 per cent share in global exports, followed by Bangladesh at 6.4 per cent, Vietnam at 5.5 per cent, and India ranks fifth with a 4 per cent share in the global trade of textiles in 2018-19. (Commerce Ministry; Cotton Textile Export Promotion Council).

Despite Indian handlooms' tremendous potential with the world's highest number of looms and artisans, accompanied by a rich cultural legacy of over 10000 years, India's global handicrafts share is small and failed to capitalise on the potential.

Within the Textiles sector, handlooms contribution is just 15 per cent. The export of handlooms to total textile exports is insignificant, with less than 1.75 per cent over the years. Major handloom exports from India include fabrics, bed and table linen, toilet and kitchen linen, towels, curtains, cushions and pads, tapestries and upholsteries, carpets, and floor coverings. (Exim Bank, 2018). During 2019-20, the USA was the major importer of Indian handloom products, with an estimated purchase of USD 100.47 million, followed by the UK, Spain, Italy, Germany, UAE, France, Netherlands, Australia and Japan (Exim Bank, 2018).

At the macro-level, the government often projects export earnings and forex as the achievement and positive result of the government's policies and schemes. However, the reality is different: only the intermediaries, traders and other market players get subsidised and incentivised exports while relegating and ignoring the weavers. As a result, the sources of great creativity remained as homes of monumental neglect (Craft Council of India, 2011).

Despite significant global demand for handlooms, India has failed to consolidate its position. As a result, the export of handloom products from India has steadily declined over the last few years (Figure 61). Exports that stood at USD 369 million in 2013 declined to USD 227 million in 2021-22, registering a negative CAGR (Development Commissioner Handlooms, GoI).

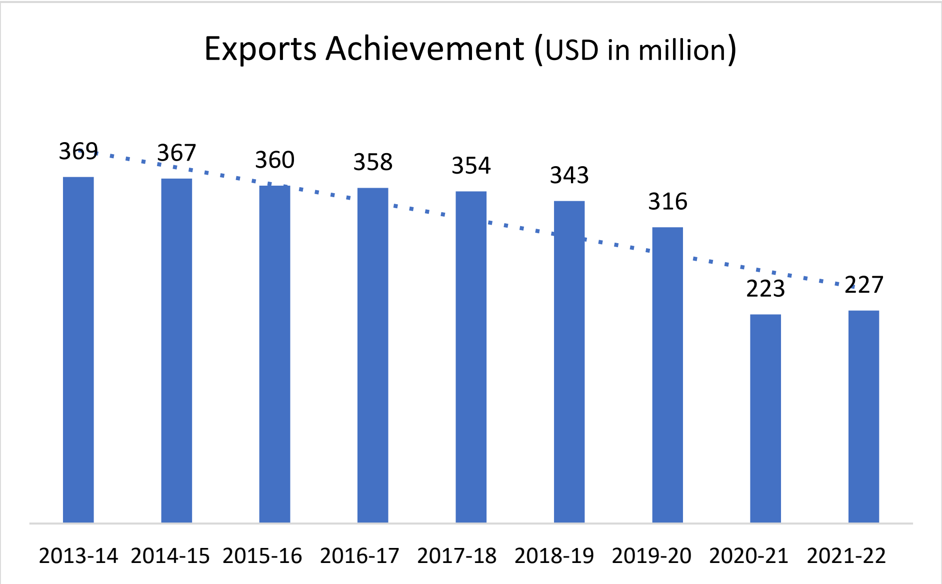


Figure 61
Declining exports of handloom products

India also depends on imports of certain handlooms, which make up 2 to 2.64% of handloom products and the imports were valued at USD 5.4 million in 2016-17 and further increased to USD 10.8 million during 2017-18. Bangladesh is the leading import source of handloom, followed by China. The other importing sources include Japan, Germany, the UK, Greece, Belgium, the US, Singapore, and Italy (Exim Bank, 2018).

Untapped Exports: It is noted that there has been a shift in the consumers' penchant for eco-friendly handmade goods. As a result, handicrafts, which are expressive, personalised and unique with a background brand history, are in great demand across the globe.

Vishal Kumar Singh and Amit Gautam (2019) have measured the export performance of Indian Handlooms by Revealed Comparative Advantage (RCA) based on trade flows, using Balassa and Lafay Index (LFI) for a period from 2008 to 2017. The empirical studies suggest that some commodities such as Indian silk, cotton, special woven fabrics, articles of apparel and clothing accessories have a significant comparative advantage in export, followed by carpet and other floor coverings.

A study conducted by the MVIRDC World Trade Centre, Mumbai, India, reveals that India has an unexploited potential of up to 83 per cent in the International Market for 13 handloom products and other textile products. These 13 products include toilet and kitchen linen, carpets, bed linen, floor cloths and other interior furnishing articles such as gloves, shawls, scarves and terry towels, which have a tremendous demand for a tune of USD 20.18 billion in the global market. However, India’s contribution is a meagre USD 3.4 billion, or 17 per cent of the global demand (MVIRDC World Trade Centre Mumbai, 2020).

Expert Market Research estimated that the global handicrafts market touched USD 680 Billion in 2021 and is further expected to reach USD 1,252 Billion by 2027, with a CAGR of 10.41 per cent (Research and Markets, 2022).

5.5.1 Systems Thinking Approach

The diagram (Figure 62) is built comprehensively with the findings of all four models tested in this study and embeds the secondary data’s evidence-based observations. The diagram showcases the web of interrelations and interdependencies among various factors.

Policy formulation is the starting point in this diagram. It drives many virtuous happenings if the policies are designed rationally and objectively to help the wider artisanal population and implement them effectively. Empirically based policies seek to embolden investment in technology, infrastructure, and human resources for sustainable long-term gains.

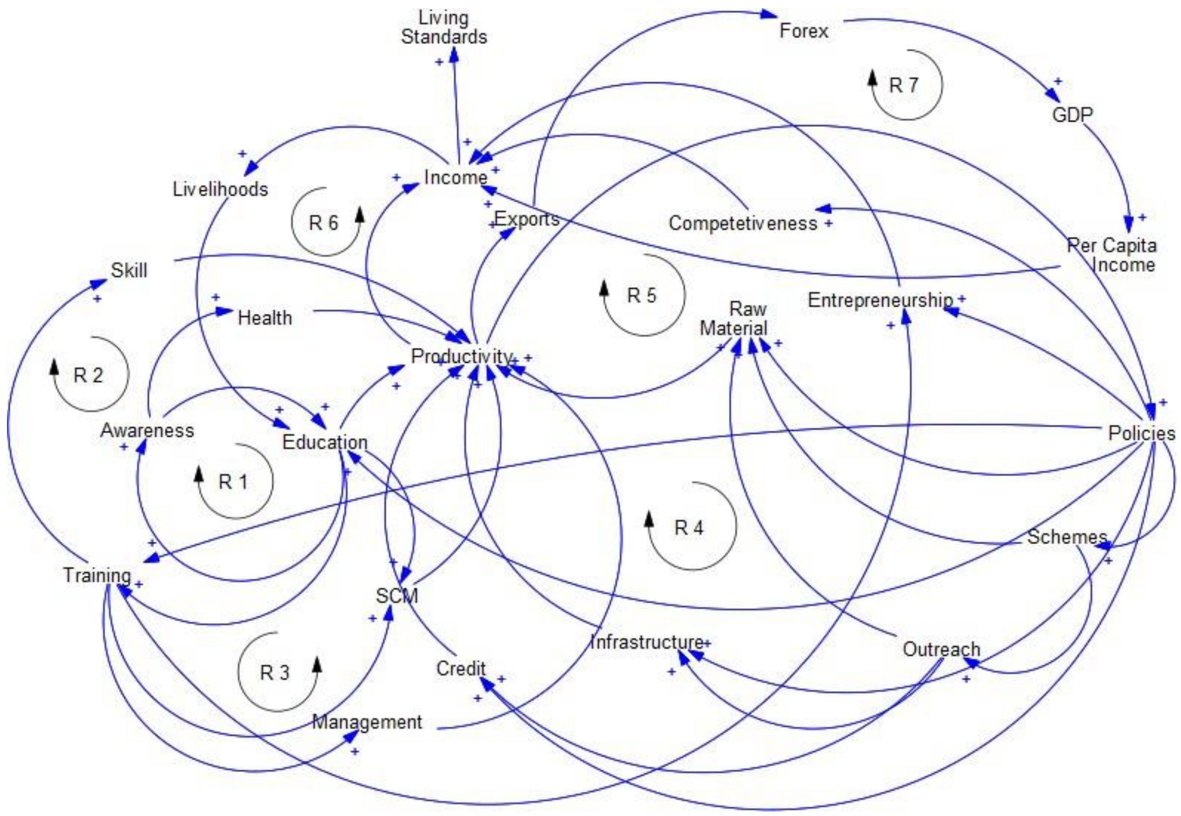


Figure 62
Positive implications of sound policies

Policy for honing the human capital components would yield positive results with better educational and skill levels, health, general awareness, entrepreneurship qualities and other attributes among artisans (R1, R2 and R3). Moreover, as has been already established, the improved human capital factors would eventually lead to a surge in productivity.

The policies and programmes that ensure hassle-free access to all supply chain components, such as raw materials, credit availability, and marketing support to the artisans, would bolster productivity (R4).

Addressing and fostering productivity factors such as technology, infrastructure, skilled human resources, and enterprise would yield higher productivity and improved competitiveness and eventually contribute to increased income (R5).

In furtherance, the increased income level, besides extending improved livelihood support (R6) to the weavers, facilitates exports and earning foreign exchange reserves (Forex) and finally adds to the Gross Domestic Product (GDP) of the country (R 7).

5.5.2 Reasons for Poor Policy Formulation and Implementation

The national policies seem to incriminate the informal and decentralised economic activities with a disconnect in policies and implementation.

It is widely believed that policy implementation is as important as policy formulation. Because policies alone do not yield expected outcomes, success depends on the strict implementation of the policies.

Most government organisations that assist, such as credit, raw material, technology and organisational resources, research and marketing help, are centralised and fail to reach the decentralised weaving community, leaving a big void in implementing the policies and schemes unveiled by the government.

Putting policy into practice needs great effort. ‘Policy consistency can be defined as the degree to which government policies are constant and steady over time’ (Béland and Powell 2016). Therefore, policy consistency is characterised by certainty, continuity and predictability.

Lack of Monitoring and Evaluation Mechanism: The absence of robust and efficient monitoring and evaluation mechanism at the government level has a debilitating effect on the overall implementation of the schemes and programmes.

There is no mechanism to track and follow up on programmes’ physical and financial performance through a real-time monitoring system (12th Plan Policy Steering Committee Report).

The government is quite enthused to show only the financial releases made to the artisans, and the results of such releases and the impact are not reflected in any government notifications.

Information and Resource Gaps: While commenting on the government’s performance, the Planning Commission’s steering committee (2012) explained the reasons.

The lack of a proper mechanism for information diffusion is the main reason for the poor progress of the schemes and programmes launched by the government. In addition, the implementing agencies are often equipped with incomplete information and further fail to disseminate the information up to the last mile, resulting in serious implementation gaps.

The restricted information flow between buyers and the weavers has incapacitated the artisans from showing quick reflexes to the dynamic market demands (12th Plan Policy Steering Committee Report).

Absence of Database: The absence of reliable and sector-specific data impedes evidence-based policy development and makes it difficult to know the outcomes of policy decisions. Inadequate data hampers the efforts of inter-sectoral comparisons for the betterment of the policies and implementation. The aggregate data used by the government cannot reflect the rich diversity of handlooms across the country. Reliable data concerning the number of weavers and looms and productivity is still a significant problem. The latest weavers census 2019-20 is inadequate and has several shortcomings.

The production figures are also unreliable because of the obsolete conversion factor calculation of 'hank' yarn converted into the fabric (12th Plan Policy Steering Committee Report). The productivity figures of handlooms used to be estimated with an assumption that the handloom industry utilised 76 per cent of the yarn produced by mills. However, many studies have already confirmed that only 39 per cent (Satyam committee) of 'hank' yarn was used up by the handloom sector (Chandrasekhar, 2001, cited in Niranjana and Vinayan, 2001).

The government even stopped notifying exclusive handlooms production figures; instead, it started showing productivity data under the decentralised sector; ironically, this sector is dominated by powerlooms.

Lack of Stakeholder Engagement: Despite a slew of support schemes launched by the government to encourage the artisans, the outcomes were quite disappointing, and the industry remains in tatters. The modus operandi of the government often reflects a disconnect between the scheme objectives and the reality at the micro-level.

The significant aberrations comprise the absence of weavers' involvement in the decision-making, communication gap, rampant corruption in government machinery, shifting markets, and the growth models incompatible with the weavers' culture and traditions (Craft Council of India, 2011).

Rampant Corruption: The role of top bureaucrats and the official machinery up to the gross root level (street level) plays an important role in successful policy implementation. However, the inefficiency of the bureaucracy in realising the policy intentions is driven by various factors such as lack of control and monitoring mechanisms, lack of training, the dominance of corrupt practices and the discretionary power of those who implement the policy.

Private Sector's Lukewarm Participation: Planning Commission (2012) opines that the private sector's tepid participation, meagre investment and less stockholding in the handloom industry are major impeding factors for the expansion and growth of the industry; more importantly, in marketing and supply chain activities, which are the frailest links.

There have been sporadic efforts from the private sector to support artisans in India, such as market-based interventions, support to master artisans to create new designs and new product offerings, and social business endeavours. The social business models offer some solace to the woes of weavers. The non-profits have spearheaded the new operating business models by embedding business solutions into social enterprises to address the social and economic issues of weavers.

These models aim to achieve twin objectives of earning profit for self-sustainability and addressing socio-economic issues; the non-profits have successfully integrated business principles, market dynamics and human values for supporting a social cause.

In the handloom sector, these new social business houses extend handholding support to the artisans and provide quality inputs, training, financing, logistic support, and quality check with a buy-back arrangement of finished goods by offering remunerative prices (DASRA, 2013).

Concerted efforts are needed to provide a direct interface between weaver and consumer; the partnerships between government institutions and private social enterprises can successfully eliminate the exploitation of the middlemen.

Achieving public-private collaboration is vital to reviving the handloom sector, and the government should create an enabling environment for such partnerships.

5.5.3 Need for a Dedicated Handloom Policy

The changes in policies of the government towards handlooms have been revealing and tumultuous. After the 1950s, there was a marked shift in government policies and laws favouring mechanical means of cloth production, which gradually paved the way for a systematic rise of powerlooms at the expense of handlooms. Moreover, the policymakers continued to play down the ascendency of the powerloom sector and its perilous effects on handlooms from time to time.

The government never considered the handloom industry a driver of the country's economic growth, and it erroneously branded the handloom sector as a sunset industry. As a result, the government's programmes are primarily skewed toward the welfare of the weavers.

The normatively appealing policies predicated on dubious assumptions are naturally devoid of coherence and comprehension, and such policies are bound to fall flat. Moreover, government policies are stuck in a time warp, and the hollowness of development strategies is often exposed.

In addition, the government's schemes and programmes lack objectivity and focus, and the policies are further dented by inefficient monitoring and follow-up mechanisms. As already observed, the Indian Handloom sector was entangled in a web of complexities highlighted by inconsistent and irrational policy formulation and inefficient implementation with minimal or no impact.

The multiplicity of programmes, frequent changes in guidelines, absence of assessment and evaluation mechanisms, and involvement of over 17 government departments to deal with the handloom sector are some anomalies in government policies that affected the viability of the weaving industry.

Various irreducible policies with frequent changes and channelling through a fragile implementation mechanism caused chaos and retraction. Over time, the policies concerning handlooms have been the subject of frequent fervent debates because of their overall failure to accomplish the desired results.

Therefore, it appears the policies of the Indian Government are either capricious or lack objectivity and are mostly biased towards powerlooms and the mill sector. Given this context, there is an imminent need for a dedicated handloom policy that tackles and obviates all complexities.

A comprehensive and dedicated handloom policy is needed to give a much-needed impetus to the handloom industry and induce competitiveness, cutting across the sectors and regions with a resilient and robust administrative setup.

Until now, frequent changes in the policy landscape and schemes have led to chaos and uncertainty. Therefore, to get optimal results, the government should ensure the sustainability of the policies for longer periods since the global experience shows that anticipating instant results from new policies is unfounded.

Some quick fixes can be contemplated for the immediate resolution of urgent problems. However, for a lasting impact, actionable policy and implementation frameworks are mandatory with an unambiguous prediction of outcomes.

5.6 Proposed Conceptual Frameworks for Policy and Implementation

In recognition of the complex nature of the problems associated with the handloom sector, this paper proposes two conceptual frameworks for policy formulation and implementation based on the findings of this study, literature, and experience.

A conceptual framework is an abstract or a visual narrative of steps, actions, strategies, and practices to guide and prod the implementation process for optimal results.

The conceptual framework illustrates the practical course of action, entailing a series of steps and phases with interconnected and interdependent activities and actions, some of which are initiated before the commencement of the implementation process as obligatory prerequisites to create a supportive environment.

5.6.1 Conceptual Policy Framework (CPF)

Initiation for a new policy is usually driven by the complex nature of the existing problems. This paper suggests a conceptual policy framework with many nonlinear discrete steps for a dedicated policy for the handloom sector (Figure 63).

A clear understanding of the problem is a mandatory prerequisite for meaningful and pragmatic policy formulation. Given this, there is a need to unpick the factors behind the policy failures under varied contexts.

The first step in policy formulation begins with internal and external situation analysis. The internal analysis assesses the strengths and weaknesses of the organisations both at national and subnational levels as to their readiness to take off the policy implementation. Further, delving into the weaver's issues concerning low productivity and impoverishment unfolds the underlying reasons. The external analysis evaluates the demand, product life cycle, trends, consumer preferences, competition, and other dynamics and benchmarking reports to assess the business environment.

The next step explores and compares various options, examining similar successful projects implemented elsewhere and choosing the suitable model based on the desirability, affordability and feasibility. In the next step, draft policy designing assumes shape by infusing several inputs from multiple activities undertaken parallelly.

Support activities for ensuring technology up-gradation, new designs, branding, seamless credit flow, and marketing, among many others, would empower the weavers to utilise the new interventions efficiently and purposefully.

Certain actions, such as timely funds flow and real-time reporting, buttress the policy's credibility. In addition, harmony and convergence with other departmental welfare schemes would invigorate the policy endeavour.

Institutional readiness is achieved by deploying an optimal level of a trained workforce which is accountable and works with fidelity.

Vision and mission building underlines clear objectives, goals, and targets. An operational plan and a strategy associated with policy drivers would accentuate the policy process.

Thus, a draft policy emerges after imbibing all the necessary inputs. The draft is then circulated among the stakeholders and the public for opinions and suggestions. Finally, the refined policy is ready for implementation after incorporating the changes suggested.

An efficient monitoring system analyses the policy implementation periodically and makes suggestions for mid-course correction or up-gradation, and the cycle continues.

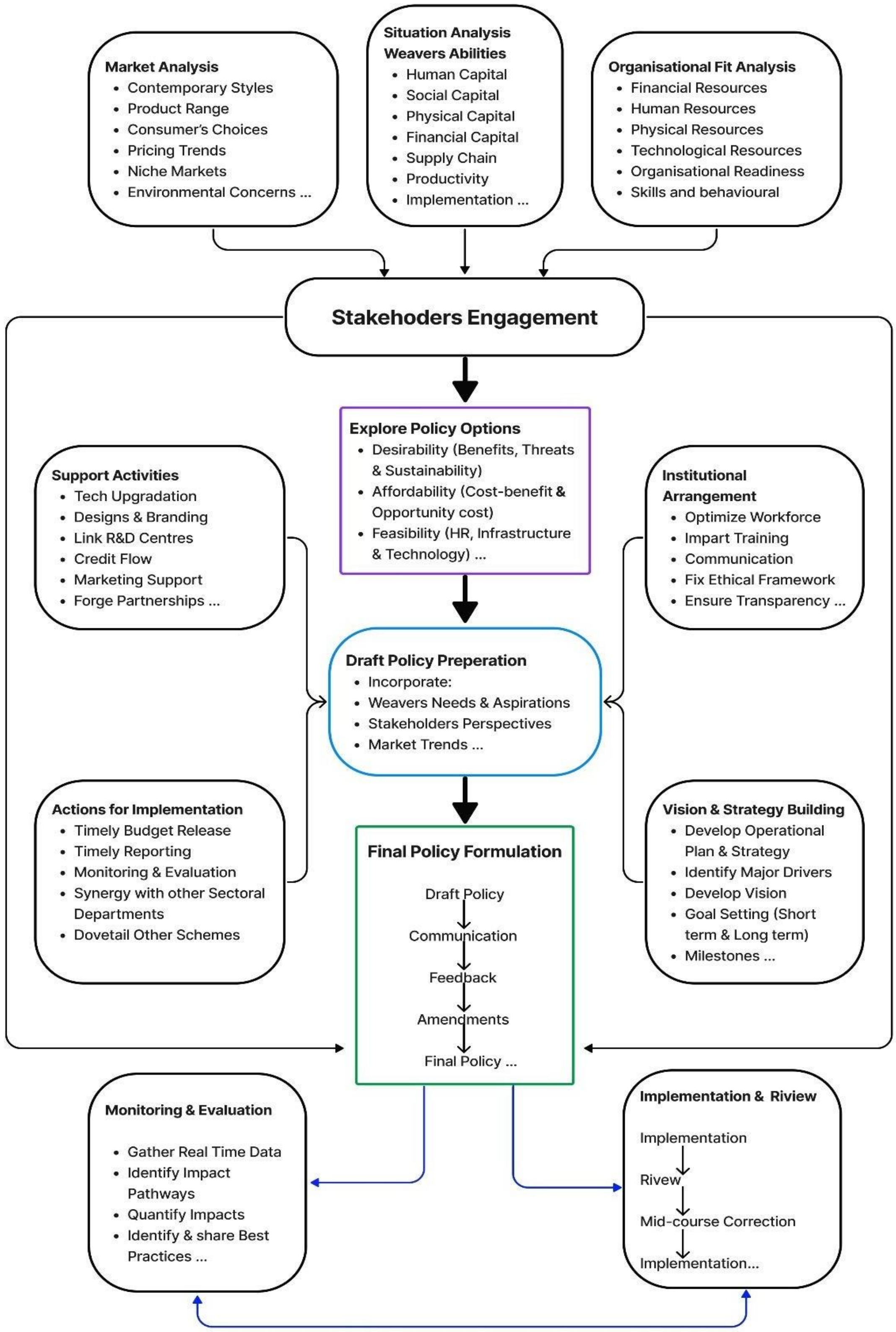


Figure 63
Suggested Conceptual Policy Framework

Stakeholder engagement is paramount throughout policy formulation, and their varied perspectives and insights contribute substantially to policy development.

In furtherance of a robust policy, fidelity to the moral values that stimulate actions on socioeconomic determinants should precede the policy formulation and implementation strategies. Therefore, this researcher believes that fidelity to the values should guide policy formulation and action.

5.6.2 Conceptual Implementation Framework

As in figure 64, the implementation framework has three major phases.

First, the prerequisites phase incorporates some mandatory actions started well ahead of the actual implementation.

The activities related to education, health, and skill and the creation of opportunities for individual housing and modernisation shall begin on a long-term basis to create a congenial climate for any intervention independent of a scheme or a programme.

Financial allocation for the programme implementation, including awareness building, technology promotion and physical infrastructure, is a compelling priority.

The programme shall be people-centric, and stakeholder engagement at every level and stage of the implementation process brings in multiple perspectives and collective wisdom and fosters transparency. The programme drivers and barriers shall be identified and addressed. Risk analysis carried out beforehand helps pre-empt any possible backlash.

Second, the empowerment phase encompasses various activities to strengthen and hone the abilities of the weavers, such as skill, enterprise, and other management practices. Easy access to raw materials, credit, new design vocabulary and work sheds reinforce the implementation efforts.

Third, the implementation phase triggers many parallel activities. Based on the projected outcomes, fixing benchmarks followed by planning and strategy designing forms a basis for fixing targets and milestones.

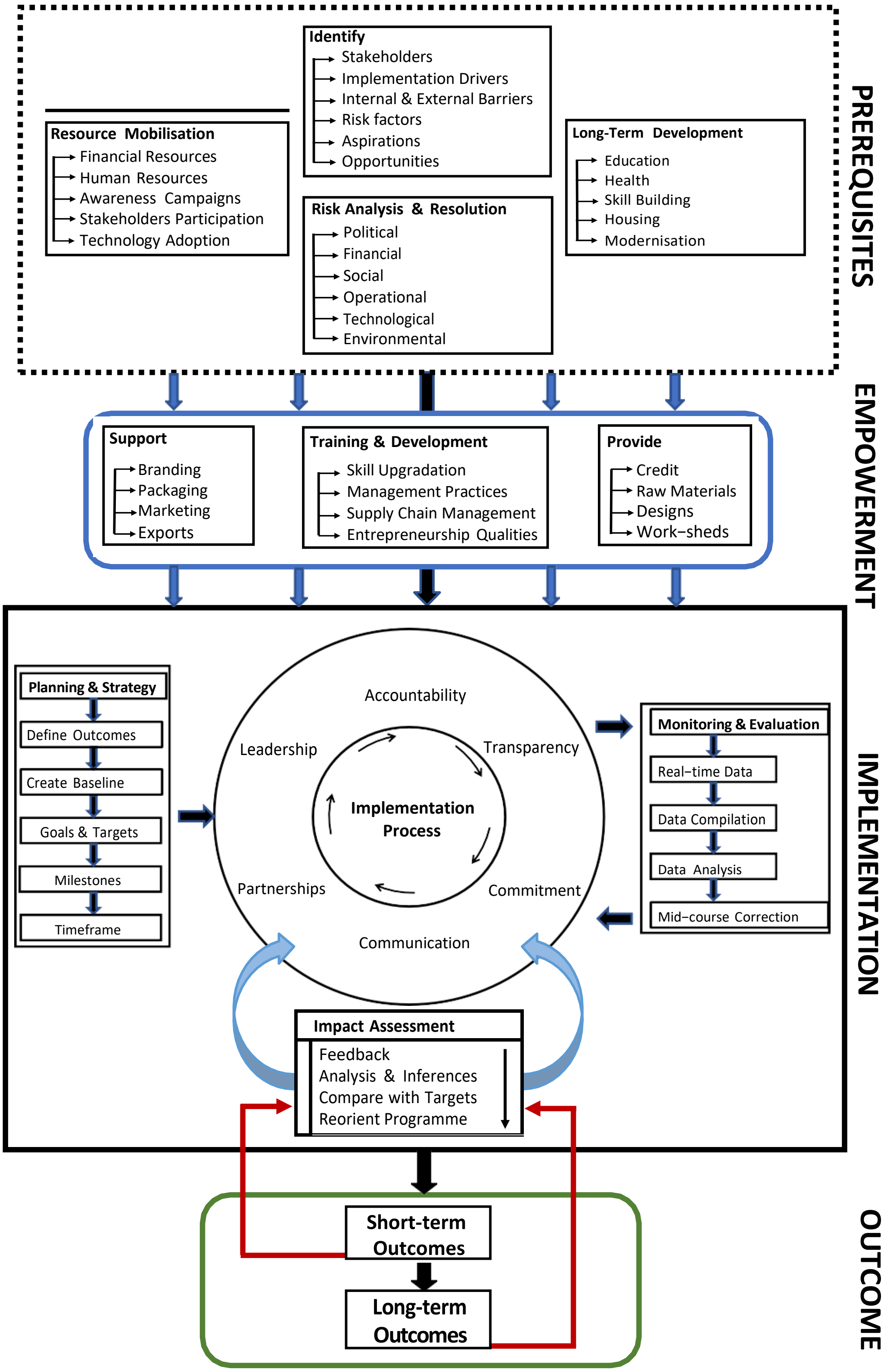


Figure 64
Suggested Conceptual Implementation Framework

Imparting training to the field functionaries and other executives enhances implementation efficiency. In addition, regular performance evaluation by determining Key Performance Indicators (KPIs) makes them accountable.

Collaborative partnerships with NGOs and other interest groups add to the efficiency and transparency of the implementation process.

Monitoring and evaluation through real-time data with apt communication mechanisms is the key determinant of the programme's success.

Last, the short-term and long-term outcomes need to be assessed and evaluated concerning the programme objectives and targets by conducting an impact assessment to gauge the programme's overall performance.

5.6.3 Conclusion

The handloom sector is one of the largest informal sectors in India and employs over three million artisans. Artisans are subject to severe neglect by both Central and State Governments over time, as evidenced by the declining number of artisans practising the craft, meagre average income below subsistence level and devastated livelihoods.

Weavers used to be an integral part of the village economy; however, with globalisation and industrialisation, the traditional weaver-consumer relationship has broken down and been replaced by traders and intermediaries. This shift has rendered weavers' skill and artistry, attained over generations, redundant and made crafts an unsustainable source of livelihood.

After the 1960s, while the country was racing for industrialisation, the government viewed the handloom sector as a misfit and irrelevant instead of providing an enabling environment for the crafts to thrive. Subsequent governments also continued the same philosophy and considered the handloom industry a sunset industry and set to have its death naturally sooner or later in the current age of globalisation and industrialisation.

Currently, the sector is inflicted with a stigma of inferiority and backwardness and is further impaired by the unfair treatment meted out to the industry and considering the handloom sector as a sunset industry.

The government's programmes and policies were unleashed and intended to benefit the weaving community; in reality, they benefitted only a few and left the more significant chunk with no hope.

This study has already uncovered the reasons and provided evidence about how social, economic and public policy engendered and shaped the inconsistencies leading to the survival crisis and ultimate failure of artisans to move up the economic and social ladder.

Most government support programmes tend to focus largely on economic policies, ignoring an important perspective that privileges and respects the craftsmanship, artistry, knowledge, and experience of the artisans who are making the ancient art pass on from generation to generation.

Until now, the government ostensibly confined itself to the exposition of the problems the weavers face. Nevertheless, the time has come for a reinforced effort to reduce poverty and livelihood crisis through action on the social, economic and moral principles that augur handloom activity well.

Despite the considerable disruption because of adverse policies and the onslaught of powerlooms, the handloom sector is still surviving and showing resilience on its own strength. To push for improvements in the conditions in which artisans are born, grow, live, work and age, and to mitigate their woes, they need to be mainstreamed and aligned with all government sponsored schemes on a priority basis.

CHAPTER VI:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

This chapter focuses on the summary, conclusions, implications and limitations of the study.

The first section, the summary, presents the survey overview, research findings and analysis. Then the second section offers the conclusions, providing a comprehensive picture of the entire study with inferences.

The following section narrates the implications of the research toward contribution to the literature and practice. The implications of practice are presented as recommendations in this section.

The last section concludes the writing by revealing the limitations of the study.

6.1 Summary

Handloom craft is a lasting legacy of great imagination, artistry and aesthetics and weaving was in practice in India as far back as 4000 BC. Artisans are considered guardians of these great crafts and skills, which they have been inheriting and bequeathing for ages.

Over time, weavers have lurched from a series of crises and survived on the strength of their resilience. Up to the beginning of the 20th century, the traditional craft sector overcame many challenges associated with changes in generations, environment and cultures.

However, in recent times, the problems have precipitated and attained a catastrophic proportion, threatening the very survival of the handloom industry.

The low productivity and low income of artisans are sparked by several challenges such as raw material shortage, the dominance of intermediaries, lack of credit and marketing, inadequate skill and education, inability to adapt technology and above all, the outrage of mechanised looms (Powerlooms) and proliferation of imitation products.

The decades of neglect and ambivalent attitude of successive governments have triggered the systematic marginalisation of handloom weavers. Moreover, the adverse and inexpedient policies associated with the ineffective implementation of the schemes have exacerbated the crisis.

Given this current situation, this study aimed to size up the complexity of the problem and proposed implementation and policy frameworks for holistic problem resolution. Therefore, this study posed four research questions to elicit answers to achieve the aim.

In tune with the objectives and research questions, the literature was studied, seeking insights under four major categories; production and productivity challenges, supply chain challenges, Human capital challenges and Public Policy challenges.

The study then organised the sample collection in Prakasam District, Andhra Pradesh, India, where the concentration of the weaving community is among the highest in the country.

This study adopted a mixed data collection method, serving a questionnaire with close-ended questions for quantitative data, and organised a few face-to-face interactions to get qualitative data.

The qualitative data was analysed using the content analysis method. The quantitative data was then processed and analysed, deploying usual statistical tools and Predictive Analytics techniques such as Artificial Intelligence and Machine Learning.

The study conceived four different models with different variables and tested them with Multi Nominal Logistic Regression (MLR), Artificial Neural Networks (ANN), and Decision Tree (DT) techniques.

The results were then analysed using Systems Thinking Tools and the Sustainable Livelihoods Approach.

Findings of the Survey: About 11594 weavers responded to the survey. The survey showed that about 76.30 per cent of the weavers adopted weaving as the main occupation, and the rest took up allied/ancillary activities as the mainstay. Only 10 per cent of the active weavers fell within the age group of fewer than 30 years; however, the rest were between 31 to 60 and above.

The social profile of the artisans appeared frail, with over 94 per cent either illiterate or less than the 10th grade of educational level, and women had a high illiteracy rate of 68 per cent than males with 46 per cent. Moreover, about 97 per cent of weavers inherited the skill from their parents or siblings, and only three per cent received skill training arranged by the government.

Regarding social infrastructure, only 60 per cent of the artisans had permanent houses, only 39.50 per cent of artisans accessed safe drinking water, about 53 per cent had sanitation facilities, and approximately 89.16 per cent suffered from various health disorders.
The weavers had limited professional infrastructure; around 59 per cent of them had work-sheds, only 79.25% of weaver households possessed looms, and 98 per cent of them were outdated pit looms.

The survey further revealed that over 92 per cent of the weavers work under the absolute control of Master Weavers, and they invariably depend on master Weavers for other needs such as raw materials, working capital, marketing and personal needs.

Regarding credit access, only 66 per cent of the weavers had bank accounts and 32.96 per cent accessed Bank Loans; however, over 52 per cent got loans from private moneylenders.

Over 90 per cent of the weavers had a limited income of less than Rs 6000 ($80)/month with a fabric production of fewer than 4 yards a day; however, most women earned less than their male counterparts.

The needs assessment also disclosed that over 64% of the artisans needed alternative lighting systems in their houses, about 43 per cent wanted work sheds, and around 23 per cent required individual dwellings. In addition, over 20 per cent felt the need for advanced training besides many other professional and social needs.

Research Question-wise Findings of the Analysis: The analysis took place model-wise, employing Multi Nominal Logistic Regression (MLR), Artificial Neural Networks (ANN), and Decision Tree (DT) techniques.

Model 1 was designed to explore the reasons for the low productivity and answered the first research question.

What deters the weavers from achieving higher productivity growth despite the handloom sector's inherent potential?

All three methods adopted productivity as the dependent variable and eight independent variables, including Total Looms Own, Total Looms Working, Type of Looms, Total Looms, Weaver Working For, Source of Weaving Knowledge, House Ownership, and House with Work-shed.

The test's findings proved that the independent variables applied were relevant and substantially influenced productivity at varying levels. The inefficient contribution of production factors such as poor skill level, weak infrastructure, use of obsolete looms, dependence on the master weaver and lack of congenial social and uncongenial work environment were perceived to be affecting productivity.

Further, the MLR and DT methods predicted that about 98% of the artisans produce less than 2 yards/day, while the ANN showed about 73% in this production category.
Model 2 relied on supply chain factors influencing productivity and answered the second research question.

Whether the business performance in the handloom sector lies in the broader, robust, and resilient supply chain?

In this model, Monthly Income was taken as the dependent variable and tested against five independent variables, including Price Realisation and Negotiation, Source of Raw Material, Marketing of Final Product, Dependence on Others and Bank Loan Availed.

The test results indicated that all the independent variables considered in the test significantly influenced Monthly Income, however, to varying degrees. The analysis further showed that the independent variable Dependence on Others was a key determinant of the supply chain with normalised importance of 65.70 per cent. Furthermore, as the survey revealed, weavers largely depend on master weavers for raw materials and marketing without any chance for any price negotiation. Because of this, the other independent variables, Price Realisation and Negotiation, Source of Raw Material, and Marketing of Final Product, were found impactful.

The survey disclosed that out of the 11594 weavers who responded, about 90% earned less than Rs 6000/month ($78/month). The analysis of all three methods, MLR, ANN and DT, also predicted that over 95% of the weavers would earn less than Rs 6000/Month.

Model 3 sought the reasons for the degraded livelihoods and low income by examining human capital attributes for answering the third research question.

Is the prevailing livelihood crisis and impoverishment of the weaving community the culmination of centuries-old neglect of human capital assets?

The dependent variable in this model was Monthly Income, and the independent variables selected were Gender, Education, Skill Training Received, Age and Sound Health.

The analysis through all three analytical methods uniformly clarified that all the independent variables employed in the test were found relevant and influenced the Monthly Income of the weavers.

The survey revealed the high frequency of illiteracy, low educational standards, low focus on skill development, and prevalence of chronic health problems among most artisans. In addition, the analyses have established a direct correlation of independent variables derived from human capital components such as education, skill and health with the dependent variable income of weavers.

Moreover, Model 3 also predicted that all the weavers would earn an income of less than Rs 6000/month.

Model 4 responded to the fourth research question by analysing the programmes launched for the benefit of weavers and the policy support extended by the government.

Why have government policies and schemes designed to improve the industry's competitiveness and strengthen the artisan's livelihoods failed to make a positive impact?

This model critically analysed the utility and effect of various government programmes and welfare schemes. The variable Monthly Income was considered as the dependent variable, and six independent variables designated include Bank Account Y/N, Bank Loan Availed, Loan Purpose, Housing Loan Availed Y/N, Skill Training Received and Type of Looms.

The findings of the tests showed that the independent variables deployed were significant and influenced the dependent variable Monthly Income at different strengths. The survey already disclosed the limited reach of the government programmes and meagre support, such as low bank penetration and coverage, inadequate support to upgrade the looms and other infrastructure, and lack of formal skilling. Hence, all the independent variables were influential in determining the monthly income.

Further, Model 4 predicted over 99% to be in the less than Rs 6000/month ($78/month) income group.

6.2 Conclusions

Handlooms contributed over 30 per cent of total cloth production and around 50 per cent in value terms before 1947. However, over time, the handloom sector has been whittled down with persistent problems and a lack of conscious support from the government.

Because of this precarious situation, the current research aimed to identify the factors and circumstances that led to the deterioration of the handloom sector. Therefore, the study predominantly focused on the issues related to the weavers' productivity, income, and livelihoods to gain more clarity.

The study further intended to set out a conceptual policy framework for guiding the policymakers and an operational framework to overcome and remedy the constraints.

Based on the literature, field experiences and feasibility, this paper has identified a few variables which belong to four categories; productivity, supply chain, livelihoods and government support. The Pragmatism Paradigm has provided the basis for the selection of data collection methods and use of multiple analytical methods such as Multinominal Logistic Regression (MLR), Artificial Neural Networks (ANN) and Decision Tree (DT) and further analysis of the results under Systems Thinking Approaches and Sustainable Livelihoods Framework.

The overview of the survey results shows consistency with most of the insights of the literature. The weaver's productivity levels have been found low, and the income is far below the subsistence level and suggested minimum wages.

These chosen variables have been tested against the dependent variables to identify the interrelationships and interdependencies. Further, the test pinpoints the overall effects on the efficiency of a weaver in terms of productivity and income. Finally, the assessment and evaluation of all four Models have shown the relevance of the variables tested.

Model 1 has answered the first research question and revealed the disdain and neglect of the production factor's influence and contribution.

The stagnated skill levels and absence of entrepreneurial culture among weavers because of a lack of skill up-gradation and other professional training opportunities have significantly enervated the productivity of artisans.

The continued use of outdated and labour-intensive Pit Looms, whose productivity is relatively low compared to the improved and advanced looms, has impeded productivity substantially. In addition, failure to have reasonable accommodation with basic amenities for decent living and other infrastructure for professional needs has compounded the productivity woes.

The passive role of the government in creating awareness and popularising advanced technologies and the inability to arrange a basic dwelling unit in collaboration with banks is quite pronounced and revealing. Further laxity towards improving the situation would render the artisans less productive.

Model 2 has responded to the second research question and exposed the weaknesses in supply chain activities.

The analysis has disclosed the weak linkages among the attributes of the supply chain, mainly because of the government's passive and apathetic attitude and the resultant pervasive dependence of weavers on master weavers.

The supply of raw materials is the mandate of the government. However, the violation of Hank Yarn Obligation notification by the yarn producers and the diversion of 'hank' yarn to the powerlooms resulted either from the government's ineffective vigilance or passive attitude and the inefficient distribution mechanism, have resulted in the severe scarcity of raw materials.

Another weak link identified in the research is the absence of timely credit for working capital requirements and infrastructure up-gradation. Despite many norms like Priority Sector Lending (PSL), directions of the Reserve Bank of India (RBI) and a complex bricolage of schemes like Pradhan Mantri Mudra Yojana (PMMY) and weaver's credit cards, credit continued to be a serious restraint and impaired the productivity.

Lack of support and advice for domestic and export marketing and failure to harness the benefits of eCommerce and other technological advancements through training and support services for promoting and creating sustainable marketing avenues have coerced the weavers to have an intimate association with master weavers.

Therefore, the fortunes of weavers invariably depend on the master weaver's changeable and unpredictable whims and fancies. This research has also predicted that the weavers would continue to endure with paltry earnings if the current situation stays.
In response to the third research question, Model 3 has uncovered and expounded the primacy of human capital attributes and analysed their impact on weaver's livelihoods and income.

The survey and the quintessential analysis have revealed the deeply entrenched structural deficiencies of human capital assets and their profound influence on a weaver's abilities.

Weavers' illiteracy and education levels are found far below the general population, which establishes that weavers are the most neglected chunks of the population occupying the lowest echelons.

The analysis further divulged the low income and education levels of women artisans compared to their men counterparts. Therefore, it could be inferred that based on field experience, the traditional and obsolete societal norms are still prompting and guiding women's lives, in addition, to the lack of awareness and insipid education system.

Deficient skill up-gradation and the prevalence of chronic health problems adversely confronted the weaver's capabilities. This observation further corroborates the state of insufficient infrastructure and fragile institutional mechanisms in the sample area.

In addition, Model 3 also foresees no improvement in the income range of most weavers if enough timely measures are not initiated.

Model 4 has been designed to answer the fourth and last research question, encompassing the variables derived from the features of promised and mandated support of the government for snowballing the handloom activity.

The survey revealed that most government programmes did not have an effective and broader outreach, as evidenced by low bank penetration, inadequate coverage of bank loans and accessing loans from private moneylenders and master weavers at exorbitant interest rates.

The support to strengthen professional and social infrastructure as mandated in many government programmes is quite inadequate and exposes the incongruity and irrationality of the government's proclamations.

The frequent policy changes and the multiplicity of programmes have confounded the welfare ecosystem. In addition, an inefficient delivery system and lack of monitoring and evaluation mechanism have further created considerable consternation.

6.3 Implications of the Study

This scientific study has both theoretical and practical implications.

Theoretical Implications: The following features of this paper contribute to the theoretical constructs:

- This study sets the standards for scientific evidence to maximise the scientific rigour in social sciences by gathering primary data from a big sample to form an extensive database. Furthermore, perhaps for the first time, the big data of artisans were analysed by employing advanced Artificial Intelligence methods.

- Many observations in this study are not new but found elsewhere in the literature in bits and pieces and recounting the same issues. However, besides adding many new observations, the current study has coalesced and assimilated all such insights into a meaningful and actionable framework to understand the complexity better. The study further facilitates the identification of the causal pathways of the factors responsible for wickedness to guide policymakers to address them effectively.
- Using Systems Thinking perspectives in the handlooms sector, perhaps a maiden effort in the social sciences research has enabled this researcher to establish causal relations among several factors considered from the domains of productivity, supply chain, human capital and policy initiatives. The inferences drawn from such an approach and the consequent designing of modelling frameworks would significantly contribute to the lore and literature.
- Applying the Sustainable Livelihoods Framework to analyse the livelihood issues of weavers and design a diagnostic framework adds value to the literature.
- The conceptual frameworks introduced could form the basis for future policy formulation, strategy development and implementation and help explain the limited success of the existing policies and restricted outreach of programmes, duly exposing the anomalies and offering several opportunities for improvement.

Practical Implications and Recommendations: This study uncovered and identified many gaps and inadequacies in policy, programme design, and implementation. Given this, the following indicative suggestions may supplement the government’s efforts to better the handloom industry and weavers.

Data and Knowledge Management: Acquiring and managing knowledge enables manufacturers to produce more efficiently, called disembodied and invisible technology. The handloom industry needs to leverage data and invisible technologies to optimise organisational structures and enhance organisational effectiveness.

Knowledge management is a strategic process of identifying, collecting, and processing knowledge, information, and data accompanied by collation, analysis, and drawing inferences for organisational use.

A robust central database with an elaborate architecture deploying database systems and other types of repositories with a network to disseminate vital information to weavers, government departments and other stakeholders is the first step towards developing the handloom sector.

Gathering and maintaining artisanal data concerning all aspects of their socioeconomic and professional development in real-time enables good Governance. However, besides exclusive surveys or conducting periodic handloom censuses, the data through other sources such as population census, surveys conducted by the National Sample Survey Office (NSSO), Periodic Labour Force Survey (PLFS), National Family Health Surveys (NFHS) need to be integrated to get more nuanced insights.

Evaluating the data provides required processed information for decision making, gauging KPIs (Key Performance Indicators) and further facilitates predictive analytics and prediction.

Resilient Communication Strategy: Businesses have come under enormous challenges from new-age organisations in the era of globalisation and industrialisation.

Access to qualitative information is an indispensable input to business enterprises; however, among weavers, lack of awareness is widespread and is impelled by the inability of individuals to access, seek and assimilate the information and knowledge because of a lack of literacy and low education level and cultural context.

Business success depends on market information, and weavers are primarily subject to information asymmetries. Usually, market forces impact the behaviour of producers and consumers and the pricing signals also stem from the market dynamics based on supply and demand fluctuations. However, the low education and illiteracy of weavers incapacitate them from understanding the market dynamics. Eventually, they cannot garner the potential benefits of having a sound understanding of market dynamics.

Continuous learning and gaining knowledge, getting information and seamless communication flow have become vital intangible success factors for the businesses that learned to use them productively. Therefore, modelling an organisational communication strategy is essential for establishing a communication process with respective stakeholders to gain a competitive advantage.

For sustained growth and success of a business organisation, regardless of its size and profile, organisations must ensure an adequate flow of information within and outside the organisation.

Effective Training and Capacity Development: The training gives the artisans a greater understanding of the dynamics of the industry and instils confidence. Upskilling the artisans increase creativity and innovation in developing new products and enhances overall performance with increased productivity.

Training needs to be undertaken at two levels, as the requirements differ for the current practising weavers and the future younger generation. Most adult and present-generation weavers are proficient in weaving. However, they lack other attributes, such as education, market exposure, and technological and communication skills. Hence, the training needs to focus on those deficiencies.

On the other hand, the members of younger generations, who are educated and comfortable with technology, need to be imparted skills and knowledge related to weaving. Besides focusing on skill-building and designing interventions, training shall also concentrate on financial literacy and supply and value chain activities, such as production planning and management, costing, quality control, and marketing, under an overall ambit of the entrepreneurship programme.

In addition, weavers need to be sensitised about the hazards of chemical dyes and impart training on natural dyes and vegetable processing, compliance with environmental statutes and occupational health, hygiene and safety.

Since women account for over 70 per cent of the weavers, emphasis must be on inclusive training with flexible timings to comfort the women members. Women's empowerment is key to achieving a more peaceful, prosperous world. Empowerment through education, training and professional development promotes women's sense of self-worth. It enables them to determine their own choices, and they, in turn, influence social change for themselves and others.

Promoting Human Capital: Research has already shown how social determinants such as health, education, gender discrimination and skill have a long-term impact on the weaving activity. For example, a lack of a certain level of education, health and skill debilitates the weavers' abilities to improve their productivity and quality outcomes.

The key reason for the degraded human capital among weavers is a lack of supportive presence across all stages of human capital initiatives, including suitable metrics and mechanisms to gauge the health, talent and skill levels, which eventually led to the socioeconomic asymmetries among weaving communities. The global experience has shown that spending on human capital is proven to be a high-return investment and rewarding with positive economic returns. Likewise, investing in artisans' abilities makes them realise their potential and spurs productivity.

The current development discourse needs to refocus on robust transformational initiatives, including substantial investments in health, education, skill development and social protection by providing infrastructure and safety nets which would accelerate transitions and create high-performance workplaces.

Literacy and educational levels among weavers continue to be below the national average and less than the general population. Many programmes and policies the government unveiled, such as the Right to Education Act, National Education Policy 2020, Non-formal Education, and many others, have limited outreach and success. India is still home to around 30 per cent of global adult illiterates, the largest in the world.

Economic fragility is the primary factor behind artisans' low literacy and educational attainment. Therefore, there is an immediate need to identify the other obstinate barriers.

In order to equip the artisans with foundational and upgraded skills to navigate professional and personal challenges, specialised and customised learning such as Accelerated Learning and Community Based Learning methods need to be explored.

In partnership with private social organisations, the government shall devise a strategy encompassing specialised support and new learning pathways to offer equitable and quality education to adult illiterate artisans and others who are cut off from schooling.

Poor health is an insidious determinant of productivity and income. Evidence shows that impoverishment restricts weaver's access to nutritious food, pleasant neighbourhood, congenial work environment, clean air and safe drinking water and eventually results in poor health.

There is a dire need to identify each location's unique obstacles and challenges, followed by their resolution to improve the health status of weavers.

There is an impending need to promote the integration of public health and primary care interventions and leverage telemedicine while aligning with national-level endeavours such as the National Health Mission and Ayushman Bharat Digital Mission.

Partnering with other private health care and social service organisations helps advance the integration of different programmes in the neighbourhood to mitigate the health woes of weavers.

Safety nets are the main pillars of building substantial human capital and protecting the vulnerable. Moreover, evidence shows that strengthening social safety nets makes households resilient and helps them withstand the consequences of economic, natural and other crises.

Despite having multiple insurance schemes such as Ayushman Bharat Yojana (ABY), Pradhan Mantri Suraksha Bima Yojana (PMSBY), Pradhan Mantri Jeevan Jyoti Bima Yojana (PMJJBY), and Converged Mahatma Gandhi Bunkar Bima Yojana (CMGBBY) including three exclusive schemes meant for weavers, the coverage has been abysmally low due to poor implementation mechanism.

Therefore, the government should move from fragmented programmes to a more affordable and all-inclusive programme with a provision to provide liquidity through direct benefit transfers (DBT), offering alternative employment, and promoting positive coping mechanisms to enable weavers to manage risk efficiently.

Addressing human capital challenges on time with strong policy support and implementation mechanism creates the conditions to drive workforce productivity growth.

Expand Raw Materials Access: The government must implement the Hank Yarn Obligation (HYO) notification in letter and spirit to ensure an adequate supply of ‘hank’ yarn at a reasonable price to the handloom industry.

To amplify the weaver's ability to source quality raw materials at affordable prices government needs to organise as many delivery points as possible in the weaver's populated areas, including PWCs, Apex organisations and even NGOs can be encouraged to start warehouses.

Most of the dedicated cooperative spinning mills to provide 'hank' yarn to the handloom industry are in crisis and facing closure, and they need to be resurrected, and the export of yarn can be contemplated only after fully meeting the domestic demand.

An efficient mechanism to control and monitor the prices of yarn, dyes, and other chemicals shall be in place to avoid exploitation by traders and intermediaries.

Strengthen Credit Flows: Cash-starved handloom weavers have a relatively small share in the lending space. Therefore, they need to be supported with timely credit to fulfil working capital, infrastructural, and marketing needs and to escape from costly and unreliable credit to increase productivity and adhere to delivery schedules.

In the handlooms' revival endeavour, the key area of improvement is widening the lending landscape and finding innovative solutions to unlock sources of capital to improve access to finance by weavers, including weaker borrowers, women and the underserved, who require it the most. Bulk lending shall be facilitated to the Weavers Cooperative Societies and other organisations which procure and market handloom products.

By improving banks' density, penetration and credit infrastructure, an enabling environment to meet credit off-take can be created with credit guarantee schemes, interest subventions, and subsidies.

Apart from the commercial banks, the NBFCs, Microfinance Institutes, Fintech companies and other private lending agencies need to be brought into the lending ecosystem to support weavers for investment, growth, export, and diversification.

In India, under Priority Sector Lending (PSL), the Reserve Bank of India (RBI) mandated all commercial banks to lend at least 40 per cent of their Adjusted Net Bank Credit (ANDC) to specified sectors such as Agriculture, Micro, Small and Medium Enterprises, Export Credit, Education, Housing among others. In addition, under PSL, artisans shall be given a separate target of at least 5 per cent within 40 per cent.

Besides continuing and strengthening the existing credit schemes, including weavers credit cards, interest subvention scheme and weaver MUDRA Scheme under concessional credit needs, there is a need to explore new and alternative financing models unleashing customised credit instruments, tools and products such as Cash-flow lending, Peer-to-peer (P2P) lending and equity inflows and many other innovative methods and products.

The cash-flow lending method suits small borrowers with weak collateral and physical assets. This system relies on the information of future cash flows of a weaver based on business plans, orders received and repayment capacity.

The Peer-to-peer (P2P) lending method facilitates a direct transaction between two individuals, eliminating a mediator.

Building a robust digital ecosystem is a viable option by leveraging the government's successful digital infrastructure initiatives such as BHIM, UPI and Aadhaar. Digital transformation facilitates quick loan approvals and quality decisions and eventually enables weavers to have easy access and reduced transaction costs of lending.

Develop New Products and Branding: Product Branding is a key business strategy that differentiates itself from competitors. Branding helps customers recognise and discern one product from another. The well-crafted and publicised brand attracts consumers incessantly and keeps them coming back. However, the India Handloom brand launched by the Government of India has several limitations.

India has a rich, versatile and exquisite product range with disparate styles. Moreover, every region has its own signature weave, such as the Ikkat of Odisha, Kalamkari from Andhra, Rajasthani Sheesha work, Bhagalpuri silks of Bihar, Kosa of Chhattisgarh, Jharkhand's Kuchai, Mysore silks, Paithani of Maharashtra, Telangana's Pochampally, Kashmir's Pashmina, Eri and Muga Silks from north-eastern India, and many more.

Hence, each product can be developed into a specific brand or sub-brand to illustrate the uniqueness of the product.

Design Innovations and Product Diversification: Globalisation and modernisation have created new market opportunities for innovative products; however, a product's lifecycle has shortened due to fast communication and ever-changing consumer needs.

Design innovations and interventions reflecting the market trend would foster easy marketing of the handloom products, however, with caveats like observing certain protocols, such as timely production and delivery of quality products with specifications prescribed by the customers.

Indian handlooms have a vast potential to dominate the global markets besides meeting domestic demands. In order to withstand the global competition, the handloom industry needs to focus on product diversification and design innovation while following a market segmentation strategy to create market subsets depending on needs, attitudes, aspirations, values, interests, trends and demographics. As part of this strategy, different groups of people are targeted and presented with product lines appealing to their interests.

Products that keep abreast of trends with contemporary styling are fast-moving and command maximum market share. Pure ethnic and traditional products still command a sizable market. However, high-quality products with innovative and distinct designs combining both traditional and the latest trends will find their place in niche markets.

Evidence suggests that niche and high-end markets are on the rise, environment-friendly products are in great demand, and people are willing to pay a premium for such products.

Investment in Physical Capital and Technology Adoption: There is an immediate need for improvement in capacity utilisation and a better outlook for Capex investment. Modern equipment transforms the traditional work ecosystem, which is currently limping, into a more dynamic and performing system.

The adoption of technologies, more than any other inputs, facilitates business expansion.

To harness the potential of the handloom industry, the proper infrastructure with sophistication shall be in place. Exploiting technology and modernity would foster the industry and change the fortunes of the weavers for the best. Conversely, the handloom units which do not maintain pace with technology will be unviable and become non-performing assets (NPAs).

Even though many units are inclined towards digital transformation to manage their finances and operations and to make strategic business decisions, a lack of financial resources and knowledge has held them back; therefore, handloom units need continuous assistance to transform.

Despite having over 28.2 lakhs of traditional looms in the country, their productivity remains low. Hence, modernising the looms assumes the importance of enhancing weavers' overall productivity and achieving zero-defect weaving.

The higher and more sophisticated physical capital to labour ratio in any economy boosts the quantity and quality of output and results in higher income. However, artisans mostly use pit looms or other looms associated with low productivity and high labour.

Several models of advanced handlooms, both manually operated and motorised, are now available in the market. These modern devices mainly remove the drudgery while preserving the scope for creativity and skill. They include Semiautomatic Handloom Machines, Electronic Jacquard Machines, Motorised Jacquard Lifting Machines, Dobby Machines, Automatic Pirn cum Dabba winding machines, Let-off and take-off motion devices, and several other improved devices.

Improvements in Quality Packaging and Labelling: The critical stages after manufacturing handloom products comprise product agglomeration category-wise, bundling, packaging, labelling, and finally, preserving for shipment.

It is widely known that good packaging and labelling are vital in attracting customers' attention in the modern marketing milieu.

To promote and popularise suitable, affordable and contemporary packaging practices, the Indian Institute of Packaging (IIP), the National Institute of Fashion Technology (NIFT) and the National Institute of Design (NID) need to come together and work in conjunction.

These institutions shall develop the latest and export-worthy bundling, packaging and labelling methods, observing international standards to enhance product visibility. In addition, frequent training for weavers on such practices, including shape, size, structure, graphics, colour, and materials, would augment their self-confidence and persuade them to adopt such methods quickly.

The packaging materials such as eco-friendly nonwovens with good holding capacity and moisture and heat resistance may be explored. Furthermore, instead of barcoding, smart labels with Radio Frequency Identification (RFID) can be considered for labels and tags.

Effective and Robust Marketing: A successful marketing strategy relies on many components and activities that work together and harmoniously.

Irrespective of the size of the organisation, marketing strategy is an integral part of business architecture. It encompasses various stages like market intelligence and competitor analysis, market segmentation and identification of target customers, innovation and product design, branding and finally, launching the product with publicity.

Vigorous publicity and awareness campaigns shall be launched, initiating public debate and advocacy through media for highlighting the traditional crafts. The risk analysis and problem analysis need to be carried out before launching and shipping the product.

Besides unveiling a new marketing strategy, the existing marketing channels, such as weaver’s cooperatives, apex organisations, and government showrooms, need to be geared up and widened. In addition, NGOs and private traders shall be assured and roped into the supply chain.

Unlock Export Potential: India is the only country in the world with a maximum number of artisans engaged in handmade fashion. However, once the most sought-after textile destination, India has been steadily losing the race in international trade to Bangladesh, Sri Lanka, Vietnam and China.

Product and market diversification shall constitute the core of the agenda to tap export potential fully. Therefore, besides banking on the traditional markets, new destinations shall be explored with new products to suit their needs.

Exports can be steered by trade facilitation and promotional activities, like virtual buyer-seller meetings, virtual exhibitions and linking with e-commerce platforms, utilising technology, apart from traditional methods of fairs and exhibitions.

Since global markets are increasingly integrated due to technological advancements, eCommerce platforms can be effectively utilised. In this regard, the Indian Handloom industry needs support and handholding for training and building entrepreneurial qualities for easy export navigation. The need assessment made by the Handloom Census 2019-20 reveals that over 52 per cent of weavers expressed the need for training in marketing, packaging, market information and export procedures (Handlooms Census, 2019-20).

Given this, the government needs to partner with tech-based companies or NGOs for training, handholding and catalysing digital marketing.

Provide Constitutional Safeguards: Government should obtain a political consensus for including Handlooms (Reservation of Articles for Production) in the Ninth Schedule of the Indian Constitution as already advised by the Abid Hussain Committee in 1989.

Improve Governance and Leadership for Efficient Delivery Systems: Improving the delivery of the services and benefits targeting the weaving community requires a multisectoral working approach at macro and micro levels supported by robust Governance with solid leadership.

Effective delivery systems must be built based on informed shreds of evidence and supported by efficient human and sound financial resources.

An efficient delivery system is multidimensional with attributes such as stakeholders' engagement, the feeling of ownership, statutory responsibilities and accountability, continuous flow of finances, periodic pieces of training, and performance management.

Effective Monitoring and Evaluation: Midcourse correction and flexibility. The intended objectives of many policies and several schemes were defeated because of the rigidity of the scheme or policy guidelines and the absence of a mechanism for midcourse correction. Hence, there is a dire need for effective monitoring and evaluation by fixing achievable benchmarks or performance indicators and an efficient reporting mechanism for quick decision-making at the national level. In addition, such arrangements at the regional or sub-regional level would identify and address the local-level inconsistencies and aberrations.

Impact assessment for every programme conceived and rolled out by the government must be an integral part of the scheme.

Establish Partnerships with NGOs: The government needs to establish operational and strategic alliances with global agencies and NGOs by providing unswerving leadership to promote handlooms through coordination, mutual understanding and benefit, and cross-cultural exchange. It is imperative that NGOs have better outreach in their areas of operation than the government machinery, and they play a vital role in filling the gap between the government and the weaving communities. However, such forging partnerships succeed when associated with the highest level of commitment and resources.

To overcome the crisis and end the regular humiliations and insolence that the artisans and the industry face too often, concerted and holistic efforts are needed from all the stakeholders.

Comprehensive Support and Set up of One-Stop Centres: To set up an autonomous 'National Command Control Centre (NCCC)' within the handlooms department at the national level with affiliated centres in every state to act as knowledge and advocacy hubs with a mandate to advise, coordinate, and support the activities of handlooms.

These centres house a team of professionals and experts from industry, academia, artisans, NGOs, technocrats and banks by recruiting or onboarding from open source or other government departments. This panel consists of experts drawn from the fields of marketing, technology promotion, extension services, exploring new opportunities and products of demand, and other relevant fields.

By maintaining a real-time dashboard for all the activities of the handloom's development, these centres ensure converging and dovetailing of all concerned activities undertaken by various government departments and NGOs for better efficiency.

A central legal cell should also be constituted within this command control centre to facilitate the legal processes and documentation required for contractual export orders. The legal cell also supports issues of Intellectual Property Rights (IPRs), non-disclosure agreements, employment of child labour, use of harmful chemicals and others.

6.4 Limitations of the Study

This section narrates the limitations of the present study and opportunities for future work.

- The findings of this study have emerged from a big sample, however, collected from one District in the state of Andhra Pradesh, India, and the findings are generalised to the entire country. The results are found to be consistent with the general observations made in literature and national-level studies. Nevertheless, this study might have missed certain localised issues which may contribute to the big picture and require attention. Therefore, similar studies in more expansive areas under different settings are recommended to bring out more comprehensive insights to broaden the understanding of the problem.
- This study has considered the effect of only a few independent variables for testing the data with the dependent variables in all four models conceived. The weavers have voluntarily contributed to the data collection, and many other variables which were believed to impact the handloom sector and weaver’s lives could not be included in this study because of the sensitive nature of such variables and other practical reasons. Given this, future studies may focus on other variables of importance related to productivity, supply chain and human capital attributes.
- Since this paper primarily relied on quantitative methods and analysis, deploying statistical tools and AI techniques might have missed certain insights, which would have been possible to capture such nuanced observations had some other methods been adopted. Qualitative explorations like case studies and lab studies may be used to gain qualitative and non-numerical data. Further analysis may be carried out using

grounded theory or other appropriate methods while observing recursive methodology, which would pull together and assimilate more insights to theorise.

- Further research is needed to identify, measure and synthesise existing knowledge about social factors influencing human capital attributes and gender discrimination for potential interventions.
- This chapter necessitates and seeks to extend research on cultural, environmental and behavioural factors, including emotional and cognitive dynamics surrounding the misery of the weavers.
- In the literature and experimentation narratives of the handloom sector, there is no mention of the application of Systems Thinking methods to comprehensively analyse the interrelations and impact of various factors. However, this paper followed the Systems Thinking approach and used a few tools. Therefore, future research could delve more into Systems Thinking learning mechanisms and develop operationalisation frameworks for ingraining the Systems Thinking approaches into the policy and implementation frameworks.
- Further, there is a challenge to develop reflective thinking and activities in the workplaces of artisans to reinforce critical connections in organisational design and practice. This development is helpful for programme executives and street-level bureaucrats to maximise the effectiveness of the programmes unleashed. Hence future studies may also include the perspectives of reflective actions under divergent contexts.
- Based on exclusive interviews with weavers, literature and other secondary data, this paper has pointed out the mounting concerns about the powerlooms' predatory dominance and threat to the existence of the handlooms sector. However, this study has not attempted to identify the extent of damage engendered by the powerlooms in

terms of employment, productivity and income. Therefore, a detailed scientific investigation is warranted to quantify the pernicious impacts of Powerlooms and to suggest remedial action to protect and promote the handlooms.

In conclusion, tackling impoverishment among weavers should stem from moral, social, and economic perspectives. Any intervention in this direction calls for attacking the deeply entrenched structural issues wrapped around those perspectives.

Moreover, the country cannot afford to forego the centuries-old craft, as hand-looming is not only a rich cultural heritage but a semblance of artistry inherited over six thousand years, in addition, an economic activity with the potential to meet the country’s economic imperatives.

APPENDIX A:

DISTRICT PROFILE

District Profile		
Sl. No	**Details**	**2011 Census**
1	Actual Population	3,397,448
2	Male	1,714,764
3	Female	1,682,684
4	Population Growth	11.05%
5	Area Sq. Km	17,626
6	Density/km2	193
7	Proportion to Andhra Pradesh Population	4.02%
8	Sex Ratio (Per 1000)	981
9	Child Sex Ratio (0-6 Age)	932
10	Average Literacy	63.08
11	Male Literacy	72.92
12	Female Literacy	53.11
13	Total Child Population (0-6 Age)	378,261
14	Male Population (0-6 Age)	195,753
15	Female Population (0-6 Age)	182,508
16	Literates	1,904,435
17	Male Literates	1,107,686
18	Female Literates	796,749

Comparative Estimate of Weaver Households- Prakasam District				
Sl. No	**Mandal Name**	**AP Handloom Department Estimation**	**Government of India Census**	**CHCDS Survey GoI**
1	Addanki	-	18	-
2	Ballikurava	50	45	36
3	Bestawaripeta	300	259	161
4	C S Puram	35	55	-
5	Chimakurthi	30	90	16
6	Chirala	10,950	6,687	6,064
7	Cumbum	72	30	-
8	Donakonda	-	44	-
9	Inkollu	20	3	-
10	J panguluru	100	103	85
11	Kandukur	-	76	-
12	Kanigiri	600	480	134
13	Kotha Patnam	325	345	257
14	Markapur	-	6	-
15	Marripudi	60	47	4
16	Martur	625	592	580
17	Naguluppala Padu	100	138	15
18	Ongole	62	46	39
19	Pedacherlo Palle	100	299	10
20	Santhamaguluru	150	155	5
21	Tangutur	-	8	-
22	Ulavapadu	-	320	-
23	Veligandla	15	9	-
24	Vetapalem	9,450	3,964	4,414
25	Pamuru	50	-	-
27	Gudluru	-	-	4
Total		**23,094**	**13,819**	**11,824**

APPENDIX B:

QUESTIONNAIRE

BASELINE SURVEY OF WEAVER AND ANCILLARY WORKER HOUSEHOLDS UNDER MEGA HANDLOOM CLUSTER- PRAKASAM DISTRICT, AP, INDIA

Questionnaire No		**Date**			
District		Mandal		Village	

A. General Household Information (put a tick √ or fill as deemed fit)

1	Name Head of the family	Surname	Name	Father/Husband Name					
2	Address								
3	Nature of the Household	Weaving Activity	Ancillary Activity	Both	Other than Weaving	Loomless Weaver			
4	Age (Years)	18-25		26-30		31-35		36-40	
		41-45		46-50		51-60		>60	
5	Gender & Marital Status	Male	Female	Others	Married	Un-married	Widow	Separated	
6	Religion	Hindu		Muslim		Christian		Others	
7	Caste/category	BC		SC		ST		Minority		Others	
8	Education	Illiterate		< 5th class		6th to SSC			
		Intermediate		Graduation		PG			
		ITI/ Diploma		BTech		Others			
9	Current Occupation	Weaving	Ancillary	Agriculture	Business	Service	Labour	Un-employ	others
10	Seasonal Occupation	Weaving	Ancillary	Agriculture	Business	Service	Labour	Others	
11	Monthly Income	<Rs.3000	Rs. 3001 to 6000	Rs. 6001 to 9000	Rs. 9001 to 12000	>Rs.12000	No Income		
12	Dwelling Details	Pucca House	Asbestos House	Thatched House	Own House	Rented House	Rent/month		
		Does the House have a Work Shed?	Yes		No				
13	Facilities	Electricity Connection	Water Connection	Gas Connection	Toilet Facility	Others			
14	Bank Account	Yes		No					
15	Immovable Assets	Wet Land	Dry Land	House site					
		Acres …	Acres …	Sq Yards/cents…					
16	Other Assets	Cycle	2-Wheeler	3-Wheeler	4-Wheeler	TV	Fridge	AC	Others

B. Family Members/ Dependents Information

Sl No	Name	Relation with Family Head	Gender M/F	Age	Qualification	Occupation	Income/ Month (Rs)

***PresentOccupation**:A.Weaving (a1)Cotton(a2)Silk(a3)Polyester(a4)Others B.Ancillary(b1) Dying(b2) Warping(b3)*

Sizing(b4) Pirn winding (b5) Others C. Agriculture D. Private Service E. Govt Service F. Pettybusiness G. Withoutwork

C. Profession Related Information (For the weavers presently engaged in weaving profession)

1	Number of Looms presently existing in the House	Own		Rented		Total	
2	Number of Looms Outside of the House	Own		Rented		Total	
3	Ifnothaving ownlooms, where is he/she working?	Master Weaver Work-shed		PWCS Work-shed		Others (Specify)	

3 a	Name and Address of the Work-shed Where He / She is Working	
4	Total Number of looms Presently Working	
5	Total Number of looms Presently Idle	

6	No. of Years Engaged in Weaving	<5		6-10		11-15		16-20		>20	
7	Source of Weaving Knowledge	Traditional		Newly Acquired							

8	Type of looms Presently Working (Pl. indicate the Number of looms)	Pit looms	Raised pit looms	Frame looms	Pedal looms	Others (Specify)
9	Weaving Space Available (in Sq. Ft)	<100	100-200	200-300	300-400	>500
10	Loom Design (Pl. indicate the Number of looms)	Plain	Dobby	Single Jacquard	Double Jacquard	Others

11	Number of looms Engaged for the Production of :	Cotton Sarees		Silk Sarees	
		Cotton Dress Material		Silk Dress Material	
		Cotton Lungies		Cotton Shirt Material	
		Cotton Towels		Livery Material	
		Cotton Bedsheets		Any Others Specify	

12	Weaver Works For	Coop Society	Master Weaver	SHGs	Independent
13	Name and Address of the Society/ SHG/ Master Weaver				
14	Member of PWC, if any				

D Financial Related Information

1	Mode of Working on Weaving Activity	Part-Time		Full Time							
2	No.ofDaysWorkingonWeavingPerMonth	Up to 15 days		15 to 25 days							
3	Average Production Per Day (in yards)	<2		2-4		4-6		6-8		8-10	

4	Average Income Per Day from Weaving (in Rs)	<150	151-200	201-250	251-300	301-350	350-400	>400

5	Different Sources of Monthly Income of the Family (in Rs)	From Weaving	Rs.	Agriculture	Rs.		
		Ancillary	Rs.	Others	Rs.		
		Total Monthly Income		Rs.			
6	Debts of the Family	Bank loan	Rs.	SHG Loan	Rs.		
		Private Moneylenders	Rs.	MFI	Rs.		
		WCC Loan	Rs.	Others	Rs.		
		Total Family Debt		Rs.			
7	Reasons for Taking loans	For Investmentin Weaving Activity		For illness			
		For Marriages		For Children Education			
		For Other Business		Others if any			
8	Benefits Availed from Govt. Schemes	Housing Scheme		Year of Sanction			
		Insurance	MGBBY		HIS (ICICI Lombard)		
		Details of Pensions if any	OAP	Widow	PHC		
		Training	Designing	Weaving	Dying	Printing	Others
		Assistances	Looms	Accessories	Jacquards	Dobbis	Others
			WCC		10%YarnSubsidyScheme		
		Placement to Educated Family Member	RYK	IKP	MEPMA	BC Corp.	SC Corp.
		Any Other (Specify)					
9	BenefitsAvailed Under Loan Waiver Scheme	Weavers Credit Card	Govt Loans	Through Society: Cash Advance	Through Society: Yarn Advance	Total Amount	
		Rs.	Rs.	Rs.	Rs.	Rs.	
10	Weather Enrolled into Thrift Fund (TF)	Yes		No			

E Production & Market Related Information

1	Source of Yarn Purchase	PWCs	NHDC	APCO	Master Weaver	Local Yarn Dealer		
2	Name & Address of the Yarn Supplier							
3	Type of Yarn Used	Cotton		Silk	Polyester	Zari	Others (Specify)	
		Coarse	Fine					
4	Quantity of Yarn Used Per Month (in KGs) in Household.	Count	Cotton	Poly-ester	Silk	Zari	Others	Grand Total
			KGs	KGs	KGs	KGs	KGs	KGs
		<40s						
		40s						
		60s						
		80s						
		100s						
		2/ 120						

		Total					
4	Production Details (inMtrs) Per Monthina Household	Cotton Sarees		Cotton Dress Material			
		Silk Sarees		Silk Dress Material			
		Cotton Lungies		Livery Material			
		Cotton Towels		Cotton Shirt Material			
		Cotton Bed Sheets		Any Others			
		Total (in No's)		**Total (in Mtrs)**			
5	Availability of Raw Material (Distance in KMs)	Within 5 KM	Between 6-10 KM	Between11- 15 KM	Beyond 15 KM		
6	Product Market Facility	Within 5 KM	Between6-10 KM	Between11- 15 KM	Beyond 15 KM		
7	Marketing of Final Product to:	Master Weavers	PWCS	Local Traders	Others (Specify)		
8	Demand for the Product (Round the Year)	Poor	Fair	Good	Very Good		
9	IsthereRegularWorkAvailable Round the Year?	Yes		No			
10	Seasonality of Demand	1-3 Months	3-6 Months	6-9 Months	9-10 Months		
11	Are you Getting the Required Credit from Bank?	Yes		No			
12	If No. What is the Source for Credit?	SHG	MFI	Moneylender	Others (Specify)		
13	Doyouwantany Creditlinkage from Bank for Handloom Weaving / Handloom Business	Yes		No			
14	If Yes, Amount Required?	Rs.					
15	Are you Facing any Health problems on account of Handloom Activity?	Yes		No			
16	If yes,whatisthe Health Problem?						

F. Future Needs of the Weaver's Family

1		**Training**	Yes	No	If Yes, Mention Details
	a	Weaving			
	b	Dyeing			
	c	Printing			
	d	Designing			
	e	Garmenting / Value Addition			
	f	Any Others (Specify)			
2		House			
3		Work Shed			
4		Improved Handloom			
5		Alternate Lighting System			
6		Handloom Parts/Accessories			
7		Repairs / Replacement of old loom			
8		Design Intervention			
9		Group Work-Shed			
10		Dobby			
11		Jacquard			

12	Yarn Supply			
13	Dyeing Facility			
14	Printing Facility			
15	Value Addition Unit			
16	Market linkage			

17	Anyothersuggestionsconcerning the availabilityof Common Infrastructureinthe Habitationand suggestions for the further requirement of Common Infrastructure.	
	Existing Common Infrastructure	Further Common Infrastructure Required

Nameofthe Enumerator	**Signature of the Enumerator**

APPENDIX C:

INTERVIEW SCHEDULE

Name of the Participant:

1. How long have you been associated with the handloom activity?
2. Would you believe that handloom activity is a significant economic activity and employment generator?
3. Would you believe the demand for handlooms across the country and the world would decline or expand? Reasons thereof:
4. What is the present status of the handloom industry? Is it growing or shrinking?
5. What is your impression about the sustenance of the handloom activity in the wake of modernisation? Will it sustain or wither?
6. Many feel that the industry is in crisis; is it true? If so, what are the reasons for the crisis?
7. What is the present socioeconomic status of the handloom weaver? Cite the reasons for their current state.
8. Suggest improvements for ameliorating the socioeconomic condition of the handloom weaver.
9. What role are the Powerlooms playing in the handloom industry, and is it positive or negative?
10. What are your suggestions to overcome the threat from Powerlooms and the mill sectors?
11. Whether the contribution of the Government in promoting the handloom activity is substantial? If not, why? and what are your suggestions to improve?
12. Suggest improvements for reinvigorating the handloom industry.

APPENDIX D:

SURVEY STATISTICS

Weavers' Gender Profile

Gender	Number	%
Male	7,071	60.98%
Female	4,523	39.01%
Total	11,594	100%

Occupational Status of Weavers

Main Occupation	Female Number		Male Number	%	Total Number	%
Weaving	2,741	60.6%	6,105	86.3%	8,846	76.3%
Ancillary	1,720	38.0%	911	12.9%	2,631	22.7%
Agriculture	3	0.1%	1	0.0%	4	0.0%
Business	43	1.0%	21	0.3%	64	0.6%
Service	0	0.0%	1	0.0%	1	0.0%
Others	14	0.3%	27	0.4%	41	0.4%
Un-Employed	2	0.0%	5	0.1%	7	0.1%
Total	4,523	100	7,071	100	11,594	100

Weavers' Occupational Profile and Engagement

Nature of Weavers' Engagement	No of weavers	% of Weavers
Independent Weavers	594	5.12%
Working under Master Weaver	10,640	91.77%
Working under PWCSs	300	2.59%
Working in SHGs	60	0.52%
Total No of Weavers	11,594	100%

Age Profile of Weavers

Age in Years	Number	%
18-25	331	2.85
26-30	978	8.44
31-35	1,317	11.36
36-40	1,605	13.84
41-45	1,594	13.75
46-50	1,346	11.61
51-60	2,217	19.12
>60	2,206	19.03
	11594	100

Source of Weaving Knowledge and Skill

Source of Weaving Knowledge	Number	%
Newly Acquired	386	3.32
Traditional	11,208	96.67
Total	11,594	100

Educational Profile of Weavers

Education	Men Number	%	Women Number	%	Total Number	%
Illiterate	3056	67.57	3,272	46.27	6,328	54.58
< 5th	731	16.16	1,491	21.09	2,222	19.17
6th to 10th	616	13.62	1,777	25.13	2,393	20.64
Intermediate	56	1.24	237	3.35	293	2.53
Graduation	35	0.77	184	2.60	219	1.89
Postgraduation	2	0.04	26	0.37	28	0.24
ITI/Diploma	10	0.22	49	0.69	59	0.51
B.Tech	13	0.29	10	0.14	23	0.2
Others	4	0.09	25	0.35	29	0.25
	4523		7,071		11,594	100

Weavers' Health Profile

Health Problems	Number	%
Yes	10,337	89.16
No	1,257	10.84
Total	11,594	100

Details of Weaver's Health Problems

Health Problem	Number	%
Allergy, Asthma and Tuberculosis	1,848	18.06
Blood Pressure and Diabetes	4,160	40.65
Diabetes	1,465	14.32
Eye Sight problems	1,441	14.08
Ear Related Problems	155	1.51
Heart Problem	440	4.30
Fistula	228	2.23
Cancer	16	0.16
Others	480	4.69
Total	10,233	100

Availability of Essential Services to Weaver's Families

Facilities Available	Number	%
Electricity Connection	11,594	100.00
Water Connection	4,670	39.50
Gas Connection	9,184	77.67
Toilet Facility	6,248	52.84

Availability of Bank Account

Having Bank Account	Number	%
Yes	7,657	66.04
No	3,937	33.96
Total	11,594	100

Source of Debts/Loans

Source of Debt/Loan	Number	%
Bank Loan	2,869	32.96
Private Money Lender	4,549	52.26
Weavers Credit Card	168	1.93
Self Help Group (SHG)	1,067	12.26
Micro Finance Institutions (MFI)	7	0.08
Others	44	0.51
Total	8,704	100

Purpose of Taking Loans

Reasons for Taking Loans	Number	%
For Investment in Weaving	1,246	14.32
For Marriages	6,785	77.95
For Other Businesses	127	1.46
For Illness	546	6.27
For Children Education	-	0.00
Others if any	-	0.00
Total	8,704	100

No of Weavers Availed House Loans

House Loan Availed Y/N	Number	%
Yes	1,246	10.7
No	10,348	89.3
Total	11,594	100

Weaver’s House Ownership Status

House Ownership Status	Number	%
Own House	9,417	81.22
Rent House	2,177	18.77
Total	11,594	100

Nature of House

Nature of House	Number	%
Pucca House	6,598	56.91
Asbestos House	4,482	38.66
Thatched House	514	4.43
Total	11,594	100

Work-Shed Availability with Weavers

Work Shed Availability	Number	%
Yes	6,659	57.43
No	4,935	42.56
Total	11,594	100

Income Profile of Weavers in Indian Rupees (Rs)/Month

Monthly Income	Female	%	Male	%	Total	%
< Rs. 3000	2478	54.79	2,302	32.56	4,780	41.22
Rs. 3001 to 6000	1776	39.27	3,844	54.36	5,620	48.47
Rs. 6001 to 9000	213	4.71	707	10.00	920	7.93
Rs. 9001 to 12000	49	1.08	180	2.55	229	1.97
> Rs. 12000	7	0.15	38	0.54	45	0.38
Total	4523	100	7,071	100	11,594	100

Source of Yarn

Source of Yarn	Number	%
PWCs	327	2.82
Master Weaver	10,613	91.54
SHGs	60	0.52
Independent (Own)	594	5.12
Total	11,594	100

Volume of Fabric Production by Weavers (Yards/Per Day)

Fabric Production	Number	%
<2	8,467	73.02
2 to 4	2,334	20.13
4 to 6	521	4.49
6 to 8	144	1.24
8 to 10	128	1.10
Total	11,594	100

Source of Market for the Finished Product

Source of Market	Number	%
Master Weavers	10,678	92.10
PWCSs	57	0.49
Local Traders	19	0.16
Others	840	7.25
Total	11,594	100

Price Realisation and Negotiation

Price Realisation & Negotiation	Number	%
Yes	19	0.2
No	11,575	99.8
Total	11,594	100

Looms Availability in Weavers’ Households

Households’ Looms Availability	Number	%
No of Households with Looms	9,189	79.25
No of Households without Looms	2,405	20.74
Total Households	11,594	100

Weavers' Ownership Status of Looms

Number of Looms	Looms Existing Inside	Looms Existing Outside	Total Looms Inside & Outside	%
Total looms of weavers (Own + Rented)	12,399	999	13,398	80.29
a) Own	10,197	969	11,166	66.92
b) Rented	2,202	30	2,232	13.38
Looms in Work Location owned by Master Weavers, PWC, & Others			3,287	19.70
Total Looms in Project Area			16,685	100

Functional Status of Looms

Working Status of Looms	Number	%
Looms Presently Working	13,342	80
Looms Presently Idle	3,343	20
Total Looms	16,685	100

Workspace Availability in Square Feet

Particulars	Number	%
<100	10603	91.45
100-200	969	8.36
200-300	13	0.11
300-400	6	0.05
>500	3	0.03
Total	11,824	100

Number of Looms in Possession of Weavers

No. of Looms	Looms Inside Own	Looms Inside Rented	Looms Outside Own	Looms Outside Rented	Total	%
One Loom	7,784	2,183	880	77	10,924	97.83
Two Looms	186	30	11	1	228	2.04
Three Looms	6	2	-	-	8	0.07
Four Looms	2	-	-	-	2	0.02
More than 5	3	1	-	-	4	0.04
Total	7,981	2,216	891	78	11,166	100

Types of Looms in Possession of Weavers

Particulars	Number	%
Pit Looms	13,216	97.38
Raised Pit Looms	271	2.00
Frame Looms	84	0.62
Pedal Looms	-	0.00
Others	-	0.00
Total	13,571	100

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