

Structural Equation Modeling (SEM), and mediation analysis, both direct and indirect effects on subscription willingness are explored, providing a comprehensive understanding of how cultural traditions, sustainability awareness, and perceived product authenticity collectively influence consumer adoption behavior. The results establish a behavioral basis for encouraging the repeated purchase of traditional eco-friendly products, connecting sustainability with consumer loyalty and lifestyle integration. The study discusses the nuanced effects of attitudinal and motivational factors on subscription intentions by examining mediating methods, offering practical guidance for the development of marketing interventions, awareness campaigns, and community engagement strategies that promote continuous sustainable consumption.

The third analytical dimension examines logistical and distributional constraints that limit market connection and equal access. The study employs facility location optimization models to determine the optimal number and location of sales points for jaggery and bamboo-based products, thereby effectively addressing urban and semi-urban demand. The framework integrates transportation expenses, capacity limitations, and demand fluctuations to optimize coverage while reducing operational costs and product waste. This component presents a data-driven decision support system that connects production and consumer behavior via effective logistics planning. The optimization results also guide initiatives for formalizing informal supply chains, enhancing accessibility for producers, and expanding market reach while promoting sustainable livelihoods.

The study establishes a complete, systems-oriented framework by integrating three analytical dimensions: barrier evaluation, behavioral analysis, and logistics optimization, thereby linking production, market dynamics, and geographic distribution. This multidisciplinary approach constitutes one of the first comprehensive studies of informal-sector products, offering both theoretical and practical strategies for improving resilience, marketability, and sustainability. The methodology is applicable to different livelihood sectors, such as millet, handcrafts, and other organic products, addressing differences in consumer behavior, operational barriers, and strategic logistics planning.

This research is novel due to its integrated approach, analyzing production barriers, consumer adoption, and distribution optimization simultaneously. This study integrates consumer behavior and supply chain restrictions into a livelihood-centered sustainability framework, unlike previous research that focuses just on one of these areas.

The study identifies strategies for incorporating unorganized producers/processors into formal value chains, emphasizing the necessity of policy interventions that promote sustainable production, efficient marketing, and informed consumer engagement while maintaining cultural authenticity. Focusing on value enhancement, branding, and effective logistics offers a strategy for transforming local livelihoods into sustainable businesses. The results strongly support several Sustainable Development Goals (SDGs), specifically SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).

The results provide a reference framework for policymakers, nonprofit organizations, entrepreneurs, and sustainability practitioners, offering recommendation for inclusive policy formulation, successful marketing strategies, and strong market connections for sustainable products. The integrated method shows that environmental sustainability, economic viability, and cultural preservation can be concurrently attained in informal-sector value chains.

This thesis signifies an important attempt to revitalize traditional, livelihood-based sectors in India. By integrating barrier analysis, behavioral analysis, and facility location optimization, it offers both theoretical depth and practical solutions for improving sustainability, customer engagement, and producer empowerment. The study emphasizes that sustainable development in emerging countries must combine ecological responsibility with inclusivity, equity, and the preservation of traditional knowledge, providing a framework for integrating cultural heritage with modern innovation to create a sustainable future.

Keywords: Jaggery and Associated Products, Bamboo-Based Products, Informal Sector, Sustainable Consumption, Manufacturing Barriers, Consumer Behavior, Subscription Intention, Mediation Analysis, Facility Location Optimization, Supply Chain Resilience, Value Chain Integration, Sustainable Development Goals.

सारांश

सततता पर बढ़ती प्रवृत्ति और पारंपरिक एवं जैविक विकल्पों के प्रति जागरूकता ने भारत के अनौपचारिक क्षेत्रों में निर्मित पारिस्थितिक रूप से अनुकूल और सांस्कृतिक रूप से महत्वपूर्ण उत्पादों जैसे गुड़ और बाँस आधारित उत्पादों में नवीन रुचि पैदा की है। यद्यपि ये उद्योग पर्यावरणीय अनुकूलता और आजीविका के लिए महत्वपूर्ण हैं, फिर भी ये मुख्यधारा के बाजारों में पर्याप्त रूप से मान्यता प्राप्त नहीं हैं और अकादमिक शोध में इनकी पर्याप्त जांच नहीं हुई है। यह अध्ययन अनियोजित क्षेत्र के उत्पादों का विश्लेषण तीन आपस में जुड़े पहलुओं-निर्माण और आपूर्ति श्रृंखला बाधाएँ, उपभोक्ता व्यवहार और सदस्यता इच्छाएँ, और लॉजिस्टिक अनुकूलन-के माध्यम से करता है, जिससे सतत और आजीविका-केंद्रित उत्पाद प्रणालियों के पुनरुत्थान से जुड़ी चुनौतियों और अवसरों की संपूर्ण समझ प्राप्त होती है। मुख्य उद्देश्य नीति निर्माता, उद्यमी और स्थिरता कार्यकर्ता के लिए व्यावहारिक दिशा-निर्देश तैयार करना है, जिससे बाजार तक पहुँच बढ़ाने, उत्पादक आजीविका मजबूत करने और पर्यावरणीय रूप से जिम्मेदार उपभोग को प्रोत्साहित किया जा सके।

अध्ययन का पहला आयाम उन उत्पादन और आपूर्ति श्रृंखला बाधाओं की जांच करता है, जो अनौपचारिक गुड़ और बाँस उद्योगों के विस्तार को सीमित करती हैं। इस अध्ययन में बाधाओं को प्राथमिकता देने के लिए संकरित श्रेष्ठ-न्यूनतम विधि का उपयोग किया गया और आपसी संबंधों का विश्लेषण करने के लिए निर्णय-मूल्यांकन प्रयोगशाला की संकरित पद्धति का उपयोग किया गया। अध्ययन ने इन बाधाओं का व्यवस्थित मूल्यांकन पाँच महत्वपूर्ण आयामों में किया है: कच्चा माल और स्रोत, निर्माण और प्रसंस्करण, परिवहन और लॉजिस्टिक्स, उपभोक्ता जागरूकता और विपणन, तथा संस्थागत और नियामक कारक। परिणामों से प्रमुख बाधाएँ उजागर होती हैं, जैसे अपर्याप्त कच्चा माल, सीमित तकनीकी सहायता, अपर्याप्त लॉजिस्टिक आधारभूत संरचना और कमजोर बाज़ार दृश्यता। ये बाधाएँ आपस में जुड़ी हुई हैं, जो उत्पादन में अक्षमताओं और बाजार के अधिविकास को बढ़ाती हैं। यह विश्लेषणात्मक रूपरेखा अनिश्चितता और प्रणालीगत जटिलताओं के विश्लेषण के लिए सघन और मात्रात्मक तरीका प्रदान करती है, जो अनौपचारिक उत्पादन प्रणालियों के अध्ययन में एक पद्धतिगत प्रगति का प्रतिनिधित्व करती है और नीति विकास, क्षमता संवर्धन और मूल्य श्रृंखला सुदृढीकरण के लिए विशिष्ट दिशानिर्देश प्रदान करती है।

अध्ययन का दूसरा आयाम उपभोक्ता की धारणाओं, प्रेरणाओं और सदस्यता इच्छाओं का विश्लेषण करता है। यह अध्ययन मिश्रित विधियों का उपयोग करता है और व्यावहारिक कारकों जैसे कार्यात्मक मूल्य, उपभोक्ता जागरूकता, सुखद प्रेरणा, बाधाएँ और दृष्टिकोण का मूल्यांकन करता है। लॉजिस्टिक

प्रतिगमन, संरचनात्मक समीकरण मॉडलिंग और मध्यस्थता विश्लेषण के माध्यम से सदस्यता की इच्छा पर प्रत्यक्ष और अप्रत्यक्ष प्रभावों का अध्ययन किया गया है। यह विश्लेषण दर्शाता है कि सांस्कृतिक परंपराएँ, स्थिरता जागरूकता और उत्पाद की प्रामाणिकता मिलकर उपभोक्ता को अपनाएने के व्यवहार को प्रभावित करती हैं। परिणाम पारंपरिक और पर्यावरणीय रूप से अनुकूल उत्पादों की पुनरावृत्ति खरीद को बढ़ावा देने का व्यावहारिक आधार प्रदान करते हैं और स्थिरता को उपभोक्ता निष्ठा और जीवनशैली के एकीकरण से जोड़ते हैं। मध्यस्थता विश्लेषण द्वारा व्यवहार और प्रेरक कारकों के सूक्ष्म प्रभावों को उजागर किया गया है, जिससे मार्केटिंग हस्तक्षेप, जागरूकता अभियान और सामुदायिक सहभागिता रणनीतियों के लिए व्यावहारिक मार्गदर्शन मिलता है।

अध्ययन का तीसरा आयाम लॉजिस्टिक और वितरण बाधाओं का समाधान करता है, जो बाजार से जुड़ाव और समान पहुँच को सीमित करती हैं। बिक्री केंद्र अनुकूलन मॉडल का उपयोग करके गुड़ और बाँस आधारित उत्पादों के लिए बिक्री केंद्रों की सर्वोत्तम संख्या और स्थान निर्धारित किए गए हैं, ताकि शहरी और अर्ध-शहरी मांग को प्रभावी ढंग से पूरा किया जा सके। इस ढाँचे में परिवहन लागत, क्षमता प्रतिबंध और मांग में उतार-चढ़ाव को शामिल किया गया है ताकि कवरेज अधिकतम और संचालन लागत व उत्पाद अपशिष्ट न्यूनतम हो। यह आयाम एक डेटा-संचालित निर्णय समर्थन प्रणाली प्रस्तुत करता है, जो उत्पादन और उपभोक्ता व्यवहार को प्रभावी लॉजिस्टिक्स योजना के माध्यम से जोड़ता है। अनुकूलन परिणाम अनौपचारिक आपूर्ति श्रृंखलाओं को औपचारिक बनाने, उत्पादकों के लिए पहुँच बढ़ाने और बाजार विस्तार को बढ़ावा देने के लिए मार्गदर्शन भी प्रदान करते हैं।

तीनों आयामों-बाधा मूल्यांकन, व्यवहार विश्लेषण और लॉजिस्टिक अनुकूलन-को एकीकृत करके यह अध्ययन एक संपूर्ण, प्रणालीगत दृष्टिकोण प्रस्तुत करता है, जो उत्पादन, बाजार गतिशीलता और भौगोलिक वितरण को जोड़ता है। यह बहुविषयक दृष्टिकोण अनौपचारिक-क्षेत्र उत्पादों का समग्र विश्लेषण करने वाले पहले प्रयासों में से एक है, जो सैद्धांतिक और व्यावहारिक रणनीतियाँ प्रदान करता है और उत्पादकता, बाजार क्षमता और स्थिरता में सुधार के लिए मार्गदर्शन करता है। इस पद्धति को अन्य आजीविका-आधारित क्षेत्रों जैसे बाजरा, हस्तशिल्प और जैविक उत्पादों में लागू किया जा सकता है।

इस शोध की नवीनता इसके एकीकृत दृष्टिकोण में निहित है, जो उत्पादन बाधाओं, उपभोक्ता अपनाएने और वितरण अनुकूलन को एक साथ विश्लेषित करता है। यह अध्ययन उपभोक्ता व्यवहार और आपूर्ति श्रृंखला प्रतिबंधों को आजीविका-केंद्रित स्थिरता ढाँचे में जोड़ता है, जबकि पहले के शोध अक्सर केवल एक पहलू पर ध्यान केंद्रित करते थे।

अध्ययन अनियोजित उत्पादकों/प्रसंस्कर्ताओं को औपचारिक मूल्य श्रृंखला में शामिल करने की रणनीतियाँ सुझाता है और नीति हस्तक्षेप की आवश्यकता पर जोर देता है, जो स्थायी उत्पादन, कुशल विपणन और सूचित उपभोक्ता सहभागिता को बढ़ावा देते हुए सांस्कृतिक प्रामाणिकता बनाए रखें। मूल्य संवर्धन, ब्रांडिंग और प्रभावी लॉजिस्टिक्स पर ध्यान केंद्रित करना स्थानीय आजीविकाओं को स्थायी व्यवसायों में बदलने की दिशा में मार्गदर्शन करता है। परिणाम कई सतत विकास लक्ष्यों का समर्थन करते हैं, विशेष रूप से सुसंगत कार्य और आर्थिक विकास, उद्योग, नवाचार और आधारभूत संरचना, जिम्मेदार उपभोग और उत्पादन, और जलवायु कार्रवाई।

परिणाम नीति निर्माताओं, गैर-लाभकारी संगठनों, उद्यमियों और स्थिरता कार्यकर्ताओं के लिए संदर्भ ढांचे प्रदान करते हैं, जो समावेशी नीति निर्माण, प्रभावी विपणन रणनीतियों और मजबूत बाजार कनेक्शन के लिए मार्गदर्शन करता है। यह एकीकृत दृष्टिकोण दिखाता है कि पर्यावरणीय स्थिरता, आर्थिक व्यवहार्यता और सांस्कृतिक संरक्षण को अनौपचारिक मूल्य श्रृंखलाओं में समान रूप से प्राप्त किया जा सकता है।

अंततः, यह शोध भारत में पारंपरिक, आजीविका-केंद्रित क्षेत्रों को पुनर्जीवित करने का एक महत्वपूर्ण प्रयास है। बाधा विश्लेषण, व्यवहार विश्लेषण और बिक्री केंद्र अनुकूलन को एकीकृत करके यह सैद्धांतिक गहराई और व्यावहारिक समाधान दोनों प्रदान करता है, जो स्थिरता, उपभोक्ता सहभागिता और उत्पादक सशक्तिकरण में सुधार करते हैं। अध्ययन इस बात पर जोर देता है कि उभरती अर्थव्यवस्थाओं में सतत विकास केवल पर्यावरणीय जिम्मेदारी तक सीमित नहीं होना चाहिए, बल्कि इसमें समावेशिता, समानता और पारंपरिक ज्ञान का संरक्षण भी शामिल होना चाहिए, जिससे सांस्कृतिक विरासत और आधुनिक नवाचार का सामंजस्य बनाकर स्थायी भविष्य का मार्ग प्रशस्त किया जा सके।

मुख्य शब्द: गुड़ और सम्बंधित उत्पाद, बाँस आधारित उत्पाद, अनौपचारिक क्षेत्र, सतत उपभोग, निर्माण बाधाएँ, उपभोक्ता व्यवहार, सदस्यता इच्छाएँ, बिक्री केंद्र अनुकूलन, आपूर्ति श्रृंखला स्थिरता, मूल्य श्रृंखला एकीकरण, सतत विकास लक्ष्य।

Contents

Chapter 1	Introduction	1
1.1.	Background of the Study	1
1.2.	Thesis Organization and Summaries	7
Chapter 2	Literature Review and Research Gaps	10
2.1.	Literature Review.....	10
2.1.1.	Supply Chain Management in Rural and Informal Sectors	15
2.1.2.	Alignment of Products with Sustainable Development Goals.....	20
2.1.3.	Barriers in Manufacturing and Processing and Market Access	23
2.1.4.	Market Potential, Consumer Behavior, and Subscription-Based Models.....	27
2.1.5.	Transportation and Distribution in Resource-Constrained Settings	30
2.2.	Research Gaps.....	33
2.3.	Research Problem and Objectives	36
2.4.	Scope of the Thesis	38
Chapter 3	Methodology	40
3.1.	Conceptual framework.....	40
3.1.1.	Supply chain barriers analysis	41
3.1.2.	Understanding consumer behavior and subscription intentions	45
3.1.3.	Optimization of Logistics for Improved Market Access.....	49
3.2.	Connectivity between Objectives	51
3.3.	Analysis techniques for objective solution	54
3.3.1.	Techniques for analysing barriers	54
3.3.2.	Multinomial Logistic Regression.....	59
3.3.3.	Structural Equation Modeling.....	61
3.3.4.	Facility Location Model.....	62
Chapter 4	Analysis of Supply Chain Barriers	67
4.1.	Literature Review.....	70
4.1.1.	Jaggery and Associated Products	70
4.1.2.	Bamboo Based Products	79
4.2.	Case Study	83
4.2.1.	Survey Design.....	83
4.2.2.	Data Collection	84
4.2.3.	Qualitative Data Processing and Analysis	86
4.2.4.	Ranking using FBWM.....	87
4.2.4.1.	Jaggery and Associated Products	87

4.2.4.2.	Bamboo Based Products	90
4.2.5.	Modelling using FDEMATEL	90
4.2.5.1.	Jaggery and Associated Products	90
4.2.5.2.	Bamboo Based Products	91
4.2.6.	Results and Discussion	92
4.2.6.1.	Jaggery and Associated Products	92
4.2.6.2.	Bamboo Based Products	96
4.2.7.	Implications and Sustainability Realization.....	100
4.2.7.1.	Jaggery and Associated Products	100
4.2.7.2.	Bamboo Based Products	106
4.2.8.	Conclusion and Future Scope	108
4.2.8.1.	Jaggery and Associated products	108
4.2.8.2.	Bamboo Based Products	110
Chapter 5	Analysis of Consumer Behavior and Subscription Intentions.....	113
5.1.	Analysis of Consumer Behavior	114
5.1.1.	Context of the problem	116
5.1.1.1.	Jaggery and Associated Products	116
5.1.1.2.	Bamboo Based Products	118
5.1.2.	Case Study	120
5.1.2.1.	Jaggery and Associated Products	120
5.1.2.2.	Bamboo Based Products	133
5.2.	Analysis of Subscription Intentions	144
5.2.1.	Context and Hypothesis Development.....	146
5.2.1.1.	Jaggery and Associated Products	146
5.2.1.2.	Bamboo Based Products	152
5.2.2.	Case Study	158
5.2.2.1.	Jaggery and Associated Products	158
5.2.2.2.	Bamboo Based Products	169
Chapter 6	Optimization of Logistics for Improved Market Access	183
6.1.	Context of the Study	185
6.1.1.	Current Status of Jaggery in the Indian Context.....	185
6.1.2.	Significance of Bamboo-Based Products in the Indian Context.....	186
6.1.3.	Challenges with jaggery and bamboo-based products.....	186
6.1.4.	Rationale for Optimizing Selling Centres.....	187
6.2.	Mathematical Modeling	189

6.3.	Case Study	195
6.3.1.	Data Collection	195
6.3.2.	Analysis.....	196
6.3.3.	Results and Discussion	199
6.3.4.	Sensitivity Analysis.....	203
6.3.5.	Implications.....	206
6.3.6.	Conclusion and Future Scope	208
Chapter 7	Conclusion and Future Scope	211
7.1.	Key Findings.....	211
7.1.1.	Analysis of Supply-Chain Barriers (RO1).....	211
7.1.2.	Analysis of Consumer Behavior and Subscription Intentions (RO2).....	212
7.1.3.	Optimization of Logistics for Improved Market Access (RO3)	213
7.2.	Study Limitations.....	215
7.3.	Future Works.....	218
References	222
Appendix	247

List of Tables

Table 2- 1 Literature Research of MCDM Techniques	26
Table 4- 1 List of barriers (Jaggery and Associated Products)	78
Table 4- 2 List of barriers (Bamboo-Based Products)	88
Table 4- 3 Best and Worst criterion for FBWM (Jaggery and Associated Products)	90
Table 4- 4 Best and Worst criterion for FBWM (Bamboo Based Products).....	90
Table 4- 5 Prominence and Relation matrix of jaggery and associated products	91
Table 4- 6 Prominence and Relation matrix of bamboo-based products	92
Table 4- 7 Ranking of barriers using FBWM	93
Table 4- 8 Prioritization matrix for FBWM.....	98
Table 4- 9 Implications of the study	107
Table 5- 1 Model Parameters of the Significant Variables.....	125
Table 5- 2: Parameter estimate of the significant independent variables.....	125
Table 5- 3: Advisories for government	128
Table 5- 4: Advisories for industries and local units.....	129
Table 5- 5: Advisories for consumers	130
Table 5- 6: PEST analysis for promoting bamboo’s global competitiveness	136
Table 5- 7: Significant variables with MLR analysis.....	137
Table 5- 8: Constructs Evolved from Literature Study.....	146
Table 5- 9 Literature evidence on the constructs under study.....	157
Table 5- 10 Cross Loading, Composite Reliability (CR) and Average Variance Extracted (AVE)	162
Table 5- 11 Heterotrait - Monotrait (HTMT) Fornell Larcker (FL) discriminant validity measurement	162
Table 5- 12 Structural model results for direct path	163
Table 5- 13 Cross Loading, Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE).....	172
Table 5- 14 Fornell-Larcker discriminant validity measurement.....	173
Table 5- 15 Heterotrait-Monotrait (HTMT) discriminant validity measurement	173
Table 5- 16 Structural model results for direct path	173
Table 5- 17 Interpretations for significant variables	174
Table 5- 18 Mediation results	177
Table 5- 19 Implications of the study corresponding to the valid hypothesis	180
Table 6- 1 Sensitivity Analysis for Jaggery and Associated Products	204
Table 6- 2 Sensitivity Analysis for Bamboo Based Products	205

List of Figures

Fig. 2- 1 Annual scientific production on the concept of “Fuzzy Logic and Barrier Study”...	11
Fig. 2- 2 Annual scientific production on the concept of “Multinomial Logistic Regression and Consumer Behavior”	12
Fig. 2- 3 Annual scientific production on the concept of “Subscription and Consumer Behavior”	13
Fig. 2- 4 Annual scientific production on the concept of “SEM and Consumer Behavior”	14
Fig. 2- 5 Annual scientific production on the concept of “Facility Location Model and Warehouses/Selling Centres”	15
Fig. 2- 6 Overview of Supply Chain Management in Rural and Informal Sectors	20
Fig. 2- 7 Overview of product alignment with SDGs.....	22
Fig. 2- 8 Process of supply chain barriers analysis.....	25
Fig. 2- 9 Conceptual highlights of market and consumer study	30
Fig. 2- 10 Conceptual highlight of logistics network of informal products.....	33
Fig. 3- 1 Comprehensive Framework for Supply Chain Barriers Analysis.....	44
Fig. 3- 2 Comprehensive Framework for Studying Factors Influencing Product Usage.....	46
Fig. 3- 3 Comprehensive Framework for Studying Subscription Intentions	49
Fig. 3- 4 Comprehensive Outline for Logistics Network Study	50
Fig. 3- 5 Conceptual Framework for the flow of study	54
Fig. 4- 1 A Schematic of Jaggery Manufacturing	73
Fig. 4- 2 A Typical Indian Bamboo Supply Chain.....	80
Fig. 4- 3. Cause- Effect relationship plot (Jaggery and Associated Products).....	95
Fig. 4- 4 Cause-Effect Interrelationship Model (Jaggery and Associated Products).....	96
Fig. 4- 5: Causal-Effect Relationship Plot (Bamboo-Based Products).....	99
Fig. 4- 6: Influence relationship map (Bamboo-Based Products).....	100
Fig. 4- 7: Causal Barriers Sustainability Realizations	105
Fig. 4- 8: Effect Barriers Sustainability Realizations	105
Fig. 4- 9: Top causal-effect barriers and their mapping with SDGs	108
Fig. 4- 10: Top barriers and their SDGs realizations	108
Fig. 5- 1 Overview of flow of the study	118
Fig. 5- 2 Interlink between government, industries and consumers.....	127
Fig. 5- 3 Research Model.....	159
Fig. 5- 4 Constructs and Corresponding Items	160
Fig. 5- 5 Research Model (Bamboo Based Products).....	170
Fig. 5- 6 Constructs with corresponding items.....	170
Fig. 5- 7 Mediation Analysis	176
Fig. 5- 8 Overall summary of the study, implications, and SDGs mapping	180
Fig. 6- 1 Schematic of a General Distribution Network	189

Fig. 6- 2 Optimal Locations for (a) Jaggery and Associated Products and (b) Bamboo Based Products.....203

Fig. 6- 3 Graphical Representations of Sensitivity Analysis for Jaggery and Associated Products.....205

Fig. 6- 4 Graphical Representations of Sensitivity Analysis for Bamboo Based Products ..206

Chapter 1 Introduction

1.1. Background of the Study

The need for sustainability has become a global concern in recent years, influencing economic, environmental, and social policies in both developed and developing countries. Increasing uncertainty regarding resource depletion, environmental degradation, and social disparities have highlighted the importance of shifting towards sustainable production and consumption systems (Castro, 2004; Grönman et al., 2013). This worldwide movement increasingly acknowledges that local and traditional industry sectors, typically situated inside informal economies, provide considerable potential to advance sustainable development (Brenya et al., 2023; Guo et al., 2022). These sectors are defined by their utilization of renewable resources, low environmental effect, and significant integration with community livelihoods. In India, informal industries such as jaggery production and bamboo processing highlight the equilibrium between ecological sustainability and cultural legacy (Chand et al., 2018; Montaña & Dam, 2021; Rao et al., 2007; Patel et al., 2019; Revathy et al., 2021).

The informal sector in India contributes significantly to its economic and social framework. It includes an extensive network of small-scale producers, artisans, and entrepreneurs functioning outside official regulatory and institutional structures. Although these industries significantly contribute to employment growth and rural income, they are sidelined in policy discussions and overlooked in formal value chains (Baksy, 2014; Canavan et al., 2017; Ministry of Communications & Information Technology, 2010; Estrada & Park, 2018). The informal sector's adaptability, resilience, and indigenous capabilities at the grassroots level are frequently overshadowed by barriers such as restricted access to technology, insufficient market infrastructure, and weak financial support (Manfredi & Capik, 2022). These industries are crucial for sustaining traditional knowledge systems, preserving cultural identities, and fostering inclusive economic growth (Bi et al., 2017; Karuppiah et al., 2023; Kumar & Kumar, 2018).

The connection between sustainability and livelihood generation is especially important in the context of developing economies (Brown, 2023; Guo et al., 2022; Shah, 2018). The informal

sectors in India function as livelihood-oriented systems that support millions of people in agricultural, artisanal, and cottage businesses. These systems often operate through community collaboration, traditional expertise, and locally tailored production techniques (Dania et al., 2018; Maryunani, 2019; NRMCM, 2018). Their sustainability is derived from little automation, dependence on locally sourced materials, and manufacturing methods that produce negligible waste (Gangwar et al., 2015; Manandhar et al., 2019; Nath et al., 2015; Zea Escamilla & Habert, 2014). However, these strengths are accompanied with significant weaknesses, including low productivity, inadequate quality control, absence of branding, and uncertain supply chain connections (Brenya et al., 2023; Hailemariam et al., 2023; Dadsena & Pant, 2023).

From a sustainability perspective, revitalizing informal sectors closely aligns with multiple Sustainable Development Goals (SDGs). These encompass SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) (Bloemhof & Soysal, 2017; Pettit et al., 2010). Promoting these sectors not only advances sustainable production and rural development but also improves social inclusion by empowering marginalized producers and artisans. Consequently, understanding the barriers, consumer behaviors, and logistical inefficiencies impacting these sectors is crucial for promoting sustainable transitions (Castro, 2004; Guo et al., 2022; Karuppiyah et al., 2021).

Traditional sustainability research typically emphasizes either production/processing efficiency or consumer behavior, little addressing both within the context of the informal sector (Manandhar et al., 2019; Powar et al., 2022; Tyagi et al., 2022). However, unorganized sectors like jaggery and bamboo-based products encounter multiple barriers across production, consumption, and distribution dimensions. A thorough understanding requires an integrated approach that connects barrier analysis, customer behavior assessment, and logistics optimization under an overall framework. This method facilitates the recognition of connections between supply-side and demand-side components, assisting in the formulation of comprehensive strategies for sustainable growth.

This thesis therefore presents three fundamental analytical dimensions linked to jaggery and associated products and bamboo-based products that collectively establish the general framework for revitalizing these informal product systems: Barriers in manufacturing and supply chain, consumer behavior and subscription Intentions, and optimization of supply chain

network and logistics. Each dimension tackles a unique yet interrelated aspect of the issue, thus offering a systems-oriented perspective on enhancing informal, livelihood-based industries for sustainable market engagement (Gangwar et al., 2015; Kumar & Kumar, 2018; Mogale et al., 2018).

Manufacturing and supply chain barriers constitute a primary challenge to the sustainable development of informal industries (Burger et al., 2017; Potdar et al., 2017; Singh et al., 2013). In industries like jaggery and bamboo, production facilities are generally inadequate, resource-limited, and geographically fragmented. They frequently depend on outdated machinery, and inconsistent raw material availability. Seasonal reliance, absence of mechanization, and restricted access to capital further limit production and profitability (Kumar & Bolia, 2025). Furthermore, inadequate infrastructure and insufficient logistical support prevent the attainment of consistent product quality and prompt market delivery (Al-Shboul, 2017; Manfredi & Capik, 2022).

In addition to production challenges, marketing and organizational barriers also contribute significantly (Akhter et al., 2025; Baksy, 2014; Dang-Van et al., 2024). Informal producers at times function outside established certification and quality assurance frameworks, constraining their competitiveness in urban or international markets (Brown, 2023; Vorst, 2006). Lack of awareness on branding, packaging, and value addition reduces consumer confidence and market penetration. Fragmented institutional coordination and insufficient recognition of informal producers limit their integration into broader value chains at the policy level (Mishra & Dey, 2018). Consequently, understanding and addressing these barriers requires a systematic analysis that demonstrates both their relative significance and interconnections. The application of multi-criteria decision-making (MCDM) frameworks, such as the Fuzzy Best-Worst Method (FBWM) and Fuzzy Decision-Making Trial and Evaluation Laboratory (FDEMATEL), offers a methodical approach to prioritizing and identifying these barriers under uncertainty (Thakkar, 2021). This analytical approach acknowledges that barriers in informal sectors are interconnected and mutually reinforcing. Weak infrastructure contributes to marketing challenges, but insufficient financial support hampers technological advancement. Analyzing these interdependencies establishes an important foundation for formulating specific policy interventions and sustainable production strategies (Filer, 2019; Ministry of Communications & Information Technology, 2010).

Supply-side inefficiencies limit production capacity, whereas demand-side issues predominantly influence the market viability and long-term sustainability of informal products (Lindgreen et al., 2012; Walter, 2020). Understanding consumer attitudes and motivations regarding sustainable and traditional products is thus crucial (Ghorbanloo & Shokouhyar, 2023; Krystallis et al., 2012; Ramsey et al., 2024). In recent years, the growing focus on organic, environmentally sustainable, and responsibly sourced products has resulted in a rise of customer interest in alternatives such as jaggery and bamboo-based products (Manandhar et al., 2019; Pimentel et al., 2005).

Consumer choices are influenced by various aspects, including functional benefits, perceived quality, emotional connection, cultural familiarity, and social influence (Assarzagdegan et al., 2025; Huber et al., 2015; Jaffe, 2012; Walter, 2020). For traditional products, factors such as authenticity, tradition, and health value are particularly crucial (Kumari et al., 2025; Quevedo-Silva et al., 2024; Samoggia et al., 2019). However, despite these characteristics, products from the informal sector frequently encounter perceived barriers concerning hygiene, consistency, and reliability (Chen & Chang, 2012; Konuk, 2018). Resolving these behavioral issues necessitates comprehension of both cognitive and emotional elements of consumer decision-making.

Moreover, the rise of subscription-based consumption patterns presents a unique opportunity to merge sustainability with convenience and consistency (Bischof et al., 2020; Gal-Or & Shi, 2022). Subscription intentions for traditional and eco-friendly products can generate consistent demand, sustain producer income, and enhance consumer producer connections (Bischof et al., 2020; Tao & Xu, 2018).

This thesis is also based on analyzing subscription intentions toward a sustainable products (jaggery and bamboo-based products) having the potential to grow in the domestic and international markets. Subscription as a tool offers the organization, or entrepreneurs an opportunity to bring new products to the table. It is a business model that allows customers to automatically receive deliveries of products or services at regular intervals of time as selected by the customers (Bischof et al., 2020; Bray et al., 2021). Many subscription models are currently operational in the market but broadly there are three very common archetypes: Replenishment (supplies and services with regular demands), Access (access to specific platforms, services, or contents), and Curation (personalized or specialized but recurring demands). Quite a few industries or platforms offer these kinds of subscription options to their

customers; e-commerce subscriptions by Amazon and Flipkart, streaming services subscriptions by Netflix, Spotify, and Prime, software subscriptions by Microsoft Office 365, Adobe Acrobat Cloud, and Avast antivirus, Gaming subscriptions by Xbox games pass and educational subscriptions by Coursera, Udemy and Skillshare. These companies highlight the features they offer through subscriptions operating in India, one of the largest emerging markets in the world. The benefits accrued from these kinds of models include reliable recurring revenue, increased customer base and loyalty, good customer retention, reduced churn, lower costs of customer acquisition, optimal inventory management, and easy financial forecasting (Bischof et al., 2020).

The intentions of people to switch or to adopt any product or service depend on many factors such as quality, availability and innovation. The literature indicates that customer behavior is analyzed utilizing perceived barriers, hedonic motivations, customer attitude, utilitarian value, and customer awareness as determinants of customer intentions concerning subscription, switching, and payment (Chen & Chang, 2012; Cook et al., 2002; Heijden et al., 2003; Krešić et al., 2023; Yoo et al., 2013). The examination of these intentions, integrating the dimensions provides insights into the evolution of sustainable consumption patterns. Examining the mediating interactions among these constructs allows for understanding how awareness and motivation shape customer attitudes, therefore impacting subscription willingness (Dua, 2024; Li et al., 2023). This behavioral factor thus enhances the supply-side analysis by connecting production sustainability with consumer-driven demand generation.

A key aspect of informal sector sustainability is the effectiveness of logistics and distribution systems (Chakravarthy et al., 2019; Cordeau et al., 2006; Mangla et al., 2018). Even when items are produced responsibly and capture customer interest, their commercial potential is underexploited if distribution networks are inadequate or fragmented. In rural informal sectors, producers are often geographically scattered, but consumer markets are predominantly located in urban or semi-urban regions (Sundarakani et al., 2020; Wetzel & Hofmann, 2020). This geographical mismatch creates logistical difficulties that raise transportation expenses, delay delivery, and reduce market accessibility (Manfredi & Capik, 2022; Polater et al., 2024).

Enhancing facility location and distribution design is essential for attaining cost efficiency and fair access. Facility Location Optimization (FLO) models offer a mathematical and analytical framework for identifying the optimal quantity and placement of selling centers or distribution hubs (Cheng et al., 2024; Ge et al., 2025; Marand & Hoseinpour, 2024). These models can

integrate variables such as transportation costs, facility capacity, demand level, and product perishability to get optimized network performance. In the context of jaggery and bamboo-based products, such optimization facilitate efficient rural–urban connections, minimize waste, and enhance producer profitability while upholding sustainability objectives (Blom et al., 2023; Klimanov & Tretyak, 2024).

When integrated with demand and production data, these models can also enhance decision support systems for local cooperatives and policymakers (Marda, 2018). They facilitate data-informed planning for infrastructure construction, transit scheduling, and resource distribution. This quantitative approach strengthens the operational foundation of informal sectors, complementing the behavioral and barrier-oriented aspects of the study (Baksy, 2014; Canavan et al., 2017).

The combination of these three analytical dimensions manufacturing barriers, consumer behavior, and logistics optimization constitutes a novel, multidisciplinary framework for examining sustainable development within informal sectors. It connects production-focused operational research with consumption-centered behavioral studies. The research aims to provide a cohesive framework by analyzing both extremes of the value chain, connecting producer livelihoods, consumer preferences, and distributional efficiency.

This integrated strategy is based on multiple theoretical frameworks. The Sustainable Livelihood Framework (SLF) highlights the significance of resources, capabilities, and activities in maintaining livelihoods; Institutional Theory highlights how formal structures and norms influence organizational and sectoral conduct; Innovation Diffusion Theory offers insights into the diffusion of new practices and technologies within communities; and Sustainability Transitions Theory examines systemic transformations toward more sustainable socio-technical systems. Collectively, these theories explain the evolution of informal production systems into robust, market-integrated, and ecologically sustainable firms while preserving their local character and social significance.

This study highlights the pressing necessity of revitalizing India's informal, livelihood-focused sectors via an integrated sustainability framework. Jaggery and bamboo industries, although traditional, demonstrate the ideas of circular economy and sustainable production (Grönman et al., 2013; Rao et al., 2007). Enhancing them requires addressing multifaceted challenges technological, behavioral, and logistical through analytical precision and policy consistency. The research emphasizes manufacturing barriers consumer behavior, and facility optimization,