IMPACT OF DESIGN INTERVENTION ON COMMERCIALIZATION OF BAMBOO FURNITURE INDUSTRY IN INDIA

Thesis Submitted for the Award of the Degree of

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Architecture

By

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Table of Contents

Declaration ……11
Certificate by Supervisor ……12
Abstract……13
Acknowledgements ……15

1.0. Chapter-1 Introduction……16

1.1 Statement of the Research Problem…… 17
1.2 Timber Availability and Consumption…… 19
1.3 Existing Furniture Market of India…… 20
1.4 Why Bamboo…… 21
1.5 Bamboo Basis…… 22
1.5.1 Anatomy…… 23
1.6 Global Bamboo Production…… 24
1.6.1 Distribution and status of bamboo species in India…… 25
1.6.2 Comparative analysis of bamboo value chain…… 27
1.7 Research Significance and Scope…… 29
1.8 Criteria for selection of Study area…… 30
1.9 Aim and Objective of the Proposed Work…… 32
1.10 Research Hypothoses…… 32
1.11 Proposed methodology for the achievement of the objectives…… 33
1.12. Study Precis…… 36

2.0 Chapter -2 Literature Study……37

2.1 Introduction…… 38
2.2 Study and Review…… 38
2.2.1 Bamboo Uses and its Development…… 38
2.2.2 Sustainability Aspects…… 40
2.2.3 Potential Uses…… 41
2.2.4 Strength…… 42
2.2.5 Comparison of Bamboo and Wood…… 43
2.2.6 Application in Interior…… 45
2.2.7 Application for Textiles…… 46
2.2.8 Application for Furniture…… 46
2.2.9 Application in Construction…… 48
2.2.10 Tools and Techniques…… 49
2.2.11 Comparitive Analysis…… 52

2.2.10 Current status of bamboo in India...……..……..……53
2.2.11 Conclusions…….. 57
2.3 Bamboo furniture examples: Indian and International model……. 57
2.3.1 Analysis of the study and furniture models…….. 61
2.4 Study Precis……..……...…...62
3.0 Chapter-3 Case Study& Interviews……..……...……....63
3.1 Case Study 01 Site study of National Institute of Design at Jorhat, Assam…….……64
3.1.1 Case study brief.…….…….64
3.1.2 Considering bamboo for campus……..……..64
3.1.3 Species used ……..65
3.1.4 Application of bamboo ……...……...……...65
3.1.5 Analysis from the case study ……...……...……...……...68
3.2 Case Study 02 Detailed Interview with Bamboo Working Specialised Architect ……..……..69
3.2.1 Introduction…..……69
3.2.2 Experience on Application…… ……..……..70
3.2.3 Interview Analysis ……...70
3.3 Case Study 03 Detailed Interview with Local Bamboo Artisan -Naresh Kumar... ……..……71
3.3.1 Introduction…..……71
3.3.2 Experience on Working…… ……..……...71
3.4 Case Study 04 Detailed Interview with Local Bamboo Artisan -Gautam Halder…..……..….72
3.4.1 Introduction…..……72
3.4.2 Experience on Application…… ……..……..72
3.1.3 Interview Analysis ……...73
3.5 Case Study 05 Detailed Interview with bamboo manufacturer -Keshav Bora..…..……..…....74
3.5.1 Introduction…..……74
3.5.2 Experience with bamboo...…… ……..……..74
3.6 Resaerch Gaps ……..…..……..….....76
3.7 Derived Interpretation ……...……..…..……..…….....77
3.8 Study Precis ……..…..……..…….....77
3.9 Expected outcomes from the research work……..…..……..…….....78
4.0 Chapter-4 Data Collection & Research Design ……..……..…79
4.1 Introduction…… 80
4.2 Identification of analysis Parameter……... 80
4.3 Variable Formations and Assessing…….. 81
4.4 Data collection and compilation approach…… 85
4.5 Study and Data Collection Parameters…….. 90
4.6 Field Survey for Segment Level Parameters……. 91

4.6.1 Personal Factors (PF)…… 91
4.6.2 Social Factors (SF)…… 92
4.6.3 Cultural Factors (CF)……..92
4.6.4 Psychological Factors (PSF)……...93
4.6.5 Design Intervention (DI)……94
4.7 Preference and Perception Survey……..95
4.8 Survey Tool…… 96
4.9 Conclusion…… 96
5.0 Chapter-5 Field Study……...……..……...……....97
5.1 North East Region- Assam…… 98
5.1.1 Introduction…… 98
5.1.2 Area Distribution…… 99
5.1.3 Bamboo Resources in Assam…… 99
5.1.4 Bamboo as a wood substitute…… 100
5.1.5 Status of Bamboo…….. 100
5.1.6 Data Collection…….. 101
5.1.7 Socio-economic status of artisans…….. 102
5.1.8 Marketing Structure and Analysis…… 103
5.1.9 Study Limitation…… 105
5.2 Study of North East Region- Tripura……..106
5.2.1 Area Distribution…… 106
5.2.2 Bamboo Resources…… 107
5.2.3 Status of Bamboo……108
5.2.4 Market Analysis……..109
5.2.5 Study Limitation……110
5.3 Study of the Northeast Region- Manipur……111
5.3.1 Area Distribution…… 111
5.3.2 Urbanization……111
5.3.3 Bamboo Resources…… 112
5.3.4 Marketing Analysis…… 113
5.3.5 Study Limitation……114
5.4 Case study on metropolitan cities – Delhi, Mumbai & Kolkata…….. 114
5.4.1 Introduction……114
5.4.2 Delhi……115
5.4.2.1 Demography……115
5.4.2.2 Bamboo Resource…….. 115

5.4.2.3 Marketing Analysis……116
5.4.2.4 Strategic Steps……116
5.4.3 Mumbai: Pune……117
5.4.3.1 Area Distribution……... 117
5.4.3.2 Resource and Diversity……... 103
5.4.3.3 Marketing Analysis……119
5.4.3.4 Limitation……120
5.4.3.5 Strategy……..…….... 121
5.4.4 West Bengal……..……..……122
5.4.4.1 Area and Distribution……..……....122
5.4.4.2 Resource and Diversity……... 123
5.4.4.3 Marketing Analysis……124
5.4.4.4 Limitations……... 124
5.5 Identification of variable by situation analysis of Bamboo Enterprise in study area 126
6.0 Chapter-6 Data Analysis……...……...…..…127
6.1 Introduction……128
6.2 Structure Equation Modelling……128
6.3 Principal component analysis : - Reliability & Validity Analysis……128
6.4 Analysis of Field Survey for Segment Level Parameters……... 131
6.5 Analysis of Segmental Attributes……133
6.5.1 Pervasiveness of Analysing Personal Factor (PF)…….. 133
6.5.1.1 Buyer-based Personal Factor (PF1.1)……. 133
6.5.1.1.1 Region distribution of respondent – (PF 1.1.1)…… 134
6.5.1.1.2 Gender – (PF 1.1.2)……... 134
6.5.1.1.3 Age distribution – (PF 1.1.3)……135
6.5.1.1.4 Qualification -(PF 1.1.4)…….. 135
6.5.1.1.5 Marital status – (PF 1.1.5)……136
6.5.1.1.6 Family type- (PF 1.1.6)…… 137
6.5.1.1.7 Employment type –(PF 1.1.7)…….. 137
6.5.1.1.8 Department –(PF 1.1.8)…… 137
6.5.1.1.9 Income level –(PF 1.1.9)……..138
6.5.1.2.1 Pervasiveness of analysing Personal Factor (PF)-Stakeholders (sellers & manufacturer)…... 139
6.5.1.2.2 Region distribution of respondent –(PF 1.2.1)……..140
6.5.1.2.3 Age distribution –(PF 1.2.2)……..141
6.5.1.2.4 Education –(PF 1.2.3)……... 141
6.5.1.2.5 Working Experience-(PF 1.2.4)……142

6.5.1.2.6 Industry Involvement-(PF 1.2.5)…….. 142
6.5.1.2.7 Payment type-(PF 1.2.6)…….. 142
6.5.1.2.8 Income distributions –(PF 1.2.7)…….. 143
6.5.1.2.9 Adequate market-(PF 1.2.8)…….. 143
6.5.1.2.10 Adequate Buyers'-(PF 1.2.9)……. 144
6.5.1.3 Buyer consideration while furniture purchase –(PF 2.1)…… 145
6.5.1.3.1 Buyer attitude towards bamboo –(PF 3.1)…… 145
6.5.1.4 Bamboo not being adopted as a furniture material instead of wood-(PF1)…… 146
6.5.2 Pervasiveness of Analysing Social Factor (SF)…… 151
6.5.2.1 Skill level of the intermediaries (artisans), traditional involvement.-(SF1)…….. 151
6.5.2.2 Support and Funding assistance towards promotion &commercialization-(SF1.1)……. 151
6.5.3 Pervasiveness of Analysing Psychological Factor (PSF)…….. 156
6.5.3.1 The factor causing the low commercialization of Bamboo furnitur.-(PSF1)…… 156
6.5.4 Pervasiveness of Analysing Cultural Factor (CF)…….. 163
6.5.4.1 Cultural factor measuring adoption of bamboo furniture –(CF1)…….163
6.5.4.2 The preferable measures considering the buyer behaviour and ideas. -(CF1.1)…….164
6.5.5 Design Intervention (DI)…….170
6.5.5.1 Major interventions can be incorporated into the design -(DI1)……... 172
6.5.5.2 Analysing the Interventions by Prototype Chair Mode…….. 176
6.5.5.3 Evaluation of Product Prototype…….180
6.5.5.4 Inventive measure that can promote design intervention-(DI2)…… 184
6.5.6 Conclusion…….. 188
7.0 Chapter-7 Results and Discussion…..……...……...…190
7.1 Introduction…….190
7.2 Research Finding…… 190
7.2.1 Interpretation from a field study of bamboo furniture commercialization …… 191
7.3 Interpretation from Hypothesis testing……..…….....214
7.4 Interpretation from a field study of the urban and bamboo growing regions in India……...216
7.5 Interpretation of bamboo furniture commercialization friom users perception in study……...219
7.6 Conclusions…….221
7.7 Recommendations Findings…….221
7.8 Strategies…… 222
7.9 Study limitation…….. 227
7.10 Future Research…….. 227

References……...230

Appendix……244
Appendix-01 Questionnaire for Field study of furniture end users ……..…….…..244
Appendix-02 Questionnaire for field study bamboo artisans/manufacturer……..…..…..249
Appendix-03 Questionnaire for Prototype Evaluation …….……...252
Appendix-04 Surveyed Bamboo Artisans and Manufacturer……...254
Appendix-05 List of Publications,Conferences and Patent…….…….....255

List of Figures

Figure 1: Ecological debt of India.....17
Figure 2: Gap between bio-productivity and Ecological Footprint.....18
Figure 3: Share of Organised and Unorganised.....20
Figure 4: Comparative Analysis of Harvesting Age of Bamboo vs Wood.....21
Figure 5: Analysis of carbon footprint by bamboo.....21
Figure 6: Carbon footprint analysis of bamboo.....22
Figure 7: Growing structure of Sympodial (clumping) bamboo……..22
Figure 8: Growing structure of monopodial (clumping) bamboo…….23
Figure 9: World Bamboo Distribution.....24
Figure 10: Bamboo resources states of India.....25
Figure 11: Optimal comparative utilisation analysis of bamboo culms parts in India from China 28
Figure 12 Bamboo Resources states of India.....28
Figure 13 Study area mapping.....31
Figure 14: Literature study flow chart.....38
Figure 15: Comparison of strength and stiffness of bamboo with other materials.....43
Figure 16: Eco-costs per year for SWB and alternatives.....43
Figure 17 Industrial bamboo materials, Plybamboo (left) and Strand Woven Bamboo (right).....44
Figure 18: Diagram of Canonical Correlation Model for Design factor vs Value factor.....47
Figure 19: Bamboo products by (Makowsky, 2013).....48
Figure 20: Traditional Bamboo Tools used for furniture making……..58
Figure 21: Comparative Analysis between Traditional vs modern bamboo furniture process ……...58
Figure 22: a) Bamboo Sofa, b)Bamboo chair, c) Bamboo bed at Boober, Assam.....58
Figure 23: a) Bamboo table, b)Bamboo chair, c) Bamboo sofa at Visdalia cluster.....58
Figure 24: a) Freestanding bamboo shelf, b)Bamboo stool, c) Bamboo chair and wall bookshelf.....59
Figure 25: a) Bamboo stool, b)Bamboo study table and chair.....59
Figure 26: Bamboo chairs and stools.....60
Figure 27: Bamboo tables.....61

Figure 28: Bamboo bench 61
Figure 29: Site and Surrounds (National Institute of Design) 64
Figure 30: Detailed layout (National Institute of Design) 65
Figure 31: Half-cut hollow bamboo cladding on external wall 66
Figure 32: Hollow bamboo for corridor columns and truss structure 67
Figure 33: Hollow bamboo used cladding, staircase and corridor railing 67
Figure 34: Hollow bamboo used in cladding in the dining hall and for furniture in the cafeteria. 67
Figure 35: Processed Bamboo board used reception table and corridor railing 68
Figure 36: Bamboo mat board for false ceiling and reception table 68
Figure 37: Interview with Architect Mrs Urmimala Guha, who worked with Bamboo 69
Figure 38: Interview with Naresh Kumar, Delhi-based Bamboo artisan. 71
Figure 39: Interview with Gautam Halder, Kolkata-based bamboo artisan 72
Figure 40: Bamboo Furniture by local artisan Gautam Halder 72
Figure 41: Interview with Mr Keshava Nada Bora, Assam-based bamboo manufacturer 74
Figure 42: Upscaling Programme and workshops for villagers 75
Figure 43: Bamboo furniture made from traditional solid and hollow bamboo 76
Figure 44: Bamboo products made from Processed bamboo made by Boober 76
Figure 45: Conceptual model of commercialisation. 90
Figure 46: Psychological Factor Affecting Commercialization 93
Figure 47: Geographical representation of North East region 98
Figure 48: Forest area and bamboo bearing in Northeast Region 98
Figure 49: Forest Area and bamboo delivery in the northeast region 99
Figure 50: Bamboo density in recorded forest area in Assam 100
Figure 51: Proportion of value addition in furniture manufacturing 102
Figure 52: Value Chain followed by bamboo furniture market in Jorhat 103
Figure 53: Location Map of Tripura 106
Figure 54: Present utilisation of aforesaid extracted bamboo 107
Figure 55: Bamboo bearing area by density recorded in Forest 107
Figure 56: Gandhi gram bamboo Crafts Processing Centre 108
Figure 57: Training of Bamboo Artisans Crafting Bamboo Furniture 109
Figure 58: Location Map of Manipur 111
Figure 59: Bamboo Diversity in Different Region 112
Figure 60: Imported Bamboo species of Manipur, Characteristics and Availability 113
Figure 61: Location Mapping of Delhi 115
Figure 62: Forest cover of Maharashtra 118
Figure 63: Bamboo Consumption in Maharashtra 119

Figure 64: Forest cover map of West Bengal 123
Figure 65: Commercial Bamboo species of West Bengal 124
Figure 66: Mapping study area 132
Figure 67: Buyer's Psychological Model 156
Figure 68: Graph showing the relationship between buyer-based design and its effect on supply. ... 162
Figure 69: Graph showing the relationship between non-buyer-based design & its effect on supply 162
Figure 70: Graph showing the relationship between buyer-based design and supply. 163
Figure 71: Proposed product commercialisation model..... 169
Figure 72: Planning Constructs of Design Intervention..... 170
Figure 73: Impact evaluation model 171
Figure 74: Conceptualization of prototype design..... 177
Figure 75: Human ergonomics and seating angle single line design 177
Figure 76: Reclining chair in plan with openable footrest..... 178
Figure 77: Reclining chair in plan with closed footrest 178
Figure 78: Reclining chair in side elevation with openable footrest..... 178
Figure 79: Reclining chair in side elevation with closed footrest 178
Figure 80: 3D model of zero gravity reclining chair..... 179
Figure 81: Joinery mechanism of footrest..... 180
Figure 82: Blow-up detail of joinery mechanism 180
Figure 83: Joinery mechanism of footrest..... 180
Figure 84: Blow-up detail of joinery mechanism footrest 180
Figure 85: Income effects on purchase ……..... 192
Figure 86: Strategies needed for improvising design & commercialising bamboo furniture……..223

List of Tables

Table 1: Major Indian Bamboo species for Furniture and Craft 27
Table 2 Cost analysis of Sofa at three levels nodes- Directly to Retailers, With additional..... 104
Table 3: Position of Bamboo stakeholders in Maharashtra……..120
Table 4:Reliability test of selected variables by Cronbach Alpha 131
Table 5: Technical evaluation of Chair by Manufacturer and Users 182
Table 6: Users-based evaluation of prototype model..... 183
Table 7:Suggestion for Policy Improvision 222

List of Graphs

Graph 1: Respondents region distribution 134
Graph 2: Respondents' gender distribution..... 135

Graph 3: Respondents' age distribution 135
Graph 4: Respondents Qualification 136
Graph 5: Respondents' Marital Status 136
Graph 6: Respondents family type 137
Graph 7: Respondents employment type 137
Graph 8: Respondents working departments 138
Graph 9:Respondents Income level 138
Graph 10: Stakeholders region distribution 140
Graph 11: Stakeholders' age distribution 141
Graph 12: Stakeholders education level 141
Graph 13:Stakeholder's working experience 142
Graph 14: Stakeholders' Industry Involvement 142
Graph 15: Payment criteria 143
Graph 16:Stakeholders Income distributions 143
Graph 17: Adequate market 144
Graph 18: Adequate Furniture Buyer 144
Graph 19: Buyer consideration while furniture purchase 145
Graph 20: Buyer attitude towards bamboo 146
Graph 21: Bamboo is not being adopted as furniture but rather wood 148
Graph 22: Skill level of the intermediaries (artisans), traditional involvement, prospectus 152
Graph 23: Participation in Skill Development Programs 154
Graph 24: Funding Assistance 154
Graph 25: Funding assistance towards promotion & commercialization 155
Graph 26: Factor causing the low commercialization of Bamboo furniture 158
Graph 27: Factor measuring adoption of bamboo furniture 164
Graph 28: Preferable measures increase the awareness and commercialization 165
Graph 29: Major Interventions in Design for Increasing commercialisation and Adoption 173
Graph 30: Technical Evaluation of Chair by Manufacturer and User 181
Graph 31: Inventive measures that can promote design intervention 185

DECLARATION

I hereby declare that the thesis titled **" Impact of Design Intervention on Commercialization of Bamboo Furniture Industry in India"** was prepared and submitted by me under the supervision of **Dr. Mahendra Joshi**, Professor, Lovely School of Architecture and Design, Lovely Professional University, Phagwara, Punjab. As part of the requirements for the award of the degree of Doctor of Philosophy (Ph.D.) in Architecture, my original work and ideas and references are duly acknowledged.

It does not contain any work submitted for the award of any other degree or diploma from any university. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature and acknowledgement of collaborative research and discussions.

I further declare that there is no falsification or manipulation in terms of research materials. I hereby confirm that the thesis is free from any plagiarised material and does not infringe any rights of others. I also confirm that if any third-party-owned material is included in my thesis that requires written permission from the copyright owners, I have obtained all such permissions from the respective copyright owners.

Date: 15 September, 2022

Priyanka Shukla

Signature of Candidate

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Certificate by Supervisor

I hereby affirm as under that:

i.) The thesis presented by Priyanka Shukla entitled " **Impact of Design Intervention on Commercialization of Bamboo Furniture Industry in India** " is worthy of consideration for the award of the degree of Doctor of Philosophy.

ii.) She has pursued the prescribed course of research. The thesis submitted is a record of original research work done by the Research Scholar during the period of study under my supervision.

iii.) The thesis represents independent research work on the part of the Research Scholar. The work is the original contribution of the candidate.

iv.) The candidate has incorporated all the suggestions the external panel members made during the End Term Presentation-3 held in June'2021.

v.) The candidate has not submitted the same research work to any other institution for any degree/diploma, Associateship, Fellowship, or other similar titles.

Supervised by:

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Place: Phagwara, Punjab
Date: 15 September 2022

Abstract

The global spotlight on climate change and sustainability has recognised the potential of bamboo as a material for the future. Furniture has been scaled up from luxury to necessities, suppressing the natural resources of timber. Overcoming the excessive furniture demand of Indian consumers, bamboo, used extensively as a substitute raw material for wood by many sub-sectors and countries, can be used in furniture making. This versatile material has gained popularity worldwide in furniture markets in the last two decades. Countries like China and Indonesia have been aggressively promoting their bamboo furniture around the globe and gaining a significant market share. However, India has yet to be able to tap into this market despite being the second biggest bamboo producer in the globe. The study's objective is to analyse why bamboo furniture has not been able to gain acceptance in the Indian furniture market. The analysis is simplified into seven chapters. The first chapter provides a basic introduction to the research and the problem that led to this research. Chapter -2 accumulates the various studies carried out globally in the bamboo industry, briefing the conceptual framework done with bamboo and the industry's impediments. In Chapter -3, all the case studies and interviews were to understand the users' perception and bamboo acceptability preferences. Identification of the factors affecting commercialisation and the design-based intervention that could stimulate commercialisation is discussed in Chapter -4.

In contrast, the related field study, which is being carried out in three metropolitan regions, Delhi, Mumbai, and Kolkata, and three bamboo regions, Assam, Manipur, and Tripura, includes feedback from end users/ buyers, bamboo artisans, producers, manufacturers, architects, and designers are simplified in chapter -5. The field survey, interviews, questionnaire analysis, and prototype-type model designing and analysis based on the user's preferences are specified in Chapter -6. The last chapter discusses the brief results and suitable recommendations that can be adopted to promote the adoption of bamboo furniture.

Overall, the study focuses on the Indian consumers with the highest stake in revenue generation and current industry value proposition. The analysis highlights consumers' narrow mindset towards bamboo furniture, inadequate training facilities, inappropriate knowledge about ergonomics, lack of innovative design, and deficiency in trade and promotion. This study will give bamboo furniture manufacturers, retailers, researchers, and students an idea about the consumers' expectations of bamboo furniture and the gap in design that affects its acceptability.

The Study demands immediate intervention towards design and changing the few policies that can help preserve and promote bamboo artisans. The recommendations will help provide some insights to create better designs, which is one of the significant interventions needed to promote bamboo furniture in the Indian market.

In conclusion, we can take an innovative step toward sustainability by promoting bamboo as a sustainable alternative to wood as a furniture material.

Keywords: Bamboo furniture, Bamboo Artisans, Indian Bamboo Market, Consumers Behaviour, Purchase

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Priyanka Shukla

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CHAPTER 1

Introduction

This chapter provides a preface to this Ph.D. research. In section 1.1, the problem steered to this dissertation is explored, focusing on the relevance of renewable materials input for furniture making, including the need to look for substitutes for wood, such as bamboo, for furniture making. Section 1.2 discusses timber availability and consumption, and 1.3 classifies India's existing furniture industry. Section 1.4 states why bamboo should be used for furniture, its maturity cycle, and its carbon footprints. Sections 1.5 and 1.6 discuss the anatomy of bamboo, its growth, its global production, and its current status in India. Finally, sections 1.7, 1.8, 1.9and 1.10, respectively, state the scope, significance, criteria of selecting the study area, scope, objective, and structure of the proposed work.

1.1 Statement of the research problem

Today, India grapples with various environmental impacts due to the growing gap between the number of natural resources utilised and their availability. The ecological footprint accounts for the productive land and sea resources required to produce the resources that consume and absorb waste. As per National Footprints Accounts (2014), **India has an ecological footprint of 1.12 global hectares per person and a biocapacity of 0.45 global hectares per person, meaning there is 148% more demand than supply**[1]. Ending up as a 'biocapacity debtor' or an 'ecologically deficit country'. India has the third heavier ecological footprint in the world and its resource use is double its biocapacity due to the sizes of its populations (Vikalp Sangam, n.d.)

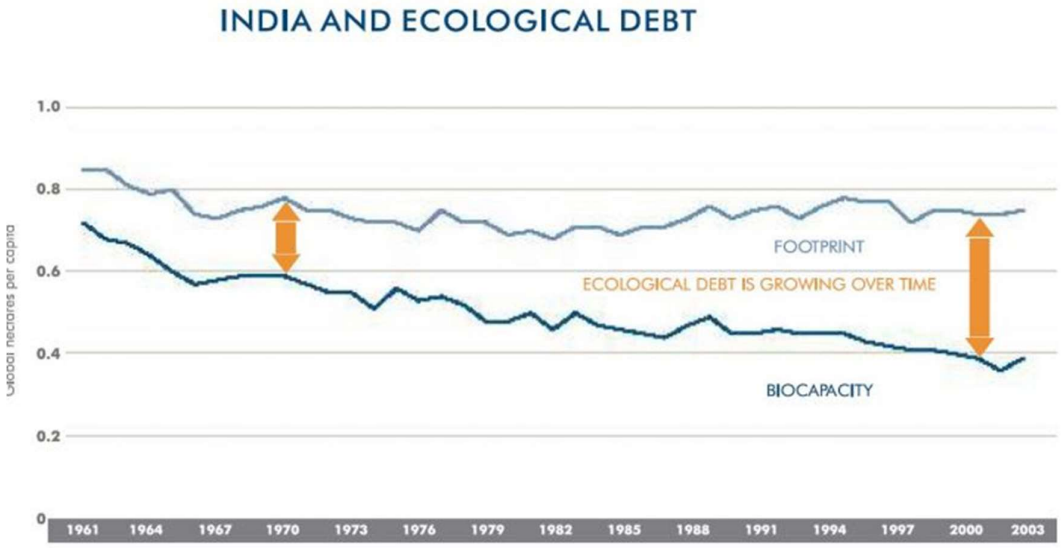

Figure 1: Ecological debt of India
Sources: *(Global Footprint Network , 2008)*

As per (Vikalp Sangam, n.d.) India has a decentralised distribution of over one billion people in hundreds of thousands of semi-self-reliant villages dependent on nearby resources. The urban middle class has an attitude of open influence from surroundings and societies having heavier ecological footprint. This part of the community follows lifestyles with extremely high levels of resource consumption, which tends to produce heavier ecological footprints than poor people (Vikalp Sangam, n.d.).

[1] *Global Footprint Network*. (2008, October). Retrieved from https://www.footprintnetwork.org/2008/10/03/indias-demand-nature-approaching-critical-limits-report-finds/.

The eco-footprint measures the pressure on natural resources due to population consumption and lifestyle. India has a large ecological footprint per person because it has a large population. However, it has 200 million middle-class and affluent people with consumerist aspirations and lifestyles. In low and moderate level household expenditure, the carbon footprint is driven by the consumption of electricity (0.19 tonne/capita), food (0.12 tonne/capita) and consumables (0.07 tonne/capita), which includes our day-to-day useable in which furniture industry deploys a critical part (Moudgil, 2021). In the economy of furniture, objects, and implements, human habits relating to surroundings require making more with less, concerning the environment, avoiding wasting natural resources, and optimising substitute resources (Ribeiro, 2014).

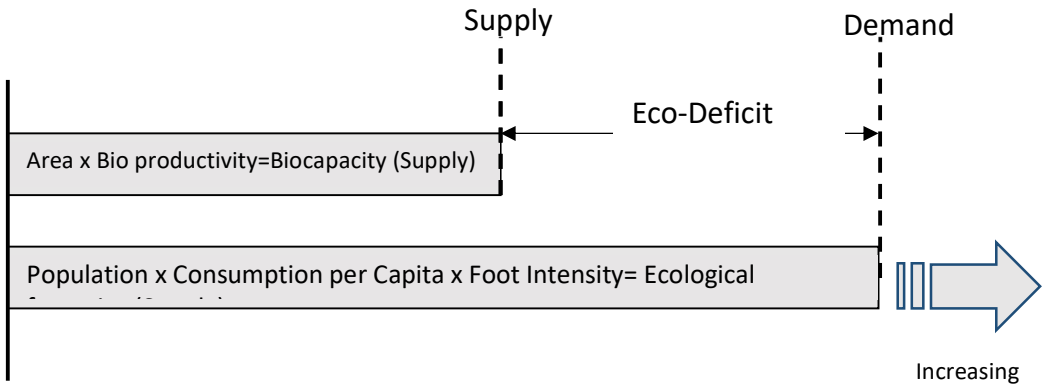

Figure 2: Gap between bio-productivity and Ecological Footprint
Sources: *(Global Footprint Network , 2008)*

Evaluating the impact on the environment, the product choice is essential for addressing sustainability-related issues. Adopting the usage of bamboo and its by-products instead of wood for furniture making can address the ecological footprints at a sustainable level. This research tries to identify the following cumulative effect the Indian bamboo furniture market is facing in its adoption:

RQ1 What are the reasons for the low acceptance of bamboo furniture in India, and why is there a lack of promotion compared to other countries despite its wide availability?

RQ2 What significant Intervention must be adopted to commercialise bamboo furniture among Indian consumers?

RQ3 What constraints are faced by small, micro, and medium-scale bamboo furniture manufacturers, and what is the modification suggestion towards an existing policy for a better-skilled bamboo industry in India?

RQ4: Evaluating the skill level of involved rural artisans and the gaps between end user aspirations and produced product.

RQ5 What is the Impact of design intervention in promoting bamboo furniture in India?

RQ6 What role do architects and designers play in promoting bamboo furniture in India and modifying the architecture/ interior design curriculum to promote awareness?

1.2 Timber Availability and Consumption

As per the recent survey report by the Indian State of Forest, the total forest cover accounts for 712,249 km2, which is 21.67% of the total geographical area. There has been a significant increase of 0.13% from 2017, but with this steady increase, India still needs more timber production. As per the FSC report, there has been a gradual decline of 0.70 % every year since 1991. This gradual decline in output has been due to an increased focus on conserving forest resources after the notification of the National Forest Policy in 1988, as per (The International Tropical Timber Organization, n.d.) and FAO Yearbook, India's compound annual Growth Rate (CAGR) declined annually from 1991 to 2000 by 0.70. The total production of round wood is 47 million m3 per annum, of which 45 million m3 comes from outside forests and nearly 2 million m3 from state-owned forest resources. Pine and teak round wooden logs are mainly used for high-value furniture making, and other species are used for various constructions, paper making, and other engineered wood furniture (Kant & Nautiyal , 2020)[2].

The furniture industry is growing considerably due to increasing urbanisation and rising disposable income. The demand for round wood for furniture making rapidly increased in 2016-2018 from 6.88 million m3 to 8.49 million m3, and 65% of the furniture market is captured by wood [3]. As per the (Kant & Nautiyal , 2020) report, the round wood demand for the furniture industry is estimated to increase from 9 million m3 to 13 million m3 by 2030. It needs a proper channelised approach towards the projected increase.

[2] Kant , D., & Nautiyal , R. (2020). *India timber supply and demand.* International Tropical Timber Organization.

[3] As per (Lugt, 2008), the total area of certified forests is growing with high requirements, resulting in complex logistics and management systems needed during the value chain, and the availability of certified wood is low.

1.3 Existing Furniture Market in India

In the last two decades, India has emerged as the fastest-growing economy in the global market. When it comes to the worldwide market, according to the World Bank study, The furniture industry is estimated at approximately INR 3,500 billion (around USD 47 billion), including wood, metals, plastics, and the rest)[4] the organized furniture industry grows by 20 % every year. When it comes to Gross Domestic Product (GDP), the furniture sector has a rimming contribution of 0.5 % of the net GDP. The furniture industry in India is majorly unorganized. As shown in Figure 3, about 85% comprises small local furniture sellers and retailers, whereas the remaining only 15 % are owned by large established brands such as, Godrej & Boyce Manufacturing Co. Ltd., BP Ergo, Feather lite, Durian followed by other big names (India Brand Equity Foundation (IBEF))[5].

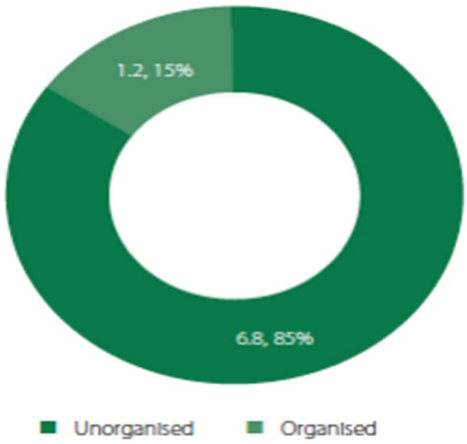

Figure 3: Share of Organised and Unorganised
Sources: *(India Brand Equity Foundation (IBEF))*

In furniture industry 50% of the total wooden furniture crafted using teak ,while sal and deodar account for about other 20% and the balance 30% includes mahogany, cedar and other tree types (Kant & Nautiyal , 2020), (The International Tropical Timber Organization, n.d.). The fat demand is been generated due to rapid growth in Asian consumer market. The constant developments in the global economy and increase in the population have raised the demand for timber and it is - composites; therefore, a suitable raw material which should have comparable substantial properties, be fast-growing, readily available, and most importantly, should be relatively to the existing processing technologies like timber. As per (Kant & Nautiyal , 2020) India's significant population preferences evidenced that people demand more contemporary-styled types of furniture. Bamboo, botanically known as "Bambusa" from the humble grass family Gramineae, is a viable remedial substitute option to vitalize the upcoming furniture demand. (Chaowana, Bamboo: An Alternative Raw Material for Wood and Wood-Based Composites, 2013).

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[4] Kant , D., & Nautiyal , R. (2020). *India timber supply and demand.* International Tropical Timber Organization.

[5] India Brand Equity Foundation (IBEF). (n.d.). Furniture Market & Opportunities https://www.mordorintelligence.com/industry-reports/india-furniture-market.

1.4 Why Bamboo

The present scenario is facing the increasing concern of Global warming. This has turned into a concerning issue for most countries, and they are trying to find measures through which they can contribute to making the ecosystem greener with less embodied energy. Globalization and industrialization lead to massive shrinkage in many viable native resources, and a superlative surrogate is necessary for one such draining resource, "timber". The elevated demand for natural resources (timber) has diminished its production. It is gradually leading the footstep towards ecological degradation meditated approach towards the receptiveness and evolution of bamboo as an alternative to reduce the load on demand for natural timber for furniture production.

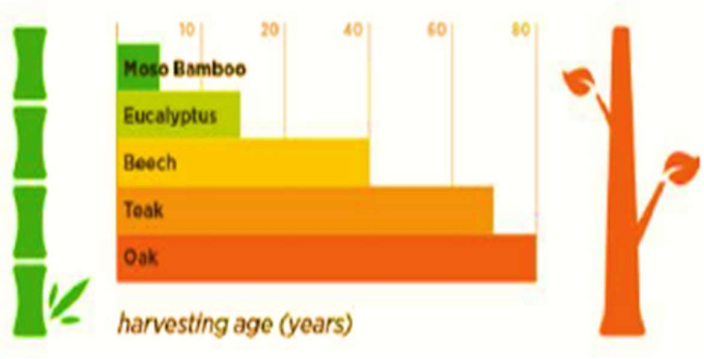


Figure 4: Comparative Analysis of Harvesting Age of Bamboo vs. Wood
Source: (Kamble, 2019)

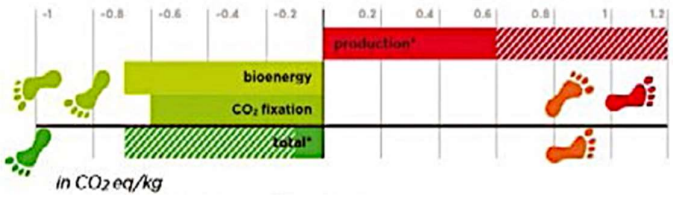


Figure 5: Analysis of carbon footprint by bamboo
Source: (Kamble, 2019)

The growth comparative analysis shown in Figure 4 of bamboo with other wood-generating species by (Kamble, 2019), the growth cycle of bamboo is observed to be higher, and it takes just 3 to 5 years to get mature bamboo, whereas any usual hardwood or softwood tree takes averagely 10 to 30 years. The carbon dioxide (CO2) absorption rate and oxygen (O2) release to the environment is also higher.

The carbon footprint analysis by (Kamble, 2019) showed that bamboo has a shallow, almost negative carbon footprint even after considering the environmental damages caused during its transportation and production process. It is also found highly sustainable due to its capacity of capturing CO2 from the environment.

The Footprint was found to be low even after a complete life cycle from production to use for more advanced form and using bamboo can add 'Green' to the nature (Chaurasia , 'Bamboo' with reference to Indian context: Potential sustainable building material and awareness, 2019). As per the principles of green or eco-friendly products, bamboo for the furniture industry could be an ideal raw material as it ensures that the carbon stays locked in it till end of its life. (Boran, Cavdar, & Barbu, Evaluation of Bamboo as Furniture Material and its furniture material, 2013).[6]

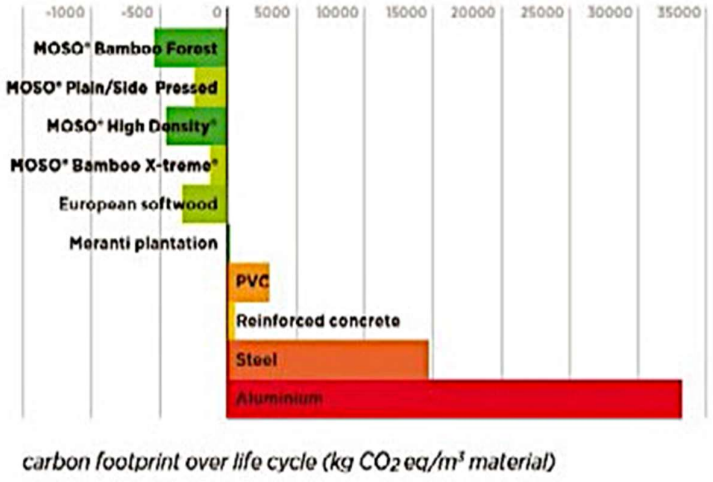


Figure 6: Carbon footprint analysis of bamboo
Source: (Kamble, 2019)

1.5 Bamboo Basis

Bamboo is one of the most versatile and sprightly growing perennial grasses, belonging to the Poaceae (Gramineae) family. Its abundant availability is found in sub-tropical, tropical and mild-temperate regions worldwide. As per a (Indian Council of Forestry Research and Education Dehradun, 2017)[7], there are about 1200 species in 90 genera worldwide. Bamboo is generally considered an accumulator when it comes to phytoremediations. Bamboo's ability to accumulate high concentrations of specific metals comes with specific root system development. Bamboo as a plant is mainly classified into two categories based on the rhizome systems: sympodial and monopodial.

[6] Boran , S., Cavdar, A. D., & Barbu, M. C. (2013). Evaluation of Bamboo as a furniture material and its furniture design. Proligno, 9.

[7] Indian Council of Forestry Research and Education Dehradun. (2017). *Bamboo Conservation, Management and Utilisation in India.* Director General, Indian Council of Forestry Research and Education (ICFRE).

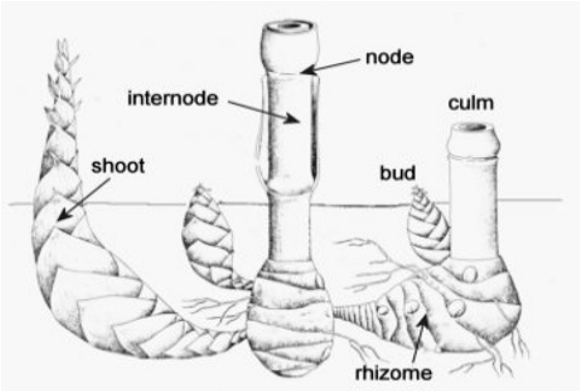


Figure 7: Growing structure of monopodial. (clumping) of bamboo
Sources: *(Bamboo Land , n.d.)*

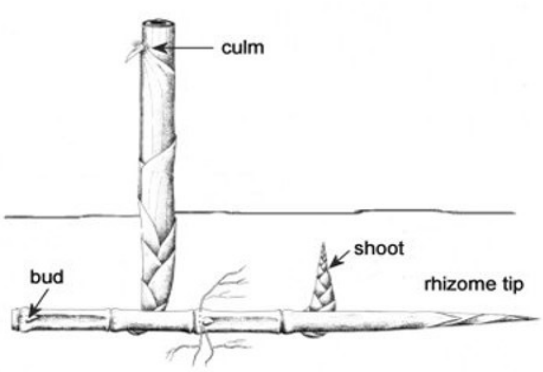


Figure 8: Growing structure of Sympodial (clumping) of bamboo
Sources: *(Bamboo Land , n.d.)*

Monopodial bamboo forms a subterranean grid net leading to widely spaced clumps, whereas sympodial bamboo grows in clumps. Bamboo has a vital root networking, consisting of rhizomes at subterranean parts. Some species can grow up to 30 meters, whereas some do not even reach the height of 1 meter and 1cm in diameter. The bamboo has a record of growing up to 1 meter per day and can be harvested in about 3-5 years. Bamboo growth generally needs high temperatures and heavy rainfall for growth.

1.5.1 Anatomy

The bamboo plant comprises two parts subterranean part is termed the underground axis, and the above surface is called the above axis (National Mission on bamboo application, 2011)[8]. The covert axis is comprised of horizontal rhizomes, roots, and buds. The surfaced axis includes other parts like stems, branches, and foliage. The outermost part of bamboo has no vascular bundles. Lignin serves as the bond between fibres and gives the plants resistance in the transversal direction of the culm. However, it has a soft and brittle behaviour. Culm, one of the most essential parts of bamboo, describes the bamboo shoot itself. Bamboo mostly has hollow culms, but some species are found with solid culms. The segment of culm from where it begins and ends has a stable joint, termed a node.[9] The segments seen between two nodes are termed as internodes (Sulaeman, et al., 2017), (National Mission on bamboo application, 2011)

[8] National Mission on bamboo application. (2011). The Bamboo Book -Field Guide. https://nectar.org.in/images/publications/Final_Bamboo_Book.pdf

[9] Sulaeman, A., Dungani, R., Nurudin, N., Hartati, S., Karliati, T., Aditiawati, P., . . . Sulistyono. (2017). Review on Quality Enhancement of Bamboo Utilization: Preservation, Modification and Applications. *Asian Journal of Plant Sciences*.

1.6 Global bamboo production

Bamboo and its species have been naturally available in various tropical and subtropical belt lying between 46°north 47°south latitude, majorly in Central and South America , Asia and Africa. Asia, one of the major contributors in bamboo productions and processing, it is been known that south east is the most diverse resource for bamboo species with 65 genera and about 900 species (United Nations Development Programme)[10].

As per the analysis from United Nation Comtrade the bamboo trade in the year 2019 came around $3.054 billion. The main trading region who came up enveloping the global bamboo trade was – Europe, Asia Pacific and North America. The Asia-pacific regions came as the main dominant of the global market. As per the (The International Bamboo and Rattan Organisation, 2021) Asia pacific encompass 81% of the cosmos export whereas Europe accounts to 10% and Northern American countries exported to 9%.

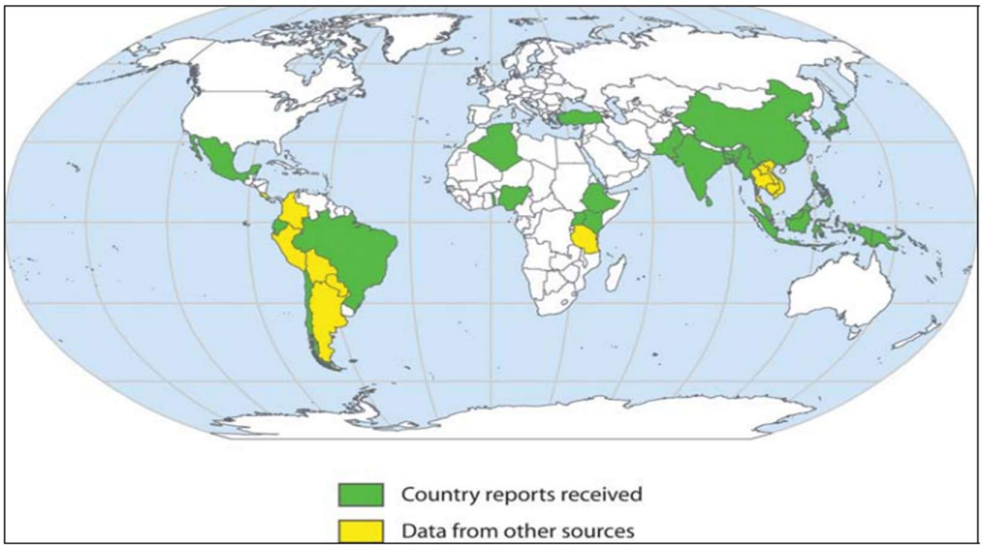


Figure 9: World Bamboo Distribution
Sources: (lobovikov, Paudel, Piazza, Ren, & Wu, 2007)

Together India and China accounts 45 % of total world bamboo resources. It is analysed that nearly 2.5 billion people use bamboo in one form or another form at global level. It is being estimated that annual turnover is more than $15 billion and this is estimated to shoot up to 20

[10] United Nations Development Programme. (n.d.). Sustainable and Profitable Bamboo Value Chain Management in Assam. Export import bank of India.

billion by 2015. The China has turned up to be major exporter for the bamboo industries. The total export value of bamboo is $ 5.50 billion per annum.

1.6.1 Distribution and status of bamboo species in India

India, which is estimated to be the second-largest country worldwide with nearly 40% of the total bamboo forest area after China (National Bamboo Mission, 2011) .Due to low industrialization in bamboo industry specifically at supply side, produced products are not in significant quantity . Resulting , stagnant and low level of exports of bamboo-based products. Bamboo shares an important part of supporting rural livelihood in many countries, especially developing counties like India. Reportedly, India is home to about 125 indigenous and 11 exotic species of bamboo from 23 genera (FSI , 2015)[11]. Some of the major Indian bamboo genera are Dendrocalamus, Dinochola Arundinaria, Gigantochloa, Bambusa, Chimonobambusa etc . Northeast the region of semi-green and deciduous forest bamboo contributes majorly up to 50% to the total bamboo resources of the country (Naithani, 1993). Some other major contributors are Andaman & Nicobar Islands, Chhattisgarh, Madhya Pradesh and Western Ghats marked in Figure-3 as per (State forest report, 2017). As per the field study the major species used furniture making is 'Tama Bans 'which is solid bamboo comes under male bamboo species . However, Kotaha bans, Kanta bans and Lathi Mulla categorized as hollow bamboo species[12].

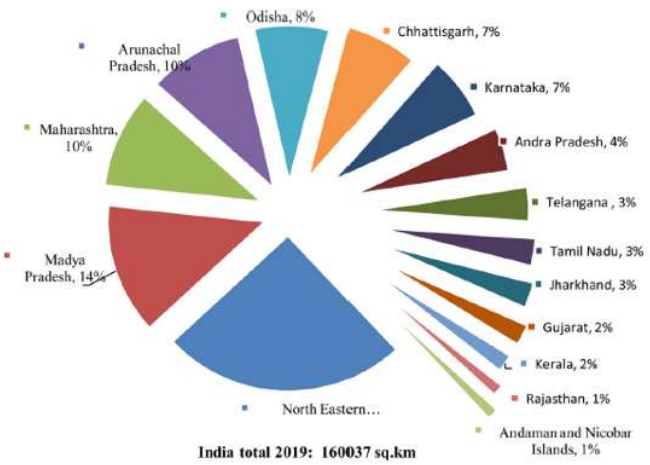


Figure 10: Bamboo resources states of India
Sources: *(FSI, 2019)*, *(Cajee, 2018)*

[11] FSI. (2015). India State of Forest Report. Forest Survey of India, Government of India.

[12] "Male Bamboo" seems to be the most commonly used, though the flowers are mostly bisexual , so the plants are just as female as they are male. Sometimes its called "Solid Bamboo"

Male Bamboo Species				
SN	**Local name**	**Scientific name**	**Uses**	**Description**
1	Bengal Bamboo (WB), Jati Bahn (Assam), Mritinga (Tripura), spineless Indian bamboo	Bambusa tulda	Building construction, rack, furniture, hanger, chair etc.	
2	Tama Bamboo (Assam)	Dendrocala mus hamiltonii	Temporary constructions (houses, bridges), paper, making baskets and mats	
3	Marihal bamboo (Assam)	Dendrocala mus stocksii	Substitute for cane and rattan in bamboo-based furniture industry.	
Female Bamboo Species				
SN	**Local name**	**Scientific name**	**Uses**	**Description**
1	Kanta bans (Orissa); Nal bans (Punjab)Kotoha (Assam); Behor bans (WB); Mula (Malayalam); Saneibo (Manipur); Mungil (Tamil Nadu); Mulla eduru (AP)	Bambusa balcooa	Building material for houses, bridges, fishing floats, auto rickshaw head frame hood, building scaffolding and fishing equipment's.	
2	Kanak kainch Baans; Lathi mula Bans	Thyrsostachys oliveri	Furniture and houses constructions, fishing equipment's (rods,) umbrella, baskets, Edible shoots.	

3	Kanta bans (Orissa); Mulla veduru (Andhra Pradesh) Mungil Baans(Tamil Nadu);Kotoha (Assam); Nal baans (Punjab); Behor Bambusa bambos baans (West Bengal); Saneibo (Manipur).	Bambusa bambos	Substitute for in bamboo-based furniture industry and many bamboo by products	

Table 1: Major Indian Bamboo species for Furniture and Craft
Sources: (National Bamboo Mission, 2011)

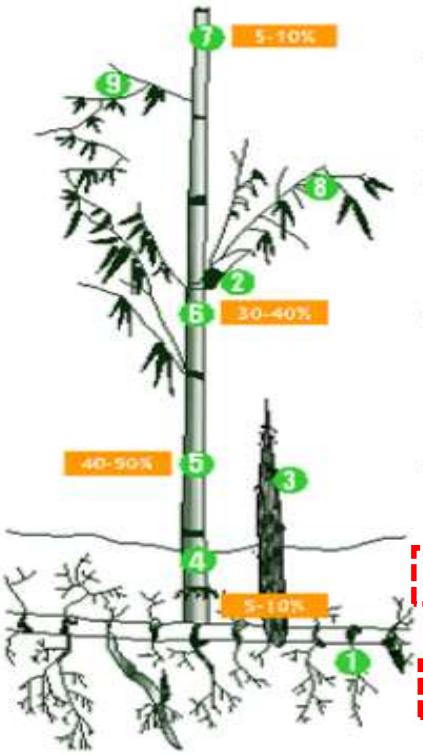
1.6.2 Comparative analysis of bamboo value chain

The pre-processing which is one of the major prime process that includes grading and sizing of culms to further process them as per the requirement of various value chain .But in India unlike other countries like China ,majorly the processing and manufacturing facilities area not premium (Tambe, Patnaik, Upadhyay, & Edgaonkar, 2020). As per the survey observation that pre-processing of bamboo in India are mostly done manually. The direct supply of entire culms to the end user results to inefficiencies and wastage .In optimal utilization analysis of bamboo it is been observed that base , sheath and rhizomes part which is far more adequate for furniture and handicraft making is left unutilized in India [13].The Pre-processing units and the traders are not been effectively utilised in the Indian value chain whereas in China the valued effective utilization of each part By carrying out market segmentation and directing it to value chains can encourage effective utilization[14] (Tambe, Patnaik, Upadhyay, & Edgaonkar, 2020).

To make bamboo more viable and promoted as furniture resources some species cultivation need to be more focussed specially the species used in making furniture and measures needed to increase land cultivation of these species. There is a wide prominent impact of bamboo on the existence of people, however currently the industry is facing huge suspicion.

[13] Tambe, S., Patnaik, S., Upadhyay, A. P., & Edgaonkar, A. (2020). Evidence-based policy for bamboo development in India: From "supply push" to "demand pull". *Forest Policy and Economics*.

[14] It is been observed that by utilizing 1 m^3 of bamboo plyboard, it would save 2.8 m^3 of timber.https://www.bioversityinternational.org/fileadmin/bioversity/publications/Web_version/572/ch24.htm



		CHINA	INDIA
9	Leaves	Manure, Fodder, Extract, Medicine	Manure, Fodder
8	Twigs	Broom, Cloth	Broom
7	Top (locally called DP)	Chopstick, Toothpick, Bamboo poles, Scaffolding	Bamboo sticks for vegetable & horticulture
6	Middle upper (locally called Jumbo)	Blind, Mat, Carpet, Chopstick, Toothpick, Handicraft	Bamboo poles used in horticulture (orange, banana, grapes etc.) Handicraft, Incense stick & Toothpick
5	Middle lower (locally called Jet)	Flooring, Laminated furniture	Scaffolding, Housing
4	Base	Charcoal, Pulp	Not used
3	Shoots	Vegetable	Vegetable
2 1	Sheath & Rhizome	Handicraft	Not used
	Leftovers & processing waste	Fiber board, Charcoal, Pulp, Fuel, Lumber	Used as firewood for household & small scale industry

Figure 11: Optimal comparative utilization analysis of bamboo culms parts in India from China
Sources: (Tambe, Patnaik, Upadhyay, & Edgaonkar, 2020)

Bamboo product being imported and exported in top five Countries.
(Source: Adapted from INBAR, 2019a,b).

Bamboo products and their HS* code	World Export (Million $)	China (Thousand $)		EU (Thousand $)		USA (Thousand $)		Japan (Thousand $)		India (Thousand $)	
		Exp	Imp	Exp	Imp	Exp	Imp	Exp	Imp	Exp	Imp
Bamboo Raw Materials (140110)	101	74848	966	12454	61333	520	23578	NA	5140	255	28683
Bamboo Shoot (200591)	323	284633	142	16610	46846	278	28843	1989	130210	NA	114
Bamboo Mats/ Cushions (460121)	86	73309	123	6560	23049	245	3013	NA	8552	NA	519
Bamboo Plaits & Plaiting Materials (460192)	48	43441	15	2021	8539	435	3608	987	2319	NA	104
Bamboo Basketwork (460211)	246	166733	513	14498	54566	1524	51631	NA	15630	NA	848
Bamboo Charcoal (440210)	57	36357	361	1229	8897	386	4562	NA	7226	NA	115
Bamboo Flooring (440921)	228	212701	372	5707	25347	1452	3883	NA	1273	352	799
Bamboo Panels (441210)	135	101389	6285	11931	50686	12625	68654	NA	4917	NA	460
Bamboo Pulp (470630)	3	1972	16	999	1361	83	121	NA	139	NA	1255
Bamboo Paper Product (482361)	23	12035	19	8868	22901	758	4167	NA	15	NA	2
Bamboo Seats (940151)	103	19398	2341	18451	62820	2651	65602	215	12610	NA	15
Bamboo Furniture (940381)	163	89677	1190	32213	87625	3971	56778	NA	4750	NA	146
Total	1516	1116493	12343	131541	453969	24929	314440	3191	192781	607	33060

Figure 12 Bamboo Resources states of India
Source: (National Bamboo Mission, 2011)

In year 2014, the analysed bamboo and rattan producing countries domestic market was estimated at USD 57.5 billion, with an international trade of additional USD 2.5 billion. Whereas the evaluated domestic bamboo market of China is worth 19.5 billion USD in 2012 (Tambe , Patnaik , & Upadhy, Research Trends: Evidence-based policy for bamboo development in India: From "supply push" to "demand pull, 2020). India's share in the global bamboo export is a mere 0.04%, while China's share is 65% at 1194 million USD (International Bamboo and Rattan (INBAR)). Analysing the sub market sectors it has been observed that bamboo has been used in traditional markets with a declining demand. The only sub-sector having bulk utilization of bamboo is horticulture. Despite of 9.57 million hectares, which compose about 12.8% of the total bamboo area, the available export of bamboo products is very low in comparison to other countries, rather India imports bamboo furniture and other by - products from other countries to meet the domestic necessities. The imperative to drive bamboo furniture industry development forward need demand creation . By developing medium and premium processing industries (such as incense sticks, mats, blinds, flooring, tiles, ply board etc.) create opportunities[15] (Tambe , Patnaik , & Upadhy, Research Trends: Evidence-based policy for bamboo development in India: From "supply push" to "demand pull, 2020). Therefore, this "poor man timber" needs to attain the social status and acceptability primarily among the local buyers and market

1.7 Research Significance and scope

Considering the rapid growth in the demand of furniture in India the timber as resources is overexploited so to satisfy and overcome this issues bamboo turned as viable alternative to it. But being a viable alternative Indian furniture market has not found accepting bamboo as a furniture raw material. Considering the rapid pace of globalization there is urgent need to under the root cause. There is urgent need to understand the challenges and major loopholes industry are facing. The research aims to analyse the potential of bamboo furniture industry, causes of low adoption. The study analyse the economic impacts based on the market research and possible design intervention end- users demands from the bamboo furniture market followed by its impact on end-users . The findings of this research help in reviewing the existing policies that are initiated by the government for bamboo and its artisan development. The evaluated results help to understand the major drawbacks of bamboo not being conventionalised in the Indian market and

[15] Inbar. (2019). *Sustainable Development Goals*. Retrieved from https://www.inbar.int/programmes/sdg13-climate-change/#2, (Tambe , Patnaik , & Upadhy, Research Trends: Evidence-based policy for bamboo development in India: From "supply push" to "demand pull, 2020)

the viable problems of artisans & consumers not actively adopting bamboo instead of wood furniture. The study can help in restructuring the policies that can help in the process of making bamboo a viable substitute for wood for furniture and can protect our local bamboo artisans, cultivators and manufacturers. The suggestion and recommendation can help to shift focus to the supply side by channelling incentives to medium and premium processing industries for opening new selling outlets and markets.

1.8 Criteria for selection of Study area

In recent years, gradual improvements in lifestyle and economic conditions have drastically inflated the demand for furniture, which has led to the evolution of the furniture industry in India. The furniture sector is the largest wood processing sector, and to meet the demand chain, bamboo can cater to the need to create sustainable bio-based products and furniture. The selection of the study area is done based on two significant parameters. As climatic conditions hold a paramount spectrum in the growth and production of any species, it is therefore catered
as one of the site selection criteria. The second significant parameter considered was urban furniture consumer market for selecting the study area.

India is classified with eight growing climate zones, and most of the tropics and sub-tropic areas in India fit between 10-12 [16]. As per the United States Department of Agriculture (USDA)[17] plant Hardiness Zone map, zones 8 to 12 have specific temperature ranges influencing bamboo growth. Many bamboo species die at or near freezing temperatures. Most of India's tropical and subtropical regions fall within zones 10 to 12, with the Metropolitan city Delhi NCR falling into Zone 10, Parts of Maharashtra and the northeast region falling into Zone 10 -11and Kolkata falling into Zone 10. These zones follow minimum temperatures of +4.4ºC to +10 ºC, leveraging warm temperatures and other climatic factors attributing to bamboo growth and ideal area for studying the adaptability of bamboo .

Moreover, one of the prime aspects to select these areas were, because of being the major urban centres with diverse populations and distinct consumer behaviours. The economic significance of this area also made them ideal locations for assessing the economic viability of bamboo furniture and its potential contribution to the regional economy.

[16] Adapted from https://www.farmersknowbest.com/2020/07/india.html

[17] As per the article reference https://www.mashrita.com/usda-hardiness-zones-context-india-major-cities/ USDA hardiness zone is a geographical categorization of area in which a specific type of plants are capable of growing, defined by many climatic conditions, including its ability to withstand the minimum temperatures of the zone.

The inclusion of the Northeast region in the study was done to understand a rich and multifaceted perspective, considering the native region towards the bamboo furniture performance and acceptability in its diverse region. As the Northeast is a rich bamboo resource region, selecting areas were prioritised based on significant bamboo crafts and furniture-making players. Examining the furniture market, Assam came up as the main bamboo furniture producer in the Northeast region, whereas Manipur and Tripura are rich in bamboo craft and furniture regions. To address socio-economic factors and utilization of bamboo furniture in urban-rural dynamics, Assam, Manipur and Tripura were selected for in-depth analysis and detailed data collection as focusing on smaller regions can help to capture internal diversity. Exploring the traditional craftsmanship techniques and artistic aspects of bamboo furniture, these areas were selected compared to urban regions.

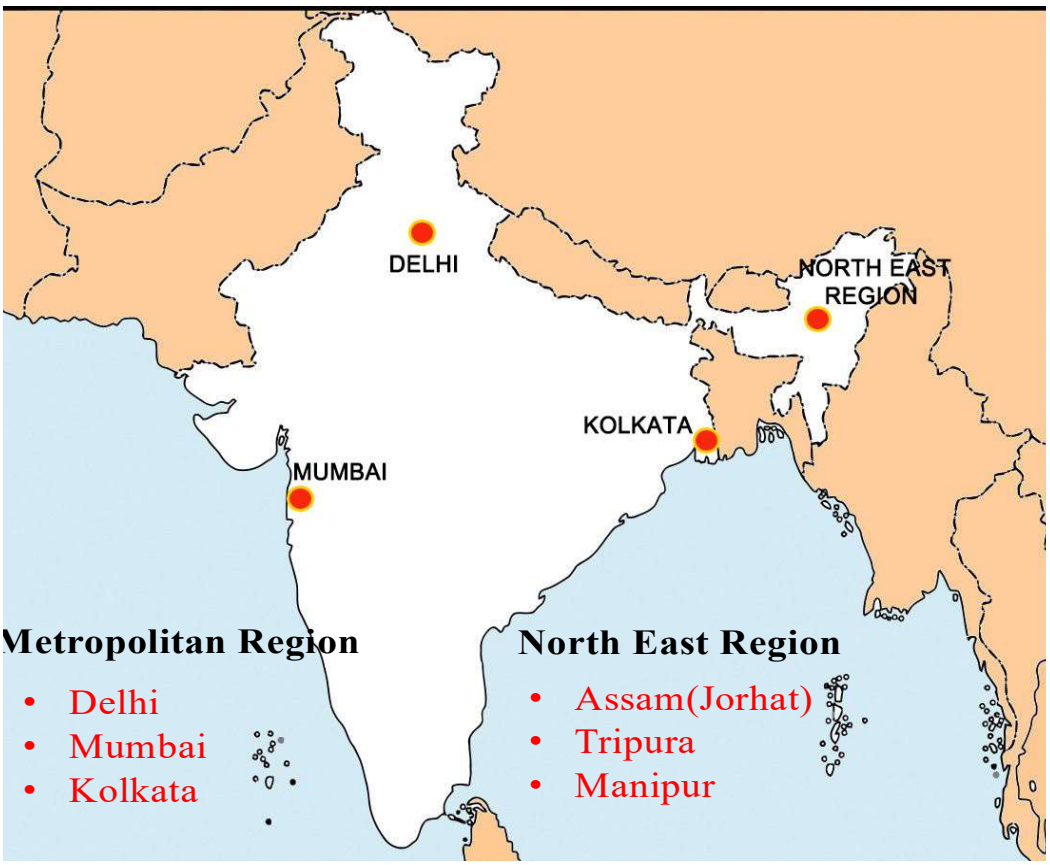


Figure 13 Study area
Sources: The Authors

To evaluate fostering the integration of bamboo furniture among Indian buyers. The three highly bamboo furniture-producing areas selected from the northeast Assam (Jorhat), Tripura, and Manipur, and consumers-oriented metropolitan states are Delhi, Mumbai (Maharashtra), and

Kolkata (WB) simplified in Chapter 5. The location map is shown above in Figure 13. State cluster bamboo artisans and consumers have been focused on data collection, which includes field visits for the data collection from the cultivators, artisans, mapping entrepreneurs and consumers. The value and supply chain were undertaken. The interaction covered both males and females, and the study was divided into qualitative and quantitative data collection.

1.9 Aim and Objective of the Proposed Work

This research aims to have a perceptive understanding of consumer perceptions and which intervention in design can impact the commercialization of bamboo furniture.
Objectives to achieve the mentioned aim of this research are

1. To analyse the reasons for bamboo not being widely used as a furniture material in India despite large-scale production across the country.
2. To assess the causes of low commercialization of the bamboo furniture industry in India and understand to what extent design intervention can stimulate interest in bamboo furniture amongst consumers.
3. To understand the constraints of the bamboo furniture industry in India and provide recommendations for skill development of artisans keeping in mind the market demand amongst end users regarding bamboo furniture

1.10 Research Hypotheses

The commercialization of furniture relies on ecological sustainability and consumers' preferential needs. This consideration posits that bamboo-based furniture's mechanical and physical properties play a pivotal role in bridging the ecological deficit. Within this context, the design emerged as one of the potential catalysts for advancing the promotion and acceptance in the Indian market. The initial study characterised the various parameters' inherent capacity to respond to dynamic consumer preferences and functional requirements. The study unravels the relationship among the stakeholders, design principles and its acceptance among the probable buyers. As we explore the path of potential design measures for promoting bamboo, the following hypotheses are formulated to investigate the probable role of intervention in influencing consumer perceptions and market dynamics.

Statement 1: The income of the consumers is the parallel mediator, influencing the commercialize bamboo furniture in the market.

Statement 2: Consumers awareness and perception significance on the adoption and commercialization of bamboo furniture in the market.

Statement 3: Predicting a defined staged approach in design (Design Intervention) to facilitate the commercialization of bamboo furniture.

Statement 4: Mechanical and physical properties (characteristics) of bamboo furniture could regulate commercialization.

Statement 5: Minimalistic multi-functional design support in regulating the adoption and commercialization of bamboo furniture.

Statement 6: Product standardization, branding and certification positively support to commercialize and increase bamboo furniture adoption.

Statement 7: Online promotion, bamboo design fairs and exhibitions can enhance the commercialization of bamboo furniture.

Statement 8: Connecting to the designers and consumers by bamboo artisans and manufacturers in fabricating initial design, support promoting adoption and commercialization of bamboo furniture.

Statement 9: The existing government promotional measures and incentives can enhance the adoption of bamboo furniture.

Statement10: Self-assembly flat pack with personalised and intricate detailing can improve the commercialization and adoption of bamboo furniture.

Statement 11:Region availability of specific furniture crafting bamboo species can impact the adoption and commercialization of bamboo furniture.

The significant correlation between consumers and various above-specified parameters is hypothesised that **"The application of "protean design" contributes significantly, shaping consumers' perceptions of bamboo furniture, fostering greater interest and recognition in the market."**

1.11 Proposed methodology for the achievement of the objectives

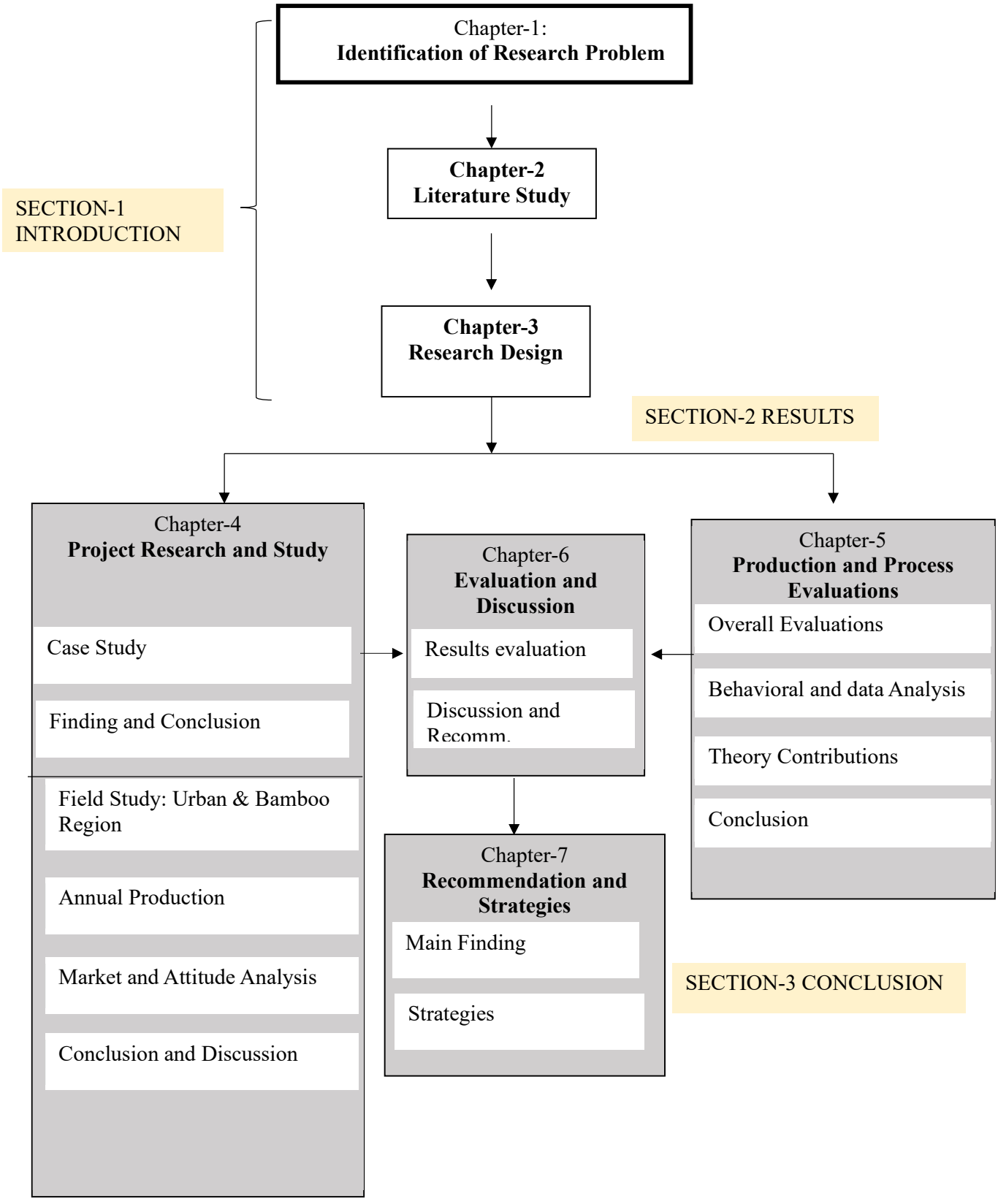
The methodology followed for the proposed study unfolds across three significant sections. Section 1 subsets the introduction and overall design contextualising of the bamboo industry. The section formulates the structured and systematic framework to integrate the key components, such as identifying the core research problems and ensuring a comprehensive and cohesive literature study and research design approach. Section -2 intricacies the results based on research design, production and process evaluation and summarises the discussion. The last section, Section -3, concludes the summary of key findings and reiterates the overall significance of the research.

Section -1 is contexed within three chapters. Chapter -1elucidating the identification of the research problem through various factors, articulating the scope in alignment with the identification of the research problem. The chapter formulates the research questions and hypotheses, concluding with an emphasis on significance and potential contributors. The second chapter, Chapter 2, is dedicated to the theoretical framework for a comprehensive review of related literature, summarising the existing studies and highlighting the research problem. The chapter concludes by outlining the identified research gaps and conceptualising the key variable. The third part of this section, Chapter 3, provides a roadmap to address the research problem. The chapter addresses the research design based on population and sampling size. The methods follow detailed data collection, calculation and analysis techniques to ensure the validity and reliability of the questionnaire based on the objective.

Section -2 is the result-based section encompassing three chapters. The first chapter under this head, Chapter -4, is a research and study-based section. The chapter clearly states connecting to overall research goals, detailing data collection and analysis methods. The findings are further discussed, strengthening the connection between stakeholder and identified intervention. Chapter -5 signifies production and process evaluations. The production aspects evaluate challenges and modifications, whereas the process considers the effectiveness of the implemented behavioural and data analysis procedures. The third part, under this section as Chapter 6, is the extent of validity and reliability outcomes, a comparison of the findings, practical implications of the research, and an address of how the findings can be applied to existing scenarios.

Section -3 bases the desired conclusion on Chapter 7, which addresses customisation to meet the study objectives. This structured approach provides a clear and logical progression through the research process and recommendations. The chapter further, based on proposed recommendations, states that future research.

The structural methodology flowchart below outlines the systematic approach to address the study's objective and acknowledges the dynamic nature of the research process and step-by-step methodology.


Chapter-1:
Identification of Research Problem
Chapter-2
Literature Study
Chapter-3
Research Design
SECTION-1
INTRODUCTION
SECTION-2 RESULTS
Chapter-4
Project Research and Study
Case Study
Finding and Conclusion
Field Study: Urban & Bamboo Region
Annual Production
Market and Attitude Analysis
Conclusion and Discussion
Chapter-6
Evaluation and Discussion
Results evaluation
Discussion and Recomm.
Chapter-5
Production and Process Evaluations
Overall Evaluations
Behavioral and data Analysis
Theory Contributions
Conclusion
Chapter-7
Recommendation and Strategies
Main Finding
Strategies
SECTION-3 CONCLUSION

1.12 Study Precis

The chapter provides a comprehensive outlook of the core introduction to bamboo. The chapter begins with addressing a critical problem that led to the foundation of the case study. It addresses the relevance of sustainable and renewable materials in section 1.1 and establishes the context of bamboo as a substitute for traditional wood in furniture production. The section emphasises the importance and stages of the subsequent discussion. Further, section 1.2 delves into the availability and consumption of timber in India, and 1.3 reviews the literature analysis to highlight the current challenges and limitations of relying on conventional wood resources. In determining the current state of the furniture industry, it is essential to identify areas where implanting sustainable and crucial practices, such as substituting wood with bamboo, could make a significant impact. Section 1.4 builds a strong relative need for bamboo as a viable material for making furniture. It also closely outlines the reasons behind choosing bamboo, including its unique properties, maturity cycle, and environmental benefits. The section also advocates a foundation for adopting bamboo in furniture making as a viable replacement for wood and by-products.

Sections 1.5 and 1.6 enlighten bamboo, defining its anatomy, growth pattern, and specific status in India and global production. The details also provide a holistic understanding of bamboo as a material, covering both its local and international context. The preface concludes with sections 1.7, 1.8, 1.9, 1.10 and .11, addressing the significance of the research, the criteria used for selecting the area, The aim and objective of the proposed work and the approach that will be undertaken to conduct the research. The chapter lays the ground for exploring bamboo and its related upscaling issues and provides an overview of the study's purposes and scope.

CHAPTER 2

Literature Study

The literature study is divided into five sections; the first section details the production and distribution of bamboo worldwide majorly in various sub-states of India. The first section broadly evaluates the "The total production area and quantity of various bamboo species cultivated". The second section covers bamboo's significant contributions, its processing, its uses in various sectors, and workability" whereas the third part examines the analysis towards "Bamboo sustainability, its compression and tensile strength". The fourth section insights into the "Conceptual framework done with bamboo for various product developments especially in furniture's". It also insights Chemical and mechanical composition of bamboo with its workability. The last sections brief the "Impediments and highlights the related issues and identify critical gaps that are existing in the promotion and execution and the jurisdiction measures that have been adapted for the development of the sector."

2.1 Introduction

This chapter examines previous studies executed in the bamboo industry globally. The review provides in-depth information on the related issues, critical gaps, the conceptual work done and significant execution issues of the industry.

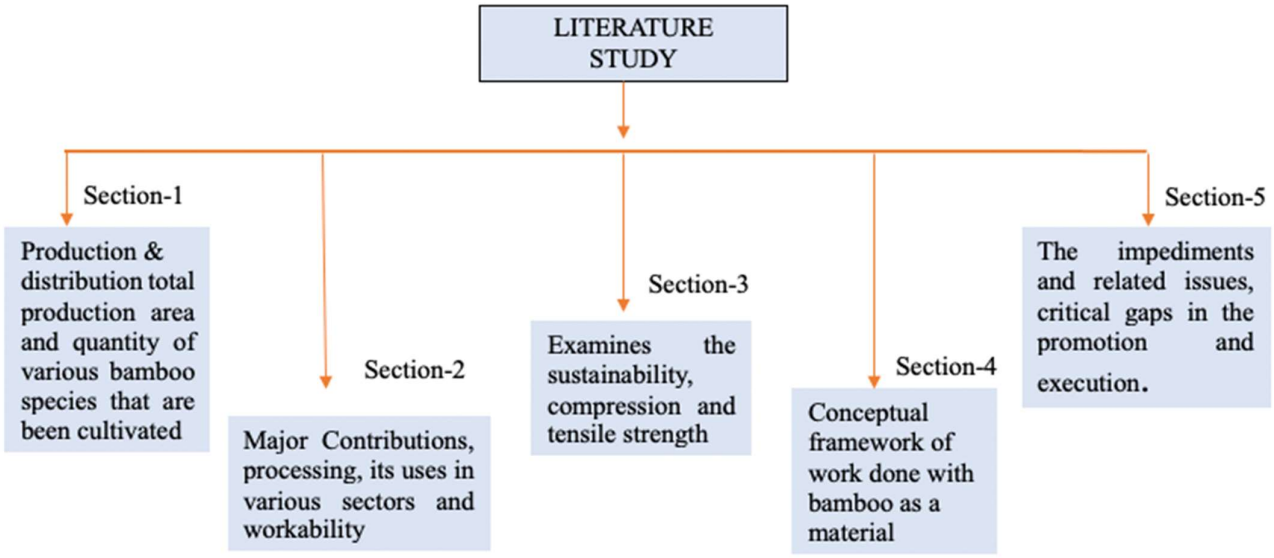


Figure 14: Literature study flowchart
Source: The Authors

2.2 Study and Review

2.2.1 Bamboo Uses and its Development

Bamboo is one of the most versatile resources known as the "gentleman" among other plants; as per ancient history, the bamboo species evolved between thirty million years ago. The primary research about bamboo species began after 1920. It is said that the word bamboo originated from the Malay word "mambo." The Dutch named it "Bamboos'" and then got its neo-Latin name "Bambusa". As per the German Botanist Charles Kunth, "Of all the grasses, bamboo is the largest and the only one that can diversify into the forest." Bamboo is one the most sustainable resources, which is used to produce more than 1500 products from a tiny toothpick to constructing a building. Bamboo has always been known as "green gold" and is one of the most sustainable and resistant resources than traditional timber. This literature review focuses on the different uses of bamboo, from a constructional material in disaster-prone areas to its use in making fabric, which is considered soft and tough, like cotton. In this review, the positive impact of bamboo is compared to that of wood and has been summarized by life cycle assessment (LCA) and why its products have been considered Green Sustainable for Trade (GSFT). The Indian bamboo market,

the impediments and issues this industry faces, and legislative measures need to be taken for its promotion.

(Gupta & Ranjan, 2016), In their paper "Role of Bamboo in Sustainable Development", describes bamboo as a perennial grass famous for its multipurpose uses, from being a comprehensive source of food material to building uses. Due to its multiple uses, bamboo has enormous potential to improve the rural economy and be a sustainable building material. With the gradual advancement of technology, people forget the scope of bamboo. The paper reviews bamboo's future and present role in the country's economy. The potential economic status of the bamboo market needs good research. Most bamboo laboratories are engaged in bamboo conservation, such as the Tropical Botanical Garden and Research Institute, which has 48 species, while the Kerala Research Institute has 45. Many government institutes have introduced modular courses to develop skills in producing bamboo products among the people. Government legislation is formed to keep a mind frame of harnessing the maximum benefits of bamboo crops; the Indian government is implementing schemes with the mutual support of the people. Bamboo has a huge employment potential of employing 10 million people annually. Women are majorly associated with some craft industries, and 68 million tribal populations depend on exploiting non-timber forests. India covers 8.96 million hectares of bamboo forests, which occupy 129 million jobs or even more. In the global market, India contributes only 4.5% while China shares 50% of commercial production, which shows that being one of the largest bamboo producers, **the contribution is meagre globally.**

(Jamatia, 2012) in the paper "Livelihood of the Bamboo Base: Challenges and Opportunities", discusses how bamboo, which is being known as a most versatile material with various inputs in building materials, paper pulp resources, scaffolding, weaving material, basketry and medicines can be converted in the primary raw material for construction. With new industrial applications and modern construction design, it has been demonstrated that bamboo has colossal potential. The combined total value of bamboo worldwide comes to 50000 crores annually, which is expected to double **in future**. The lack of awareness and antiquated legislation inhibited bamboo-based industrialization. The **biggest impediments towards the bamboo-based sector are scant and insufficient supply for entrepreneurial use**. A decisive regulatory establishment is essential for the market to evolve sustainably. Transaction costs must be minimal, and information availability must be maximal with a clear focus on maintaining forest cover. The bamboo industry is being caught under the antiquated forest laws. Therefore, it is necessary that the

industrialization of the bamboo sector can provide a massive link to the rural sector. Despite having detailed estimates on the sizes and the market segments of the bamboo-based industry, the appropriateness and reliability of the market potential, along with the availability and method of estimating, is circumspect. The consultation process is needed with the stakeholders and people associated with resource **use, including government officials and representatives from the various bamboo-based industries.** However, the viable entrepreneurial activity of any bamboo-based product will be a market trend to provide the supply and demand linkages, and livelihood benefits will only be possible.

2.2.2 Sustainability Aspects

The paper "Environmental, social and Economic Sustainability of Bamboo and Bamboo-based Construction Materials in Buildings" by (Manandhar, Kim, & Kim, 2019) examines the environmental aspects of bamboo as an edifice material and its social and economic facets to understand sustainability. Being one of the cheap and durable materials, it has been suitably developed as a modern construction material. Using bamboo in housing projects is a source of earnings for those involved in bamboo cultivation. Traditional construction technology has been transferred from generation to generation and has become an integral part of socio-culture. Revival of such technology and further its development and moving the updated technology to the people who are already familiar that it is a key to the success of bamboo sustainability. For economic and social suitability, necessities are ecological development. Bamboo-based construction must be promoted suitability because of its environmental benefits that can improve social and economic standards. As per the study report, bamboo is potentially strong to be used as a sustainable material, but this area still requires more studies, especially in a **social context.** Bamboo is being considered for its superior seismic property, which is being studied theoretically and practically. However, studies on bamboo as a building material have still not been widely accepted and require a better understanding of the socio-economic aspects of bamboo-based construction. Further **studies should focus on the** built-in environment and comfort effect of bamboo-based building construction.

The paper "Economic, Social and Environmental Assessment of Bamboo for Infrastructure Development" by Field (Akwada & Akinlabi, 2016) focuses on the sustainability aspects (economic, social and environmental) of bamboo and shifting from industries to cultivation. The higher demand for timber has led to the gradual depletion of resources, formulating global warming, and to overcome this issue, industries are now focusing on using natural substitute

resources to develop economic substructures. Bamboo is a sustainable alternative to wood with broad uses and fast-growing properties. Its wide range of demand and uses adds employment and income generation. The social context overviewed how investment in bamboo industries helps people's livelihood and its benefits, risks, and threats. The development of bamboo will add to the ecological balance and struggling industries and boost the social life of the related people. The paper indicates the planned and scientific approach to the cultivation. With an extensive range of species, the biomass of bamboo is growing. The environment-supportive resource of bamboo and its by-products crossed the value of 100 million in global trade. It serves as an alternative to soft and hardwood. **The weakness of bamboo is the availability of techniques for reproducing bamboo seeds.** It is perishable after its harvesting, so it requires proper preservation methods. Bamboo is a heterogeneous material with properties varying from species to species. Bamboo is a highly opportunistic material and can reinstate products with fossil fuels and chemicals. Replacement of all the needs of timber can be catered with bamboo and can deploy the pressure on the forest ecosystem. The main threat is the demand for bamboo products, which depletes Bamboo resources. Up-boost infrastructure is a barrier for controlling floods and preventing soil from eroding. In Africa, however, bamboo cannot eradicate all sustainability problems (social, economic, and environmental). Switching to bamboo resources will improve stabilization in the development of its financial structure.

2.2.3 Potential Uses

The facts of the potentiality and properties of Bamboo as a building material and its comparison with the conventional building materials available around the world are discussed (Chaurasia, 'Bamboo' with reference to Indian context: Potential sustainable building material and awareness, 2019). The construction activity consumes a lot of material and monetary resources, so bamboo can be added as a primary construction material, reducing the bills, adding profits to the clients, providing good jobs, and returning opportunities to the farmers producing bamboo. The most significant aspect of bamboo is that it can reduce the “carbon footprint” as Bamboo is a Natural material with low energy and can menace global warming. It is a natural, sustainable material that requires nature-friendly preservation methods to minimize the use of harsh chemical chemicals for nature. Bamboo can be shaped to any free-flowing form that can add to a meaningful architecture. The author's important aspects of this paper are to present **awareness among the people through the academic platform and draw the attention of all the ordinary people and construction stakeholders.**

The paper by (González-García , et al., 2011), "Assessing the global warming potential of wooden products from the furniture sector to improve their eco-design", concentrates on ascertaining the several timber products' influence on global warming. The two techniques involved are quantifying the greenhouse gas of several representatives of wood-based products and the integral environmental aspects. The products are divided into indoor and outdoor products, sub-distinguished into convertible pieces of furniture, headboard accessories, non-convertible wooden wall playgrounds, etc. According to the assessment results, metal, board, and energy are considered to have a maximum impact of more than 39% to 90%. As per the journal, manufacturing wood-based materials such as boards and panels is an essential process for energy production in almost all items. The transport of inputs to the factory and metal production depends on the products and improvement alternatives for each product under assessment to be set out in the short term.

2.2.4 Strength

The author (Suhaily, et al., 2019) , in her paper "Evaluation of screw pulling, and flexural strength of bamboo-based oil palm trunk veneer hybrid bio-composite intended for furniture applications", discusses the structural strength of Dendrocalamusaper and Gigantochloa (bamboo Species) with local traditional wood. He has followed the experimental studies with dry bamboo stripes and oil palm trunks, which are processed into thin laminates to produce Bamboo oil palm trunk veneer and bio composites. It has been studied that bamboo furniture is more resistant than traditional wooden furniture. The results also define a strong correlation of bamboo hybrid under screw withdrawal strength but have a weaker mechanical property of the bamboo hybrid due to laminate selection from different inappropriate species. The research aimed to develop a wood-like material from a non-wood source to meet the increased demand for wood-based products without exploiting forest resources. Further results showed that OPTV composites could be suitable wood alternatives.

The paper "Materials Selection for Sustainable Product Design: A Case Study of Wood-based Furniture Eco-design" by Field (Bovea & Vidal, 2004) discusses the environmental behaviours of materials so that they can be incorporated directly into multi-criteria decision-making problem-solving. The paper discusses the life assessment method tested in parallel and applied to different polymer materials used for packaging. The journal aimed to study the need to perform analysis during the process of selecting material and to enhance the environmental performance of a product. It must be kept in mind to choose the product variety of segments, such as cost properties, performance, environmental aspects, etc. LCA incorporated ecological elements that should be

used in designing a product. As per the designer, obtaining indication to analyze and evaluate the environmental behaviour of a material can be incorporated into multi-criteria decisions. The author supported simple examples to perform a sensitive analysis of material selection. It solved the problem of selecting material by using an environmental score.

2.2.5 Comparison of Bamboo and Wood

The comparison of bamboo and wood by (Vogtländer, Van Der Lugt, & Brezet, 2010) in "The sustainability of bamboo products for local and Western European applications. LCAs and land-use" describes the positive impact of bamboo evaluated by life cycle assessment (LCA). The comparison of bamboo and wood detailed that bamboo products have comparatively less eco-cost than hardwood. Even bamboos imported from Europe have less eco-cost than locally available soft wood. The yield of bamboo is high compared to other woods.

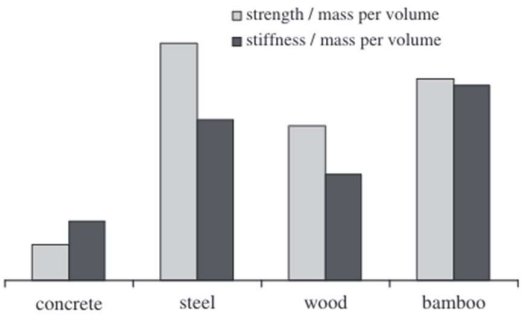


Figure 15: Comparison of strength and stiffness of bamboo with other material
Sources: *(Vogtländer, Van Der Lugt, & Brezet, 2010)*

Figure 16: Eco-costs per year for SWB and alternatives
Sources: (Vogtländer, Van Der Lugt, & Brezet, 2010).

The SWB (Strand Woven Bamboo) scores better in eco-costs than tropical hardwood from FSC-certified sources. The SWB's eco-costs can be considerably lowered when bio-resin is used instead of the Phenol Formaldehyde resin. The stem of bamboo (Culm) is sustainable for local application. Therefore, from an eco-cost perspective, it is recommended only to use bamboo materials. The main hurdle in terms of environmental impact is the transport distance, and the local species proves to be a more sustainable solution. Though some bamboo products

developed and commercially available in Europe includes Industrial bamboo in form of plywood and SWB (Strand Woven Bamboo) score well compared to FSC hard wood.

Material	Density (kg/m^3)	Eco-costs/kg	Kg/FU	Eco-costs (€)/FU
SWB	1080	0.52	3.08	1.61
Teak (FSC certified)	650	1.70	1.85	3.15

Figure 17 Industrial bamboo materials, Ply bamboo (left) and Strand Woven Bamboo (right). Sources: *(Vogtländer, Van Der Lugt, & Brezet, 2010)*.

Bamboo **is an excellent source of biofuel and second grade Bamboo products –Mdf Board and Panel Board are good for local use but cannot be completed in the European market of soft wood**.

(Bovea & Gallardo , 2006) In his paper "The influence of impact assessment methods on materials selection for eco-design" presents a criterion for selecting material with low environmental impact. The LCA (Life Cycle Assessment) methodology has been applied to wood-based materials. Compared to wood-based boards, the standard particleboard has a lower environmental impact than the Standard Fiber Board. **The particle board with low formaldehyde is preferred due to the partial replacement of Urea-formaldehyde (UF) resin by Melamine Formaldehyde (MF) resin. Additional processes such as cutting and machining are needed to transform the furniture-making board**. For surface covering, low-density laminate is preferred over high-density laminate. The most impactful stage for raw material is its acquiring time and production, with total impact (of 59.8% and 37.1%). He states that from the life cycle perspective, it is essential to consider the environmental impact and the entire cycle of the veneer incorporated into the board; additional processes are needed to treat the wood veneer surface.

(Hayles, 2015) in her paper "Environmentally sustainable interior design: A snapshot of current supply of and demand for green, sustainable or fair-trade products for interior design practice" briefed on the chain of Green Sustainable Fair Trade (GSFT) products supply and demand for the developing adequate design. For instance, the desk research of presently available GSFT material was carried. Finally, brief structured interactions with the retailers were carried. The analysis depicted that product of GSFT available, like material treatments for ceiling and roof surface including fabrics and window treatments, can be sourced from retail outlets. About the Knowledge of ESID, the Researcher has also elaborated that designers have accepted it but not translated it to processing. The main issues that have been discussed are that the green,

sustainable, fair-trade products are available for Environmentally sustainable interior design (ESID) and how these materials should be promoted by giving sustainable credentials so that designers and stakeholders can avail them easily. The solution is better and delivers complete awareness of sustainability through promotion. The paper discusses the difficulties of finding out Provence of the material using external resources and better material so that **the product selection and comparison can be made effectively**. Some solutions that need to be improved have also been discussed, such as "Green Shelter" for products and labels, which could promote awareness and become a significant, **remarkable footprint for promoting awareness.** Therefore, environmental sustainability requires a substantial change in the value and behaviour of interior designers and the adaptability of familiar sources.

2.2.6 Application in Interior

The paper "Comprehensive Application of Bamboo Elements in Modern Interior Design" by (Song, 2019) states the application of bamboo elements and their interaction with interior design. This paper's researcher briefly analyses how bamboo can be integrated into contemporary modern design, as it is the fastest acceptable material by designers and has been widely used in environmental protection and green building construction. The paper also discusses the deficiency in the application of bamboo and the challenges of making bamboo a separate design element rather than simply a visually appealing material. In the **specific indoor space environment, it is necessary to feel bamboo uses and expand the knowledge to ordinary people** so that bamboo can be further broadly elaborated and incorporated into the design culture.

The paper "Factors that Impact on the Implementation of Sustainable Interior Design "by (Hankinson, 2012) aims to discuss the understanding of sustainable design and the defining of the obstacles that influence design practices like the **reliability of information from product suppliers and manufacturers (greenwashing), a limited selection of environmentally responsible products and materials being produced by product suppliers and manufacturers and long-distance runners inability to source locally produced ecologically accountable products**. The paper discusses the findings that are obtained from the study performed in 2011. The research is considered significant because it has shared the outcomes documented for the first time. The conclusion shows that education and experience inform designers to understand sustainable designs. Designers understand the design affects their behaviour, attitudes and practice in accordance with the constitution and building regulations. It

determines that the designers are blocked by barriers in design such as education, cost, product, materials and rating tools. The paper speculates **on the potential transformation of practitioners by Improvising sustainable design knowledge, Supporting government policy and implementation regulations, Initiating product rating tools and educating the client** on sustainable materials for their wide acceptability.

2.2.7 Application for Textiles

The paper by (Waite, 2009) "Sustainable Textiles: The Role of Bamboo and a Comparison of Bamboo Textile Properties" discusses material for sustainable development. The researcher includes what constitute sustainable textile. How can textile have formed out of Bamboo resources used for maintaining of suitability? Observations formulated the answer of some aspects. The difference between the properties of chemically manufactured and mechanically manufactured bamboo textiles and, secondly, the property difference in the textile obtained from different species like (Bambusa and Phyllostachys). The paper discusses cotton and polyester fabric that is commonly used in the textile industry and focuses on the species of bamboo used as bio-based renewable resources. The fabric formed from bamboo is softer and less rough, and mechanically manufactured. The primary constraint the bamboo textile industry faces is its cost. The examined issue related to sustainability was its moisture wicking and handling. The research focused on two aspects –Addressing Bamboo resources for sustainable textiles, its pertinent information, its various manufacturing processes, and its pros and cons in the industry. It addresses the experimental part with a discussion and limitations under sustainable bamboo textiles. Bamboo is a sustainable textile material, but it has some drawbacks in its industry, like the issues of necessary chemical treatments and consumption of energy and water, which could be addressed by loop fabrication and economic tools.

2.2.8 Application for Furniture

The paper "An Evaluation of new bamboo furniture through examining the relationship between Design" by (Ying-Pin , Chenk, & CAi, 2007) examines the methodology and relationship between design and its value, exploring the critical elements in the field of development of new products. The design elements of bamboo furniture are evaluated by preparing prototypes and gathering information from environments.

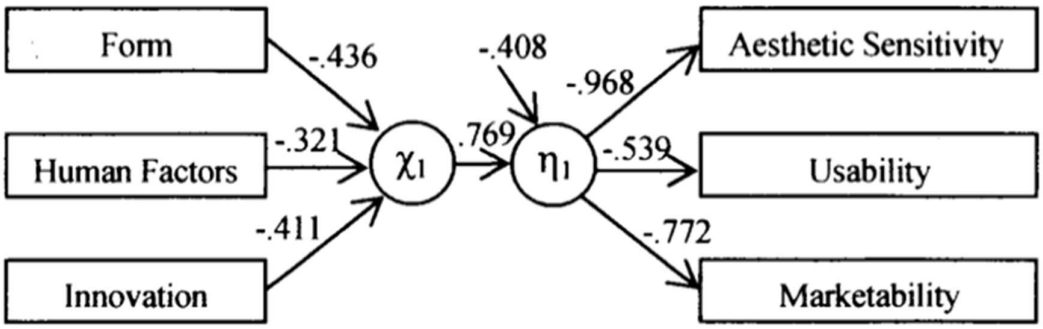


Figure 18: Diagram of Canonical Correlation Model for Design factor vs. Value factor
Sources: *(Ying-Pin , Chenk, & CAi, 2007)*

These prototype models have been showcased to visitors in an exhibition conducted in Taiwan. It was found that they had different perceptions **towards bamboo furniture and its origin**. Further people review that bamboo furniture has not been attractive; people don't find a**ny innovation in design, aesthetics, sensibility, and usability**. The traditional bamboo style will always hold a strong foot on the path of innovation and originality of bamboo furniture. It was observed that designers of bamboo furniture need **to possess the knowledge and craftsman technique with new design knowledge and marketing strategy**. Bamboo furniture thus cannot be upgraded from handcrafted production. Research methodologies such as discriminant analysis and multiple regression were used for collecting data from various questionnaires, and the results obtained stated that it is affected by biological variables, the relationship between design and value and the designing elements such as style, comfort, modernity, production techniques and texture are some of the significant elements. It was found that designers **should focus on the functional aspects** of bamboo furniture before production techniques and other design elements. The paper by (Boran, Ayfer , & Marius , Evaluation of bamboo as furniture material and its furniture designs, 2012) discusses the chemical and mechanical composition of the bamboo and its use in construction and furniture industry. Bamboo has some **positive features, like mechanical strength and availability, in many tropical and sub-tropical areas, which confers it to become a renewable substitute for** wood. Many wood processing companies have now been considering bamboo as a sustainable alternative for wood for construction purpose and for

furniture design. Some of the furniture produced by University of Wisconsin in Madison is shown in Figure 19[18].

Figure 19: Bamboo products by (Makowsky, 2013)
Sources: *(Boran, Ayfer , & Marius , Evaluation of bamboo as furniture material and its furniture designs, 2012)*

These are naturally durable for less than two years as it contains high levels of starch which make it (untreated) easy vulnerable to fungi and rot and attract insects such as termites. The **cost of the bamboo furniture is directly affected by the distance between plantation and processing site** and of course the aesthetical decision of client. Bamboo has been called as green eco-friendly material for interiors as natural material has been getting depleted and thus this can be used both in external structure and interior to make long lasting competitive product with long life.

2.2.9 Application in Construction

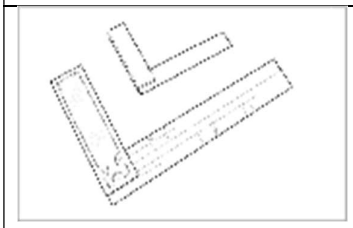
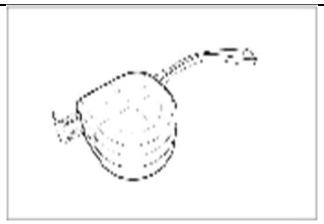
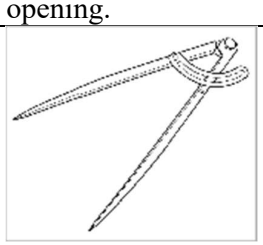
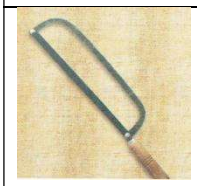
(Hong, et al., 2019) In his paper "Review on connections for original bamboo structures" describes how joinery system plays a vital role in building structures. It detailed that why bamboo is not widely accepted and what are the factors that seriously hinders the development and describing the categories of raw bamboo joints in the form of bolt joints. The experimental study carried out on joinery strength of bamboo which showed a specific question mark on the bearing capacity, stiffness, durability, and construction. Hence, a definite **development is required for easy operation and workability with raw bamboo joints**. The paper draws attention to serious studies and experiments that are needed to establish the proper and result-oriented bamboo design system. Bamboo is still a sustainable and green material **behind timber because of its non-standard, inefficient, and non-stable joinery system**.

[18] Bamboo can produce many laminated furniture, such as tables, desks, chairs, cabinets, etc. (Cross-). Laminated bamboo furniture is a new type of furniture that is similar to laminated wood furniture. Some of such examples are highlighted (http://inspirationgreen.com/bamboo-furniture.html).

In the “Bamboo as Sustainable Material for Furniture Design in Disaster and Remote Areas in Indonesia” by (Sofiana, Wahidiyat, & Sylvia Caroline, 2018) discusses is worldwide sustainable building material for architecture, but its utility is limited to the furniture industry and its still been out seen as **outcast materials because of its appearance**. Bamboo is considered for its traditional design. The continuous development in creative design and modern technology made bamboo uses not explored further. The study focuses on Indonesia and how its bamboo furniture can be the solution to a disaster-prone area. The processing process of bamboo and techniques used in both traditional and modern society have been determined based on learning outcomes that the determination of form design is unornamented multi-function. The study involved producing furniture prototypes on a scale of 1: 2.5 and 1:1 as the final result. These prototypes will be examined and expected on the public test (exhibition) to gain feedback. The introductory study showed that bamboo as a resource is modulating furniture needs through investigation; bamboo is a sustainable perennial grass that is venerable because of its confined breeding and because of its short term of planting. It became the captive roots of Indonesia. Bamboo has various species in its roots, and the government must encourage the use of bamboo in construction processes for economically weaker grades and furniture making in disaster and remote areas.

2.2.10 Tools and techniques

(Wu & Ho, 2015) In his paper “A Study of the Technique Combining Traditional Bamboo Furniture and Carpentry, " comprehensively explores the historical, cultural and economic aspects of crafts and furniture in Chushan City of Taiwan. The structure of the paper covers traditional techniques, carpentry methods and potential innovations in bamboo furniture. It gives thoughtful exploration, offering readers historical content and the economic significance of bamboo craft while assessing the evolution of traditional art. Addressing the economic framework during the process of growth and decline contextualises shifts in the production process and the dwindling number of bamboo factories. The review identifies the intricate processes for crafting traditional bamboo furniture, the uniqueness of skill, joints and the method employed for the production. Bamboo is hollow, and without an xylem, it is tough to grow in parallel form; therefore, the tools and techniques employed are unique shown below:

Marking and Measuring	**Right Angle** Also known as hand square used to measure angles.	**Measure Tape** Used for adequate measurement	**Divider** Used for steeping of distance and measuring opening.
			
Cutting	**Thin Blade Saw** Used to saw bamboo.	**Chopper** Used to cut down, sharpen, and knock bamboo.	**Inclined Knife** Used to polish holes in bamboo
			
Crafting	**Mortise Chisel** There are five chisels, with widths of 1, 0.8, 0.7, 0.5, and 0.3 inches respectively, that are used for gouging.	**Chisel** This tool is used to create a hollow space inside bamboo, making it easier to bend.	**Arch Sharpener** Used to sharpen a circular angle
			
Crafting	**Bamboo Straightening Stand** Used to straighten arch bamboo stems.	**Bench Vise** Used to hold the bamboo piece so that it can be crafted and finished easily.	**Wooden Hammer** Used for pounding wooden chisel tools

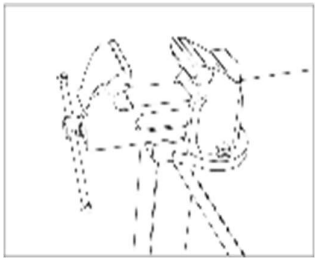
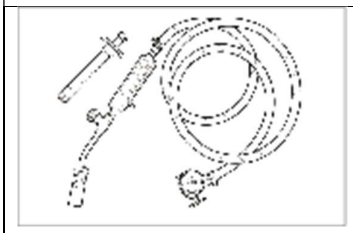
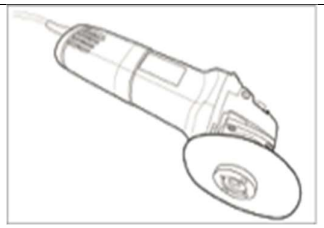
			
Finishing	**Gas Blow Torch** Used to straighten arch bamboo stems.	**Angle Grinder** Used for cutting ,edging sawing and pounding, bamboo.	**Disc Sander** Used for pounding wooden chisel tools
			

Figure 20: Tradional Tools used for Bamboo furniture making.
Sources : *(National Institute of Design Center for Bamboo Initiative, 2015)*, *(Wu & Ho, 2015)*

The carpentry techniques offer valuable insights addressing the dynamic interplay between tradition and innovation. The review shed light on the current bamboo crafts of Taiwan. Analysing the market demands, consumer preferences, and economic considerations initiated an understanding of the artisan challenges they face in the modern context. The literature concludes with an in-depth exploration of bamboo crafts and furniture, balancing historical insights, technical details and contemporary perspectives.

The paper "The Application of Bamboo Weaving in Modern Furniture" by (Zheng & Zhu, 2021) explores bamboo furniture, emphasising its properties and traditional craftsmanship in China. The study gives a comprehensive approach to the needs of the furniture industry to embrace technical modernisation while preserving cultural significance and poses various ideas of innovations and aesthetic trends of modern bamboo. Encouraging enterprise-led design collaboration between stakeholders, envisioning the balance between traditional craftsmanship and modern design, which could facilitate modernised manufacturing techniques and parametric designs. Combining

bamboo furniture with current trends needs to be emphasised, and designers should integrate modern aesthetic tastes into their designs. The paper suggests mechanical production lines as 3D printing techniques for digitally manufacturing bamboo furniture. The study initiates a focus on the evolution of bamboo furniture production and modernization.

2.2.11 Comparative Analysis of Traditional Bamboo furniture vs Modern bamboo furniture making process

	Traditional Bamboo Furniture	**Modern Bamboo Furniture**
Material	Hollow or solid bamboo (Running or clumping bamboo)	Bamboo plywood, Strand Woven Bamboo, Bamboo MDF Cross laminated board, fiber board and veneer
Tool	For crafting bamboo furniture in most of the Indian region still traditional practices are followed which involves tools likewise • Thin blade saw , knife for cutting. • Chisel , Arch sharpener, ruler, Wooden hammer (mallet) for shaping. • Electric drill , whetstone flame gun for desired bending and fixing .	For crafting bamboo furniture, tools used are Computer numerical control (CNC) bamboo processing machines, Automatic splitting machines, advanced bending machines, Digital design and prototyping software, Advanced finishing technologies and environmental control
Technique	The common practices followed for bamboo furniture making are : • Securing joints with bamboo dowels and nails . • For making curves and adding bends heating methods is used . • For connecting right angles dovetail can be used. • To combine legs and rungs V shape dowel joint. • For crossing tenons and connecting one side tilting to a certain angle edge tenon joints is considered	The standard technique for modern bamboo furniture follows as per the desired furniture. • For the splitting process, there are automated splitting machines that can split the bamboo. • For the bending and joinery, the structure advanced bending machine with computer controlled heating and bending process to achieve precise curve. • The Computer-aided design(CAD) and prototyping software to test the design before production. • Mechanical finishing system for high-quality finishes.

Finishing	To maintain the simplicity and natural texture • Polyurethane • Lacquer • Melamine	The finish of bamboo furniture depends upon the taste and aesthetics • Natural oils (tung oil, linseed oil) • Shellac • Wax • UV-cured finish • Pigmented finish

Figure 21 : Comparative Analysis between Traditional vs modern bamboo furniture process
Sources: *(Wu & Ho, 2015)*

The general insights observed from the comparative analysis and the study were that traditional bamboo primarily focuses on the natural qualities of bamboo, but still as a material, it is not resistant to wear moisture compared to bamboo plywood, Strand Woven Bamboo and other engineered bamboo products. The traditional bamboo tools mostly rely on manual working skills, which tend to be labour-intensive. In contrast, modern bamboo tools and materials incorporating CNC techniques give more precision in carving and shaping with less time and manpower. Flame guns and gas blow torches are some of the common traditional techniques used for adding bends to traditional bamboo, which needs skilled manpower and high precession; moreover, little over-flame or heating can break or burn the bamboo pole. Whereas the modern setups for bamboo plywood, Strand Woven Bamboo, etc, involve advanced bending machines, often computer-controlled, providing controlled heat and bending process, allowing precise control for complex design and curves. The traditional finishing techniques follow uncontrolled factors which affect the optimal finishing, whereas using controlled workshops allows optimal regulatory conditions with temperature and humidity adjustment, ensuring better finishing. The differential gap between the two processes follows different techniques and tools: modern tools are less labour-intensive and adequate for precision finishing compared to traditional working, which needs more manpower and good hands-on work. However, being integrated at a high cost due to low awareness and non-approachability, these modern methods are not widely followed in India for furniture making.

2.2.12 Current status of bamboo in India

(Singh O. , 2008) In his paper "Bamboo for sustainable livelihood in India" discusses the critical species of bamboo available in India, its contribution and impact to rural development. It is primarily used as raw material for various applications, and such resources are widely available

in moist and deciduous forests. As per (FSI 2003) total forest area is 67.7 million ha, from which bamboo acquires 11.4 million ha. The country has 16.7% of the total forest area, of which 3.4 % (329 million hectares**)** is in India. Having one of the largest bamboo resources in the world, India contributes just 4% to the global market. The country has lower productivity than other bamboo-producing countries such as China, Malaysia, and Japan, whose contribution is 80%. Bamboo is a versatile gift of nature that has a variety of benefits. Bamboo is a significant source of raw materials for various industries, such as bamboo mat boards, veneers, corrugated sheets, etc. Bamboo craft is one of the old industries and has been used for various applications from building to household utilities. Apparently been known as that "poor man timber", "friend of people", and the cradle to coffin timber. It is a fast-growing plant that matures early and once planted, keeps on shooting and maturing every year. The major challenges in cultivation include a lack of harvesting mechanisms, appropriate storage, transportation, and conservation awareness. The challenges addressed for the bamboo sector are serving it as an eco-friendly source and livelihood for millions.

In the literature (Baksy, The Bamboo industry in India , Supply chain structure , challenges and recommendation, 2013), the study explores the commercial viability of bamboo and its by-products in India with respect to environmental, economic and socio factors. The study attempts to unfold this "green gold" dynamics, addressing factors like value chain, challenges in the production to Consumption, and domestic and international market potential.
The paper indicates the perspective findings on the domestic market base of bamboo products in India and the export market currently owned by China. The comprehensive study **diagnoses the complexities and related issues and proactively provides a framework of proposals** for the same. Each prescribed proposal is tailored to address the challenges faced in industrialisation.
The study indicates a blueprint spanning the value chain explicitly on advancing bamboo cultivation and manufacturing. The interconnectedness of the recommendations, like collaborating with respective bodies, stringent quality control, efficient production, and a coordinated approach, has ushered in the desired transformation in the bamboo sector, leading India to be a key player.

The study "National Consultation on Opportunities and Challenges for Bamboo in India" by Field (Department of Agriculture Cooperation, 2021) presents a narrative on the untapped potential of bamboo in India, showcasing the possibilities for economic growth and development. Bamboo is

an overlooked material with diverse applications. Despite its utilization in various sectors, from construction, paper, biofuel, and agarbatti, its adaptability still underscores. Various collaborations with government agencies like the National Bamboo Mission and Niti Avog reflect the holistic approach of the government. However, the promotion passage excludes acknowledging the potential challenges faced, infrastructural constraints and market competition. The study's robust conclusion adds a call to action, whether by encouraging investment locally, fostering small-scale participation, or raising communal awareness. A comprehensive understanding of the demand of each sector in the bamboo industry, from paper to product, can propel the potential of bamboo.

(Manjunath N. , 2015), in her paper "Contemporary Bamboo Architecture in India", discusses the acceptability of Bamboo and its status. India is the largest bamboo producer and one of the fine bamboo artisans and craftsmen. Bamboo building is one of the old traditions in India. Due to various climatic conditions, we have different species available. The various typologies of bamboo buildings in India and their evolution with change in time are influenced by new interests, research, and developments in materials. The hindrance in the acceptability of bamboo as a preferred material in modern architecture and the strength that can make India the major contributor to the bamboo building sector in future. The Traditional Bamboo Architecture Acceptability in India Problems, Issues and Acceptability of contemporary bamboo architecture and the significant limitations bamboo faces in the various aspects are also discussed:
The Material limitation in elevating bamboo to a level that can be structurally stable, and durable is susceptibility towards fire. Another major limiting factor in the usage is working with the round-shaped bamboo; its **cumbersome joinery** with reducing diameter along the length adds to the drawback. The most common reason for the f**ailure of bamboo is its splitting in the longitudinal direction**. Bamboo is conveniently used as reinforcement for small-sized buildings, but managing large spans is difficult with bamboo, and very long lengths **can lead to the tapering of the structure.** With its hygroscopic nature, bamboo use is a deterrent.

- Academic, Research and Development issues- not including bamboo in the architectural curriculum as mainstream material and lack of awareness about its sustainability. Reformation of bamboo is low and the research and the innovation in alternative materials have yet to be implied. Standardization**, testing, and field testing of bamboo can lead to broader acceptability.**

- Legal and financial policy—Bamboo needs inclusion in SSR and NBC, special policies, laws, and relaxation of regulations. Finance schemes for bamboo buildings should be formulated, such as cheap loans, subsidies, social agencies, and housing standards schemes.
- Social Issues- **Affordability** is a prime reason to opt for permanent solutions, whereas substandard houses can be more demanding in terms of maintenance, energy efficiency, time and money. Social acceptability and standards evolving needs majorly.
- Execution Issues - **Material availability, skill development,** Prefabrication, raising standards for Bamboo, treatment of bamboo, elaborate expensive and non-reliable testing methods and backward linkage are unavailability.

The central concern India is facing is not "**How to produce bamboo" but "how to promote Bamboo"** and stating statement that if the bamboo building technology is made convenient to handle and promoted with standards, codes, and byelaws, it could go a long way in creating the gateway all the alternative material and technologies.

"Application of Natural Landscape in Modern Public Interior Design" by (Ai, 2019)discusses the application of natural landscape (bamboo) to modern interior design. The research summarized that the landscape should match modern interior space and analyze the application of natural resources. The interior landscape should not be kept for just viewing or decoration purposes but should be linked with green buildings by using bamboo. Essentially, the combination of design and ecology tends to be integral parts of the natural landscape and ecological building of the natural environment.

(Phimmachanh, Ying , & Beckline , 2015) "Bamboo Resources Utilization: A Potential Source of Income to Support Rural Livelihoods" discusses and examines the potential of bamboo as a source of income and better livelihood for the rural sector. Bamboo is a widely available global resource and has various uses, from making small toothpicks to construction. The great profit deals for businesses and rural people are proper **adequate skills and market value chains that can cut the poverty trap**. By involving rural communities in Bamboo cultivation, management and marketing generation, a good amount of income and profit can be generated. Bamboo processing for **income generation is largely underdeveloped, and it's primarily limited to** handicraft and other household processing only. Hence, countries should continue to develop some administrative strategies to guide and enable business climate. While totally depending upon the **natural resources, household plantation of bamboo should be encouraged** and focused more which would reduce the scarcity of natural resources as well as add to the long way

to improve rural livelihood The current understanding of the bamboo resources and its value chain is still limited and had certain loopholes of resourceful data and development in various countries and these gaps can only be bridged by the government policies involvement of stakeholders and social acceptability.

2.2.13 Conclusions

- From the above literature review, we analyzed that bamboo is one of the most eco-friendly available resources. It is widely used in everything from building construction to fabric making, and boosting its usage has been an inventive step for the economies of many countries. However, it is still an untapped sector.
- Many researchers have proved that bamboo has a good tensile strength like steel as well it can replace traditional timber .Life cycle assessment (LCA) tests have proven that bamboo has negative carbon impacts, and its harvesting age is far less than wood. Though some Asian countries have accepted bamboo and have developed themselves as major bamboo producers and developers globally, countries like India don't have a well-developed bamboo industry. The Indian artisans and cultivators are still suffering because of inadequate legislative policies, resources and facilities. It was seen that there is a massive gap in the development chain of bamboo resources.

2.3 Bamboo furniture examples: Indian and International model

Indian Model of Bamboo Furniture

1. Furniture by Assam-based Manufacturer Boober [19]

Figure -22 indicates Bamboo sofas and chairs crafted by local Assamese artisans using locally available bamboo species for framing, draped with piles of soft rugs and cushions. The agency involved several bamboo farming communities locals by providing them employment and financial assistance. The agency has trained more than 500 local artisans with basic furniture joinery and working details to get independent setups.

[19] Indian whole bamboo furniture -https://boober.in/

Figure 22: a) Bamboo Sofa , b)Bamboo chair, c) Bamboo bed at Boober ,Assam
Source: (Boober-Bamboo and Cane craft, 2016)

2. Furniture by Visdalia Bamboo cluster[20]

Figure -23 indicates the Indian bamboo furniture models made by the artisans of Visdalia cluster Gram Vikas Samiti (bamboo table, bamboo chair and bamboo sofa). The cluster first trains tribal artisans and then hires interior designers and marketing professionals to support them. The tribal s from 32 villages are getting employment and getting recognition at the national level. The cluster came up with the 'Rural Mall', whose primary attraction is bamboo furniture, which received a massive response from customers in Delhi, Mumbai, Gandhinagar, and Ahmedabad.

Figure 23: a) Bamboo table , b)Bamboo chair, c) Bamboo sofa at Visdalia cluster
Source: (Foreset Department , Surat, n.d.)

"The Visdalia cluster provides direct employment to over 120 people and indirect employment to more than 400. Now, the Bamboo unit has got recognition at the national level, which will boost the confidence of the artisans,"

Puneet Nayyar by Deputy Conservator of Forests (Surat Division) September 9, 2020

3. Furniture by Design Bamboo[21]

Figure 24 indicates the models by bamboo design; the concept behind the collection explores design possibilities with solid bamboo poles – Strictus Dendrocalamus – and splits, using modular

[20] Visdalia Bamboo cluster - https://timesofindia.indiatimes.com/city/surat/visdalia-bamboo-cluster-selected-under-nbm/articleshow/78004609.cms
[21] Some Indian furniture models- https://www.designboom.com/design/bamboo-furniture-systems)

forms and lamination joints for new applications. The product crafting involved the artisans in Sankhela, Tripura, India. The basic design concept used for this furniture is modular and repetitive, and the equipment involved in production is mainly hand tools.

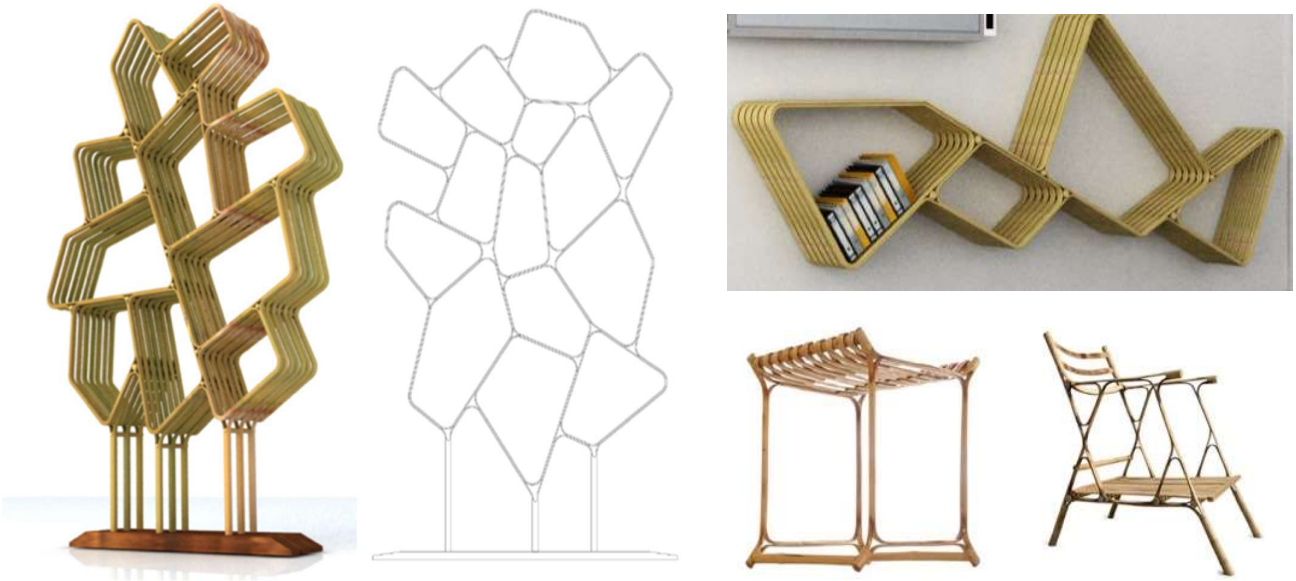


Figure 24: a) Free standing bamboo shelf , b)Bamboo stool, c) Bamboo chair and wall book shelf
Sources: *(Design Boom, 1999)*

International Models of Bamboo Furniture

1. Bamboo stool and study table and chair models

Figure 25 (a) indicates bamboo stools in a green Village in Indonesia with engineered bamboo, and Figure 25 (b) study table and chair with traditional bamboo in a green classroom with 100% bamboo usage [22].

Figure 25: a) Bamboo stool , b)Bamboo study table and chair
Sources: (IBUKU, 2014)

2. Bamboo chair and stool models

Figures 26 (a) and (b) indicate the chair by Jeff Dah-yue Shi using Moso bamboo species.

A chair by Zuarq Builders, Colombia, South America23 combines engineered and traditional

[22] International models-ibuku.com
[23] Chair by Zuarq Builders- casasbambuzuarq.mex.tl

bamboo. Figures 26 (c) and (d) indicate Bamboo Jefe chairs 24 and chair by Sebrae Tres Rios—figure 26 (e) Bamboo stools from raw solid bamboo held together.

Figure 26: Bamboo chairs and stools
Sources: (Insteading , n.d.), (bamboocraft, 2011)

3. Bamboo tables models

Figure 27 (a) indicates tables made up of raw bamboo poles of different sizes and colours held together by metal belts, eliminating the need for any screw or glue by Elena Goray and Christoph Tongues,[25] , Figure 27 (b) table from vertically cut raw bamboo strands [26], Figure 27 (c) indicates to a table from processed moso bamboo **Ed van Engelen Haans**[27].

[24] Chair by - Sebrae Tres Rios –. bamboocraft.net
[25] Raw bamboo pole table elenagoray. wordpress.com
[26] Raw bamboo pole vertically cut tablegreenvillagebali.com
[27] Table from processed bamboo -http://moso-bamboo.com/

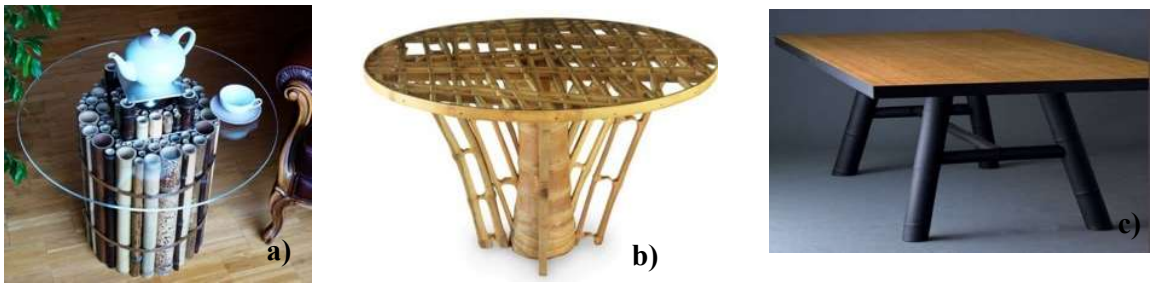


Figure 27: Bamboo tables
Sources: (Elena Goray & Christoph Tönges, 2018), (Green Village, n.d.), (Moso Products, 1997)

4. Bamboo benches models

Figure 28(a) indicates a bench made up of raw bamboo poles different sizes and colours held together by processed bamboo frames by University of Wisconsin, Madison, Art Dept[28] , Figure 28 (b) bench made from raw hollow bamboo poles and stainless steel framing, back support and legs[29,] Figure 28 (c) indicates to bench composed from 10 different bamboo from Colombia, China and Indonesia The various colours and diameters of the bamboos fixed by 4 belts of stainless steel to keep it in shape with no screws or glue by Elena Goray and Christoph Tönges[28].

2.3.1 Analysis of the study and furniture models

Figure 28: Bamboo bench
Sources: (CALI, 2004) , (Conbam, 2004)

- The Indian bamboo furniture models look much more traditional in design than international models. The Indian bamboo furniture appearance seems to be raw and rustic in comparison to the international.
- The Indian bamboo furniture had significantly less colour variation; most of the pieces analysed were kept in their natural state, whereas overseas models were tried with different colours, sometimes using other colour bamboo species and sometimes using paint on them.

[28] Bench by http://calibamboo.com/
[29] Bamboo bench by conbam.de

- The available furniture in India is generally crafted from raw (traditional) bamboo. In contrast, processed bamboo is used in making small handicrafts, as it offers less wastage and maximum utilisation of these processed bamboo sheets. The availability of engineered bamboo is found to be limited in the country, with very few agencies like Epitome, etc., who work on engineered bamboo manufacturing, and most of the time, these engineered bamboo have to be imported from China, which leads to the enormous import duty and transportation charge of raw material.
- Indian furniture was found to be more straight-lined and minimalistic in appearance than any international style. The joinery is unfinished and needs to be exposed.
- The Indian model's designs are found to be more for the exterior rather than to be incorporated into the interior. The available designs must be more flexible to match a modern, contemporary interior.

2.4 Study Precis

The chapter explores global and regional production and distribution aspects of bamboo. The study signifies the characteristics of Indian bamboo furniture compared to international models. The challenges in the availability of engineered bamboo are restricted, leading to the high import cost. Furthermore, the study emphasises the importance of incorporating sustainability measures into developing sectors, including jurisdictional measures. The design of Indian bamboo furniture is more straight-lined and features exposed joinery, which seems to lack the flexibility to align with the contemporary interior. The study is structured in five sections and addresses the crucial aspects of bamboo, from its initial production to utilisation to its sustainability challenges. The overall research offers a comprehensive understanding of the Indian Bamboo industry, its tools, working measures, and design framework. Overall, the chapter gives a well-rounded exploration of the bamboo industry globally.

CHAPTER 3

CASE STUDY & INTERVIEW

The chapter aims to study the constraints, user preferences, perception, and acceptability of bamboo. The initial case study was carried out to evaluate the position of Bamboo and the native people's perspective on bamboo as a material. As a local material of the north-eastern states, one of the campuses used bamboo as the prime material for interior and exterior studies as part of the initial study. The Design campus is built in the heart of a native area of Assam. The chapter further details the case study and interviews with the architects, manufacturers, and artisans, specifically from the study area, who are involved in the industry, detailing the working prospects of utilising bamboo, the existing users' acceptability, and constraints faced by stakeholders to formulate the variable for further study and evaluation.

3.1 Case Study-01: Site study of National Institute of Design at Jorhat, Assam Studying application and use of bamboo in Interiors and Exteriors

3.1.1 Case Study Brief

To understand the working prospects, users' acceptability, and constraints faced by stakeholders, artisans and manufacturers while working with bamboo in its native area where it is grown abundantly, this study of the NID campus in Jorhat, Assam was executed. The campus is located in the Eastern part of Assam. The campus site is near Toklai Chabagan and measures 30.87 Acres about Toklai River on the West, with Residential areas on the East and north. The water channel passing through the site connects the residential area on the East. Due to the site configuration and a water channel passing through the site, the campus has automatically been divided into two areas: -

a) Academic area on the North side

b) The residential area is on the south side.

Figure 29: Site and Surrounds (National Institute of Design)
Sources : Axis Consultants

3.1.2 Considering Bamboo for Campus

As Assam is rich in sylvan resources and the local forest has been stocked with various bamboo species, it was decided to use these natural resources to define the cultural heritage of the

campus. Bamboo tends to be durable, versatile, solid and highly renewable. It was considered partly in structure for furniture and interior applications of the campus.

3.1.3 Species used

The state covers tropical wet evergreen, tropical semi-green, tropical moist deciduous, subtropical broad-leaved hills, subtropical pine forests, and coastal and swamp forests. The species mainly considered interiors and exteriors were Dendrocalamus hamiltonii (Kako), Bamboosa tulda (Jati) and Bamboosa balcooa (Bhaluka).

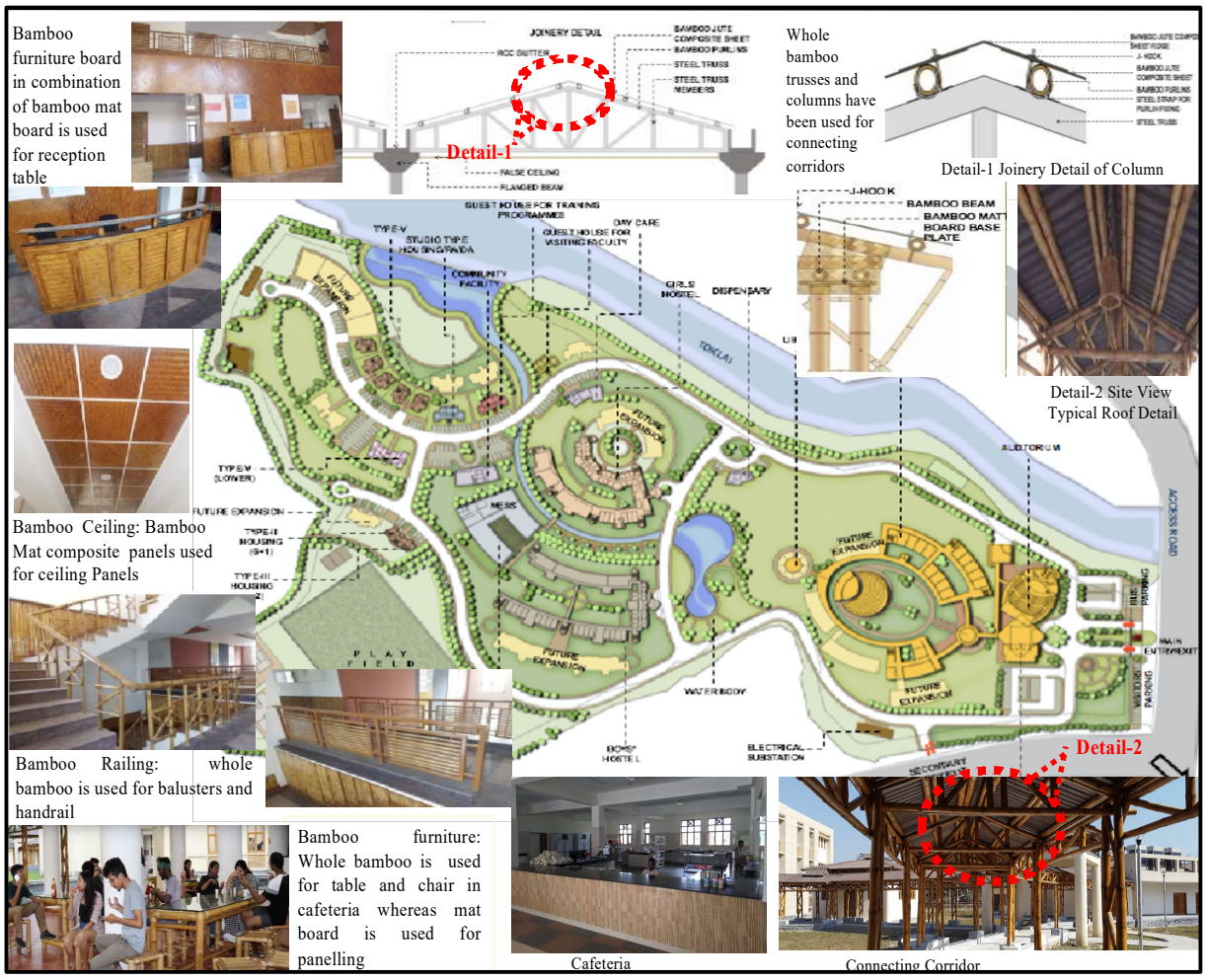


Figure 30: Detailed layout (National Institute of Design)
Sources : Axis Consultants

3.1.4 Application of Bamboo

On campus, designing bamboo used in structures was guided by the North East Centre for Technology Application and Reach [NECTAR], and raw materials for the application were procured locally. The basic structure was done in R.C.C. framed except for the roof, which was

designed with steel members and bamboo purlins and was finally covered with Bamboo Jute composite sheets—traditional raw treated bamboo used for the trusses in the Cafeteria, Design Shop, Connecting corridors. The engineering principles of using bamboo components are identical to any conventional system. Bamboo's hollow tube sections (section properties are based on mean diameter and mean thickness) are considered for the supporting frame and columns, as marked in Figure 32, detail -2. Half-cut treated bamboo is fixed horizontally and vertically in the interior for wall panelling. For the furniture, the traditional hollow and solid bamboo is used in combinations for making beds, wardrobes, and study tables for hostels. The reception, conference, dining and cafeteria furniture were also designed using hollow bamboo species. However, joints are considered to act as pinned or hinged and not fixed. The draft report by the National Building Code of India (CED 46) is referred to for basic joinery and different parameters like modulus of elasticity, density, etc., of other bamboo species. The values adopted for design are as follows.

Modulus of Elasticity – 1620 N/mm2

Density – 650Kg/m3

Yield Strength – 1750 N/mm3

a) Bamboo used externally :

- Cladding material
- For making corridors, columns and truss
- Window Louvers
- Treated Bamboo has been used as cladding material on buildings, Lift Wall

Figure 31: Half-cut hollow bamboo cladding on the external wall
Source: Author

Figure 32: Hollow bamboo for corridor columns and truss structure
Source: Author

b) Bamboo used internally :

- Bamboo Wood Board is used for cladding, flooring, skirting,
- Bamboo Jute Composite Sheet for Roof Covering
- Bamboo Mat Board used in partition, panelling, false ceiling
- Treated Bamboo has been used as cladding material on buildings, Lift Wall

Figure 33: Hollow bamboo used cladding , staircase and corridor railing.
Source: Author

Figure 34: Hollow bamboo used for serving station cladding in the dining hall and for furniture's in the cafeteria .
Source: Axis Consultants

Figure 35: Processed Bamboo board used reception table and wall panelling cladding, staircase and corridor railing
Source: Axis Consultants

Figure 36: Bamboo mat board for false ceiling and reception table
Source: Author

3.1.5 Analysis of the case study

- Being a native material, the bamboo industry in Assam faces **exploitation by intermediaries (mediators)**. The middleman/commission agents collected the bamboo products from the producers at a low price and supplied them at a high price. This leads to additional costs in raw materials and byproducts like furniture and handicrafts produced by the local artisans.
- The area was observed to have irregular and temporary stalls, usually erected for marketing bamboo furniture and other products. These neither help in any financial gain for the producer nor restrict the entry of new producers to the bamboo industry.
- The local artisans were found **using simple traditional tools, and the techniques used for making furniture and other products needed to be updated.** Instead, it could have been more laborious and time-consuming. On the availability of modern machines, it was found that local artisans need more funds to acquire these tools.
- The local artisans of the district stated that most of their **furniture is being locally sold,** sometimes to the locals or wholesale exporters, which include both government and private. They found a need for more funds, so they needed more time to get their work modernized.

- The artisans also informed that their **buyers are limited, and the design which they generally produce is self-analyzed**. They wanted to connect to a comprehensive market and stakeholders but needed to learn how to reach them due to the absence of funds and readily available cash loans.
- It was also observed that most of them made the same repetitive design without knowing the user's observations and requirements. Due to the similar design, there has been a competitive market, leading to undervalued sales without any profit margin.
- Most artisans tried starting their setups by taking loans at higher interest rates from private money lenders, which has now led them under the burden of debt and to spend a good proportion of their profits on paying the interest on their loans.
- Surprisingly, most artisans were unaware of processed bamboo and its by-products like bamboo mat board, furniture board, etc. Those who needed more awareness of it stated that engineered bamboo is not readily available and tends to be more expensive to craft furniture.

3.2 Case Study-02: A detailed interview was held with an architect who worked with bamboo in interiors and exteriors on 12th April 2021 via the Zoom platform.

Ar. Urmimala: Principal Architect (Axis Consultants, New Delhi)
Design Faculty (School of Planning and Architecture, New Delhi

3.2.1 Introduction

Mrs Urmimala Guha, principal architect of Axis Consultants New Delhi, worked on various prime projects in PAN India. In 2010, she completed Sustainable Integrated Township NEW MOTI BAGH in Delhi, Silver- rated by GRIHA. She is also a prime architect of the NATIONAL INSITUTE OF DESIGN, Jorhat, Assam, in which she has extensively used Bamboo for the Interior and Exterior. She shared her working experience using bamboo in NID, Jorhat in a detailed interview discussion. She shared that the campus was in Assam, so bamboo was chosen to give the institute cultural heritage.

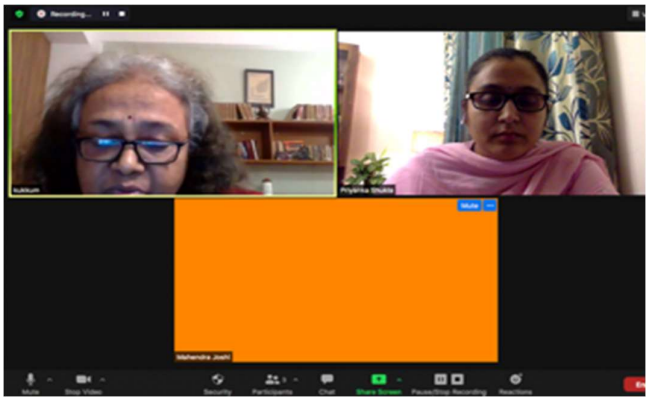


Figure 37: Interview with Architect Mrs Urmimala Guha worked with Bamboo

3.2.2 Experience in the application and use of native material

- The initial concept approval faced many obligations, and convincing various regulatory bodies to use bamboo, which tends to be a local material, was the major challenge for her. In the working stages, she found that the local artisans were not acquainted with the bamboo. The local artisans and labour were semi-skilled and were not very much aware of the detailing and modern bamboo working technology.
- The local furniture and the designs available were more traditional and did not have modernity and flexibility. The artisans were acquainted with the regular design and could not detail any new designs due to a lack of knowledge and adequate tools.
- The finishing of the furniture needed to be more satisfactory and have colour differences. The exact colour match was difficult due to the manual finishing process.
- The furniture and finishing were time-consuming and much more laborious due to untrained artisans, a scant supply of raw material (specific species) and traditional tools.
- She stated that they have faced a significant lack in the design, and people have perceived a mindset towards bamboo that it is a traditional material and can cast traditional design. She added that bamboo is a fire-resistant material and can be released and moulded into any shape. Still, due to the outcast approach and people's perception of bamboo, our society has not accepted it.
- The locals are not conversant in using processed bamboo boards and plywood for furniture making, which she said is an excellent alternative to wood and can have a good payback in future.

3.2.3 Interview Analysis

- The discussion briefed that though bamboo is a **heritage material** of Assam, people were found not acquainted with bamboo's modern usage and working techniques.
- The local **designs were more traditional and were outca**st without any modernity and flexibility.
- Local artisans needed to be more aware of upcoming modern design trends. They were still found using outdated machinery and had hand-drawn tools for crafting simple pieces, which indicates their technological barriers.
- As finishing is done manually, it is not up to the mark.
- The local artisans are conversant with their local languages, making conversation difficult for outsiders.

- The local artisans were generally found living on the outskirts, and it was challenging to connect to them due to inadequate transportation systems and road networking.

3.3 Case Study-03:Detailed Interview with Naresh Kumar Bamboo and Cane Artisans on 5Th August 2021 (Lajpat Nagar, New Delhi)

3.3.1 Introduction

Naresh Kumar has worked in the bamboo and cane industry for the past 30 years in the central marketing hub of New Delhi, Lajpat Nagar. He joined his father's bamboo furniture-making setup at the early age of seventeen. Earlier, he was involved in selling the finished bamboo furniture, but now he has also started crafting the furniture as per users' needs. With his small setup, he earns up to Rs 500/- to Rs 1000/- daily. He sources raw materials from nearby areas like Uttar Pradesh, Faridabad and Palwal. He has some semi-skilled furniture artisans under him who make craft furniture and finish them as per their needs and requirements of his customers.

Figure 38: Interview with Naresh Kumar, a Delhi-based `Bamboo artisan. Sources : The Author

3.3.2 Experience working with bamboo

- As per his experience and working, he stated that working and transporting bamboo furniture costs much less than wood because he does not need a desired formal setup or shops to sell his furniture; likewise, wood is required.
- The customers generally ask for more colour options in furniture, to which he said that it gets difficult for him to provide them with all the viable colours in bamboo because finishing bamboo needs more skilled hands and equipment and due to financial constraints, it is challenging to procure all the modern machinery and tools.
- He generally makes standard furniture designs and gets this furniture customized as per the requirements of his customers. Most of his customers demand modern design, and his non-conversation with joinery makes it difficult for him to accommodate their needs.
- He stated that customers need to be made aware of the properties of bamboo and show concern towards the stability and durability of bamboo furniture.

3.4 Case Study-04: Detailed Interview held with Gautam Halder Bamboo Cane Artisans working at Dakshinapan Shopping arcade, Kolkata, West Bengal on 8ThFeburary 2022

3.4.1 Introduction

Gautam Halder has been an artisan working with bamboo and cane for the past 24 years in the main shopping arcade of Kolkata, Dakshinapan. This shopping centre is on Gariahat Road, Dakhuria. He came into this enterprise as a helping hand to his father at the early age of 14 years. He gained practical working knowledge from his family, especially his father and friends. Without any skill training, the practical knowledge he achieved from his father made him start this small setup. He gets raw materials and semi-finished products from Siliguri and finishes as per the customer's choice. The species he uses for furniture making area - Bambusa Tulda & Boro bans, etc. He crafts furniture like tables, chairs, 3-seater sofas, lampshades, racks, etc., from bamboo and has now started selling rattan furniture.

Figure 39: Interview with Gautam Halder, Kolkata-based bamboo artisan. artisan.
Source: The Author

3.4.2 Experience working with bamboo

- He said he knows the benefits of working with bamboo. However, the bamboo industry still has some gaps, primarily lacking adequate marketing and selling channels for raw materials. Most importantly, he said solid bamboo could not be bent, so he customized bamboo with rattan to get more designs.
- He also said that customers come and ask for a modern design, but due to a lack of resources, it is

Figure 40: Bamboo Furniture by local artisan Gautam Halder.
Source: The Author

difficult for him to satisfy customers' needs. Still, he manages to sell furniture of value approx. 12000/- to 16000/-.

- Customers generally ask for online portals or websites to connect with home delivery. Still, the artisan informed us that they are not technically sound with portals, which makes it challenging to capture a broad market.

Interview Analysis

- The availability of proportional inflows of machine-made furniture at relatively lower prices adds difficulty for handmade furniture manufacturers in competing due to higher price tags. This puts bamboo artisans at a significant disadvantage in promoting their products among buyers.
- The artisans' area relied upon the traders/middlemen for fixing the prices of their products and were found to be unaware of prevailing market trends and prices.
- The customers wanted to connect with the local artisans to customize furniture as per their requirements.
- The training exposure is inadequate, and the artisans are unaware of the technical working details of bamboo, like the heat bending method, etc.
- The involvement of intermediaries for selling raw materials and their furniture leads to a minimized profit margin.
- There is also a lack of elementary education, which makes them unaware of the primitive schemes and measures initiated by the government.

3.5 Case Study-05 Telephonic Interview with Assam-based Bamboo Manufacturer Mr. Keshava Nada Bora.

3.5.1 Introduction

Figure 41: Interview with Mr Keshava Nada Bora, Assam based bamboo manufacturer.
Sources : (Boober, 2016), The Author

"Boober" is an Assam-based enterprise involved in offering a wide range of products that includes bamboo furniture, cane furniture, bamboo kitchen accessories, bamboo handicrafts, etc. They are an eminent Manufacturer, Exporter and Supplier of these products in India. Keshava Nada Bora is the man behind shaping bamboo into a business setup in Guwahati. He founded Boober in September 2016 and has been unassisted in managing the operations of his startup. The videos of bamboo artisans from Japan on YouTube carving bamboo into beautiful products were his startup inspirations. He started looking for bamboo artisans in Assam, and being in a bamboo state, finding bamboo craftsmen was not difficult. The bamboo species mainly used for furniture and handicrafts making are Bambusa Balcooa and Bambusa Tudla, which are procured from local middlemen. The main aim behind this startup was to create a positive impact on the planet with small and simple yet significant initiatives. As bamboo is environmentally friendly, the products made from bamboo are also much lighter.

3.5.2 Experience Interpretation with Bamboo

He explains that the bamboo industry has vast potential in Assam. However, simultaneously, the industry is facing a significant challenge as people immediately expect the furniture costs to be much lower. Initially, he sold the product to the local bamboo showrooms as the retail channels were underdeveloped.

- He shared that Indian bamboo furniture and products are undervalued. Users tend to overlook the artisan's work and the novelty of designs. The consumer's reluctant to pay an adequate amount for their efforts.
- The Indian market or big brands ask for customized designs with multiple numbers of modifications. Still, they are unwilling to pay for the design intervention, which does not let their designing evolve. He said out of 30%, only 2% are viable customers. Generally,

consumers look for free prototype models. Which he said that big manufacturers can still afford these samples, but it is challenging for small hubs and artisans to provide these sample models free of cost.

- Small artisans are not conversant with the language, and it is challenging for them to connect with viable customers, understand their needs and give them the desired output.
- Traditional bamboo is heavy, and engineered bamboo is the next upcoming thing which can offer a viable substitute for wood, but the major issue the industry is facing is the viable machinery for processing this bamboo, as sourcing processed bamboo is quite expensive. He also pointed out that the processed bamboo is generally imported from China and other countries, and a 30% import duty needs to be paid for sourcing these processed boards.
- Exploring the B2B market can help to connect with furniture manufacturing companies and can add a bit of value addition.
- The skill training for the artisans is not upgraded and checked by forming an adequate checklist of all the artisans prior to being trained and needing gradation training. As designs are new for the artisan, it's detailing, and technique takes a while to understand and develop. There is some skill development center, but the local artisans hesitate to go there due to financial implications.[30]

Figure 42: Upscaling Programme and workshops for villagers
Source: (Gogoi , 2020)

[30] More than 500+ artisans with collaboration from The Indian Institute of Entrepreneurship. But still various, there are many more such artisans who need skill development training with subsidized raw materials and tools.

Some of Bamboo furniture and products:

Figure 43: Bamboo furniture made from traditional solid and hollow bamboo
Source: The Author

Bamboo lamps **Bamboo basket** **Bamboo organiser**

Figure 44: Bamboo products made from Processed bamboo made by Boober
Source: The Author

3.6 Research gaps

After extensive research, it is evident that the bamboo furniture industry's adoption and commercialization are at a narrow point in India. The observed parameter impacts the commercialization (Cultural, Social, Personal and Psychological) along with possible design-based intervention that can help stimulate the commercialization of bamboo furniture in different urban areas. The commercialization with respect to the design-based intervention follows (Empathizing, Defining, ideating, Prototype and Testing)[31]. In the Indian bamboo furniture market, concerning consumers' interest, the comprehensive design intervention came as a missing element: not letting the bamboo furniture grab the consumer's interest. **Thus, this research intends to have an extensive approach towards various stakeholders' experiences in understanding conventionalised bamboo as furniture material, its relationship with design, and which design-based intervention is an invention to vitalise bamboo furniture adoption in the Indian market.**

[31] /https://www.smashingmagazine.com/2018/01/comprehensive-guide-product-design/

3.7 Derived Interpretations

Overall, analysing the case study and face-to-face interaction with the users (students), artisans, manufacturers, and involved architects shed light primarily on the undervaluation of artisans. The case study of the Jorhat campus delves into insights into the challenges local artisans encounter and understand the user's perspective. As per the users (students), the design that artisans produce is generally self-analysed by them and does not fit the user's needs. The design seemed repetitive, with very few design variations to which artisans concerned about limited buyers' and designers' accessibility was, limiting the quality of the design produced. Despite local sales, the artisans expressed their desire to expand the market, which gave them a better selling probability. They expressed myriad challenges, encompassing exploitative markets, technological barriers, and lack of awareness, resulting in low production quality. The face-to-face interaction with users (students) in the NID Jorhat acknowledged the use of bamboo in interiors and furniture. They significantly pointed out the design improvisation and modernization as their considerations in the campus. Overall, the chapter compiles, highlighting the ground prospectus of all the significant stakeholders involved in the bamboo furniture industry, addressing the complex interplay of exploitative practices, outdated design and working techniques to formulate and address the derived variables of the research questions.

3.8 Study Precis

The section aims to contribute to the comprehensive understanding of the bamboo industry and market at each nodal level. The study detailed the case study conducted in one of the prime bamboo furniture manufacturing states, Assam, to understand the ground path in context to its application in interior and exterior. The study scrutinizes the bamboo application's local and practical context and the user's perceptions and experiences towards manufactured furniture. The research includes interviews with key stakeholders, including architects, artisans, and manufacturers, to attain a richer understanding. The interaction delves into the dynamics of bamboo furniture procurements and sheds light on its manufacturing and working prospects. The chapter concludes with formulating the variables derived from the case study and interview discussions, envisioning the foundational element for the subsequent study and formulating the study parameters accordingly. The geographical specificity of the case study added a unique dimension to the study, considering bamboo's culture and environmental relevance in this region. The localized perspective on bamboo offered valuable insights into its integration into design and the study of the impact of interventions accordingly.

3.9 Expected Outcomes from the research work

The research aims to understand consumer's acceptance of bamboo furniture and the viable problems of bamboo artisans and manufacturers in commercialising bamboo furniture. The data gathered initiates in addressing the objectives and attaining the desired parameters. The study also contributes on proposing the recommendation to restructure the sequential nationwide guidelines/policies to protect and promote our local bamboo artisans, cultivators and manufacturers.

CHAPTER 4

Data Collection & Research Design

This chapter seeks to find factors that positively impact the commercialization of bamboo furniture in the Indian context. The chapter is divided into two sections: The first part identifies the commercialization factors in aspiration to the Indian furniture market, whereas the second part identifies the bamboo furniture market in design based on intervention.

4.1 Introduction

This chapter intends to develop and implement the factors that affect the commercialisation of the bamboo furniture industry and the possible design-based intervention that positively impacts stakeholders in the Indian context. The chapter is divided into two parts: - the first part identifies the factors affecting commercialization with stakeholder aspiration in the Indian furniture market. The second part identifies the bamboo furniture market in design based on intervention regarding the selected parameter and users' perception through interviews and field surveys of various selected groups, including architects, stakeholders, artisans, bamboo producers and manufacturers. This chapter discusses the study parameter, data collection process and adopted analysis affecting the commercialisation of bamboo furniture.

4.2 Identification of analysis parameter

India has the world's largest bamboo area and second-largest reserve today. As per the Planning Commission, the estimated size of the domestic bamboo economy iis around 23942 crores. [32] (North Eastern Development Finance Corporation Ltd, 2020). India comprises 16% of the world's population and 15% of the world's livestock, but only 2% of the geographical area and 1% of the forest area. The extent of commercial forestry is low, and very few cultivators are interested in cultivating bamboo. For adequate working, bamboo products' value and supply chain are formulated with various substructures until they finally reach the consumers. There is a considerable variation in the supply chain length followed in India as any product's supply chain depends on the distributors and retailers who channel the product to the customers. Due to a large number of intermediaries, the supply chain in India is much more fragmented and makes the extent of the commercial furniture industry low. In the value chain process, the nodes at each level cordially aim to share the investments, risks, resources, and gains. However, India produces extensive quality bamboo products every year despite the inadequate and scant data.

The Indian wooden furniture industry has recently been overexploited due to consumers' behavioural changes. Adding bamboo as furniture material caters to the need to create sustainable bio-based products and furniture. However, the overall labour-intensive bamboo furniture in India has many unfilled gaps in the value chain, affecting the commercialization of this industry.

[32] As per the (North Eastern Development Finance Corporation Ltd, 2020) there is no comprehensive data on trade, as the sector is unorganised in India, and it is difficult to estimate the import and export figures majorly due to most of the bamboo products are trade under HSN code of timber category

Commercialization is the interdisciplinary medium that establishes a connection between the stakeholders and buyers[33]. **Commercialization is dependent on stakeholder and buyer behaviours.** (KOTLER & ARMSTRONG, 2007) **states that behaviour traits are evaluated positively or negatively on cultural, social, personal and psychological parameters.** Considering the consumer behaviour traits in reference to the literature study (Gilal, Zhang, & Gilal, 2018) catered for South Koreans and Chinese consumers states that design is an important parameter in capturing consumer interest. Framing the concepts from the theoretical study Steven Bradley created in 2010, "Design Hierarchy Needs", in the translation of the Maslow theory, **the design should meet the user's needs.** To stimulate the commercialization of bamboo furniture, the consumer-defined intervention in design was further modelled as the fifth variable for study to understand the user's traits. The factor is studied based on empathizing, defining, ideating, prototype design model and market testing to assess the route area of non-acceptability of bamboo furniture.

4.3 Variable Formations and Assessing

Though bamboo's physical and mechanical properties make it viable to substitute wood for furniture making still, it is not accepted by Indian urban consumers. Each user is unique, with different buying choices and habits. The commercialization of any product or service is consumer-centric, and the behaviour of consumers strongly affects its commercialization. The study by (Abekah & Joseph K. A, 2015) states that satisfaction is not desirable at the end but rather it means to ascertain future customer responses. He also linked interest in satisfaction to customer buying intentions.

A theory on consumer behaviour (Hawkins, Best, & Coney, 2004) states, "**The study of individuals, groups or organizations and the processes they use to select, secure, use and dispose of products, services, experiences or ideas to satisfy needs and the impacts that these processes have on the consumer and society".** For the commercialization of any product, customer satisfaction is measured by the level of customer contentment, and for its assessment, the universally adopted construct that affects commercialization is the buyer and Seller behaviour (BSB)[34]. Considering the user's behaviour based on the theory model by (Hawkins, Best, & Coney, 2004) and (KOTLER & ARMSTRONG, 2007) the commercialization (C) factor will be

[33] Adapted from https://www.marketing91.com/commercialisation/
[34] Derived from (KOTLER & ARMSTRONG, 2007) and (Slabá, 2019)

independently analysed by behaviour traits variables of consumers, i.e., cultural, social, personal and psychological variable and design based variable
i.e. Design Intervention(DI). Studying the consumer-based theory models and initial pilot study based on interviews and discussions, few constructs below were formulated and analysed.

S1	Bamboo furniture should be incorporate intricate designing details to improvise the interest and commercialization.
S2	The available quality of bamboo furniture is low in comparison to the wood furniture in market whose improvising can increase its acceptability among the stakeholders
S3	Bamboo furniture physical and mechanical properties is highly susceptible to fire in comparison to wood
S4	The furniture from bamboo needs high maintenance and can invite termite infestation easily.
S5	Bamboo furniture tends to be more expensive than wooden furniture
S6	The available furniture in the market has lack in design and they are not as per customers' expectations
S7	The available design give traditional style to the interior and should be modernize and multifunctional.
S8	Connecting with designers and consumers to produce design by bamboo artisans and manufacturer to produce better designs can regulate the commercialization.
S9	The Engineered/ processed bamboo furniture is not easily available like engineered wood which are easy to craft and give modern looks to the furniture

As the bamboo sector in India is scattered and unorganised, it encompasses comprehensive variables, and due to the large data set, it was difficult to measure the underlying structure set of observed variables. So, to reduce the dimensionality of the more extensive data sets and get more defined insights on consumer preferences, market segmentation, supply chain optimization and significant interventions, Exploratory factor analysis (EFA) is recommended for the study. The method identifies the smaller set of latent factors and explains the correlation pattern. The (EFA) is recommended for this particular analysis to explore the interrelationship between commercialization and the other 5 derived variables, aiding the interpretability by transforming the original factors into a smaller number of sets. The method also explains the substantial proportion of the variance, allowing more targeted analysis, Hypothesis generation and creating a more parsimonious model.

As exploratory factor analysis (EFA) is derived to be adequate for the study determining the suitability of data. Therefore, this method simplifies the variables and enhances its interpretability by identifying the underlying factors with limited or no correlation. Further, to evaluate all the

variables and assess the suitability of data for factor analysis, Kaiser–Meyer–Olkin (KMO) was identified as a suitable method to examine sampling adequacy and factorability. This method determines whether the data set has enough common variance for factor analysis. KMO evaluate all the variables together and assists in selecting only those that contribute to common variance, ensuring the inclusion of only relevant variables in the analysis and avoiding misinterpreting factor analysis to provide a quantitively assessment of the adequacy of data.

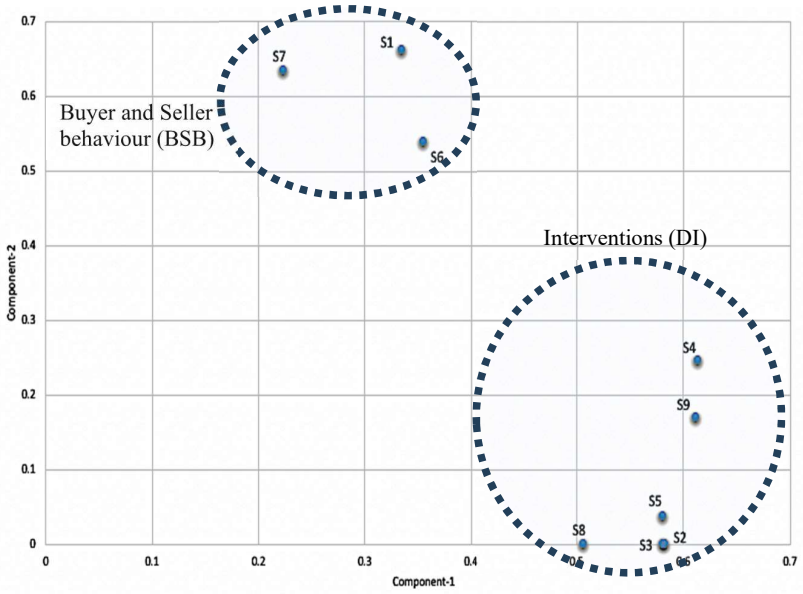
This method measures sampling adequacy (determining whether the given responses are adequate or not). A high KMO value close to 1 suggests that data is suited for factor analysis, and a low KMO indicates non-suitability for extracting meaningful factors. The Kaiser recommends 0.5 (value for KMO) as a minimum (barely accepted), values between 0.7-0.8 acceptable, and values above 0.9 are superb. In the present study, factor analysis is conducted using Statistical Package for the Social Science (SPSS) to frame and extract the most prominent variable from the 9 suggestive variables derived from the literature study for further analysing and segregating under behaviour and Intervention(DI) to identify induvial effects. The purpose of factor analysis was to reduce the dimensionality of the data set and uncover the latent variables for further analysis. The factor formation was done through a floating online questionnaire and interviews as a part of the pilot testing with 150 respondents for a more comprehensive exploration of the variable robustness and validity.

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
S1	0.618	0.035	0.002	0.059	0.130	0.136	0.192	0.016	0.166
S2	0.035	0.724	0.240	0.160	0.024	0.035	0.045	0.012	0.203
S3	0.002	0.240	0.732	0.204	0.107	0.018	0.072	0.105	0.037
S4	0.059	0.160	0.204	0.697	0.255	0.013	0.160	0.056	0.030
S5	0.130	0.024	0.107	0.255	0.710	0.158	0.048	0.093	0.007
S6	0.136	0.035	0.018	0.013	0.158	0.604	0.063	0.134	0.206
S7	0.192	0.045	0.072	0.160	0.048	0.063	0.493	0.141	0.047
S8	0.016	0.012	0.105	0.056	0.093	0.134	0.141	0.639	0.292
S9	0.166	0.203	0.037	0.030	0.007	0.206	0.047	0.292	0.655

The table below measures the KMO as 0.670, greater than 0.5, indicating that the sample is sufficient to proceed with the factor analysis. Bartlett's test measures the strength of the

relationship among variables. This tests the null hypothesis that the correlation matrix is an identity matrix. Bartlett's test of sphericity is performed by taking $\alpha = 0.05$. Here p-value is less than 0.05, and therefore, factor analysis is valid (Analysis INN., 2020), (Project guru, n.d.)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.670
Bartlett's Test of Sphericity	Approx. Chi-Square	364.853
	df	36
	Sig.	.000



		Components	
		1	2
S1	Bamboo furniture should be incorporate intricate designing details to improvise the interest and commercialization.	.335	.662
S2	The available quality of bamboo furniture is low in comparison to the wood furniture in market whose improvising can increase its acceptability among the stakeholders	.581	
S3	Bamboo furniture physical and mechanical properties is highly susceptible to fire in comparison to wood	.583	
S4	The furniture from bamboo needs high maintenance and can invite termite infestation easily.	.614	0.246
S5	Bamboo furniture tends to be more expensive than wooden furniture	.581	.037
S6	The available furniture in the market has lack in design and they are not as per customers' expectations	.356	.540
S7	The available design give traditional style to the interior and should be modernize and multifunctional .	.224	.635
S8	Connecting with designers and consumers to produce design by bamboo artisans and manufacturer to produce better designs can regulate the commercialization .	.507	
S9	The Engineered/ processed bamboo furniture is not easily available like engineered wood which are easy to craft and give modern looks to the furniture	.612	.169

By application of under principal component analysis from the above 9 statements 3 components i.e. (S1, S6 and S7) are clustered in buyer and seller behaviour (BSB) that is further analysed to cultural, social, personal and psychological factors and 6 components i.e. (S2, S3, S4, S5, S8 and S9) are clustered under Design Intervention(DI) that is further independently analysed Finally,

five independent variables are framed to find the impact of Design intervention on commercialization considering consumers behaviour.

Commercialization -Buyer and selling behaviour(BB)
Personal –(PF): *"refer to the all the personal characteristics influencing or contributing to the decision making"* (Horská & Sparke, 2007)
PF1- Reasons for bamboo not being adopted as a furniture material instead of wood • PF1.1 -Personal characteristics :Age ,gender, domicile , living structure , education , working sector influence and possible factors . • PF1.2 -Buyer consideration on assessing bamboo fitting to their preferable needs like local availability ,home delivery , intricate designing , branding , aesthetic appeal. • PF 1.3 -Buyer perception towards using bamboo as raw material for furniture making
Social –(SF): *"the status hierarchy, reference groups, status by which groups and individuals are cl*assified based on esteem and prestige" (Webster, 1992)
SF1-The skill level of the intermediaries (artisans) , their traditional involvement , and the prospectus and constraint bamboo furniture artisan are facing. • SF1.1- Support and Funding assistance towards promotion and commercialization.
Cultural-(CF) : ***"Culture is the framework of beliefs, expressive symbols, and values in terms of which individuals define their feelings and make their judgments."*** (Geertz, 1957)
CF1- The measures need to be adapted considering the buyer behaviour , beliefs to increase commercialization. • CF1.1-The preferable measures that can be adopted to increase the commercialization of bamboo furniture.
Psychological factor (PSF) :***The elements of your personality that limit or enhance the ways that you think.***
PS1- The factor that causing to the low commercialization of Bamboo furniture on basis of their perception , attitude knowledge and beliefs. • PS1.1- The Preferable choice of the buyers for buying furniture.
Design Intervention (DI)
DI1- Major Interventions can be incorporated in Design for increasing commercialization and adoption among Indian buyers. **DI2- Inventive measure that can promote design intervention in bamboo furniture for commercializing it among buyers.**

4.4 Data collection and compilation approach

The structuring of the survey was done with the creation of a comprehensive questionnaire comprising 25 items/questions divided into 2 parts, catering to furniture buyers and sellers (artisans, manufacturers and producers). Further, to ensure the validity of the questions, the questionnaire was sent for review to 3 architects who specialized in bamboo design and

construction, 5 discerning consumers, and 2 seasoned field experts in bamboo furniture production to get invaluable insight and ensure that the Survey question was pertinent and framed accurately.

After validation from experts, a subsequent pilot test was conducted with 50 buyers and 10 sellers to identify practicality and measure the intricacies of the sector. This process provided face validity to the measurement and ensured the degree of refinement in the posted questions. Finally, for the relevant results, the data was collected from buyers (which includes architects, designers, general consumers) and sellers (stakeholders from the bamboo furniture Sector). As the sector is unorganised, the estimated population was unknown. Therefore, the most significant approach was to align with conservative sample size estimation principles. This was a common strategy to ensure the sample size was sufficient to cover the broad range of potential scenarios as the actual parameters were uncertain.

The parameter to calculate the sample size (n) and construct a confidence interval for the population proportions. The formula for the margin of error (MOE) in terms of The critical value (Z) is determined by the confidence level (CL), and the standard error (SE) is assumed **MOE=Z×SE.** The critical value (Z) is determined by the confidence level (CL), and the standard error (SE) is calculated using the assumed proportions (P) and sample size (SE) state.

$$SE = \sqrt{\frac{P \times (1-P)}{n}}$$

The standard Z-value for a 95% confidence level is approximately 1.96, and the sample size is assumed following the confidence interval: proportion ± 0.05.

The standard deviation is based on the proportion (p):
$\sigma = \sqrt{(p(1-p))} = 0.5.$
$\alpha = 1 - 0.95 = 0.05.$
$p = 1 - \frac{\alpha}{2} = 1 - \frac{0.05}{2} = 0.975$
$p = Z0.975 = 1.96$

Use $p = \alpha/2$, and get the same sample size.

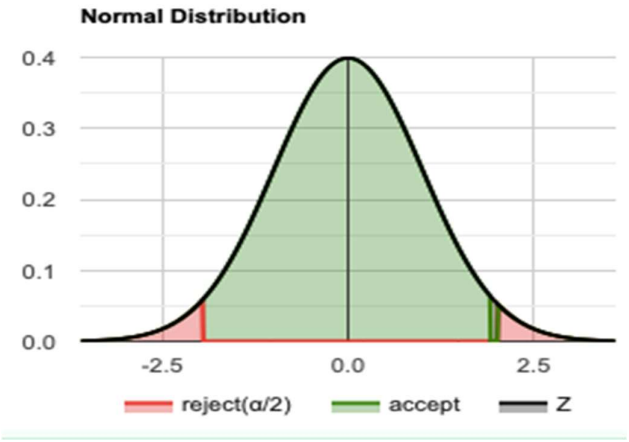
$Z_p = Z_{0.975} = 1.96$, You may instead use $Z_{\alpha/2} = Z_{0.025} = -1.96$.
The required sample size is:

$$n = \frac{Z^2_{0.975} * p\,(1 - p)}{MOE^2}$$

$$n = \frac{1.96^2 * 0.5(1 - 0.5)}{0.05^2} = 384.1459$$

Rounded up to: 385

Estimating the overall population, the specified parameter and assumptions depicted that a sample size of 385 is recommended to achieve the desired confidence level and precision in estimating the population proportion. This calculation ensures that the sample size is sufficiently large to precisely estimate the population.



Initially, 418 responses were collected, with 384 responses from buyers and 34 from sellers considering the analysis. As the study is based on measuring buyers' and sellers' attitudes, opinions, and perceptions. The five-point Likert scale is an adopted surveying tool offering a striking balance between granularity and effectiveness. The structure typically ranges from (strongly disagree = 1 and strongly agree = 5), including a neutral midpoint, allowing respondents to express neutrality or uncertainty. Collecting the data by the non-probability convenience sampling method finds the relationship strength between the derived Variable. The study defines consistency among the input variable, i.e., design intervention (DI), with the other proposed conceptual model, out of which two constructs, i.e., cultural and psychological factors, are the input variable and personal and social factors fall under the parallel supporting mediators.

Evaluating the in-depth literature followed by initial pilot testing revealed gaps in the bamboo furniture market. The study unfolds inconsistencies and gaps in the bamboo industry nationally and internationally. The study contextualized primarily towards cognizance of Indian society compared to China, Vietnam and Indonesia, as indicated in (Akwada & Akinlabi, 2016), (Singh O. , 2008). The other breaches that have been overlooked are the upgradation of bamboo as a

material for engineered wood, which is still retrograde in India, the availability of commercially viable species , bamboo product promotions and most importantly, the available design. The field-specific discourse with experts, artisans, and literary research indicates the blockchain of the bamboo furniture industry in India, which needs a focused review.

Evaluating the overall study the bamboo industry, India needs overall development, but the furniture market turned out to be scattered and untapped sector compared to other countries. Considering the current scenario, the hypothesis below is proposed to scrutinize and assess the loops of the industry in India which indicates on its adaptability and commercialization. These proposed hypothesis are not conjectures but refined propositions to bridge identified gaps and address research questions emerging from the amalgamation of theoretical and practical observations.

Statement 1	The income of the consumers is the parallel mediator, influencing the commercialize bamboo furniture in the market. *The statement is formulated basing buyers and seller behaviour (BSB) theory on commercialization by (KOTLER & ARMSTRONG, 2007). Analysing the stated theory ,commercialization of any product the focuses on various behaviour traits of users which directly or indirectly impacted by various sub initiators .*
Statement 2	Consumers awareness and perception significance on the adoption and commercialization of bamboo furniture in the market. *The statement is formulated basing the behaviours traits theory of the user by (Hawkins, Best, & Coney, 2004) . The theory stated on satisfaction is not desirable and customer satisfaction is measured by the level of customer contentment . The statement formulated analysing the theory parametric factors*
Statement 3	Predicting a defined staged approach in design (Design Intervention) to facilitate the commercialization of bamboo furniture. *The statement is authors own interpretation which is framed analysing the results from initial survey testing done with industry experts and pilot study .The proposed hypotheses statement is developed on basing the gaps stated by architects , manufacturer and artisans face to face interview discussion .*
Statement 4	Mechanical and physical properties (characteristics) of bamboo furniture could regulate commercialization. *The statement formulated considering attributes that makes bamboo as sustainable material . As species composition make it suitable for wide range specially for construction in American and African continents considering the factors the variable formulated to analyse furniture industry in India. (Boran, Ayfer , & Marius , Evaluation of bamboo as furniture material and its furniture designs, 2012)*
Statement 5	Minimalistic multi-functional design support in regulating the adoption and commercialization of bamboo furniture. *The statement is authors own interpretation which is framed analysing the comparative analysis gaps done on India bamboo furniture models and International bamboo furniture models .The result illustrated that international models were having superior visual appeal and upgraded composition.*

Statement 6	Product standardization, branding and certification positively support to commercialize and increase bamboo furniture adoption. *The statement formulated considering the issues bamboo building constructions industry facing in India. Understanding the prospective impact of the same , the variable developed for analysing its impact on furniture industry in India. (Manjunath N. , 2015)*
Statement 7	Online promotion, bamboo design fairs and exhibitions can enhance the commercialization of bamboo furniture. *The statement formulated considering the global issues stated (Phimmachanh, Ying , & Beckline , 2015) in "Bamboo Resources Utilization: A Potential Source of Income to Support Rural Livelihoods" . Analysing the literature stating the global impediments, the gaps of bamboo resources and its value chain limitation analysed and studied in India prospects. The variable developed to analyse its impact on commercializing furniture industry in India.*
Statement 8	Connecting to the designers and consumers by bamboo artisans and manufacturers in fabricating initial design, support promoting adoption and commercialization of bamboo furniture. The statement is authors own interpretation which is framed analysing the interview discussion with artisans. The constraint of having limited buyers and self-analysed design is further studied and illustrated to hypotheses by which commercialization of bamboo furniture could supported
Statement 9	The existing government promotional measures and incentives can enhance the adoption of bamboo furniture. *The statement formulated on basing case study and interview discussion, with furniture artisan ' Gautam' where they clearly highlighting on inadequate training exposures and educations practices . Analysing the gaps above hypotheses was formed .*
Statement 10	Self-assembly flat pack with personalised and intricate detailing can improve the commercialization and adoption of bamboo furniture. *The statement adapted analysing the literature study (Hong, et al., 2019) in the paper "Review on connections for original bamboo structure". It indicates the hindrance on the workability with bamboo and non-stable joinery . Understanding the users concern towards joinery and the wide acceptability towards knockdown wooden furniture.*
Statement 11	Region availability of specific furniture crafting bamboo species can impact adoption and commercialization of bamboo furniture. *The statement is author own interpretated variable for furniture industry formulated inheriting the issues bamboo cultivation is facing in India. Studying the various prospective gaps of bamboo cultivation by (Jamatia, 2012)is adapted for furniture industry model.*

In reference to evaluating the above hypotheses, the flow chart proposed below which helps to study the impact of derived behaviour trait variables (personal (PF), cultural (CF), social (SF) and psychological(PSF)and design-based variables (Design Intervention(DI)) on the commercialization of bamboo furniture.

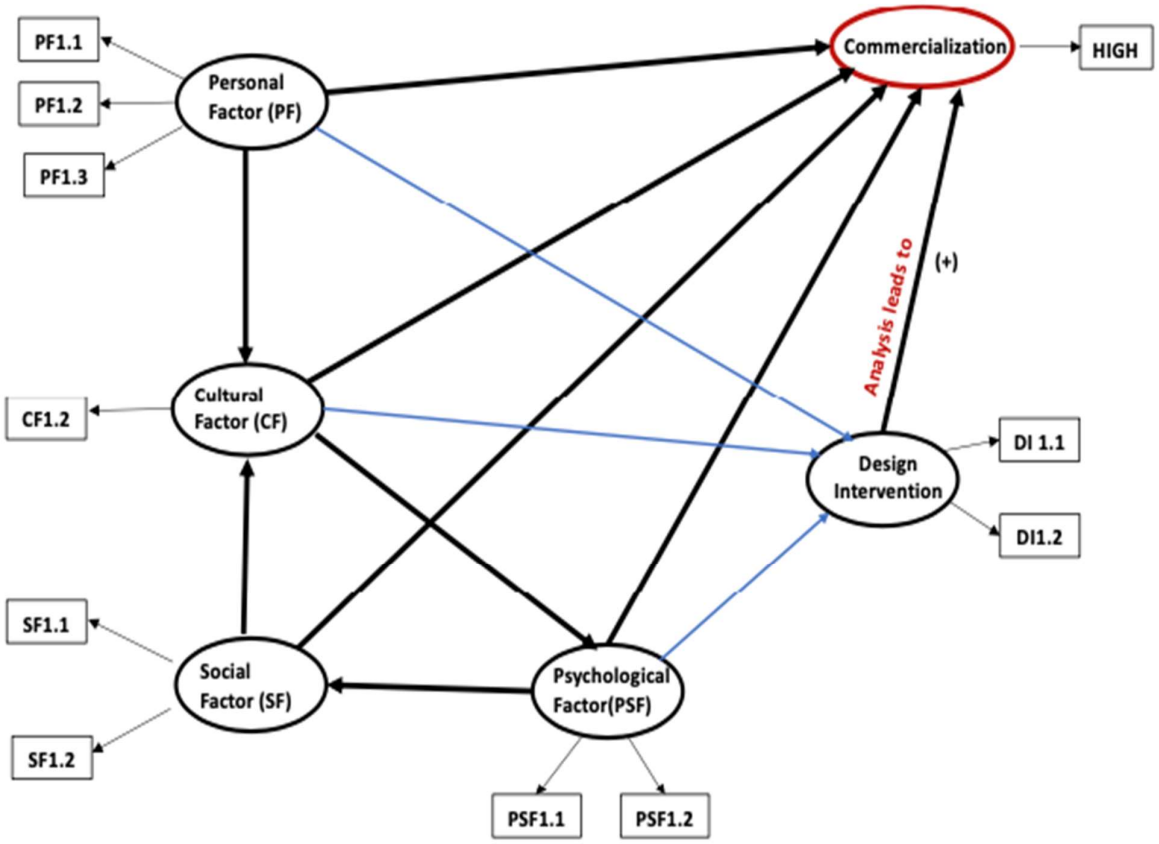


Figure 45: Conceptual model of commercialization .
Source :The Author

The factor evaluation under each variable stated their dependency on design for commercializing bamboo furniture in India. Further understanding the importance of the variable is simplified to understand the prominent factors to improvise the commercialization.

4.5 Study and Data Collection Parameters

Studying the aspects of commercialization of the bamboo furniture industry, the buyers, i.e. architects, designers, and general consumers, are the principal users of the furniture and analysing the commercialization factors and intervention impact from the furniture industry stakeholders' perspective is significant. As commercialization influencing factors, i.e. buyer and seller behaviour, BSB is derived in 4 parameters, and the 5th derived factor influencing buyer-seller behaviour, i.e. Design intervention, is accessed using users perspective by empathizing, defining, ideating, prototype designing and testing. Accordingly, the identified segments study carried out on the selected areas using a subjective-based methodology, which comprises buyer and sellers'

individual opinions, points of view, interpretation and judgement and objective-based methodology, which comprises fact-based measurable and observable positive and negative information.

4.6 Field Survey for Segment Level Parameters

One of the most critical aspects of commercialization is intervention in design. By more contemporary form, bespoke, easily movable and pack flat design is essential for commercialising bamboo as a substitute for wood for sustainable environments. Consumers' perceptions, behaviour and buying tendencies are crucial in furniture purchases. As buyer behaviour is the prime aspect of commercialising a product, numerous research studies have focused on buyers' and sellers' evaluation of commercialization. The study focuses on 5 board parameters comprising two 22 attributes in each set.

4.6.1 Personal Factors (PF)

The personality trait clouts the consumer's perceptions and their buying behaviour. Marketing experts believe that users' personalities influence the product types and branding purchased and produced. For instance, a car purchase may reflect one or more personality traits. The user's behaviours purchases study showed that people generally prefer brands and products that are compatible with their self-concept. The personal factor considers the mode of living, as identified by a person's activities, interests and opinions, which helps segment and target consumers. Self-concept, Age, sex and life-cycle contribute to building consumer behaviour; moreover, family life-cycle and a person's occupation are some of the most driving factors affecting the behaviour of consumers. Some of the significant personal factors include:

- Age is one of the primary factors that impact our preferences. The purchasing choices of young will be more vibrant and flashier and will differ from what an elderly person purchase. Meanwhile, middle-aged people naturally focus more on purchasing comfortable, durable, but vibrant.
- Income impacts our purchasing behaviour; higher the income, the more purchasing power the buyer holds and vice versa. Similarly, in the case of sellers, higher income incentivizes more people's involvement in a particular industry.
- Occupation largely steers the purchasing decision-making. The purchase of items is relevant based on the involved profession. The choice of purchase is influenced by the users involved in the occupation.

- Users' trials and tribulations are an attitude and a way an individual stays in society. The buying behaviour is highly influenced by the lifestyle of a consumer. A consumer's lifestyle affects furniture choice; for instance, the elderly look for sturdy and comfortable furniture rather than contemporary models.

4.6.2 Social Factors (SF)

Society is composed of individuals who have different preferences and behaviors. The social factor discusses the indirect or direct outside influences that people have on their purchasing decisions. Social factors guide individual decision-making and directly impact people's consumption and purchasing behaviour; these varied behaviours influence the personal preferences of individuals. The group's beliefs, values, attitudes, assessments, behaviours, and aspirations are perceived by the social factor.

- The social factor observes that all the members of the reference group share expected buying behaviour and strongly influence each other. The subfactor included the Initiator (who initiates the buying decision), Influencer (whose opinion influences the buying decision), Decision-Maker (who has the authority to make the purchase decision) and Buyer (who ultimately buys the product), (Business Jargons).
- The normative pressures strongly affect the person to act in a unique way. An essential role in consumer behaviour is related to the decision maker; they make their final decision about material choice or brand by getting influenced by these parameters filed. (Mowen & Minor, 2009)

4.6.3 Cultural Factors (CF)

As per (Mc Daniel, 1999) culture factor is a defined set of norms, values, distinct attitudes, that are transmitted from one generation to the next. Cultural factor includes basic values, needs, social essence and buying habits and it's clearly defines to a stable models of behaviour, especially in forms of consumption. The culture characteristics are adaptive and dynamic.

The studies states that culture affects, the behaviour of the consumer in buying of the good and service i.e. it has affected the decision of the consumer on buying, culture has greatly influenced diversity of consumer .The marketer studying the various market segments needs to plan and the take strategic marketing decisions accordingly. Therefore cultural factors affecting consumer behaviour will help the business in fulfilling the desires of the consumer and consequently turn the business into a successful venture (StudyCorgi , 2020).

4.6.4 Psychological Factors (PSF)

Psychology is a major determinant of consumer behaviour and Psychological needs are at the first level of Maslow's hierarchy. The psychological needs are the present and recur throughout nature.[35] These factors are powerful enough to influence a buying decision but are difficult to measure. The users psychology attempts to understand the way that buyers think, feel, involved purchase reason, and make decisions.

Figure 46: Psychological factor affecting commercialization
Source: (Clootrack, n.d.)

According to Solomon, this traditional process demonstrates that people

"Calmly and carefully integrate as much information as possible with what they already know about a product, painstakingly with the pluses and minuses of each alternative and arrive at a satisfactory decision" (Schoultz, Spetz, & Pettersson, 2019)

- The perception is a major factor that influences his behaviour. The Selective attention, distortion and retention are three processes that determine consumer perceptions. Primarily selective attention describes the process consumers use to select where they will focus. Selective distortion refers to how customers try to interpret information to align with what they already believe, like the idea of confirmation bias. Retention refers to the ways in which marketers focus on the information that supports their consumers' beliefs[36] (Lasalle

[35] Adapted from /https://courses.lumenlearning.com/clinton-marketing/chapter/reading-psychological-factors/
[36] As per the https://online.lasalle.edu/degrees/general/influences-on-consumer-behavior/report Maslow developed a model that needs relate to one another other in a "need hierarchy," with basic survival-oriented needs at the lower levels of the hierarchy, building up to higher emotional needs associated with love, self-esteem, and self-fulfilment.

University, n.d.). In total the perception is a process where information is collected about a product and gets interprets to get an image of particular product.

- Motivation influence the decision making and buying behaviour of the person. A need becomes a motivation for purchase when it reaches to the urgency that make consumer feels compelled to act. The buyers may respond to various needs depending upon the needs commonly involving their physiological, biological and social motives.[37].
- The learning grounded on skills and knowledge. Learning can be either conditional or cognitive. Knowledge can be acquired only through experience but skill is attained through rigorous practice, knowledge can be acquired only through experience.
- Attitude is defined as a person's enduring favourable or unfavourable evaluation, emotional feeling action tendencies towards same object or idea (David Krech, 2004). The attitude and beliefs plays a significant role in defining the brand image of a product. Consumers follows certain attitudes and beliefs which influence their buying practices. Based on the attitude. consumers attain to behaves towards a product.

4.6.5 Design Intervention (DI)

(Rogers, 2003) defines innovation as **"An idea, practice, or object perceived as new by an individual or other unit of adoption**." In the line of this research new furniture or product can also be perceived as an innovation. Design can be defined as "The process in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003). For commercialization of a material all the relevant members in a social system (value chain) need to be convinced before a material might make it eventually onto the final consumer market. The Design of the product came as the most important variable in initial literature study and analysing the users specifically architects and designer by interview, to formulate the possible Intervention of design. As the product design hold an important position in the value chain of most tangible products as it link the product to the potentially final consumers , material producers and application manufacturers (Bas, 2007) (Kesteren, I.E.H, & Kandachar, 2004). However, the design also comes early as the dependent nodes downstream as buyer and sellers ascertained perception. Actually connect furniture to the consumer market (Lugt, 2008).

[37] Adapted from https://businessjargons.com/psychological-factors-influencing-consumer-behavior.html

Finally, the analysis was done to evaluate buyers' and sellers' perceptions with regard to parameters considered for the present study and evaluating the intervention in design as per stakeholder perception of its viable impact on commercialization considering variables rating of the users from the defined study area and further based on evaluated outcomes the prototype model is designed and further it impact study on the users and manufacturer.

Initially, the survey was inspired by the Customer Effort Score (CES) survey format and preliminary surveying of the study area; further, it was modified to suit the study parameter. These inputs are utilised to refine the Survey Performa. The survey study is divided into two parts, and Performa is further subdivided into sections shown (Annexure -I and II). The initial section of the Buyer's questionnaire (A to C) assesses the commercialisation considering buyer behaviour, and the fourth section evaluates the possible impact of design intervention. Meanwhile, in the second set of questionnaires for sellers, part A assesses the skill level of the stakeholders of the bamboo industry, and part B evaluates their prospectus and constraints. The objective and subjective responses were recorded on a 5-point Likert scale, ranging from 1 strongly agree to 5 strongly disagree parameters.

4.7 Preference and Perception Survey

The prerequisite survey caters to the social characteristics of the respondents in terms of their gender, age, occupation and income to evaluate the preferences and the desired improvements needed. The buyer's and seller's perception towards commercialization, their latent desire while looking for the furniture and the expected improvement required in the adoption of bamboo for furniture making in lieu of wood. The survey analyses buyers' behaviour, perception and buying preferences for furniture. The other subsequent parts of the study pertained to rating bamboo furniture industry commercialization from buyer and seller perspectives. Further, the buyer and seller (including all bamboo industry stakeholders) explored their aspects to improve the adoption and commercialization of bamboo furniture. The responses were evaluated on a five-point Likert scale with the options ranging from ‘strongly disagree’, ‘disagree’, ‘neutral’, ‘agree’ and ‘strongly agree’. The last section specifically sought their desired design intervention, which they consider to build better commercialization of bamboo furniture. As many as 384 buyers and 34 stakeholders were interviewed separately in the selected state, with a sample size of a minimum of 50 buyers and an average of four sellers. This ensured feedback from a diverse set of people. The data procured was then aggregated for the whole urban market of India.

4.8 Survey tool

The survey follows the identifying and mapping of the states (with three central metropolitan regions and three bamboo-growing states). The Performa for Field Survey and Questionnaire copy for analysing the buyer and seller perception and preference. The face to face interaction with various stakeholders accounted for initial segments subsequently few segments, found more efficient for filling questionnaire survey Performa. Approximately Performa for consumers' perception and preference survey was also served through e-platform market analysis, and users' feedback is diverse. Face-to-face interviews and field surveys were undertaken simultaneously for further evaluation.

4.9 Conclusion

This chapter developed the conceptual model that evaluates the commercialization of bamboo furniture by analysing the buyer and seller behaviour in selected areas. It brings into consideration those aspects (i.e. design and design-based) that positively impact commercialization as per stakeholder aspirations by evaluating the area chosen to have an overall view in general. The suggestion is strengthened based on feedback from the involved stakeholders, and these recommendations and suggestions would help to bridge the gap in the existing setup for upcoming developments.

CHAPTER 5

FIELD STUDY

This chapter is a brief analysis carried out of the study region, selected considering major urban areas and bamboo furniture-making regions of the country. Considering this, the study is divided into 6 regions: three metropolitans to understand urban consumers and three from the northeastern region, as the northeast region is known to be a prosperous bamboo resources state. Some field visits were undertaken to collect data from the cultivators, artisans, entrepreneurs and consumers' value and supply chain. The metropolitan states are Delhi, Mumbai (Maharashtra), Kolkata (WB), and Northeastern states are Assam (Jorhat), Tripura and Manipur. The interaction covered both males & females of various age groups in which clusters of bamboo artisans and consumers were focused on analyzing the consumer's preferences for furniture and the status of bamboo furniture and its artisans in all the respective areas.

Field Study Brief

5.1 North East Region- Assam

5.1.1 Introduction

The Northeastern region is a mass contributor to bamboo production. As per the *(FSI , 2015)* the North-eastern forest cover comprises approximately 65 percent of its geographical area compared to the total National forest cover of 21% *(International Bamboo and Rattan Organisation, 2017)*. The region comprises eight significant states – Assam, Arunachal Pradesh, Manipur, Mizoram, Meghalaya, Nagaland, Tripura and Sikkim and shares borders with China, Bangladesh, Myanmar and Bhutan. Having rich natural resources, the accounted population is 45.5 million with a low density of 174 individuals per km2 *(International Bamboo and Rattan Organisation, 2017)*, *(North East Council Secretariat, Government of India., 2015)*. The state majorly constitutes 65% of the forest cover of its geographical area compared to the national forest cover of 21%. The main source of livelihood of the state is agriculture and allied activities; nearly the rational size of the population, 65%, has a dependency on agriculture and allied activities as their primary source of livelihood. The north-eastern region has approximately 45 million people, and more than 80% of the region's population lives in under-developed areas, greater than the country's average of 69% *(International Bamboo and Rattan Organisation, 2017)*. Moreover, the region comprises 1/4 of the tribal constituting 200 tribes

Figure 47: Geographical representation of North East region
Source: (Map store, n.d.)

North-Eastern States	% of forest area to geographical area	% of bamboo bearin to total forest ar
Arunachal Pradesh	61.39	31.29
Assam	34.21	26.98
Mizoram	91.47	47.94
Meghalaya	79.93	26.74
Tripura	76.71	40.35
Manipur	77.20	53.97
Nagaland	80.50	36.72
Sikkim	47.80	34.82
Total	65.34	32.68

Figure 48:Forest area and bamboo bearing in North East region.
Source: *(North East Council Secretariat, Government of India., 2015)*.

5.1.2 Area Distribution

Assam is one of the second largest state of northeast region after Arunachal Pradesh located between 24° to 28°18’ north latitude and 89°50’ to 97°4’ east longitude (Salam) .The eastern part of the state shares boundaries with Arunachal part share its boundary with West Bengal and Bangladesh whereas the southern part of the state’s shares its territory with Meghalaya, Tripura, Mizoram and northern with Bhutan and parts of Arunachal Pradesh. The state has total 33 districts and share 2.4% of total geographical area accommodating 2.6% of the population. As per the data by Census of India (2011) the population of Assam has 311.69 lakhs from which female accounts 152.66 lakhs and male 159.39 lakhs (Salam). Nearly 15% of the population is urban and rest 85% is rural who are totally dependent on micro and small-scale enterprises. The state has 2177 registered unit out which 1710 are micro sectors, 441 small scale business and rest are medium scale setups.

Figure 49: Forest Area and bamboo delivery in the North- East region
Sources : (FSI , 2015)

5.1.3 Bamboo Resources in Assam

Assam is a state rich in resources and mostly covered forests, which are richly stocked with bamboo of various species. The state is among one of the giant bamboo-producing states in India. Besides being an essential component of the forest ecosystem, bamboo can be found in every traditional home garden of Assam (Gogoi , 2020). Some of the areas rich in bamboo resources are Nagaon, Karbi-Anglong, Cachar, North Cachar Hills, and Lakhimpur. As per the study reports by (Gogoi , 2020), there are nearly 51 species grown in Assam, and some of the important species of bamboo with high commercial value are the Dalu (Teinostachyum dalloa),Muli (Melocanna bambusoides), Khang (Dendrocalmus longispatnus), Kaligoda (Oxytenanthera nigrociliata) and Pecha (Dendrocalamus Hamilton-ii). Assam has skilled craftsmen with knowledge of bamboo cultivation and management. Moreover, crafting with bamboo is one of the most common practices performed by large number of population artisans. This household-

based industry needs no mechanical device and is carried out irrespective of caste, community, or creed by all the rural. The northeast region is suffused with the highest concentration of bamboo resources and has an immense scope of earning and giving additional returns.

Parameters	Assam
Geographical Area G.A (Sq km)	78,438
Recorded Forest Area (Sq km); (% to G.A)	26,832; (35%)
Government Owned land (%)	78%
Community Owned Land (%)	22%
Pure Bamboo Area (200 or more clumps/Ha)	41
Dense Bamboo Area (101-150 clumps/Ha)	1543
Scattered Bamboo Area (21-50 clumps/Ha)	7244
Clumps Hacked Area (1-20 clumps/Ha)	102
Bamboo Regeneration (Clump formation yet to start)	25
No Bamboo Area (Bamboo totally absent)	17877

Figure 50: Bamboo density in recorded forest area in Assam
Sources: (Indian Council of Forestry Research and Education Dehradun, 2017)

The ISFR-2017 report also presents the state's growing stock estimates. The total number of green sound culms in Assam is estimated at 1848 million, and their equivalent weight is 10.375 million MT. Dry sound culms in the state are estimated at 387 million and their equivalent weight is 4.537 million MT. Thus, the total green weight of bamboo culms at the state level is estimated to be 14.912 million (Salam).

5.1.4 Bamboo as a wood substitute

Bamboo turned up as one of the most viable substitutes for wood because of its properties and low proportion of lignin. When it comes to softwood, bamboo is the best alternative. Bamboo is used as a wood substitute for making various commercial products like bamboo flooring, board, laminates, particle composites, etc. Recently, the Indian Plywood Industries Research & Training Institute (IPIRTI) has developed this technology, which allows the bamboo furniture and craft-making sector to generate about 250 million jobs by employing mainly women from rural and tribal areas. Leading to income generation of Rs. 15 billion a year (Gogoi , 2020). Surprisingly, bamboo is only considered for craft, and about 19 % of the bamboo is used in handicrafts and allied activities all over India.

5.1.5 Status of Bamboo

Bamboo products are found to be strong, resilient, uniquely attractive, and environmentally friendly. The rise is noticed in demand for bamboo and the by-product in domestic as well as international markets due to advancements in technology and the need for wood alternatives. Bamboo vendible are normally cheaper than similar wooden products and proper channelizing could raise its possibility of more demand in the market. North-East India, particularly Assam, was founded with this immense untapped resources. Bamboo-based industries, though an unorganized sector, provide livelihoods for most of the tribal and rural sectors with home-based work. The industries generate support for the domestic economy and can support the export sector with postproduction and processing operations. Assam, to a very large extent, depends upon the bamboo socio-economic advancement. This eco-friendly yield has immense potential to support the rural economy and industrial development on a sustained basis (Gogoi , 2020). Bamboo products were originally being crafted by artisans for their domestic utility, but now it's been initiated as a small-scale setup in every alternate household in Assam. But still, if we see a furniture-based market, the supply still faces the lags. The furniture crafted from bamboo is biodegradable and environmentally friendly. The government of Assam has though introduced some programs to uplift the bamboo furniture industry and encourage the artisans for commercial production. The Government came up with the Bamboo and Cane Policy for Assam development that aims for sustainable development and utilization of bamboo and cane resources in the state through scientific management and stakeholders' cooperation and participation. Though many subsidies and development incentives have also been provided to small-scale setups like handicraft and furniture making. The Government is trying to facilitate and give channelization to the direct market linkages to the entrepreneurs and artisans. In addition, the government has also set up a Bamboo Technology Park with an investment of Rs 62.28 crores enabled with a modern Common Facility Centre for producing many innovative designs (Gogoi , 2020) , (North East Council Secretariat, Government of India., 2015)

5.1.6 Data collection

The study is synthesized based on both primary and secondary-level data. For primary data collection purpose, the study confined to the adoption of mixed method approach using qualitative and quantitative techniques. The primary data is collected from the respondents by interview schedules, case study and questionnaires. The study was conducted districts of Assam viz. Jorhat.

The secondary data involves reviewing journals, paper, and reports. The study involved interaction with bamboo artisans and manufacturer. The discussion involved with various bamboo clusters like designers and architects, to get a holistic perspective of the industry. Random selection of respondents includes bamboo artisans involved in bamboo furniture making and marketing to gather primary level information. Some wholesalers were also being contacted involved in bamboo furniture making. For secondary level information collecting, the relevant data were sourced from literature, reports by National Bamboo Mission World bamboo organization, Department of Commerce and Industry, Government of India (Gogoi , 2020).

5.1.7 Socio - economic status of artisans

Raw material required by the bamboo furniture artisans is generally procured by local bamboo growers and village level bamboo aggregators. Each household stock bamboo in their homesteads or farms. Bamboo Balcooa and pallida are some of species that are adequate for crating furniture are importantly it is locally available (Salam). Bamboo furniture has though had high demand, but there is shortfall production allied activity, few skilled artisans for making bamboo furniture. The artisans involved in this process mostly use hand operated tools and very light electrical tools. Their production process is labour intensive and takes a lot of time to manufacture one kind of furniture. The artisans who are skilled are specialized only in few designs of furniture and produce the same. Artisans' houses are generally their production and warehouses to store products as they do not have a protected place for storing raw materials. Most importantly if analysed the current status, finished products they produced are not provided with any kind of packaging or protection (Salam).The Capital investment is prime factor for determining the production costs and it playing a vital role in production and productivity allied processes. Although it has been seen that entire family member are involved in bamboo furniture making activities, yet some of the artisan's household hired wage labour on daily basis as per the craft requirement. The wage rate of these artisans varied from places, person, efficiency and length (Gogoi , 2020) of working hours which varied between Rs. 250- Rs.450 per day.

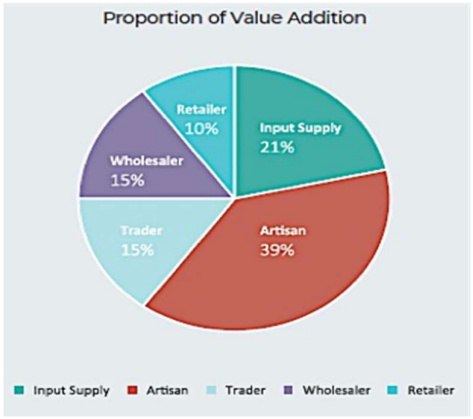


Figure 51: Proportion of value addition in furniture manufacturing
Source: (Export Import bank of India)

5.1.8 Marketing structure and Analysis

The analysis of market is a qualitative and quantitative evaluation, the success or failure of enterprise depends on promotions of its developed products. The bamboo products are produced by several small and medium scale enterprises, but due to lack of daily/ weekly market, it not possible for the individual artisan to connect directly to the consumer leading to low sale and direct marketing. Moreover, the artisans do not have suitable means of transport and adequate road connectivity to get connected to wide urban market. They dependent on the village traders and other commission agents for sale. The bamboo furniture makers mostly sell to the middleman like commission agents or village traders; these are then taken to wholesalers, retailers, and consumers (Gogoi , 2020). Though there is traditional demand for bamboo furniture in domestic area, but global market still disconnected. To the surge for wood alternative, demand for bamboo furniture need a primitive measure. The brief market study stated that bamboo furniture face variation and non- recognition in the urban market majorly because they could not connect to the consumers directly and need to as sell to the centres are usually located at far off places that add on to the cost due to middleman share. It is observed that rural markets are mostly poorly equipped in respect of roads, connectivity, and communication. The bamboo products marketing in the handed privately by traders who act as commission agents or middleman. For channelizing the marketing to take the produce to the final users. The marketing of bamboo items indicates the dominance of middleman or commission agents. The artisans manage only bi-weekly or monthly markets and direct marketing faces major challenges like storing inadequate technology and transportations. But a major part of the bamboo furniture making is handled by the local village traders and commissioning agents who trans-shipped their assembled furniture directly consumers and whole seller.

Figure 52: Value Chain followed by bamboo furniture market in Jorhat
Source:The Author

Price-spread of Bamboo Sofa Set in Jorhat					
Sl.No	**Items of costs and Market**	**% Cost**	**Price per Unit selling directly to Retailers**	**Price per Unit selling with additional node(wholesalers)**	**Price per Unit selling with additional node(intermediaries and wholesalers)**
1	**Net Price of the furniture by artisans (Including Labour charges +raw material)**		**24550**	**24550**	**24550**
2	**Miscellaneous cost (to be barred by artisans / producers**				
	Transportation	3%	737	736.5	736.5
	Labour charges	2%	491	491	0
3	**Middle man / Commission agent Cost**				
	Transportations	3%	0	0	737
	Labour charges	3%	0	0	737
4	**Wholesaler's Marketing Cost**				
	Transportation	3%	0	737	736.5
	Labour charges	2%	0	491	491
	Storage charges	1.2%		294.6	294.6
5	**Selling Price i.e. Retailer's Purchase Price**		25778	27300	27987
6	**Retailers Marketing price**	4%	1031	1092	1119.48
	Labour charges	1.5%	387	409	420
	Storage charges	1.2%	309	328	336
	Final finishing charges	2%	516	546	560
	Miscellaneous exp(transportations charge	as) 3%	644	546	700
	GST	18%	4640	4914	5038
7	**Consumer's Purchase Price**		**33305**	**35135**	**36159**

Table 2 Cost analysis of Sofa at 3 levels nodes- Directly to Retailers, with additional wholesalers and with additional intermediaries
Source: The Author

The selling chain seen directly effecting the price of the furniture, a wide variation is being seen in the prices of the furniture with each additional node in the marketing chain. The wide margin is enjoyed by the middleman and intermediaries, the involved costs from production to assembling the furniture get scattered into wide area. The services like grading of raw material, handling, transportation, labour charges production charges and marketing been charged substantially. With an additional intermediary at each level set a variation in the cost till it finally reaches to the end consumers. The adequate study of marketing margin and marketing cost is necessary. This can help to facilitate in formulation of appropriate price policy which can provide incentive prices to the producers and to will also protect the consumer at the same time from inflation. Price spread analysis not only will help in showcasing the cost and margins at different levels of marketing by different agencies but also help in representing a clear picture of the entire system of marketing. The study is allocated in the sample districts viz. Jorhat to access the working of marketing channels of bamboo furniture and what price variation derived each

addition node. The furniture sold directly to wholesalers, retailers or with involvement Intermediaries brings a differentiation in pricing till it finally reaches to the end consumers this is making bamboo furniture overvalued and inversely affecting the demand. This study can be helpful to gives overview about the marketing system efficiency and to analyse whether the services of intermediatory agents can be availed at reasonable fixed prices (Gogoi , 2020). This will also help local government to allocate an adequate price margin at each node, which could help in abridgment the inadequate and variable pricing. The adequate planning can help Bamboo furniture industry to sustain our national economy by providing some employment opportunities for rural people which includes collection of raw material, processing, and marketing. The study indicates that micro bamboo-furniture industry could develop rural areas more rapidly and be a promotive path for their socio-economic development (Swamy, 2011)

5.1.9 Study Limitation

Few artisans are engaged in bamboo furniture manufacturing, hence cannot cater to larger demands:

- Bamboo furniture making highly labour-intensive process and takes longer time and workmanship to craft a single piece.
- The artisans involved in furniture making mostly use hand operated tools or light electrical tools which makes furniture making not only a tedious job, but desired finish is also not achieved.
- Giganteus bamboo species required by the artisans is not available locally and it needs to get procured from longer distances that incur over transportation charges and higher end cost.
- Artisans generally use their house as warehouse for storing finished and semi-finished products as they have a lack of protected place to store their products.
- Artisans are generally having specialization crafting few designs and generally they come up with same repetitive design.
- There is a huge gap between artisans and their access to the market and thus they are unaware about the consumer's interest and market requirements.
- Artisans are not designated to crafting furniture only and found engaged in all kinds of processing work from collecting bamboo to making and finishing the furniture, hence they cannot cater the demand.

- Mechanically finishing, packaging, and branding of furniture are not available, and it is performed manually which are not as per the consumer's satisfaction level.

5.2 Study of North East Region- Tripura

5.2.1 Area Distribution

Tripura an isolated state, adjoining to Bangladesh from northern, southern and western sides through an 856 km-long boundary which if broadly calculated it accounts that nearly 85% of the state's perimeter (International Bamboo and Rattan (INBAR)) .If we see in Figure 27 Tripura appears like a pocket at the side of Bangladesh. Whose land-linkage if we briefly see with India is limited to a strip of 60 km that connects with Assam, with shared eastern boundary from Mizoram. This political geography had made trade with Bangladesh easier. The state topography – has hills on the east and plains in the west. Nearly 70 % of hilly terrain, makes communication and transportation difficult in Tripura . Increase in the population and low cultivable land has increases the pressure on the land. The huge rural population of Tripura is majorly dependent on agriculture for livelihood .The state nearly has 40% are agricultural labourers 55% are the. The Tripura's urban population is less than 18 % of the total that reflects the dominance of the rural character. Nearly 69 % of the state is indicating the predominantly tribal character : with total 19 tribes and some of the main tribes are Tripura, Reang, Jamatia, Chakma and Halam. The tribal populations reside mostly in the hills and practice shifting (slash and- burn) cultivation, locally called jhum, which is almost a way of life. Jhum hardly produces any surplus, but helps sustenance and partly meets food security (International Bamboo and Rattan (INBAR))

Figure 53: Location Map of Tripura
Source: (Rao, Arun Kumar, Reza , & Motukuri, 2009)

5.2.2 Bamboo Resources

The state caters in 38% of the total forested area, which includes either pure or mixed bamboo forest (International Bamboo and Rattan (INBAR)). Although Tripura caters 19 species of bamboo, the commonly used species are (Bambusa tulda), Muli (Melocanna baccifera), Bari (Bambusa vulgaris), Mirtinga and Barak (Bambusa balcooa). The state accounts bamboo in small holdings at 10,900 ha. and the annual extraction is 184.26 million culms is much beyond the sustainable annual yield of 142.60 million culms; this, combined with bamboo flowering and death of clumps, has resulted in a shortage such that the cottage industry has a need of purchasing bamboo from traders (International Bamboo and Rattan (INBAR)). It is estimated that by management and extraction of bamboo employment of 6.1 million workdays is generated. Moreover, most of tribes are engaged in shifting cultivation. These tribes are allowed to extract bamboo free of cost for construction and other uses. According to the report by Centre for Science and Environment (CSE), these tribal population extract Muli bamboo from the forest and sell it for INR 0.50 (USD 0.01) per bamboo pole. Each pole fetches about INR 2.00 (USD 0.04) when it reaches Chakmaghat and comes to INR 5.00 (USD 0.10) till Agartala market. From 330 villages that were studied for bamboo resource strength, nearly 45 villages (13.6 percent) had bamboo resources cover on 50 % of the area in 1 km buffer. Nearly out of 45 villages, half of them dependent on Muli bamboo. Although about 59% of the total of 330 villages assessed with homestead bamboo (International Bamboo and Rattan (INBAR)), (Ramanuja , Kumar , Reza , & Bhar).

Housing	134.69 Million nos.
Supply to paper mill	16.51 Million nos.
Handicrafts	3.20 Million nos.
Agricultural implements	1.47 Million nos.
Other use	28.39 Million nos.
Total	**184.26 Million nos.**

Figure 54: Present utilization of aforesaid extracted bamboo Sources (State Bamboo Policy - Farmers Portal Tripura; State forest report, 2017)

Country	Pure Bamboo	Dense Bamboo	Scattered Bamboo	Bamboo Present but Clumps Completely Hacked	Bamboo Regeneration
Arunachal Pradesh	137	5358	9558	34	38
Assam	41	1543	7244	102	25
Manipur	95	2790	7676	59	67
Meghalaya	47	2035	3816	21	24
Mizoram	35	922	2287	16	7
Nagaland	57	1669	4196	30	73
Sikkim	0	214	339	0	0
Tripura	19	545	3018	4	31
Total	431	15076	38134	266	265

Figure 55: Bamboo bearing area by density recorded in Forest Source: (Export Import bank of India ; Export Import bank of India)

5.2.3 Status of Bamboo

The requirement of furniture sector need coordinated approach planning and community plantation. Moreover, the demand of semi-processed or treated bamboo for furniture making is presently being catered from manual processed whole bamboo which adversely affecting productivity and quality . There is a need of integrated linkages between technical and technological solutions to facilities the producers at doorstep (Export Import bank of India). Common Facility Centres(CFCs) setup can be helps in facilitating reduction of wastes, drudgery and physical risks which can help to enhance quality and durability of furniture . To upscale the bamboo industry Tripura government is also focusing on setting up a (CFCs) centre for training, processing and packaging of agarbatti at Gandhi gram, Agartala. This inventive measure can support small scale manufacturing unit to upscale their business and assist artisans in processing, production and quality control of there products (International Bamboo and Rattan (INBAR)).

Figure 56: Gandhi gram bamboo crafts processing centre
Source: (Export Import bank of India)

The artisan's skill is limited to few only artisans, the rest of the bamboo-based production continues to be oriented towards the local subsistence economy, while the commerce is largely controlled by middlemen who pocket the maximum benefits (International Bamboo and Rattan (INBAR)). Bamboo is not a staple commodity nor does it have a guaranteed market. Small Changes in market demand can greatly affect its processors and suppliers, which results to undue pressure on natural resources and unsustainable harvesting. This is one of the main reasons of degradation of the bamboo. Variation in the prices of bamboo furniture can increased harvesting which can result to subsequent depletion of the resource in the future. Higher demand will increase harvesting as people want to capitalise on the increased prices but is tempered by the quality that the market demands (India brand Equity Foundation, 2014), (Export Import bank of India).

5.2.4 Market analysis

Figure 57: Training of Bamboo Artisans crafting Bamboo furniture
Source: (Bhandari, 2018)

Tripura is endowed with rich and diverse bamboo resources and home to 21 species of bamboo. Tripura's bamboo furniture and products has exquisite designs with wide range and artistic appeal. Studies indicated that bamboo as effective substitute of timber. About 10,000 artisans are engaged in the production of over 200 handicrafts products in the state. (India brand Equity Foundation, 2014) To commercialize bamboo market in Tripura TBM(Tripura Bamboo Mission) working on enhancing turnover of bamboo sector from Rs. 27.9 crore to Rs. 75.85 crores by 2010. By 2009, through various initiatives and activities, the mission had scaled up the state's turnover to Rs. 56.56 crore and Rs. 115.56 crore by 2012–13 (Bhandari, 2018). The target was Rs. 200 crore by the end of 2016–17. The turnover (export from state) of commercial bamboo sector was estimated at Rs. 96.53 crore for 2016–17. The state has 16 clusters for incense sticks production, 24 for handicraft/furniture production, and seven for bamboo plantations. In year 2016–17, the Tripura Bamboo Mission has organised 24 skill development training programmes under which 710 artisans were been trained; nearly 40 artisans were trained in two development programmes on capacity-building training in bamboo furniture, training 40 artisans and five programmes for training of 25 trainers were also been organised with two programmes on soft skill training and four skill exchange programmes for 82 artisans (Bhandari, 2018). Some private enterprise opened bamboo wood manufacturing unit for commencing the commercial production. These semi-automated facility centre are employing 100 people and surprisingly the unit producing wood , boards from bamboo and products out of that processed wood, including furniture, flooring, panels, outdoor decking etc. These products are though new in India but international market of these products is dominated by China (Bhandari, 2018).

5.2.5 Study Limitation

The state has recently initiated on imparting skills in a semi-mechanised ways for improvising production . Some entrepreneurs were trying adopting this semi-mechanised technology. But in furniture cluster there are still in acceptability in using bamboo to manufacture furniture. Market connectivity due to the remote location of the state and on-time delivery is major noticeable issues. Many order get cancelled due delay in delivery . A published report state such incidence where bamboo hanger maker received a bulk order but non-delivery of hooks from Kolkata translated into cancellation of the order and accumulation of inventory (Bhandari, 2018). Many such incidences are common in Tripura which indicates to the lacks of the sector (India brand Equity Foundation, 2014).

Some self-help group (SHG) also initiated in connecting to the market. The development by these SHG had given the women tremendous confidence and financial independence. The cluster is set near their villages so that workers could balance their house duties at the same time . With the support of Tripura bamboo Mission these self-help groups have converted to a producers' group to get connected to the markets. These groups also hired designers to help artisans to come up with new products but still intervention in design facing major linkage issues with consumers (India brand Equity Foundation, 2014).

As per the survey and study the training received from local Industrial Training Institute (ITI) is not adequate . The vast gap is observed in the skill level of the state. Moreover Bamboo dust, is only been used as a side product for making incense sticks. Whereas on contrary China use the same bamboo dust to make bamboo bricks and boards . Bamboo has potential and game change for both for the state and the country. There is only need of encouragement to make innovative products that have international demand. Bamboo is a renewable source and green gold. A small shift from livelihood-based production to modern furniture is required to be promoted. By just educating , re-skilling and up-skilling would be critical measure to reboot the Indian market (India brand Equity Foundation, 2014).

5.3 STUDY OF NORTH EAST REGION- MANIPUR

5.3.1 Area Distribution

Manipur is at eastern-most corner of northeast India and the state shares borders with Nagaland, Mizoram, Assam and as well as with Myanmar. The state Manipur is described as a 'flower on lofty heights', 'a jewel of India' and 'Switzerland of the East' because of its wealth of flora and fauna. It is also called as tourist's paradise because of its scenic beauty. With 3,268 square kms of bamboo forests, Manipur is one of India's largest bamboos producing states and a major contributor in country's bamboo resources. In the year 2017, the state accounted for 10,687 square kms of bamboo bearing area (India Brand Equity Foundation (IBEF)). Being a small State with 22,327 sq.kms area it gives major contribution when it comes to bamboo resource. Being situated at far-flung north-eastern border the country population is the important asset for all kinds of development. In terms of size of population (India Brand Equity Foundation, 2021).Manipur , the 4th largest State of North Eastern belt . The Population pressure is found to be increasing day by day reducing the man-land ratio from about 1: 7 was 85 hectares in 1901 which reduced to 1: 0 accounted 78 hectares in 2011. The state has 51 towns (28 statutory towns and 23 census towns) and 2,582 village (2515 Habited and 67 Un-inhabited) as per 2011 census (final). The state capital city is Imphal (Government of Manipur, n.d.)

Figure 58: Location Map of Manipur
Source: The Author

5.3.2 Urbanization

When it comes urbanization it always remain stagnant in the process of development. Development encompasses urbanization and enriches the quality life through a wider range of exciting amenities (Directorate of Environment, Govt. of Manipur, 2011). Manipur though is getting seized with aggressive onslaughts and heaps of solid waste in

the entire commercial area of Nagamapal , Dharmasala road, Thangal Bazar and Bir Tikendrajit (Directorate of Environment, Govt. of Manipur, 2011) . Although in terms of area and population urbanisation is slow in Manipur, the visible expansion of commercial activities in Khwairamband Bazar (main Bazar of Manipur), Singjamei Bazar , Lamlong Bazar and Kwakeithel Bazar has started creating the usual problem of **"urban –onslaught"** on many sensitive fronts**. For days and months even mere skeleton municipal services are not available;- a nice sign of institutional weakness.** (Environment and Ecology Office Government. of Manipur)**,** (Directorate of Environment, Govt. of Manipur, 2011).

5.3.3 Bamboo Resources

Manipur is rich with almost all bamboos species. Most of the bamboo species in Manipur are wild while a few species are commonly cultivated in the private lands. The major 12 important species of bamboos that are generally planted in the private lands are Dendrocalamus giganteus with (outer diameter 200–250 mm; wall thickness 25–35 mm and intermodal length 600–700 mm) and the smallest is Arundinella Hookeri with (outer diameter 15 – 25 mm; wall thickness 5 – 10 mm and inter-nodal length 200 – 250 mm). (International Bamboo and Rattan (INBAR))

Regions	Genera	Species	Reference
Manipur state	9	>54	G. J. Sharma, 1996 [6]
North eastern India	16	58	Bahadur and Jain, 1981 [4]
India	23	136	Y. M. L. Sharma, 1980 [12]
World	75	1250	Upreti and Sundriyal, 2001 [13]

Figure 59: Bamboo Diversity in Different Region
Source: (Singh, Kumar, & Singh, 2003)

Melocanna bambusoides is one of the widely and largely used species in the pulp industry. The highest price of bamboo can be fetched by Dendrocalamus giganteus (Rs. 60–75 per bamboo) while the least price by Arundinaria callosa and Arundinella hookeri (Rs. 5 – 10 per bamboo). The caloric value of bamboos ranges from 4238 to 5500 cal / g . Melocanna bambusoides, has a production potential of 100 tons/day bamboo shoot in Manipur. This single species contributes about 26% of the total bamboo shoot production in Manipur (International Bamboo and Rattan (INBAR)) (Singh, Kumar, & Singh, 2003).

Manipur bamboo forest is spread at 11700Km2 area against 204000km2 in India. About 53% of the total geographical area of Manipur comprises bamboo forest. It is estimated that the growing stock of bamboo spread in whole of Manipur. Bamboo is effective in the conservation of soil erosion due to its intricate rhizome system. In Manipur, villagers prefer bamboo plantation along

the river banks to help control flooding. Bamboo can be raised with least care and expenditure and can be harvested continuously from year to year. Bamboo shoots, both raw and fermented, provide a delicious food (International Bamboo and Rattan (INBAR)).

5.3.4 Marketing Analysis

Bamboo sector development is a high priority thrust area of the government. Recently, there have been significant policy changes done for harnessing and enhance the scope to increase the present level of market share and economy. The State Government has exempted bamboo extraction from un- classified Forest areas from felling permit to increase bamboo trade volume (Directorate of Environment, Govt. of Manipur, 2011) .

Important bamboo species of Manipur; availability, characteristics and propagation

Species	Local name	Availability	Average outer diameter (mm)	Average wall thickness (mm)	Inter-node length (mm)
Arundinaria callosa	Laiwa	Wild	25–30	5–10	260–290
Arundinella hookeri	Telwa	Wild	15–25	5–10	200–250
Bambusa kingiana	Watangkhoi	Planted/wild	100–150	12–20	480–620
B. nana	Khokwa	Planted	45–65	10–15	400–450
B. nutans	Utang	Planted	100–160	15–20	470–550
B. tulda	Waa	Planted	90–120	15–20	500–600
Dendrocalamus giganteus	Maribob	Planted	200–250	25–35	600–700
D. hamiltoni	Saneibi	Planted	100–140	25–30	550–620
D. longifimbriatus	Woonan	Planted	100–150	20–25	540–620
D. sericeus	Ooei	Planted	100–140	15–20	520–600
D. strictus	Saneibi	Planted	100–140	201–28	550–600
Melocanna bambusoides	Waak/Moubi	Wild/Planted	50–65	7–10	460–530

Figure 60: Imported Bamboo species of Manipur ,Characteristics and Availability
Source: (Singh, Kumar, & Singh, 2003)

The economic growth, states would struggle to have the necessary resources for social security programme against poverty. States like Punjab have been able to grow at 5% over the last 50 years. Crafting furniture has very good local demand but instead items are produced that still domestically used including patio, varli ,mats in different sizes etc. Most importantly Bamboo markets shall be set up with active participation of the Government and bamboo farmers. To upgrade bamboo industry, the government has come up three facility centres for bamboo processing in Tamenglong, Churachandpur and Imphal. Government of Manipur is also initiated with Bamboo technology park at Kadamatala and Jiribam (India Brand Equity Foundation, 2021).

5.3.5 Study Limitation

The artisans require an exact knowledge for making a tool/ raw material apart from implements.

- The State need active collaboration with experts agency and institutions such as National Institute of Bamboo and Rattan Development, Indira Gandhi Forest Research Institute, National Institute of Design, Forest Survey of India, Central Agriculture University, Indian Council for Agricultural Research, World Bamboo Organisation, International Association of Bamboo and Rattan and other similar institutions to meet the objectives of this policy. This institute will serve the research and development required to harness the potential of bamboo as envisaged under this policy. Awareness programmes, campaigns, workshops shall be used to disseminate the various aspects of bamboos (National Bamboo Mission, 2011).
- The proposed policy should ensure that skill training set up at State level should incur with certificate or diploma course in bamboo production and manufacturing. Most importantly State ITIs needs to develop required skilled manpower in the field of the bamboo industry. (National Bamboo Mission, 2011)
- A structured curriculum on bamboo needs to be developed. If the thrust being given on bamboo production and manufacturing, requirements of various nodes will be met.

5.4 Case study on metropolitan cities – Delhi , Mumbai & Kolkata

5.4.1 Introduction

The study comprises of the city of Delhi, Mumbai and Kolkata's contiguous area. Due to rapid urbanization, the landscape of these metropolitan cities has changed from a rural majority to urban. The growth in the urban area was 20.44% during 2001-2011 approx. The urbanization has reduced the villages from 300 in 1961 to 165 in 2001 and 112 in 2011 . According to 2011 census 27.82% of Indian population lives in urban setup . The three most populous cities are Mumbai, Delhi and Kolkata (Sharma & Sharma, 2017) The recent increased urban growth has outstripped the capacity of these cities to provide basic services resulting serious challenges are faced like environmental degradation ,increasing air and water pollution, decreasing forest cover and decreasing biodiversity. Bamboo a miracle grass and active solution to all the needs. The larger cities are efficient in generating growth and attracting investments whereas smaller towns located away from the global centres of growth hence leading to economic stagnation (Sharma & Sharma, 2017).

5.4.2 Delhi

5.4.2.1 Demography

Delhi has been one of the fastest growing cities and the national capital With the decadal growth of 47% which is more than double of national rate. A large part of state growth is due to the high level of migration The state forest cover though has increased from 0.76% of the total area in 1980-81 to 1.75% in 1994-95 and 5.93% in 2000-01 (Planning Department, 2019). The forest cover report is based on satellite interpretation data of October 2006, which state 176.58km2 i.e. 11.91% of the state geographical area. Considering the analysis Delhi forest canopy density is 6.76 Km2 very dense ,49.84Km2 moderately dense and 119.98lm2 open forest cover.

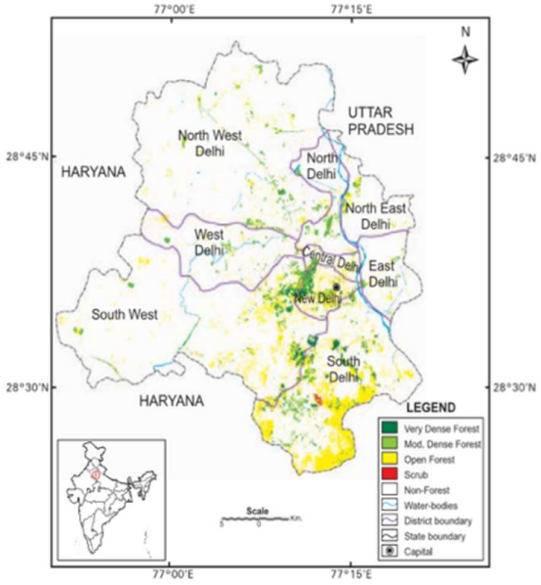


Figure 61: Location mapping of Delhi
Source: (Forest Department government of Maharashtra , 2017)

5.4.2.2 Bamboo resource

Bamboos can be cultivated on a wide variety of soils except for rock-strewn soils. The Bamboo plantation needs a well drained sandy soil to clay soil that should have a ph range of 4.5 to 6.0. In India, considering above requirements Barack Valley region is best suited for bamboo cultivation because of the best soil availability and adequate climate conditions. Particularly in Delhi Bamboo is outsourced from the neighbouring states as a raw material as well as in the form of finished products. Major demand of raw material is being catered from Uttar Pradesh and Haryana. When it comes to bamboo, being a capital region Delhi is not known as bamboo growing state but as a distributing region. This state helps to channelize bamboo as a raw material and finished product to all the industries. Majorly getting organised markets for farm bamboo remains a problem as those who are cultivating bamboo are not clear about where to sell or what the prevailing market price. Additionally, there are no set standards for the grading and classification of bamboo.

5.4.2.3 Marketing Analysis

The perception of no demand for bamboo is an insignificant fact as there is plenty of demand in various applications such as furniture, housing, construction and handicrafts .The problem is lack of established channels between buyers and sellers. Somehow, the bamboo ecosystem has not developed , despite being centuries old bamboo is still very new for all stakeholders. The blame can neither be put on the government nor on any other player. In the case of the bamboo sector in Delhi region, the issue is unorganised bamboo market, which can resolve, 80 % of the problems prevailing in the sector (Down to earth, 2022).

The government focuses majorly on bamboo mandis or wholesale markets that sell truckloads of the commodity. But there is need to create and promote weekly bamboo markets and haats for purchasing small bamboo furniture from nearby adjoining regions like Uttar Pradesh and Haryana. Market facilitation centres needs to focus majorly on smallholder farmers, who even have fewer clumps of bamboos. There are millions of such smallholder farmers growing bamboo in their homesteads. But due to absence of designated market, there is no incentive for this smallholder to manage their productivity (Down to earth, 2022).

5.4.2.4 Strategic Steps

The promotion of bamboo sector needs interconnected strategy and recommendations that reinforce each other. While suggestions are many, essentially five strategic interventions needed are:

- Bamboo Board need to promote the bamboo sector within Forest department and within Government in Delhi region. Simultaneously, also promote a multi stake holder of National bamboo Mission needs to have a formal setup to work for promoting bamboo in Delhi regions, in partnership with others.
- Increase bamboo production in forest areas by allowing communities to manage bamboo and move forward working in a free partnership with other communities.
- Earmarking bamboo forest for various categories to downstream industries for at least ten years
- Promoting intensively about 10-15 compact bamboo clusters in various parts of the state. These clusters will increase in farm bamboo production will go hand in hand with development of downstream units to absorb the bamboos that will become available.

5.4.3 Mumbai: Pune

5.4.3.1 Area Distribution:

Maharashtra is gold mine of Teak wood, Tendu leaves and Bamboo varieties. Govt. has been managing Teak & Tendu crop by adopting silvicultural practices over long period; however, Bamboo crop could not attract desired attention from foresters due to many attributes. Now, Bamboo has drawn attention of many because of its remarkable properties, variety of uses, its fast growth, livelihood of forest dwellers in rural areas of the State. Maharashtra state accounts 21% forests area and bamboo grows copiously in the forests along with other species. The state estimated bamboo cover is about 4800 km. Bamboo on other hand is also grown widely on farm bunds outside the forests as well . Especially on the linear Konkan coastal belt and in Vidarbha and tribal areas of Northern Maharashtra (Forest Department government of Maharashtra , 2017). But still in rural areas and rural weekly markets, there are thousands sustaining themselves by making and selling many household items. Most importantly the bamboo is widely used as 'poles' and fencing the cultivated land. On the other end in the 'modern' sector, the application of bamboo is made for newer uses. A number of entrepreneurs have set source this bamboo as raw material for various industrial purposes of bamboo artisans.

5.4.3.2 Resource and Diversity

Maharashtra has three native species Dendrocalamus Strictus (Manvel), Bambusa bamboos (Katanga) and Oxytenenthara Stocksii (Manga) bamboo. Majority of the stock (close to 80-90%) in Maharashtra is Strictus /Manvel and the remainder is Katanga and Manga. Except Manga bamboo harvesting of Manvel and Katanga bamboo is difficult. Mechanical harvesting of bamboo using chain saw and tractor has been tried for both Manvel and Katanga bamboo successfully. As per the reports there are 8400 sq. kms of bamboo within the forest area of about 61,000 sq. kms in Maharashtra. This is 13% of forests area. The (Planning Commission Government of India New Delhi, 2003)has identified 18 commercially viable bamboo species for plantation .First phase of the National Bamboo Mission, with major contribution from the Northeast India and to some extent in the rest of the country , Anga bamboo (Dendrocalamus stocksii) is one amongst those prioritized bamboo species (Rane, et al., 2018).

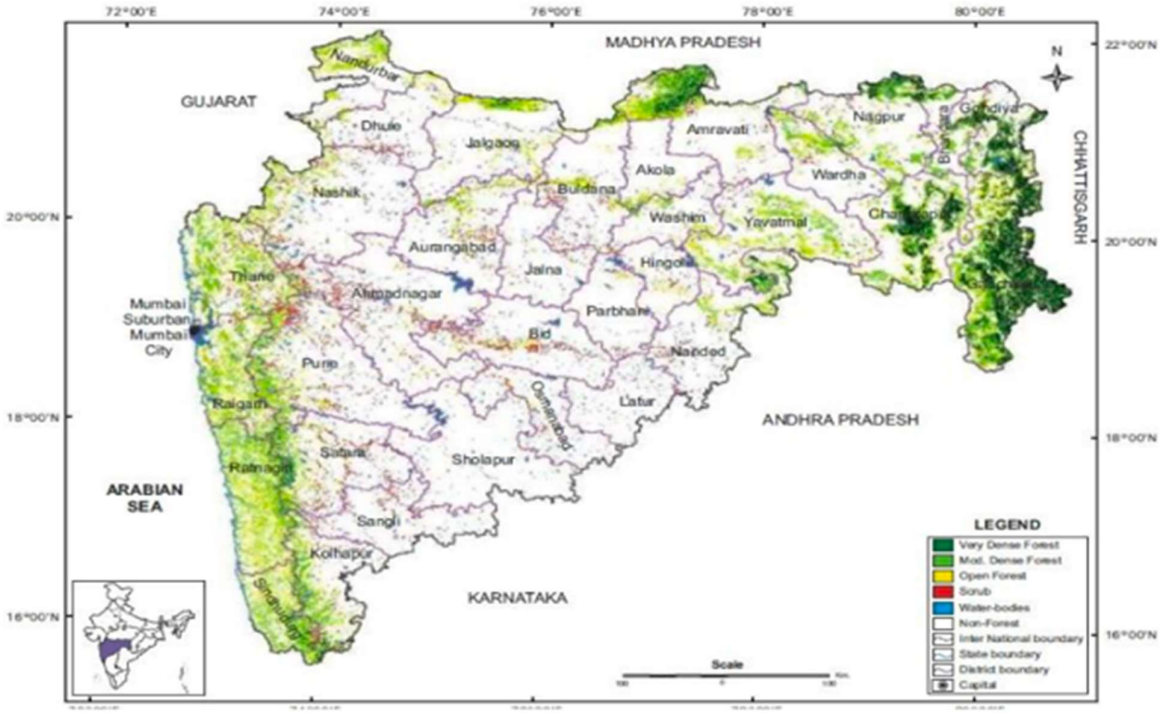


Figure 62: Forest cover of Maharashtra
Source: (Forest Department government of Maharashtra , 2017)

According to the Forest Survey of India, Maharashtra accounts 11,465 km2 bamboo- bearing area. Some of the most prominent bamboo species available in Maharashtra are Manvel (*Dendrocalamus strictus*), Katang or thorny bamboo (*Bambusa bambos*), Manga (*Dendrocalamus stocksii*) and Chivari (*Munrochloa ritchiei*). The Western Ghats part of Maharashtra provides ecological and climatic suitability for natural abundance and cultivation of bamboo (Rane, et al., 2018). Bamboo is specie for preserving biodiversity and ecology in the forests and shouldn't be only valued in commercially. the overall availability of bamboo and its yield and resultant income from sale by Forest department is pathetically low. The cost for one acre of bamboo plantation is around Rs 9400 and harvesting starts from the sixth year onwards. Most importantly income from bamboo plantation, increases each year starting from the sixth year. Hence, Bamboo is also termed as cash crop with faster growth ,low gestation period and good economic returns, generation after generation (Forest Department government of Maharashtra , 2017).

5.4.3.3 Marketing Analysis

Analysing the report by (International Bamboo and Rattan (INBAR)) bamboo furniture is the most neglected part in production to consumption process . Local producers of bamboo have no support for facilitating bamboo promotion and marketing from government or private organizations. Local growers depend upon local traders. Though being metropolitan city Maharashtra has small market for bamboo furniture and products .City like Bhandara and Nagpur additionally have small haats selling bamboo products . Studying the bamboo marketing channels in Bhandara district of Maharashtra it was been observed that local middleman plays a vital role in analysing demand and trading bamboo products .

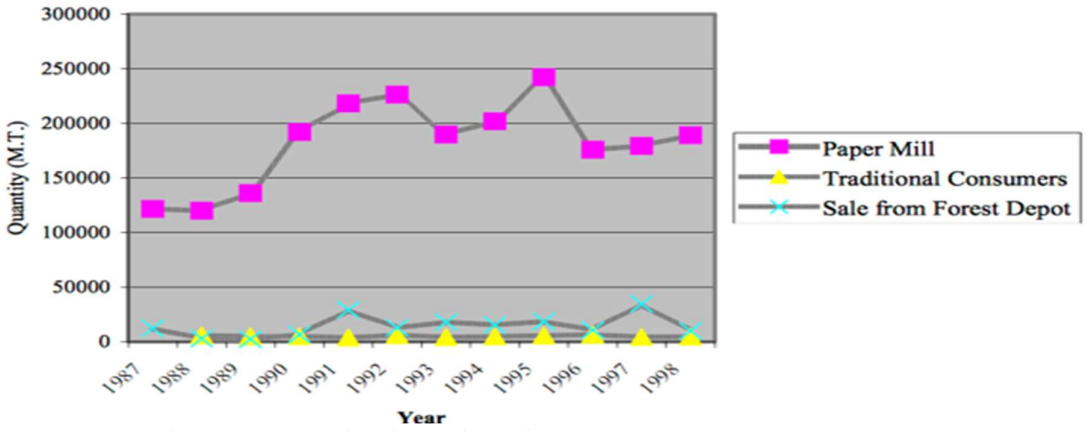


Figure 63: Bamboo Consumption in Maharashtra
Source: (Kant D. , 2001)

Brief study report by (International Bamboo and Rattan (INBAR)) state to three different categories of bamboo users-Traditional type , Paper mills and Forest depot. As per the Forest policy1988, traditional bamboo users and local people should have the first right over bamboo and industrial units should be secondary. Distribution data clearly indicates that traditional consumers get only a marginal portion (2 to 4%) of total bamboo production while industrial units get more than 90% of the total production, and these figures have not changed after 1988 Forest Policy. In fact, the total bamboo production increased from 128,238 metric tons in 1987-88 to 209,627 metric ton in 1997-98, but quantity given to traditional consumers decreased from 5,906 to 4,685 metric ton during this period (International Bamboo and Rattan (INBAR)). The industrial bamboo production is less whereas commercial production is much stable, there is lot of unsold bamboo get left in forest depot and with sample villages, local people did not get bamboo from forests, and they used illegal harvesting. The below analysis clearly indicates a great diversity in terms of government provisions for the allotment of bamboo-to-bamboo user groups, prices

fixation , license for bamboo works, transit permit requirement, and availability of bamboo to meet the requirements of local user groups (International Bamboo and Rattan (INBAR)).

Item	Description
Bamboo workers	Bamboo workers of Burad caste has there paternal bamboo working. However other many castes like Mahar, Kunbi, Teli, Gond etc categories are also involved in bamboo works
Institution / Setups of bamboo workers	Bamboo working was organized through Bamboo/ Burad Kamgar societies in all such type of villages. Societies used to provide bamboo from forest (collaboration with forest department) and used to supply all products to market.
Bamboo pricing Distribution (Nistar rights)	There is no categorization of local bamboo users. Same Nistar rights are given to all type of families, and rates based on quality of bamboo only. Sales tax (7%) and Forest Development tax (10%) are also charged
License for bamboo works	No License for bamboo workers
Transit for bamboo products	No Transit passes system on transportation of Bamboo products.
Marketing of bamboo products	Getting direct purchasing platform so that product can be sold and purchased. Products can be producers in local market.
Supply of bamboo to local people	Providing 20-25 % of raw material (bamboo to the artisans

Table 3 : Position of Bamboo stakeholders in Maharashtra
Sources: (International Bamboo and Rattan (INBAR)).

5.4.3.4 Limitation

Bamboo, at policy level is still treated as a 'forest' item, though it can be grown as much in farmlands. Unless bamboo is grown in a big way in the farmlands, there will be limitations on developing downstream activities. For growing bamboo in farmlands, various policy restrictions on its movement and transport need to be revised. Bamboo is still considered as a 'handicraft' item and its development as a Furniture material needs development and promotional measures. The definition of bamboo as a handicraft material has reduced its role, unintentionally, to mainly drawing room souvenir items. Though it is said that India has high resources of bamboo, when

one really goes to a specific area and start calculating the bamboo available to start some bamboo-based unit, the entrepreneur finds there is no adequate or assured bamboo available as raw material for a business unit. This is so even in Northeast. So, there is need to increase bamboo production and productivity in both forest and non-forest areas first. Most importantly there is great need for skilled artisans, supervisors, architects and designers- in short there is lack of skilled manpower required for this sector to expand in future.

5.4.3.5 Strategy

- **Declaring bamboo sector as a priority sector for development:** Government must declare, upfront and clearly that 'bamboo sector' will be a 'priority sector' for the State and it will grow substantially in upcoming years, considering its potential in employment and its eco friendliness, and as it makes economic sense .

- **The general impression about bamboo is that it is produced and consumed in tribal areas only**. Further, 'bamboo' is often associated with Gadchiroli or Vidharbha. Conscious attempts must be made to dispel this idea, and bamboo clusters and other initiatives must be developed in all parts of the State, wherever there is potential. Each area of the State is unique and is bound to evolve in their own way. Development of bamboo sector in different geographies of the State will also help in getting political and policy support for bamboo sector from all parts of the State.
- **Creating bamboo units within Social Forestry Directorate (SFD) and FDCM**: strengthening of the SFD and FDCM by creation of a proper dedicated cell for bamboo within these organizations. This will ensure that performance is monitored within these organizations. At present, there is no such arrangement

- **The bamboo craft has to be practiced and preserved both tribal and non-tribal:** In the non-tribal areas bamboo artisan communities referred with different names like Buruds in Maharashtra and Basods in Northern India. The Local Government by initiating raw bamboo at government subsidized rates to artisan, known as nistar rates. Considering the artisans value addition, there is need to create a special artisan welfare cell within the Bamboo Board/PCCF office which should be manned by a Social Worker (MSW). Alternately, this work should be outsourced to a good social work college/NGO in the bamboo sector.

- **Forest department must proactively introduce new bamboo species across the State**, after due diligence, keeping the ecological and other criteria in mind.

- **Developing a number of Wadali type nurseries in State**: Knowledge and skill base relating to species management is limited and need to be expanded. More nurseries like the one at Wadali, Amravati wherein several species are cultivated and propagated caringly by committed officers need to be developed for the State. It is recommend at least one Wadali type nursery per forest circle in the first round. We recommend good training and capacity building in bamboo propagation and related techniques, among the IFS and State Forest Officers on a priority.

The resource waiting to be tapped and developed, even assuming many sq. kms of bamboo must be untouched for ecological reasons, as in National Parks and Sanctuaries. To start Bamboo promotion, it is recommend that 40 % of furniture purchases in Forest guest houses and offices can be sourced from bamboo and 20% in other departments in a staggered manner.

5.4.4 West Bengal

5.4.4.1 Area and Distribution

The State of West Bengal with geographical area of 88,752sq km is in eastern part of India. This state shares the international border with Bangladesh, Nepal and Bhutan whereas national borders with Sikkim, Assam, Odisha and Jharkhand. With holding an Indian population percentage of 7.54% the state constitutes rural population as 68.13% and urban population 31.87%. The state includes percentage of tribal population about 5.80% (Ministry of Enviroment,forest and climate changes, 2019). West Bengal is rich traditional and artistic heritage state of India with cultural legacy and architectural style. Bamboo Handicraft is the one of the oldest heritage and traditional legacy of west Bengal. Bamboo is one of the most dominant and important flora compared to others and therefore this state is also known as one of the “Bamboo paradise of India”. (Basumatary, Middha, Usha, Brahma, & Goyal, 2015). Cane and Bamboo handicrafts and furniture are the one of the famous legacy ad traditions of this region. In west Bengal the bamboo is distributed in tarsi region of north Bengal, Darjeeling district and south Bengal plain (Mitra &

Mukherjee, 2007).As the population is rising and the resources are bulging, bamboo continues to serve the needy with its huge spectrum uses through traditional and modern application. The major landmass of the West Bengal is being divided into two natural geographical conditions, one is the northern Himalayan region and the other is the plains comprising of massive Gangetic delta comprising of west Dinajpur (Mitra & Mukherjee, 2007) . Furniture sector occupies important place in West Bengal economy it contributes to the employment generation and export earnings. The sector's economic importance lies because of its high employment potential and low capital investment. (National bamboo Mission, 2008).

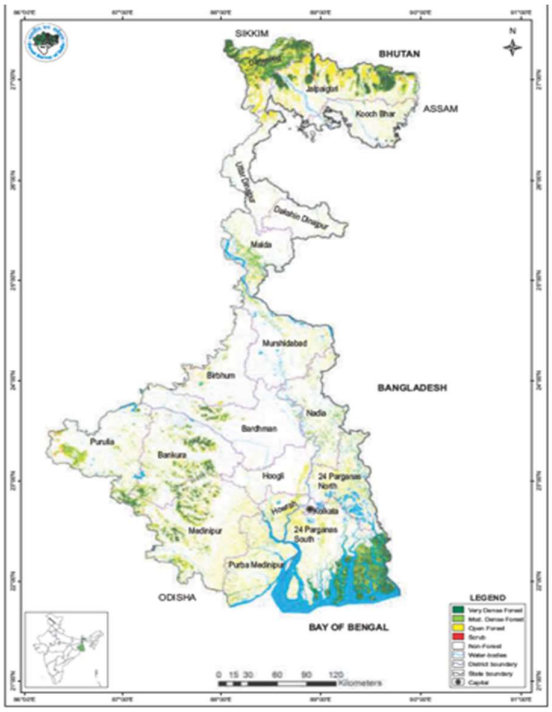


Figure 64: Forest cover map of West Bengal
Source: (FSI, 2019)

5.4.4.2 Resource and Diversity

West Bengal rich with varieties of bamboos, and each type has its own characteristics. The Goda , Gonda, and Genthe bamboos are thick, heavy and knotty species mainly used for structural purposes, for making furniture and fencing. While the Muli ,Beseni, and Talta bamboos are light in weight , thin and hollow are commonly used for making containers, fish traps, baskets etc. Each species has its own appearance and durability (Banerjee, 2011).

The bamboo genera available in West Bengal include Dendrocalamus, Arundinaria, Gigantochloa, Bambusa, Dinochloa, Melocanna, Pseudosasa, Schizostachyum, Sinarundinaria, Thamnocalamus and Thyrsostach (FSI, 2019) . In West Bengal, this giant grass is represented by 17 genera and 33 species with 3 varieties. Bamboos are cosmopolitan in distribution but majority of them occur in South- East Asia. In West Bengal, the bamboos are generally distributed in the tarai region of north Bengal, Darjeeling district and in the south Bengal plains. (Goyal, Ghosh, Dubey, & Sen). Some of the commercially viable species

Sl. No.	Species	Local name
1	*B. balcooa*	*Bhalki bans / Boro bans*
2	*B. bambos*	*Kanta bans*
3	*B. nutans*	*Makla bans*
4	*B. vulgaris*	*Basin/ basni / kalai makla*
5	*Dendrocalamus asper*	
6	*D. giganteus*	*Koko / Bhalu bans*
7	*D. hamiltonii*	*Chawa bans*
8	*D. strictus*	*Jaw bans*
9	*Melocanna baccifera*	*Muli bans*

Figure 65: Commercial Bamboo species of West Bengal
Source: (FSI, 2019)

The global market includes bamboo for internal and commercial consumption. The annual trade of bamboo in India is approximately Rs: 10,000 to 15,000 crores. Around 2.5 billion people use bamboo globally and nearly 1.0 billion people resides structures made from bamboo. Indian bamboo sector generates approx. 432 million workdays annually (Manjunath & Rao, 2015).

5.4.4.3 Marketing Analysis

Plantation of bamboo should be encouraged & promoted due to its high value, productivity, uniformity of crop, choice of species linked to peoples' need and industrial need. The industrial demand is met from state owned forests, while for domestic usage private as well as state owned resources are been accessed . A major obstacle is the availability of bamboo over excessive usage in pulp and paper industry leading to deforestation and limitation of bamboo propagation. As per the report published in (Indian Express, 2022)bamboo is purchased at Rs 120 per pole while the artisans sell a 'Kula' for Rs 30, 'Pachiya' for Rs 30, 'Dala' for Rs 25 and 'Binchana' for Rs 20. They just manage to make a profit of only Rs 20 from each item. Though the demand for their products is high earlier, but it has come down as the people prefer plastic utility because of repetitive design and scant supply.

5.4.4.4 Limitations

- **Lack of skills and awareness**: Bamboo has been traditionally raised but to a limited extend. However, it is always been considered as a forest species when it comes to plantations. There is a need of changing the cultivation perception from 'forestry mind-set' to the 'farming mind set' and creating awareness on the skills to produce commercial viability and profitability of the species .There is an need of capacity building programme and research &

development (R&D) to create awareness, demonstration and extension support (Mehra & Mehra).

- **Stipulation in Harvesting and transportation** : To cater the demand of bamboo, the 'raw material' comes from the private sources. The legal restrictions, draw away the farmers/ entrepreneurs from raising bamboo on private wastelands for commercial usage. This is one of the most crucial matters of contention probable need a focus, a restrictive harvesting and restructured transit rules can be interventive step (Vyawahare, 2009).

- **Relaxation with land Ceiling Act**: This act is one of the major restraints for producers who are involved in large scale industrial plantations. Many crops are been relaxed from the purview of this Act. Consideration to bamboo for such relaxation can be a radical measure (Vyawahare, 2009).

- **Leasing revenue wastelands for plantations**: Large part of wastelands available, could be profitably used for cultivating bamboo. Intercropping ,weeding and protective irrigation are essential for planting and stabilizing species . leasing out the wasteland will increase the plantation of commercial viable species (Vyawahare, 2009).

- **Organized Supply Chain** : Though bamboo sector has vast market but there is a need for a structured market with price fixation at each node. Adequate price regime will encourage the small farmers to take up bamboo plantations more effectively .

- **Taxation rationalization and price fixation**: In some States, bamboo is catered by private sector for which tax are levied on them by the State government or forest department. This needs to be rationalized to increase production (Vyawahare, 2009) .

5.5 Identification of variable by situation analysis of Bamboo Enterprise in study area

Moderate Bamboo growing Region *(Delhi, Mumbai and Kolkata)*	**Highly Bamboo growing Region** *(Assam, Tripura and Manipur)*
Social and Psychological Issues	
The Bamboo furniture is not easily and locally available in the markets .	Furniture made from bamboo is easy and locally available and comparatively cheap to wood or engineered wood.
The available furniture does not have fine finish and desired texture . Moreover due limited bamboo artisans the finish cannot be readily achieved.	The available furniture has comparatively fine finish and desired texture can be achieved as bamboo artisans are easily and locally available .
The available portals and e-commerce platforms do not have wide Bamboo furniture range and charge a lot of package and carriage charges .	E-commerce platforms are not useful as wide ranges are not available on theses portal and moreover furniture is locally available at much cheaper prices .
This furniture is difficult to get repair or refurbished.	Due to local availability repair or refurbishing is easy but they have same repetitive design with very less variation and options.
There is huge cost variation due to lots of carriage and transportation charges involved as most of the furniture and raw material need to b procured from the north eastern belt of the country .	The cost variation is minor and occurs from area to area, as sell centres are usually located at remote area of the city .
Reselling is difficult as there are less adequate buyers of bamboo furniture due to lack in marketing policy .	Reselling of furniture is difficult because new furniture is also available at very affordable range.
Design Issues	
• The available bamboo furniture is not as per the requirement and taste .They seems to be simple and not multifunctional.	
• The available design are not with easy assembling the dis-assembling which lead carriage and transportation difficult.	
• The design are traditional and don't have modernity and contemporary taste to it .	
• There is no Branding ,Standardization or Certification available for marking to the quality of the furniture	
• The colour needs .variation and furniture needs to be light in weight for easy movement .	

CHAPTER 6

Data Analysis

The chapter discuss the analysis of the study . The field survey , interviews and questionnaire are used in this study was analysed to ensure that the gathered data and presented with all necessary tables ,percentages bars and graphs .The conducted chart analysis capture the data essential to accomplish the research objectives .The overall aim of the study is to determine the design intervention that can impact the commercialization of bamboo furniture market in India .The basic buyer and seller behaviour was analysed to assess the constraints and the design based intervention to commercialize bamboo furniture. In addition, the overall recommendation can initiate to a new perspective to improvise bamboo furniture adoption .

6.1 Introduction

This chapter encloses the analysis of all the parameters. The study evaluates the commercialization based on buyer and seller behaviour(BSB), which needs to be analysed under five independent variables. To analyse the relationship among commercialization and other influencing parameters under cultural, social, personal, psychological and Design Intervention(DI) factors. To study the mediation and moderation effect, allowing to understand each variable influence and validity of the model structural equation modelling (SEM) method adequate for further analysis. This method is used to examine the direct or indirect relationship between variables.

The study is primarily divided into two sections: The first section examines bamboo furniture commercialization, analysing the buyer and seller behaviour by factor analysis using structure equation modelling (SEM); further, in the second section, various design intervention parameters and attributes have been analysed regarding stakeholder prevalence in selected states Overall under this chapter the analysis is done to signify the consumer's based design intervention as per their behaviour and perception which can influence the commercialization of bamboo furniture market and initiate to change in substituting the wood.

6.2 Structure Equation Modelling

For analysing the data of selected variables, to evaluate commercialization and the probable impact of all the other supporting structural equation modelling (SEM) methods is proposed. The method allows us to examine whether the hypothesized model fits the observed data. The method clearly specifies the relationship between various model paths. As mentioned in the earlier chapter, a conceptual model has been framed in smart-PLS, with two input constructs, i.e. Buyer and seller (personal and social factors), two mediator constructs (psychological and cultural) and one output construct (Design intervention)

6.3 Principal component analysis : - Reliability & Validity Analysis

Analysing the high dimensionality in the dataset, cluster relationship among the variables various method studied. Visualising the complexity of data and allowing a compact representation, Principal component analysis was proposed. The method was found most adequate as it is most sensitive to collinearity variables, emphasizing the essential pattern and minimizing the impact of noise or random fluctuation.

The Principal component analysis (PCA) is a multivariate approach that describes observations using intercorrelated variables instead of independent relationships, enabling the inference of

confounding variables. PCA is a method used in exploratory data analysis measuring the correlations among the variables, simplifying it and understanding the structure of the correlation or covariance matrix. The Value of PCA ranges between 0 and 1, higher value indicate that items are more reliable for particular construct and the Factor loading variables of latent constructs in this conceptual model is more than 0.5 .

The Cronbach alpha test was conducted to check the reliability of all the latent variable .depicting acceptable value more than 0.7 to determine the scale is reliable .As per the table Cronbach Alpha value is above 0.7 depicting the conceptual model is valid for further analysis .

	Variable	Factor Loading	Cronbach 's α	Result
Personal –(PF)	**PF1- Reasons for bamboo low acceptance and not being adopted as a furniture material instead of wood** • PF1.1 -Personal characteristics :Age ,gender, domicile , living structure , education , working sector influence and possible factors . • PF2.1 - The Preferable choice of the buyers for buying furniture • PF 3.1 -Buyer perception towards using bamboo as raw material for furniture making		**0.8**	**Acceptable**
	Bamboo furniture needs to incorporate intricate designer details.	0.797 ****		
	Quality of bamboo furniture is low in comparison to wood furniture	0.795 ****		
	Is bamboo furniture is highly susceptible to fire in comparison to wood	0.78 ****		
	Bamboo furniture need high maintenance and can invite termite infestation.	0.77 ****		
	Bamboo furniture are more expensive to than wood furniture.	0.774 ****		
	Bamboo furniture lacks in design in comparison to the wood furniture.	0.772 ****		
	It gives a feeling of traditional style of interior	0.791****		
	Is bamboo difficult to maintain in comparison to wood furniture	0.776 ****		
	Engineered bamboo furniture is not easily available like engineered wood.	0.773 ****		
Social – (SF)	**SF1-The skill level of the intermediaries (artisans) , their traditional involvement , the prospectus and constraint bamboo furniture artisan are facing.** • SF1.1- Support and Funding assistance towards promotion and commercialization.		**0.804**	**Acceptable**
	The government has made significant efforts for advancing the bamboo furniture industry	.792****		
	The government provides incentives and subsidies for undertaking entrepreneurship in the bamboo industry.	.811*****		
	Do you think government policy on bamboo transportation sales and promotion needs improvements.	.801*****		
	Do you need proper road networking and transporting for bamboo products and raw material	.785****		
	One can easily avail of loans from the banks and other regulated financial institutions for funding their bamboo furniture business.	.800*****		
	There is an adequate storage facility available for the storage of raw bamboo.	.797****		
	There are sufficient promotional measures needed for promoting bamboo furniture.	.779****		

	Direct markets, traders, newspapers and digital platform keeps you updated about bamboo furniture industry.	.799****		
	For increasing the sales of bamboo furniture and products, pertinent investment in advertisements is done.	.796****		
	The adequate bamboo species for raw material to bamboo furniture and products is easily available in the market.	.783****		
	There is a lack of skilled artisans that can produce bamboo products and furniture.	.793****		
	Bamboo furniture /product artisans need better technological developments and training for producing better designs.	.800****		
	The bamboo furniture and product making work is not just seasonal, instead, it is year-round.	.800****		
	Storing finished bamboo products and furniture is easy.	.791****		
	International fairs, exhibitions and digital marketing can be an innovative steps to promote bamboo furniture	.797****		
	Skill development and Training programmes is needed in your area to promote bamboo products and furniture making among people.	.801****		
	Government incentives on bamboo products and furniture making can encourage more artisans and promote bamboo furniture industry.	.799****		
	Connecting to the designers and consumers can help you to produce better designs	.797****		
	There is more demand for modern and intricate furniture with bamboo.	.806*****		
	Do you have awareness on engineered bamboo used internationally for furniture making	.789****		
	Consumers have good awareness about bamboo furniture.	.804*****		
	Bamboo is a viable substitute of wood for making furniture.	.796****		
Psychological factor (PSF)	**PS1- The factor that causing to the low commercialization of Bamboo furniture on basis of their perception , attitude knowledge and beliefs.**		**0.847**	**Good**
	Bamboo Furniture is minimalistic	0.832*****		
	It lacks colour choice.	0.84*****		
	It lacks fine finishing as compared to wooden furniture.	0.834*****		
	Bamboo furniture does not give a modern appearance.	0.84*****		
	Adding bamboo as furniture material can perceive in promoting environmental friendliness	0.829*****		
	Available bamboo furniture is not durable	0.857*****		
	Are you aware about the benefits of utilising bamboo furniture	0.843*****		
	Do you consider bamboo as a poor men's timber and cannot be place in modern furniture market	0.863*****		
	Bamboo furniture doesn't not have better outlets for promotions and distributions	0.828*****		
	Do you think adding branding is important for bamboo furniture	0.827*****		
	Engineered bamboo manufacturing unit can help in promoting bamboo as a wood alternative.	0.828*****		
	Furniture should be easy to assemble and dissemble	0.835*****		
	Focus needed on product design and flexibility while selecting furniture.	0.826*****		
	The design of bamboo furniture available in the market is outdated and archaic in comparison to wood.	0.829*****		
Cultural-(CF)	**CF1- The measures need to be adapted considering the buyer behaviour , beliefs to increase commercialization.** • CF1.1-The preferable measures that can be adopted to increase the commercialization of bamboo furniture.		**0.957**	**Excellent**
	Heavy discounts on furniture stock	0.964******		
	Easy assembly with home delivery	0.956******		
	Bamboo workshops and skill centres for craftsmen and carpenters	0.952******		

	Involvement of designers to create better designs	0.951******		
	Organising bamboo fairs and exhibitions	0.950******		
	Inclusion of bamboo in design and architecture curriculum	0.951******		
	Easy accessibility of warehouse for artisans and craftsmen	0.950******		
	Bamboo furniture standardization and certifications	0.949******		
	Increasing online promotion and sales of bamboo furniture	0.949******		
	Encouraging the public sector to purchase bamboo furniture	0.949******		
Design Intervention (DI)	**DI1- Major Interventions can be incorporated in Design for increasing commercialization and adoption among Indian buyers.**		**0.915**	**Excellent**
	Easily assembled & dissembled with serving multiple functions.	0.907******		
	With contemporary and modern design.	0.904******		
	It should be lightweight.	0.919******		
	Ensuring durability	0.906******		
	Must ensure termite and moth resistance	0.911******		
	More aesthetically pleasing	0.903******		
	Polished and finished in a better manner.	0.901******		
	Customized to the personal taste and space of the users	0.902******		
	Easily approachable and available in local furniture shop	0.905******		
	Bamboo furniture artisans locally available for repair and maintenance.	0.905******		
	DI2- Inventive measure that can promote design intervention in bamboo furniture for commercializing it among buyers.		**0.915**	**Excellent**
	Encouraging and promoting architects and designers for innovative furniture designs using bamboo.	0.952*****		
	Online platform and web portals to facilitate dialogue between different bamboo stakeholders , designers and buyers.	0.952*****		
	Showcasing bamboo furniture's as an integrated lifestyle solution.	0.951*****		
	Information repository on various bamboo species and its furniture	0.952*****		
	Technical facilitation and bamboo training centres.	0.958*****		
	Introducing bamboo in architecture and interior course curriculum	0.956*****		
Note: All variable items of factor loading are significant; ****0.7 ≤ α < 0.8Acceptable , *** 0.8 ≤ α < 0.9 Good , 0.9 ≤ α Excellent ********				

Table 4:Reliability test of selected variables by Cronbach Alpha

6.4 Analysis of Field Survey for Segment Level Parameters

The analysis was conducted considering two aspects: the first deals with buyer behaviour scores, and the second discusses the seller's behaviour aspects and scores in urban and bamboo-producing regions for commercialization. Their behaviour aspects, perceptions, and preferences are ranked considering the mapped area's markets as shown below and other latent factors considering the prime furniture consumers and bamboo furniture producers. The calculations involved allocating scores considering various parameters influencing there's behaviours and

commercialization aspects as indicated in studies catered earlier. The scores consider bamboo furniture evaluations on buyer and seller interfaces independently, and the evaluated score calculates the Personal, social, cultural, and physiological parameters considering their influence on adequate design intervention needed. The available scores are subjected to the Analysis of Variance(ANOVA) test to interpret the validation. Based on the study results, the prototype model was prepared incorporating all the derived interventions as per buyer-seller behaviour (BSB). Considering the variable on the prototype model, the design sample floated for the user's evaluation.

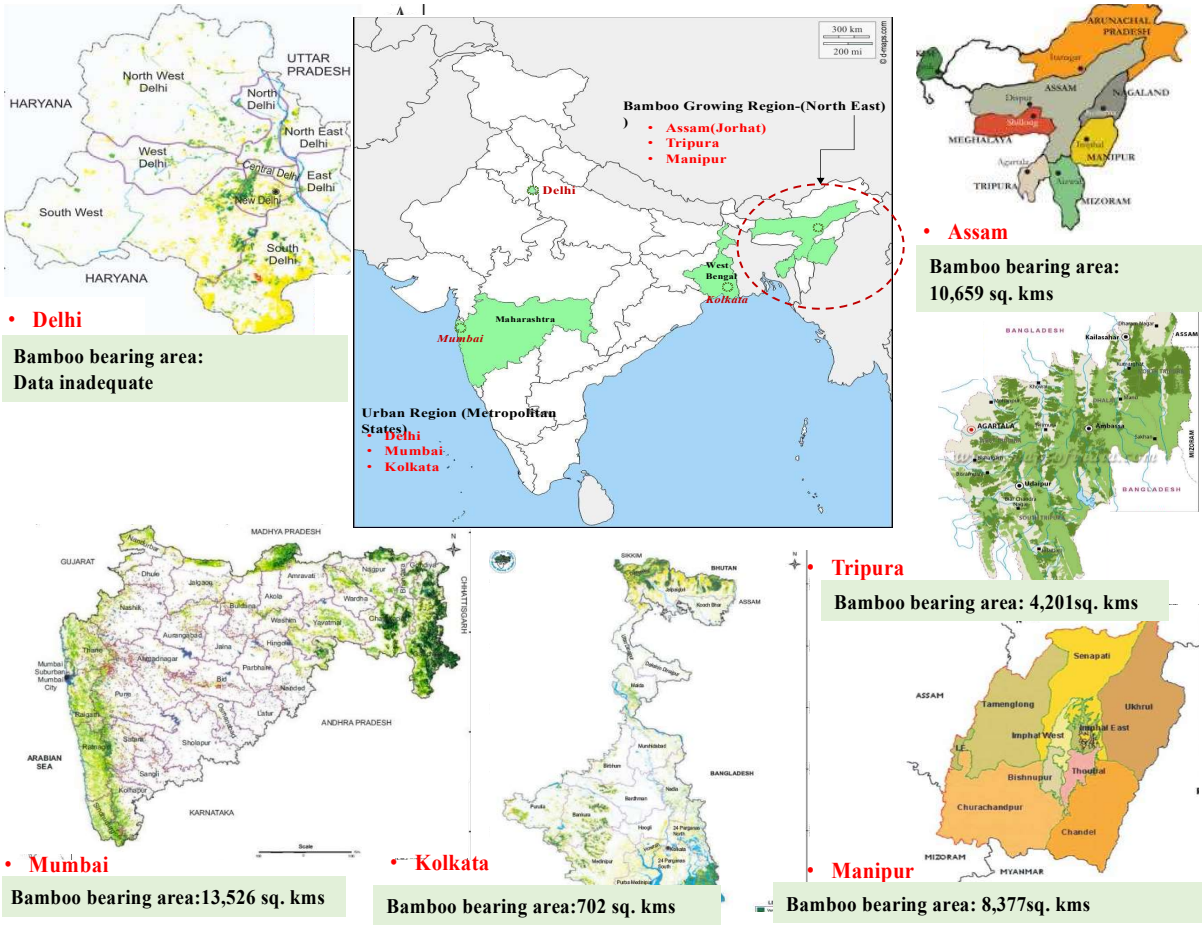


Figure 66: Mapping study area
Source: Authors own adaptation

6.5 Analysis of Segmental Attributes

6.5.1 Pervasiveness of analysing Personal Factor (PF)

6.5.1.1 Buyer based Personal Factor (PF1.1)

The pervasiveness of analysing commercialization of bamboo furniture , random survey were conducted in order to accumulate the personal factor sub-attributes affecting buyer behaviour .Total of 384 feedbacks were collected ranging minimum 15-20 respondents from each states .The data deceived from the diverse sample was been aggregated for whole state . The data provided in Table 4.8 and Figures 4.45, 4.46, 4.47, 4.48 and 4.49 are from the selected Metropolitan and bamboo producing states of India.

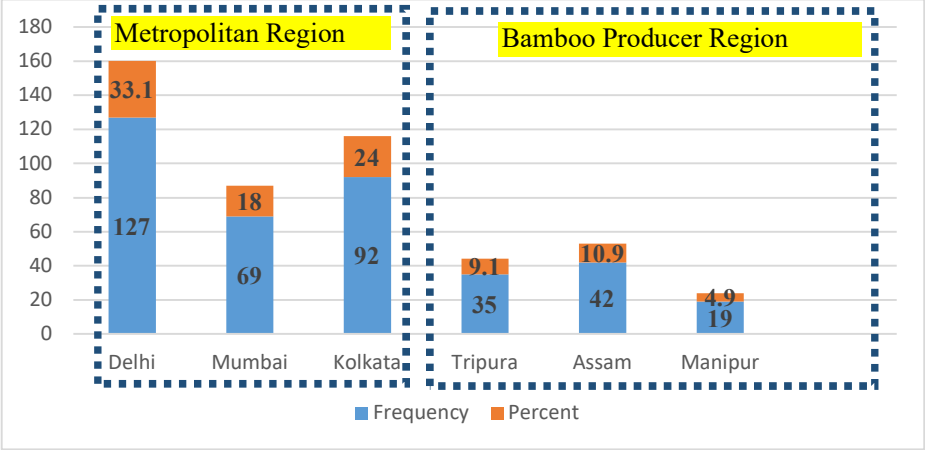
Table 4.8: Percentage of pervasiveness of analysing buyers Personal factor

Codes			Frequency	Percentage
PF1.1.1	**Region**	Delhi	127	33.1
		Mumbai	69	18
		Kolkata	92	24
		Tripura	35	9.1
		Assam	42	10.9
		Manipur	19	4.9
PF1.1.2	**Gender**	Male	227	59.1
		Female	157	40.9
PF1.1.3	**Age**	18 - 29 years	140	36.5
		30 - 39 years	126	32.8
		40 - 49 years	65	16.9
		50 - 59 years	32	8.3
		More than 60 years	21	5.5
PF1.1.4	**Qualification**	Diploma	45	11.7
		Graduate	165	43
		Higher Secondary	2	0.5
		M. Phil, pursuing PhD	2	0.5
		Marine trainee	2	0.5
		PhD	6	1.6
		Post Graduate	162	42.2
PF1.1.5	**Marital status**	Divorced	12	3.1
		Married	225	58.6
		Unmarried	147	38.3
PF1.1.6	**Family type**	Joint	161	41.9
		Nuclear	223	58.1
PF1.1.7		Full Time	285	74.2

	Employment type	Not employed	59	15.4
		Part-Time	40	10.4
PF1.1.9	**Department**	Academics	45	11.7
		Architecture /Design	98	25.5
		Finance	29	7.6
		Govt. sector	26	6.8
		Hospitality	10	2.6
		House wife	16	4.2
		Human resource	38	9.9
		Others	89	23.2
		Sales and Marketing	33	8.6
PF1.1.10	**Income level**	Less than Rs. 25000	114	29.7
		Rs. 100000 and above	120	31.3
		Rs. 25000 - Rs. 50000	67	17.4
		Rs. 50000 - Rs. 75000	40	10.4
		Rs. 75000 - Rs. 100000	43	11.2

6.5.1.1.1 Region distribution of respondent – (PF 1.1.1)

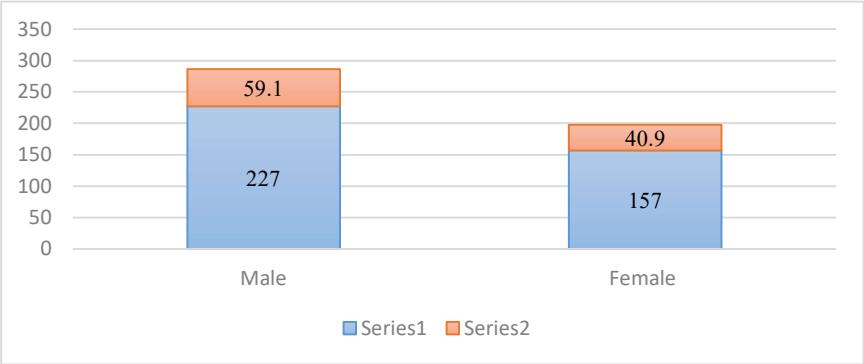
Analysing the regional distribution majority of respondent are from Delhi, accounting for 33.1%. Further, 24.0% of them were from Kolkata and 18.0% of them were from Mumbai. Followed by this, 10.9% of them were from Assam, 9.1% of them were from Tripura and only 4.9% of them were from Manipur



Graph 1: Respondents region distribution

6.5.1.1.2 Gender – (PF 1.1.2)

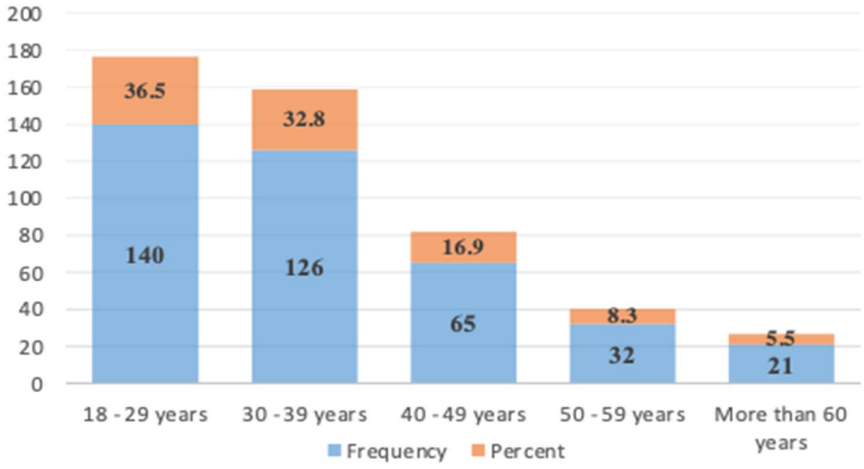
To understand the buyer's gender significance The results affirmed that nearly 59% were males while 41% were females involved in the survey .



Graph 2: Respondents gender distribution

6.5.1.1.3 Age distribution – (PF 1.1.3)

As age is an important demographic factor to understand buyers knowledge, understanding whether they fit your target audience or not. As the needs change with the age ,which influence buying decision. In accordance with age group of the respondents , the variable, 36.5% are between 18 – 29 years. Nearly 32.8% of them which between age group of 30 – 39 years. Moreover, 16.9% of the consumer's age range between 40 – 49 years and 8.3% age range of 50 – 59 years. Only 5.5% of them were such that aged more than 60 years.

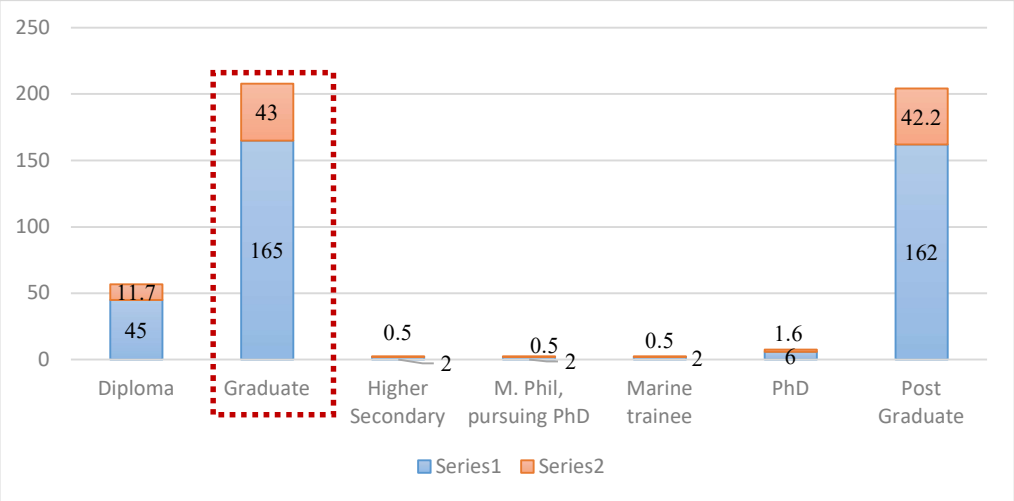


Graph 3: Respondents age distribution

6.5.1.1.4 Qualification -(PF 1.1.4)

The Queries made with the respondent consumers to comprehend their educational qualification. participants are interacting with during their everyday lives. If they're married, their buying decisions may be influenced by different factors compared to someone who isn't.

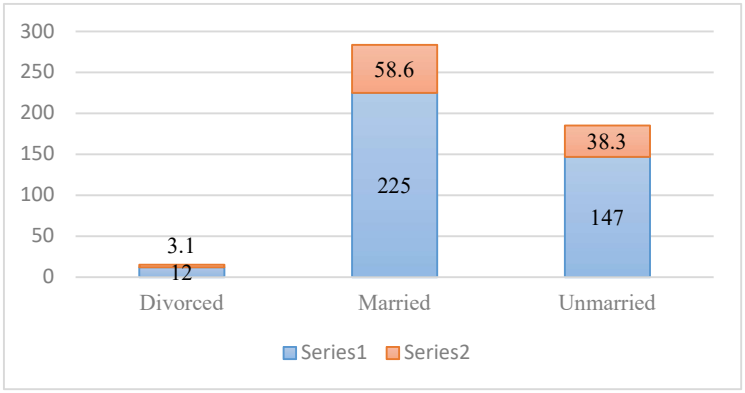
In alignment with this, it was depicted that 43.0% of the consumers were graduates. This was followed by 42.2% of them that were post graduates. Further, 11.7% of them had diploma course while 1.6% of them were PhD. Nearly 0.5% of buyer's highest level of educational qualification as higher secondary; M. Phil, pursuing PhD and Marine trainee respectively.



Graph 4: Respondents Qualification

6.5.1.1.5 Marital status – (PF 1.1.5)

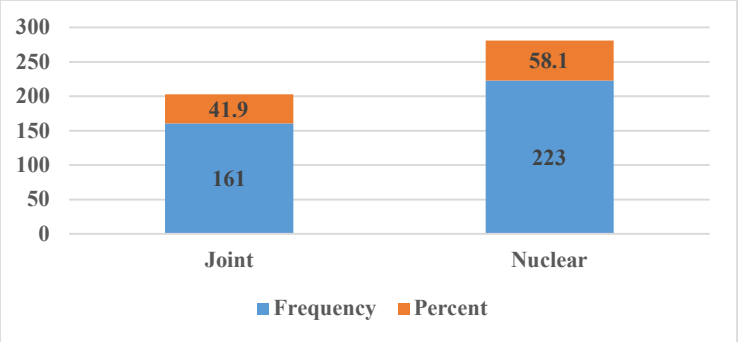
The Marital status of the respondents in accordance with their responses it was found that 58.6% were married while 38.3% were unmarried. 3.1% of the consumers that affirmed that they were divorced. This question helped to relate with respondents and understand their living criteria.



Graph 5: Respondents Marital status

6.5.1.1.6 Family type- (PF 1.1.6)

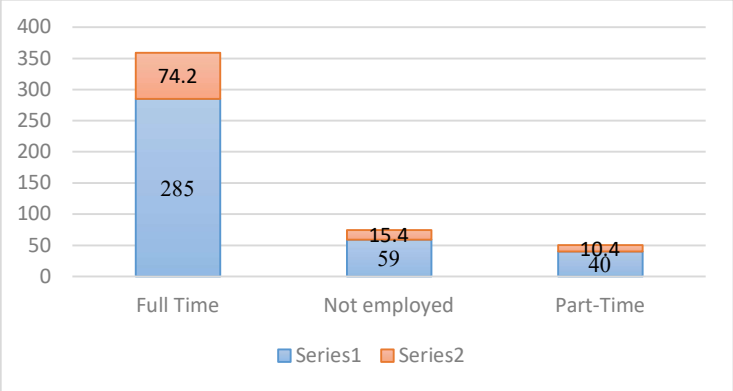
To understand the living criteria further participants were asked to accentuate their family type. In relevance to observed findings 58.1% had nuclear family while 41.9% were living in joint families.



Graph 6: Respondents family type

6.5.1.1.7 Employment type –(PF 1.1.7)

Knowing the employment type of the buyers help to analyse the amount of buying power and customer's control. To decipher the employment type of the buyers .It is been observed 74.2% of them were engaged in full-time employment and 10.4% of them engaged in part-time working. While 15.4% of them were found not employed.

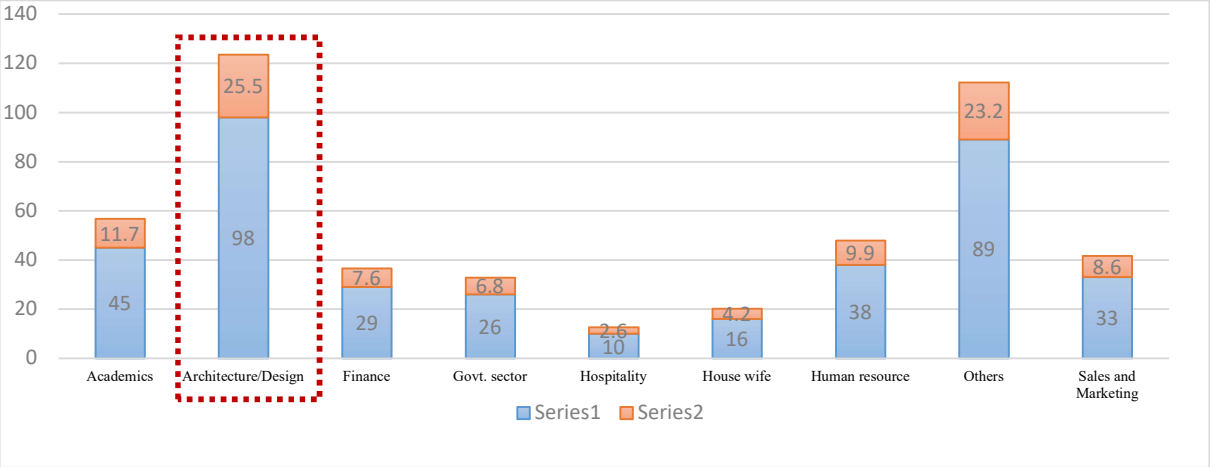


Graph 7: Respondents employment type

6.5.1.1.8 Department –(PF 1.1.8)

As the working department status contributes to the buying power With respect to this, it was found that the majority of the consumers corresponding to 25.5% of them were employed in architecture/ design sector. 23.2% of the consumers followed by this were employed in other department than listed. Moreover, 11.7% of them were employed in academics' sector. Subsequently, 9.9% of the consumers highlighted that they were employed in Human resource sector. 8.6% of the consumers were found to be employed in Sales and Marketing sector

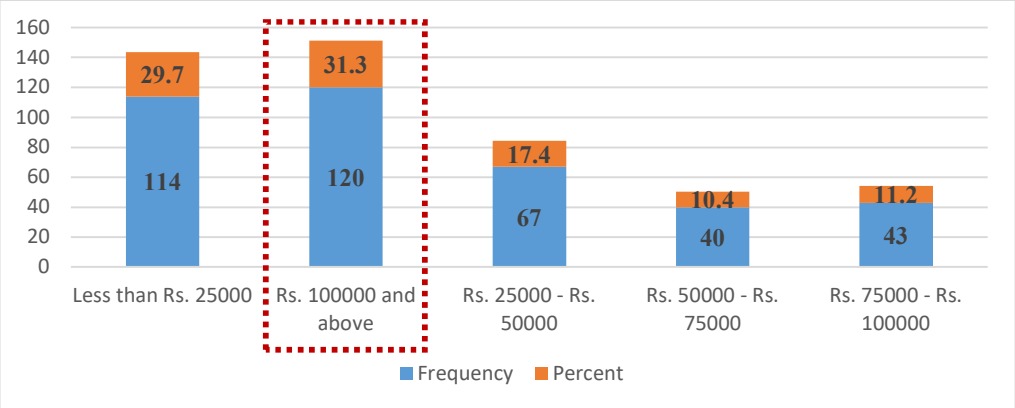
while7.6% of them were employed in Finance sector. Further, it was affirmed that 6.8% of them were employed in the Government sector and 4.2% of them were housewives.



Graph 8: Respondents working departments

6.5.1.1.9 Income level –(PF 1.1.9)

Income level of the consumers contributes to their buying power. In accordance to this, it was deciphered that 31.3% of them had highest monthly income level of Rs. 1,00,000 and above. Consequently, 29.7% of the consumers had lowest monthly income level of less than Rs. 25,000. Additionally, 17.4% of them revealed that they had a monthly income level of Rs. 25,000 – Rs. 50,000. Followed by this, 11.2% of them had a monthly income level of Rs. 75,000 – Rs. 1,00,000. Finally, there were only 10.4% of the consumers that had a monthly income level of Rs. 50,000 – Rs. 75,000. , 24.0% of them were from Kolkata and 18.0% of them were from Mumbai. Followed by this, 10.9% of them were from Assam, 9.1% of them were from Tripura and only 4.9% of them were from Manipur.



Graph 9:Respondents Income level

The surveying the buyers demographic information's from PF1.1.1, PF1.1.2, PF1.1.3, PF1.1.4 PF1.1.5, PF1.1.6, PF1.1.7, PF1.1.8, PF1.1.9 and PF1.1.10 it is analysed that maximum responses received from Delhi and it is observed that male are more partaking than female in furniture buying .The average age of maximum respondents is between 18-29 yrs. , married and having a nuclear family which states that buyers are matured enough analyse their preference while buying a furniture .As most of them were married and living in a small family so the furniture choices and buying decisions will be mostly centred towards small group of family member .The maximum respondent were from architecture and interior background so their inputs on bamboo furniture designing were inclined as per their client and personal experiences giving a boarder buyer perspective .

6.5.1.2.1 Pervasiveness of analysing Personal Factor (PF)-Stakeholders (sellers & manufacturer)

The random survey was conducted to accumulate the personal factor sub-attributes affecting seller behaviour. Total 34 feedbacks were collected ranging minimum 3-5 respondents from each states .The collected data from the diverse sample is been aggregated for the whole state . The data provided in Table 4.8 and Figures 4.45, 4.46, 4.47, 4.48 and 4.49 are from the selected Metropolitan and bamboo producing states of India.

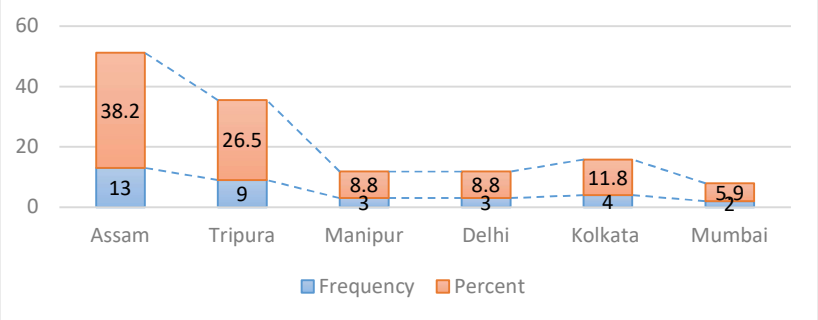
Table 4.8: Percentage of pervasiveness of analysing stakeholders (sellers) Personal factor

Codes			Frequency	Percentage
PF1.2.1	**Region**	Assam	13	38.2
		Delhi	3	8.8
		Kolkata	4	11.8
		Manipur	3	8.8
		Mumbai	2	5.9
		Tripura	9	26.5
PF1.2.2	**Age**	0- 20 years	0	0
		21 - 30 years	7	20.6
		31 - 40 years	9	26.5
		41 - 60 years	18	52.9
		61 years and above	0	0
PF1.2.3	**Education**	Up to Class 4	11	32.4
		Class 5-8	7	20.6
		Higher Secondary	9	26.5
		Graduate and above	7	20.6
PF1.2.4		Up to 5 years	3	8.8

	Working Experience	6 - 10 years	8	23.5
		11 - 15 years	7	20.6
		16 - 20 years	9	26.5
		More than 20 years	7	20.6
PF1.2.5	**Traditional Involvement**	No	11	32.4
		Yes	23	67.6
PF1.2.6	**Payment type**	Daily wages	11	32.4
		Monthly basis	4	11.8
		Target basis	18	52.9
		Weekly basis	1	2.9
PF1.2.7	**Income level**	Less than Rs. 5,000	2	5.9
		Rs. 5,000 - Rs. 10,000	12	35.3
		Rs. 10,000 - Rs. 15,000	11	32.4
		Above Rs. 15,000	9	26.5
PF1.2.8	**Adequate Market**	Urban Market	1	2.9
		Local Market	15	44.1
		Local and Urban Market	10	29.4
		All of above	8	23.5
PF1.2.9	**Adequate customers'**	Exporters	1	2.9
		Government agencies	3	8.8
		Locals	15	44.1
		Traders	3	8.8
		Urban Indian market	12	35.3

6.5.1.2.2 Region distribution of respondent –(PF 1.2.1)

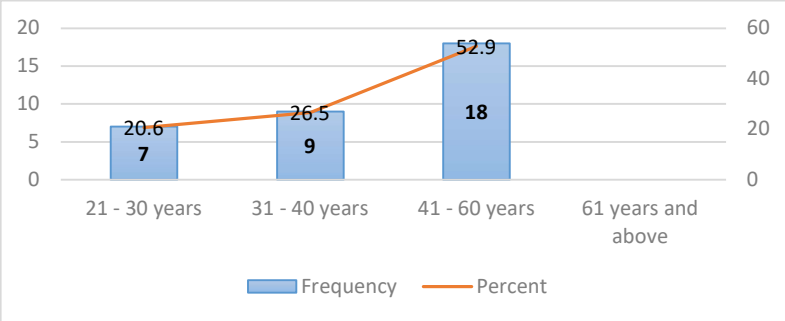
The regional distribution analysis to understand the sellers surrounds, the majority of respondent were from Assam, accounting for 38.2%. Further, 26.5% of them were from Tripura and 11.8 % of them were from Kolkata Followed by this, 8.8 % of them were from Delhi and, Manipur and only 5.9% of them were from Mumbai. The results derived that majority of bamboo furniture artisans are available in Assam from selected study area .



Graph 10: Stakeholders region distribution

6.5.1.2.3 Age distribution –(PF 1.2.2)

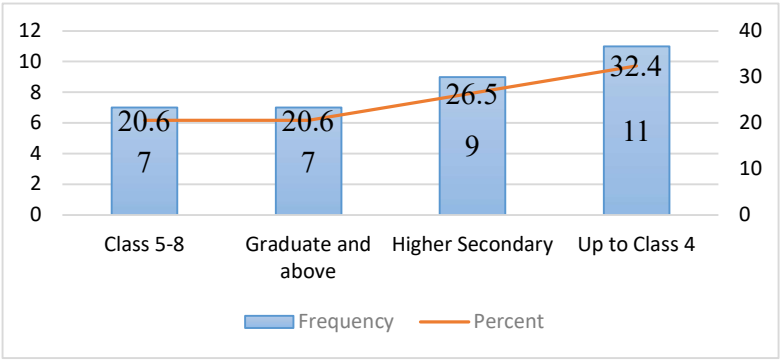
To understand seller's knowledge, understanding whether they fit to target the buyer's needs and understanding . In accordance to the age, majority of the respondents 52.9% were between 41– 60 years. The result shows that most the artisan working in bamboo furniture making is of middle age, depicting to better understanding of viable bamboo furniture markets needs and valuable feedbacks.



Graph 11: Stakeholders age distribution

6.5.1.2.4 Education – (PF 1.2.3)

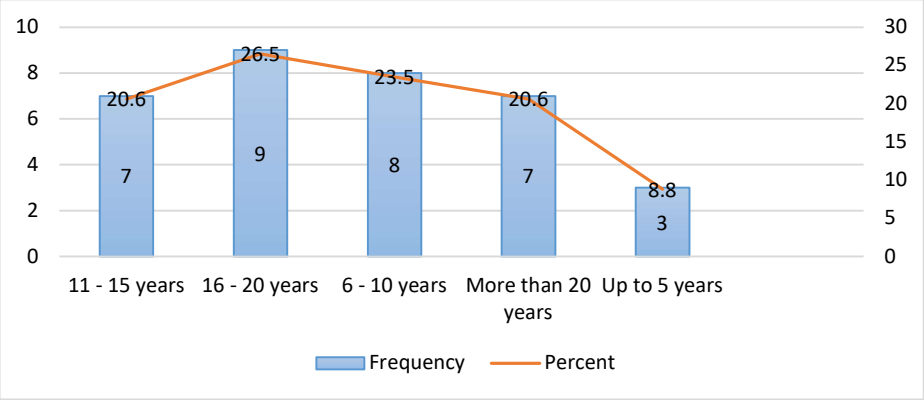
The analysing the education to understand qualification of participants and its significance in adoption of bamboo furniture. Interacting to these stakeholder considering their everyday lives, the data recorded follows 20.6 % of bamboo artisans are elementary qualified till class 5 -8 , 26.5% have done higher secondary , 20.6 % are graduate and above . The maximum respondent nearly 32.4% were just having the elementary education up to class 4 , depicting that the artisan are not even elementary educated which sets a major drawbacks in interacting and connecting with buyers .



Graph 12: Stakeholders' education level

6.5.1.2.5 Working Experience-(PF 1.2.4)

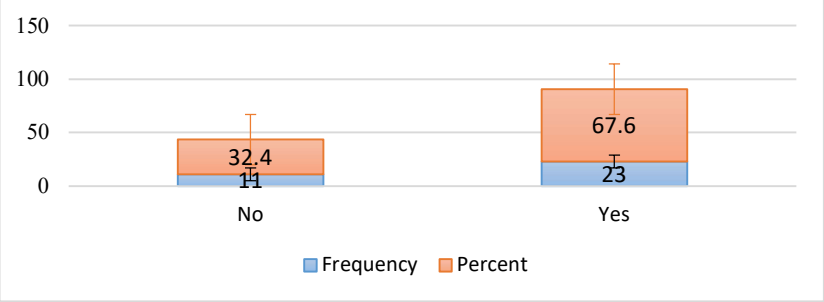
Analysing the skill and workability of artisans on basis of working experience ,The average experience of the artisan are between 10-15 years , Nearly 20.6% were found having more than 20 years of working experience. Observing the achieved data maximum respondents are skilled, but outdated to the modern design and technology.



Graph 13: Stakeholders working experience

6.5.1.2.6 Industry Involvement-(PF 1.2.5)

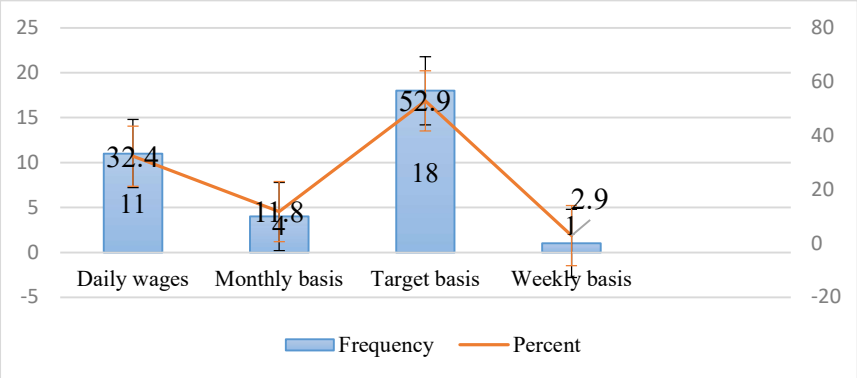
The traditional involvement of bamboo artisans, the data states that 32.4% are not traditionally involved in this industry whereas 67.6% considers bamboo craft and furniture making as their traditional business.



Graph 14: Stakeholders industry involvement

6.5.1.2.7 Payment type-(PF 1.2.6)

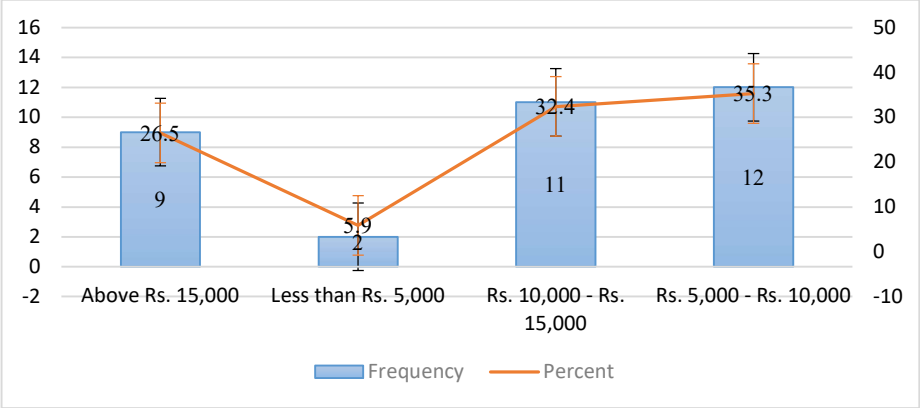
The analysis indicates that most of the bamboo artisans are paid on the basis of their production (i.e. per furniture or targeted productions). Nearly 2.9% are paid weekly basis, 11.8% of the bamboo artisan are paid monthly, 32.4% have been getting daily wages and maximum respondents 52.9% were found paid on target basis.



Graph 15: Payment criteria

6.5.1.2.8 Income distributions – (PF 1.2.7)

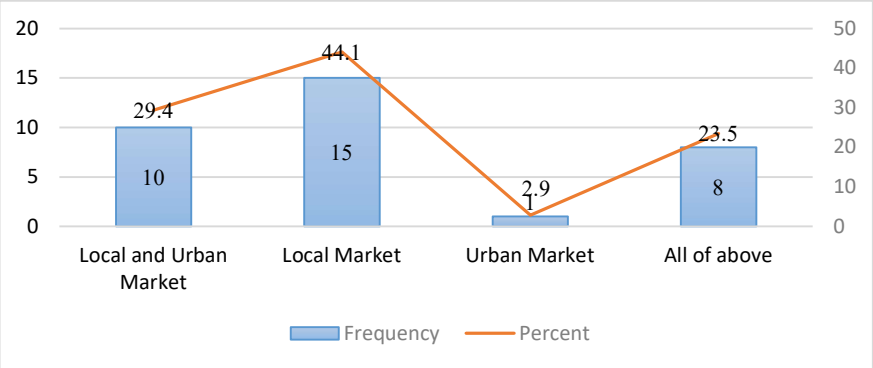
As Income is directly correlated to the industry development The Income effect positively or negatively on the business growth. The increased incomes increase the production of a goods and visa- versa if the income from the good decreased. Analyzing the data, 5.9 % were having income less than Rs 5000 ,26.5 % respondents were having income level above Rs 15000, 32.4% have income level from Rs 10000- Rs 15000 and maximum respondent 35.3 % were found earning from. Rs. 5000 -Rs 10000.



Graph 16: Stakeholders Income distributions

6.5.1.2.9 Adequate market-(PF 1.2.8)

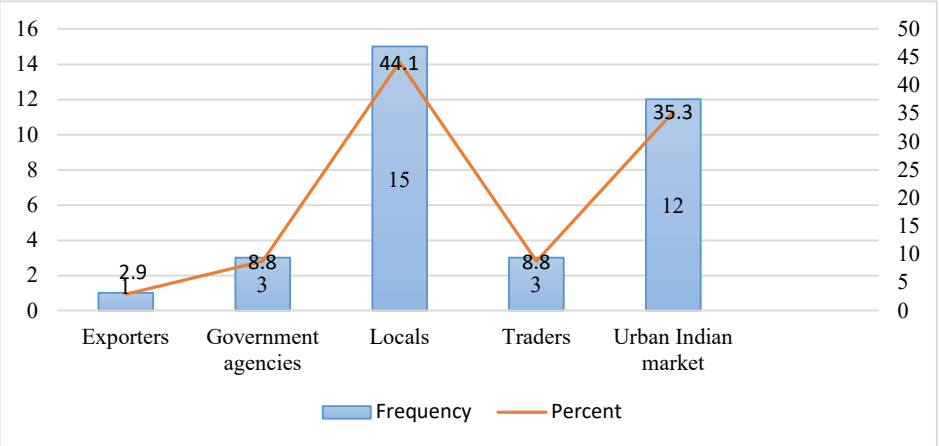
The adequate market as per bamboo stakeholders to whom the maximum furniture is sold is the nearby shops and local markets which stated by 44.1% artisans. The local buyers are considered adequate as it easy to commute and communicate to them



Graph 17: Adequate market

6.5.1.2.10 Adequate Buyers'-(PF 1.2.9)

The adequate buyers as per stakeholder are the local, 35% said that urban market are their next viable buyers who buy furniture from online portals like Amazon ,pepper fry and other traditional store like Bishwa Bangla etc but 44.1% gave the feedback that the maximum furniture are procured by the local store and buyers



Graph 18: Adequate furniture buyer

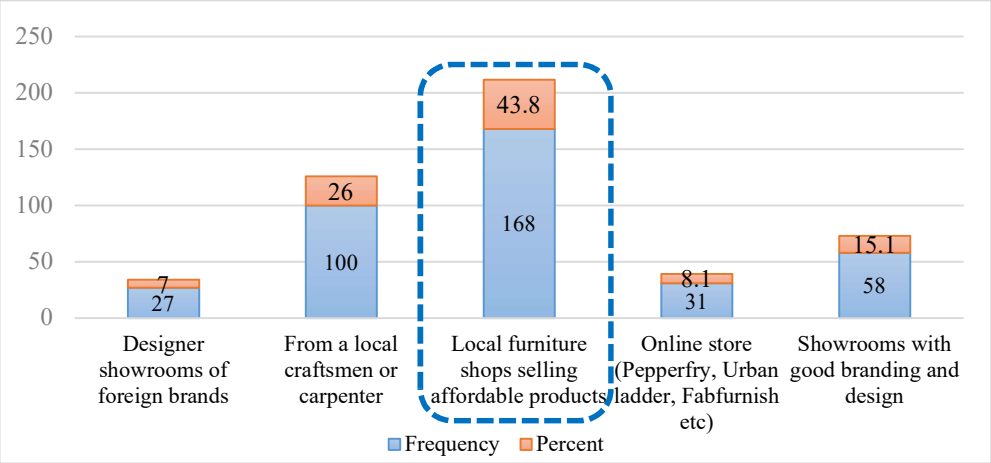
The surveying the stakeholders which includes bamboo furniture artisans and manufacturer demographic information's from PF1.2.1, PF1.2.2, PF1.2.3, PF1.2.4, PF1.2.5, PF1.2.6, PF1.2.7, PF1.2.8, PF1.2.9. The maximum responses received from Assam and average age of these artisans were between 41-60 yrs. which shows to their high experience and their traditional involvement in bamboo furniture making. The survey detailed that most of artisans involved are not even elementary educated and paid on target basis depending upon their delivered product .The average incurred by them are between Rs5000- Rs 10000 which is not enough for them to even fulfil their

basic needs. These artisans also stated that due to low income, high labour and limited local customers' they switching to other high paying jobs and taking bamboo furniture making as their part time source.

Evaluating the personal attributes of the users and the stakeholder involved as a mediator to identify RQ1 "Reasons of low acceptance of bamboo furniture in India and why there is lack in promotion in comparison to other countries despite of being a wide availability" and RQ2: Major intervention need to be adopted to commercialize bamboo furniture among Indian consumers.

6.5.1.3 Buyer consideration while furniture purchase – (PF 2.1)

The commercialization is primarily focused on assessing and solving the buyer's consideration from the products. Assessing the variable from above section and the market survey, some of the basic consideration from the various buyers' perspective is evaluated in the survey. The briefed consideration are formalised in questionnaire to understand the general preference of the buyers while buying furniture. In this context, analysing the consideration of buyers while buying furniture for their space, a maximum percent of respondents 43.8% delineated that they prefer local furniture shops that sell affordable furniture when they go for buying furniture.



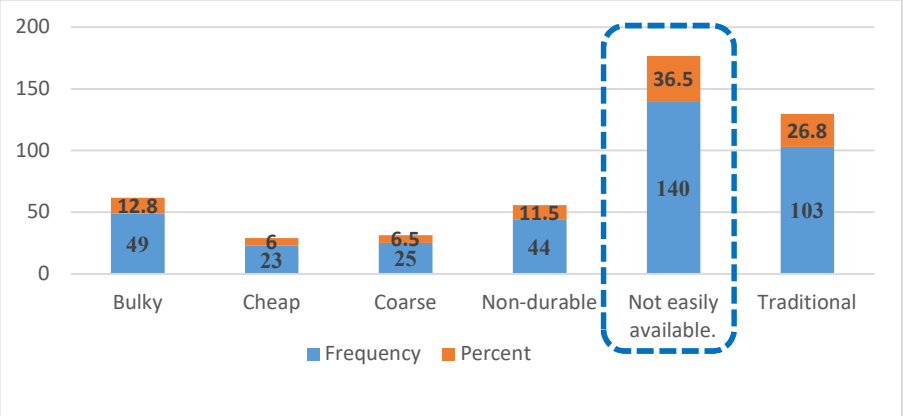
Graph 19: Buyer consideration while furniture purchase

Buying preference = Local furniture shops

As the analysis focusing on specific needs and buyers consideration from a furniture .The derived variable (preference) focused on furniture availability at local shops at pocket friendly prices Therefore bamboo furniture should be made available at local shops so that it can be easily accessed by its adequate buyers.

6.5.1.3.1 Buyer attitude towards bamboo – (PF 3.1)

In analysing the commercialization of bamboo furniture it is important is to understand its image in Indian market .The buyer's perceptions towards the bamboo is very important to understand their behaviour. The concept of attitude is defined as the sum of opinion and the evaluation of inclined attributes. As per the theory of planned behaviour by (Fishbein & Ajzen, 1975) , (Ajzen, 1991)[38] the attitudes are not the only factor that influence our decision. When we combine a strong attitude with subjective norms and with our belief that we can perform a particular behaviour, these three things will predict our actual behaviour. As different people may hold attitudes toward the same attitude object for different reasons. Investigating buyers attitude towards image of bamboo, for furniture making 384 buyers were interviewed from study area.



Graph 20: Buyer attitude towards bamboo

Perception towards bamboo= Not easy availability

The survey deciphered, 36.5% considers that bamboo is not easily available in Indian furniture market. While 26.8% of them dictated that bamboo as furniture raw material seems to be traditional, 12.8% found it bulky while 11.5% of the consumers highlighted that they feel bamboo as a raw material for furniture is non-durable. It is been observed that Bamboo is commonly associated as "food for panda" and "poor man's timber". The Indian buyers considers it non-availability as major factor of not been considered for making furniture.

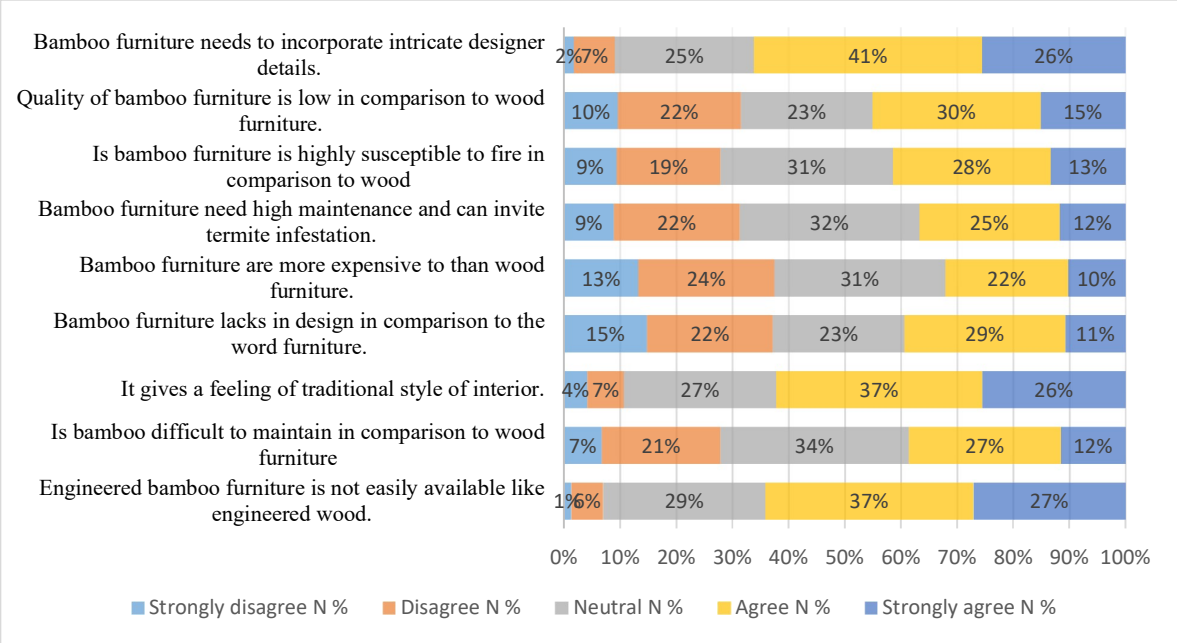
6.5.1.4 Bamboo not being adopted as a furniture material instead of wood-(PF1)

As in earlier section 1.1. and 1.2 , the over exploitation of natural resources wood for furniture making is discussed ,which leading its depletion .Considering , sustaining ecological footprint , bamboo adaptation as a substitute is considered as part of study Using bamboo and its by-products in lieu of wood for furniture making can addressed the ecological footprints. But in field

[38] Adapted from /https://opentextbc.ca/introconsumerbehaviour/chapter/understanding-attitudes/

study it is analysed that in Indian context bamboo image is still out seen. Considering the factors 9 variables derived from interview discussion and survey, which further evaluated with 384 respondents on selected study area to ascertain the whole state sample. The responses are evaluated on scale of "Strongly agree to strongly disagree" parameter on 5 point Likert scale. The responses draw consumer's perspective on reasons of bamboo still not being a part of Indian furniture industry and still unconsidered for furniture making.

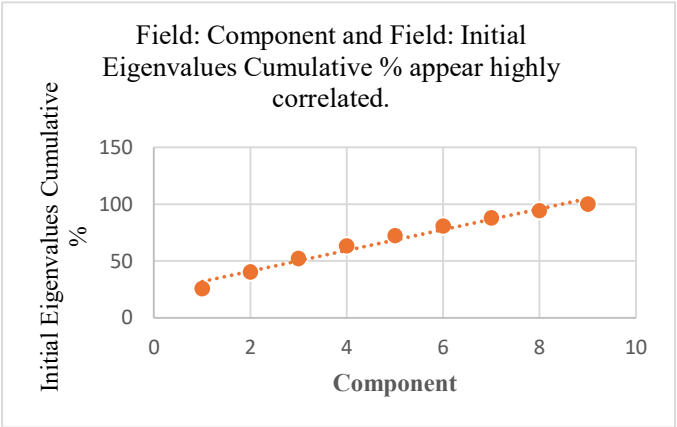
Statements	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %
Engineered bamboo furniture is not easily available like engineered wood.	5	1.3%	22	5.7%	111	28.9%	142	37.0%	104	27.1%
Is bamboo difficult to maintain in comparison to wood furniture	26	6.8%	81	21.1%	129	33.6%	104	27.1%	44	11.5%
It gives a feeling of traditional style of interior.	16	4.2%	25	6.5%	104	27.1%	141	36.7%	98	25.5%
Bamboo furniture lacks in design in comparison to the word furniture.	57	14.8%	86	22.4%	90	23.4%	110	28.6%	41	10.7%
Bamboo furniture are more expensive to than wood furniture.	51	13.3%	93	24.2%	117	30.5%	84	21.9%	39	10.2%
Bamboo furniture need high maintenance and can invite termite infestation.	34	8.9%	86	22.4%	123	32.0%	96	25.0%	45	11.7%
Do you think bamboo furniture is highly susceptible to fire in comparison to wood?	36	9.4%	71	18.5%	118	30.7%	108	28.1%	51	13.3%
Quality of bamboo furniture is low in comparison to wood furniture.	37	9.6%	84	21.9%	90	23.4%	115	29.9%	58	15.1%
Bamboo furniture needs to incorporate intricate designer details.	7	1.8%	28	7.3%	95	24.7%	156	40.6%	98	25.5%



Graph 21: Bamboo not being adopted as a furniture material instead of wood

To measure the strength of the relationship among variables and analyse correlation matrix of the variables in the dataset diverges significantly from the identity matrix Bartlett test of sphericity is used. The test evaluates that data reduction technique is suitable for further analysis. On above variable Bartlett's test of sphericity is performed by taking $\alpha = 0.05$. The derived p-value is less than 0.05, which signify the factor analysis is valid.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.670
Bartlett's Test of Sphericity	Approx. Chi-Square	364.853
	df	36
	Sig.	.000



The below table of communalities depicting the variance , here communality value more than 0.5 is considered for further analysis. As our communality values range from 0.361 to 0.686 there is 68% of the variance in "Intricate Designer details" is accounted for and 36% of the variance in "bamboo furniture more expensive than wood " .

In

	Initial	Extraction
C1-Bamboo furniture needs to incorporate intricate designer details	1.000	.686
C7-Quality of bamboo furniture is low in comparison to wood furniture	1.000	.496
C5-Bamboo furniture is highly susceptible to fire in comparison to wood	1.000	.417
C8-Bamboo furniture need high maintenance and can invite termite infestation.	1.000	.470
C9-Bamboo furniture are more expensive to than wood furniture.	1.000	.361
C2-Bamboo furniture lacks in design in comparison to the wood furniture.	1.000	.671
C3-It gives a feeling of traditional style of interior.	1.000	.553
C6-Is bamboo difficult to maintain in comparison to wood furniture	1.000	.513
C4-Engineered bamboo furniture is not easily available like engineered wood.	1.000	.530

Extraction Method: Principal Component Analysis.

below table the Principal Component Analysis (PCA) initially extracted 9 factors , the components with high Eigen values represents is considered .The initial eigenvalues has all the 9 variables after running factor analysis in SPSS, we got 3 factors explaining the 11.78% of the variance. As per the eigenvalue greater 1 selection rule factor less >1, will not be considered. So we are considering only 3 components having Eigenvalues of at least 1and as other components having low quality scores hence are not assumed.

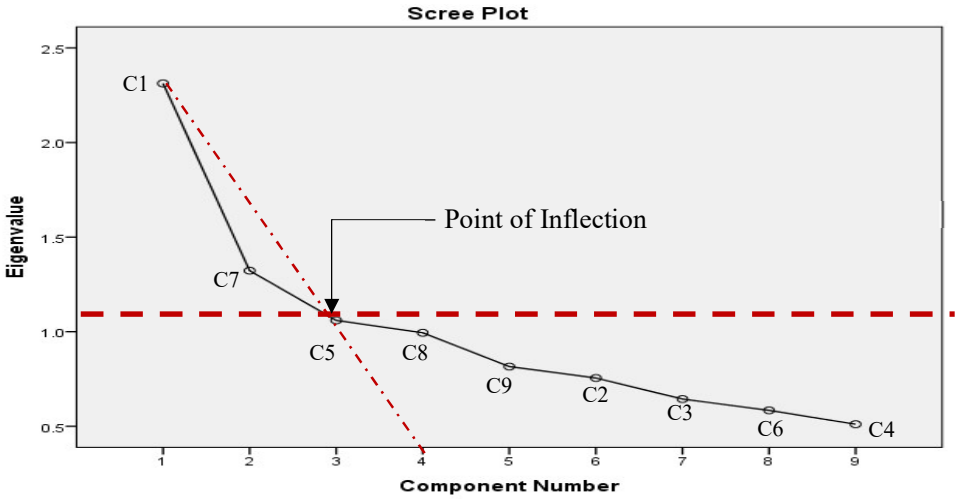
The scree plot below is a graph of the eigenvalues against all the factors we have considered .

Component	**Initial Eigenvalues**		**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**	
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**
1	2.312	25.694	25.694	2.312	25.694	25.694	2.107
2	1.323	14.697	40.390	1.323	14.697	40.390	1.523
3	1.060	11.780	52.170	1.060	11.780	52.170	1.290
4	.994	11.048	63.218				
5	.816	9.061	72.279				
6	.755	8.394	80.673				
7	.644	7.156	87.829				
8	.584	6.494	94.322				
9	.511	5.678	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

The graphs is determining , factors to retain the eigenvalue against the component number. The values in the first two values of the Extraction Sums of Squared Loadings are immediately above. From the third and fourth component the line is almost getting flat, meaning each successive component is accounting for smaller and smaller amounts of the total variance. Therefore ,will be keeping only those principal components whose eigen value are greater than 1 .Components with eigenvalue of less than 1 accounts for less variance and of little use.



The unrotated factors loading , which have correlation between the variable and the factor have been extracted in below table . The possible values range from -1 to +1.

Component Matrix[a]

	Component		
	1	2	3
Bamboo furniture needs to incorporate intricate designer details.		.481	.635
Quality of bamboo furniture is low in comparison to wood furniture.	.581	-344	
Do you think bamboo furniture is highly susceptible to fire in comparison to wood	.612		
Bamboo furniture need high maintenance and can invite termite infestation.	.614		
Bamboo furniture are more expensive to than wood furniture.	.581		
Bamboo furniture lacks in design in comparison to the word furniture.	.356	.503	-.540
It gives a feeling of traditional style of interior.	.335	.662	
Is bamboo difficult to maintain in comparison to wood furniture	.507		.503
Engineered bamboo furniture is not easily available like engineered wood.	.583	-.433	

Extraction Method: Principal Component Analysis, a. 3 components extracted.

The table above is showing the loadings i.e. extracted values of each item under 3 variables of the nine variables on the three factors extracted. The higher the absolute value of the loading, the

more the factor contributes to the variable. We have extracted three variables wherein the 9 items are divided into 3 variables according to the most important items which are similar responses in component 1 and simultaneously in components 2 and 3. The loadings less than 0.3 are suppressed. To have precise computation of each factor component the presence of cross loading i.e., one factor measuring more than one component is used. As the cross-loading. "Bamboo furniture need intricate designer detail" is very high shown in table below from other components. Therefore, for further impact analysis and relating to the personal factor affecting the bamboo not being adopted as a furniture material instead wood, we considering factor bamboo furniture need intricate designer details like wood.

6.5.2 Pervasiveness of analysing Social Factor (SF)

6.5.2.1 Skill level of the intermediaries (artisans), traditional involvement, prospectus and constraint.-(SF1)

Analyzing commercialization in social context direct and indirect initiator i.e. bamboo stakeholders (manufacturer and artisans) behavior studied to understand their traditional involvement, skill level and constraints affecting the bamboo adoption by Indian. In relation to this context 23 variables selected based on field survey and discussion with manufacturer and industry experts. The response draws to evaluate primarily "RQ3 Constraints faced by small, micro, and medium scale bamboo furniture manufacturers and the modification suggestion towards existing policy to have better skilful bamboo industry in India" and secondly RQ4 "Skill level of rural craftsmen and the gaps between end user aspirations and produced items" the specific variable and understand the skill level of the intermediaries involved and their consideration on bamboo acceptability among urban buyers. The response is evaluated on scale of "Strongly agree to strongly disagree" parameter on 5-point Likert scale.

Constraints	Strongly Diasgree		Disagree		Neutral		Agree		Strongly agree	
	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %
The government has made significant efforts for advancing the bamboo furniture industry.	18	53%	7	21%	3	9%	6	18%	0	0%
The government provides incentives and subsidies for undertaking entrepreneurship in the bamboo industry.	14	41%	6	18%	4	12%	8	24%	2	6%
Do you think government policy on bamboo transportation sales and promotion needs improvements.	0	0%	2	6%	2	6%	12	35%	18	53%

Do you need proper road networking and transporting for bamboo products and raw material?	0	0%	1	3%	4	12%	10	29%	19	56%
One can easily avail of loans from the banks and other regulated financial institutions for funding their bamboo furniture business.	18	53%	11	32%	1	3%	3	9%	1	3%
There is an adequate storage facility available for the storage of raw bamboo	5	15%	13	38%	3	9%	10	29%	3	9%
There are sufficient promotional measures needed for promoting bamboo furniture.	17	50%	10	29%	2	6%	2	6%	3	9%
Direct markets, traders, newspapers and digital platform keeps you updated about bamboo furniture industry	9	26%	16	47%	5	15%	3	9%	1	3%
For increasing the sales of bamboo furniture and products, pertinent investment in advertisements is done	12	35%	13	38%	5	15%	1	3%	3	9%
The adequate bamboo species for raw material to bamboo furniture and products is easily available in the market.	5	15%	11	32%	3	9%	11	32%	4	12%
There is a lack of skilled artisans that can produce bamboo products and furniture.	0	0%	2	6%	1	3%	12	35%	8	24%
Bamboo furniture /product artisans need better technological developments and training for producing better designs.	0	0%	0	0%	1	3%	5	15%	28	82%
work is not just seasonal, instead, it is year-round	0	0%	0	0%	1	3%	16	47%	17	50%
Storing finished bamboo products and furniture is easy.	4	12%	6	18%	3	9%	18	53%	3	9%
International fairs, exhibitions and digital marketing can be an innovative steps to promote bamboo furniture	0	0%	0	0%	0	0%	13	38%	21	62%
Skill development and Training programmes is needed in your area to promote bamboo products and furniture making among people	0	0%	0	0%	1	3%	22	65%	11	32%
and furniture making can encourage more artisans and promote bamboo furniture industry	0	0%	0	0%	2	6%	10	29%	22	65%
Connecting to the designers and consumers can help you to produce better designs	0	0%	0	0%	2	6%	11	32%	21	62%
There is more demand for modern and intricate furniture with bamboo.	0	0%	1	3%	2	6%	14	41%	17	50%
Do you have awareness on engineered bamboo used internationally for furniture	12	35%	12	35%	9	26%	1	3%	0	0%
Consumers have good awareness about bamboo furniture.	9	26%	12	35%	11	32%	2	6%	0	0%
Bamboo is a viable substitute of wood for making furniture.	0	0%	1	3%	2	6%	11	32%	20	59%

Graph 22: Skill level of the intermediaries (artisans), traditional involvement, prospectus and constraint.

a) Analyzing the stakeholder responses, for furniture making 59% of Artisans agree that bamboos can easily use as a substitute of wood to craft furniture of any design. On the awareness about bamboo among buyers, 32% of these stakeholders stated that local buyers seem to be aware about the properties and strength of bamboo, but its urban buyers still come with queries related to strength and stability.

b) To the buyer's preference for furniture, majority of the stakeholder in survey responded that there is more demand of modern intricate bamboo furniture and strongly agreed that connecting to the designers and buyers can help them in developing better designs.

c) Surveying bamboo artisans and manufacturer, it is also observed that there is need of advanced skill development training sessions and programs in the remote area, as these artisans are living in very remote village like "Hahnpuria"and "Gol gaon". These bamboo

stakeholder riposte that international fairs, exhibition, and digital marketing they need improvement in and can it help them promote bamboo furniture among urban buyers.

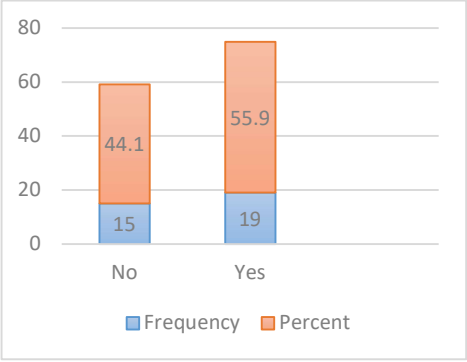
d) The bamboo furniture making work is not just seasonal, instead, it is year-round, but there is need better technological developments and training to produce better designs. The 65% responded that availability of government incentives in remote area on bamboo products and furniture making can encourage bamboo furniture artisans towards making more furniture.

e) As per the responses from the stakeholder involved in bamboo furniture making, their lack of skilled artisans to produce bamboo products and furniture. Adequate bamboo species are not locally available and needed to get transported from other state which leading to overpriced raw material and taxes.

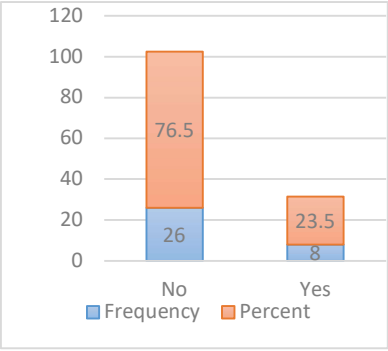
f) Observing the responses from survey, 56% stakeholder responded that there is no pertinent investment done on advertising bamboo furniture for increasing the sales, neither any updates on Direct markets, traders, newspapers, and digital platform is accessible. Majority of respondent asked for proper road networking and transportation facility for bamboo furniture and raw material. 53% artisans living remote villages of Jorhat stated that government has not made any significant efforts for advancing the bamboo furniture industry and they didn't get any incentives and subsidies for the same.

6.5.2.2 Support and Funding assistance towards promotion & commercialization-(SF1.1)

Assessing the survey responses and to understand that the current status of inventive steps taken by government for promoting bamboo furniture , the stakeholder surveyed to know what assistance they get towards promoting and commercializing their furniture. Assessing the variables received from the initial discussions from manufacturer and industry experts the survey questionnaire is developed consisting 5 sub -variables to evaluate the current scenario of government assistance received by these stakeholder for their bamboo setups

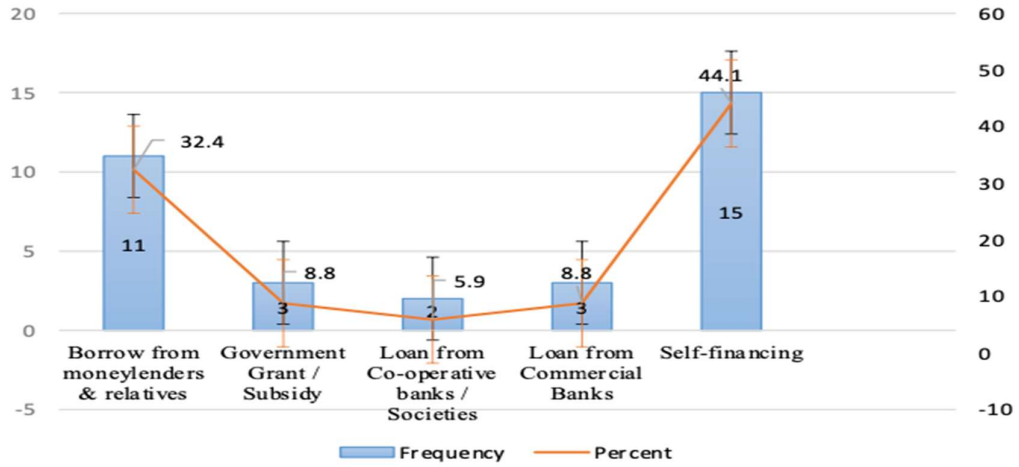


Graph 23: Participation in skill development programmes



Graph 24: Funding Assistance

Surveying artisans of selected study area, the marginal part of their income is shared with the intermediaries involved in supplying of furniture and getting raw materials. As these intermediaries are the only link to get them connected to the big units and end users. The support schemes and funding assistance raised for these artisans, as per the survey analysis data shown in Figure – 25 most of them are not able to get an access to this assistance due to many social barriers like communication, adequate awareness etc. Many of them were found either self-funding or borrowing the money for their startup's which leading them burdened over debts. Though most of them agreed to there one time participation in skill development program organized by the government. While surveying these local it is seen that they are not getting any upgradation knowledge on these initial skill-based program and they are still not well diverse with new techniques and upcoming technology developed in furniture making. Their observed skill level and produced design were not as per the buyer's preference and urban market taste. The prepared design is very traditional to accommodate modern tastes.



Graph 25: Funding assistance towards promotion & commercialization

The initial field surveying gave the observation that most of the bamboo furniture artisan s switching to different industry due lack of supporting assistance. Further initializing the study further we visited NECTAR centre to access the government inventive steps to commercialize bamboo furniture and t was observed that the promotive measure by the government are not been availed by the remote bamboo furniture artisans who actually crafts these furniture in their homestead's , rather these funds are lemmatized to big manufacturer only .

6.5.3 Pervasiveness of analysing Psychological Factor (PSF)

As human Psychology is a major determinant to his behaviour , the Physiological needs recur throughout nature .Though human psychology is difficult to measure but powerful determinant to understand the way that consumers think, their feeling , knowledge about the product. The factor influencing the buyers psychology and formulate a belief towards products is the factual knowledge , marketing trends and past memories ,these attributes creates attitudes .In pervasiveness of psychological factor of the buyers the factor affecting commercialization developed and studied .

6.5.3.1 The factor that causing to the low commercialization of Bamboo furniture on basis of their perception, attitude knowledge and beliefs.-(PSF1)

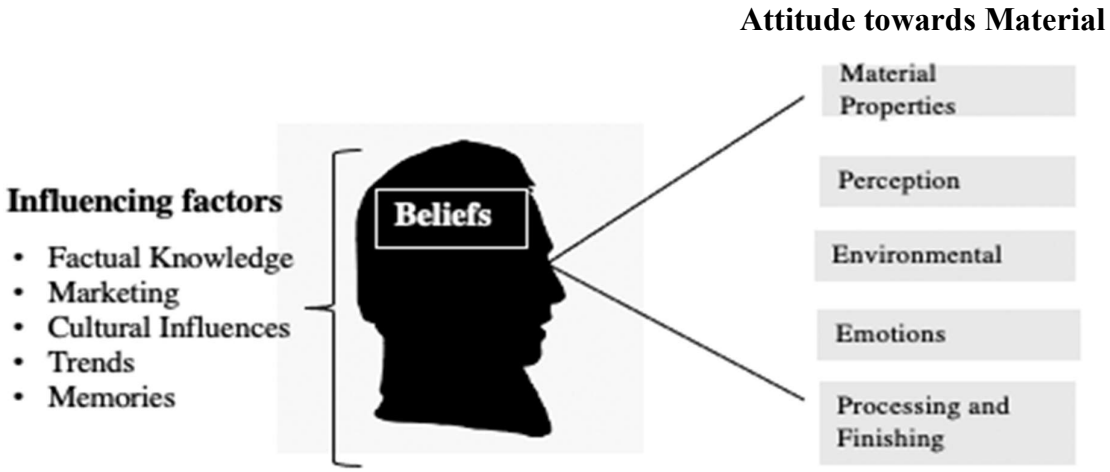
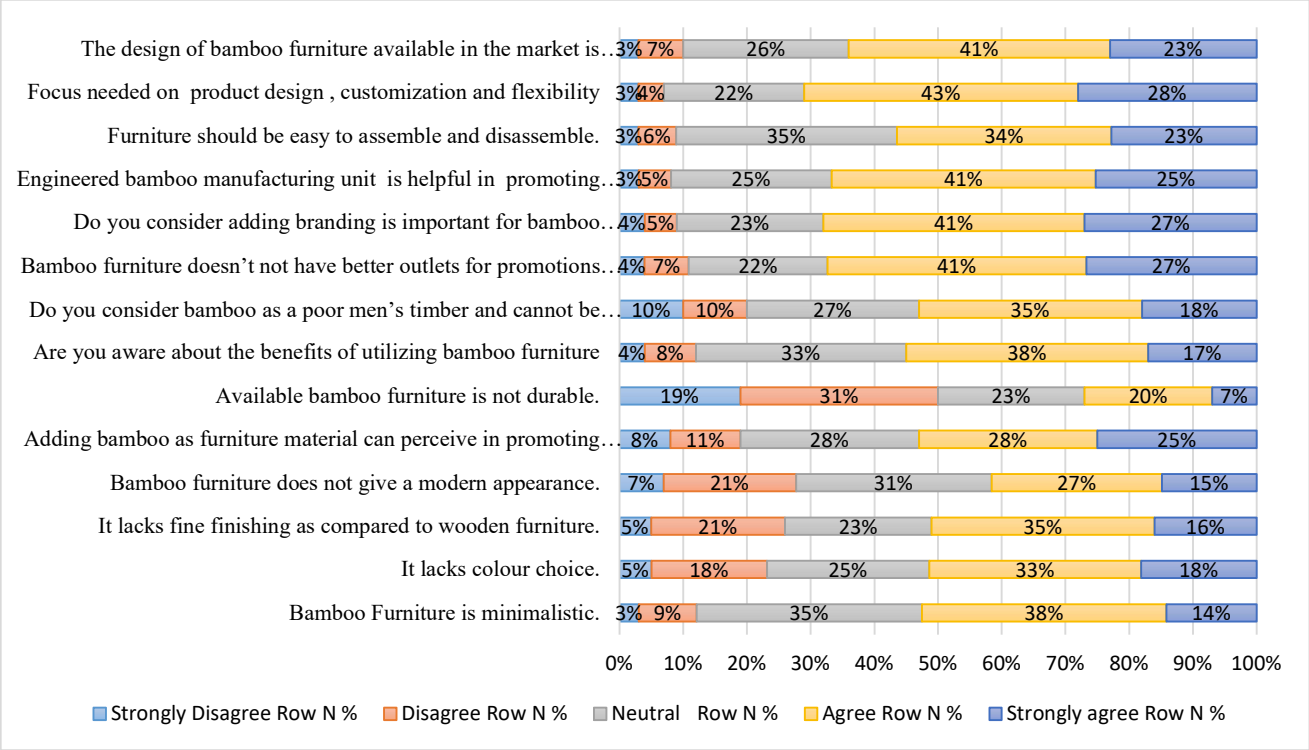


Figure 67: Buyers psychological model
Source: Adapted from (Vogtländer, Van Der Lugt, & Brezet, 2010)

Furthermore though in earlier sections the personal and social traits affecting the attitudes towards bamboo furniture positively or negatively is studied .Considering the buyer subjective aspects influencing the intangible aspects of material utilized to develop the intervention to commercializing the bamboo furniture market .

Analysing the buyers psychology and attitude towards bamboo furniture is analysed and presented , Based on the buyer belief and attitude, 14 variables derived from interview discussion and survey , which further evaluated with 384 respondents on selected study area to ascertain the whole state sample . The deceived responses are evaluated on scale of “Strongly agree to strongly disagree” parameter on 5 point Likert scale. The responses draw main causes of low commercialization of bamboo furniture on basis of the buyer’s behaviour and beliefs.

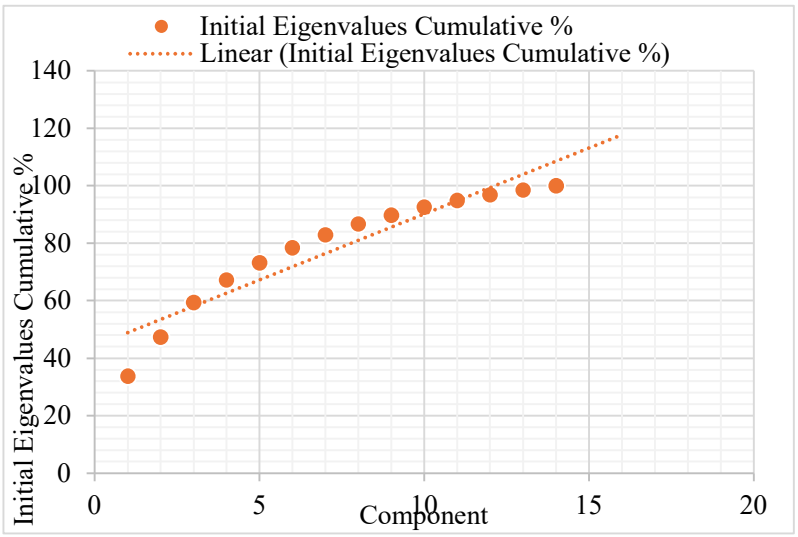
	Strongly disagree		Disagree		Nether agree nor disagree		Agree		Strongly agree	
	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %
Bamboo Furniture is minimalistic.	13	3%	36	9%	134	35%	146	38%	55	14%
It lacks colour choice.	20	5%	69	18%	97	25%	128	33%	70	18%
It lacks fine finishing as compared to wooden furniture.	18	5%	82	21%	88	23%	133	35%	63	16%
Bamboo furniture does not give a modern appearance.	25	7%	79	21%	117	31%	104	27%	59	15%
Adding bamboo as furniture material can perceive in promoting environmental friendliness	32	8%	43	11%	106	28%	109	28%	94	25%
Available bamboo furniture is not durable.	72	19%	118	31%	88	23%	78	20%	28	7%
Are you aware about the benefits of utilizing bamboo furniture	15	4%	31	8%	126	33%	146	38%	66	17%
Do you consider bamboo as a poor men's timber and cannot be place in modern furniture market	40	10%	39	10%	102	27%	133	35%	70	18%
Bamboo furniture doesn't not have better outlets for promotions and distributions	15	4%	26	7%	83	22%	157	41%	103	27%
Do you consider adding branding is important for bamboo furniture	15	4%	18	5%	87	23%	159	41%	105	27%
Engineered bamboo manufacturing unit is helpful in promoting bamboo as an wood alternative to make modern furniture	13	3%	20	5%	96	25%	158	41%	97	25%
Furniture should be easy to assemble and disassemble.	12	3%	21	6%	134	35%	130	34%	87	23%
Focus needed on product design , customization and flexibility	13	3%	16	4%	84	22%	164	43%	107	28%
The design of bamboo furniture available in the market is outdated and archaic in comparison to wood.	12	3%	26	7%	100	26%	156	41%	90	23%



Graph 26: Factor that causing to the low commercialization of Bamboo furniture

To measure the strength of the relationship among variables and analyse correlation matrix of the variables in the dataset diverges significantly from the identity matrix Bartlett test of sphericity is used. The test evaluates that data reduction technique is suitable for further analysis . On above variable Bartlett's test of sphericity is performed by taking $\alpha = 0.05$. The derived p-value is less than 0.05, which signify the factor analysis is valid.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.846**
Bartlett's Test of Sphericity	Approx. Chi-Square	2278.113
	df	91
	Sig.	.000



The table below of communalities depicting the variance , here communality value more than 0.5 is considered for further analysis. As our communality values range from 0.515 to 0.776 there is 78% of the variance on "Focusing in product design , customization flexibility " is accounted for and 51% of the variance in "bamboo furniture not giving modern appearance".

Communalities

	Initial	Extraction
C9-Bamboo Furniture is minimalistic.	1.000	.665
C13-It lacks colour choice.	1.000	.597
C12-It lacks fine finishing as compared to wooden furniture.	1.000	.589
C13-Bamboo furniture does not give a modern appearance.	1.000	.515
C14-Adding bamboo as furniture material can perceive in promoting environmental friendliness	1.000	.377
C10-Available bamboo furniture is not durable.	1.000	.647
C2-Are you aware about the benefits of utilizing bamboo furniture	1.000	.773
C6-Do you consider bamboo as a poor men's timber and cannot be place in modern furniture market	1.000	.738
C5-Bamboo furniture doesn't not have better outlets for promotions and distributions	1.000	.748
C4-Do you consider adding branding is important for bamboo furniture	1.000	.753
C3-Engineered bamboo manufacturing unit is helpful in promoting bamboo as an wood alternative to make modern furniture	1.000	.772
C8-Furniture should be easy to assemble and disassemble.	1.000	.736
C1-Focus needed on product design , customization and flexibility	1.000	.776
C7-The design of bamboo furniture available in the market is outdated and archaic in comparison to wood.	1.000	.732

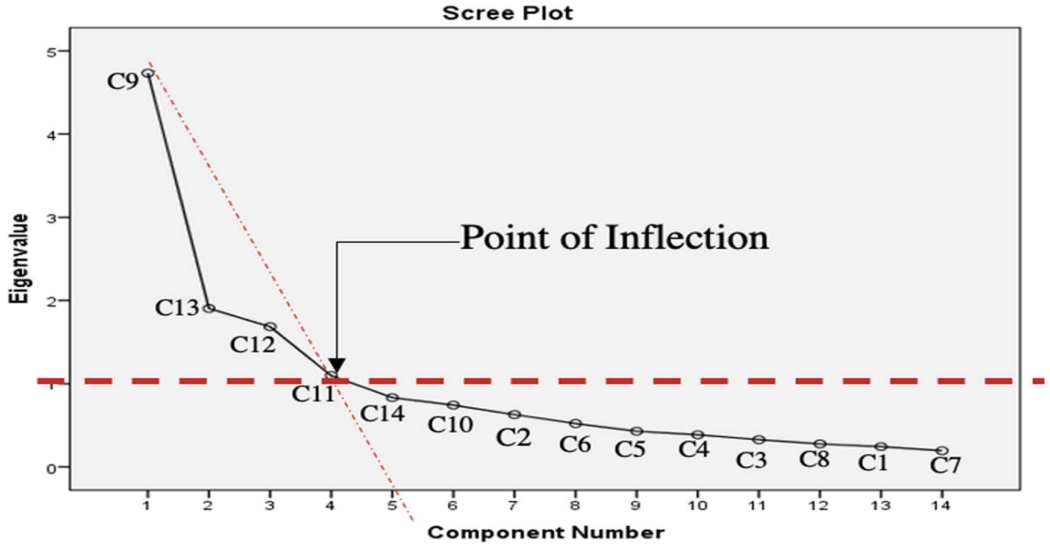
Extraction Method: Principal Component Analysis.

In below table the Principal Component Analysis (PCA) initially extracted 14 factors , the components with high Eigenvalues represents is considered .The initial eigenvalues has all the 14 variables after running factor analysis in SPSS, we got 4 factors explaining the 7.83 % of the variance. As per the eigenvalue greater 1 selection rule factor less >1, will not be considered. So we are considering only four components i.e. "Focus needed on product design , customization and flexibility ", Awareness on benefits of utilizing bamboo furniture", "Engineered bamboo manufacturing unit", "adding branding for bamboo furniture" as they are having Eigenvalues of at least while other component are having low quality scores hence are not assumed.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.732	33.800	33.800	4.732	33.800	33.800	4.639
2	1.904	13.598	47.398	1.904	13.598	47.398	2.040
3	1.685	12.035	59.433	1.685	12.035	59.433	2.002
4	1.097	7.837	67.269	1.097	7.837	67.269	1.294
5	.833	5.951	73.221				
6	.742	5.303	78.523				
7	.629	4.493	83.017				
8	.521	3.722	86.738				
9	.429	3.063	89.801				
10	.386	2.755	92.556				
11	.328	2.342	94.897				
12	.277	1.976	96.874				
13	.244	1.740	98.613				
14	.194	1.387	100.000				
Extraction Method: Principal Component Analysis.							
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.							

(Our 14 variables to measure 4 underlying factors)

Plotting all the components on the scree plot below the values in the first three components of the Extraction Sums of Squared Loadings are immediately above. From the fourth and fifth component the line is almost getting flat, meaning each successive component is accounting for smaller and smaller amounts of the total variance. Therefore , we will be keeping only those principal components whose eigenvalue are greater than 1 .Components with eigenvalue of less than 1 account for less variance and will not be considered.



	Component			
	1	2	3	4
Bamboo Furniture is minimalistic.	.770			
Its lacks in colour choice.			.548	-.466
Its lack in fine finishing as compared to wooden furniture.			.669	
Bamboo furniture does not give a modern appearance.			.658	
Adding bamboo as furniture material can perceive in promoting environmental friendliness	.456			-.326
Available bamboo furniture is not durable.			.458	.656
Are you aware about the benefits of utilizing bamboo furniture		.846		
Do you consider bamboo as a poor men's timber and cannot be place in modern furniture market		.733		
Bamboo furniture doesn't not have better outlets for promotions and distributions	.847			
Do you consider adding branding is important for bamboo furniture	.835			
Engineered bamboo manufacturing unit is helpful in promoting bamboo as a wood alternative to make modern furniture .	.850			
Furniture should be easy to assemble and disassemble.		.758		
Focus needed on product design , customization and flexibility	.864			.375
The design of bamboo furniture available in the market is outdated and archaic in comparison to wood.	.840			

Extraction Method: Principal Component Analysis.
a. 4 components extracted.

Here the unrotated factors loading , having correlation between the variable and the factor have been extracted in below table . The possible values range from -1 to +1. The table below is showing the loadings i.e. extracted values of each item under 4 variables out of fourteen variables on the four factors extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. We have extracted four variables from the 14 items that are divided according to the most important items which are similar responses in component 1, 2 and simultaneously in components 3 and 4. The loadings less than 0.3 is suppressed to have precise computation of each factor component the presence of cross loading i.e., one factor measuring more than one component is used.

From the above cross-tabulation loading. "Focus needed on product design, customization and flexibility" is very high factor loading shown from other components. Therefore, for further impact analysis considering buyer's psychology "inadequate designing, non-customization as per the buyers and inflexibility in design to get evolve as per their need" is the attributes to be considered for designing an intervention to commercialize the bamboo furniture market.

- Analysing the responses, buyers have awareness towards bamboo but as its furniture implementation is still underdeveloped in the country , this might resulting to a negative attitude toward the material.
- The buyer's knowledge is low and biased due to their previous experiences and associations related . These experiences had played an important role in forming the attitude towards bamboo. The analysed variables from the survey are indicating towards the design of furniture has a major gap , which needs a bridge to commercialize the bamboo furniture among Indian buyers.
- The viable effects of evolving design on demand and supply of bamboo furniture are studied with help of demand and supply curve . The Demand and supply curves are the model used to derive the design-quantity relationship for all buyers in a particular market (a market demand curve) or study area

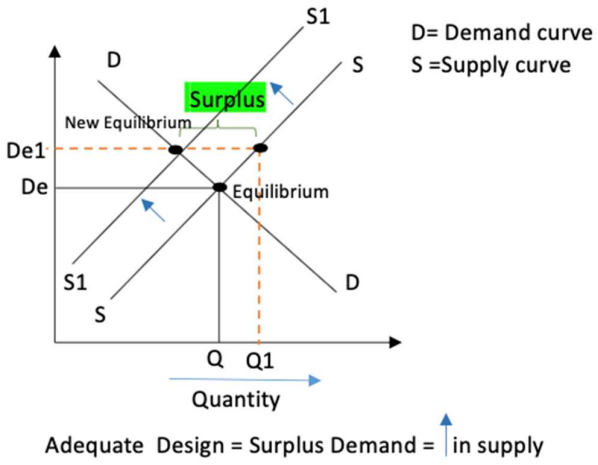


Figure 68:Graph showing relationship between the users based designing effect on supply(Increase)
Source: The Author adaptation

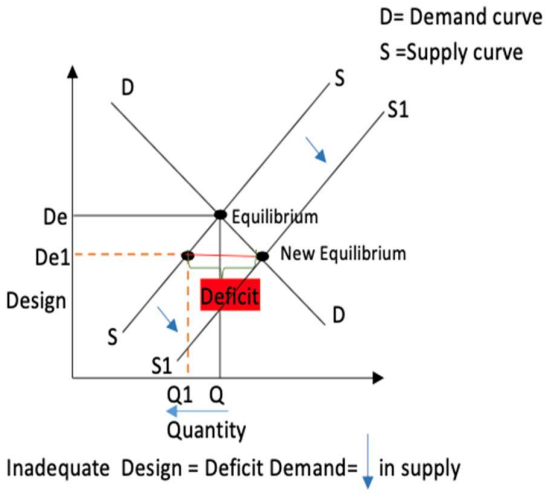


Figure 69: Graph showing the relationship between deficient users based on designing effect on supply (decrease).
Source: The Author adaptation

In the above graph "D" represents to demand and "S" representing to the supply. The independent variable is design and dependent variable is supply . It is assumed that supply curves having downward-sloping, as shown in the figure 68 showing a decreasing functionality in design .Similarly in figure 69 upward sloping of supply indicating to the increasing functionality in design.

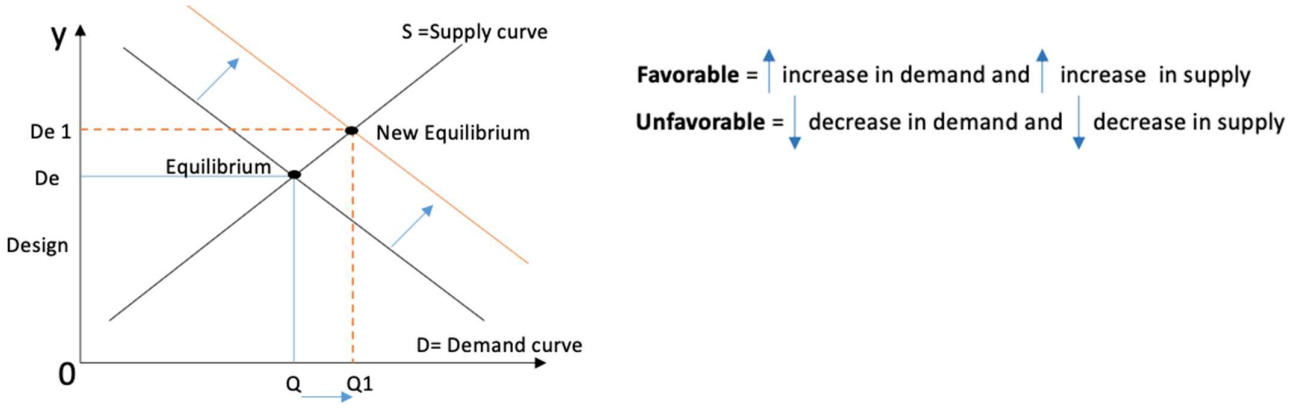


Figure 70 Graph showing the relationship between buyers based design and supply.
Source: The Author adaptation

The graph above depicts the relation of supply and demand with the designing of the products. The inadequate and non-buyer-oriented design led to a decrease in demand, directly affecting the furniture supply. Whereas favourable and buyer-oriented designing increases the demand, leading to an increase in supply, which overall can evolve the commercialization of bamboo furniture among Indian buyers.

6.5.4 Pervasiveness of analysing Cultural Factors (CF)

Buyer's behaviour, adaptability and choice towards products significantly evolve around cultural preferences. Buyer behaviour is considered as the science of "why people buy" and " how to make people buy". This makes it easier for stakeholders to develop strategies to influence buyers to buy furniture. The Influence of culture is often not realized. It deals with how buyers behave, think and feel. Culture influences how buyers use or consume furniture and what they think about its functions, form and content. Therefore, the cultural factor follows special attention on the impact of ethnic factors, beliefs and behaviours of consumers that commercialize a product[39].

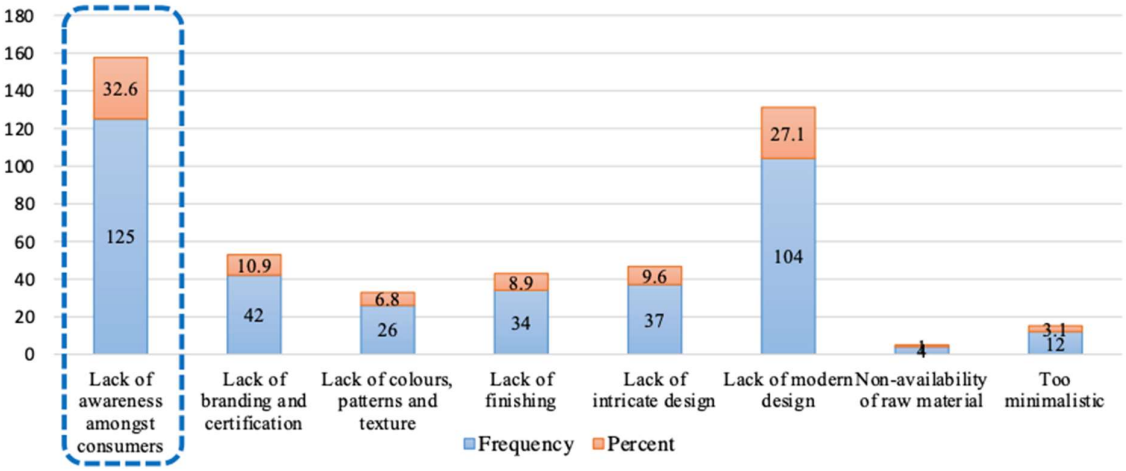
6.5.4.1 Cultural factor measuring adoption of bamboo furniture –(CF1)

Measuring adoption of bamboo furniture commercialization , evaluating various cultural influences . 8 variable are derived from initial interview and field study , Surveying these variable on 384 respondents maximum affirmed (32.6%), that there is lack of bamboo awareness among Indian Urban Market which majorly influencing other buyers and withdrawing them to adopt the

[39] Adapted from *How do Cultural Factors Influence Consumer Behavior? (on Example of Coca-Cola Company).* (2022, Jun 29). Edubirdie. Retrieved January 10, 2023, from https://edubirdie.com/examples/how-do-cultural-factors-influence-consumer-behavior-on-example-of-coca-cola-company/

bamboo furniture . The second most influencing variable derived from study is “design of the available furniture” . Considering to the analysing factors i.e. function ,forms and content , the buyers found unaware towards bamboo furniture functionality , available bamboo products strength and stability and more concerned with its basic forms and available designs .

Graph 27: Factor measuring adoption of bamboo furniture



Lack in Knowledge = (-) Association

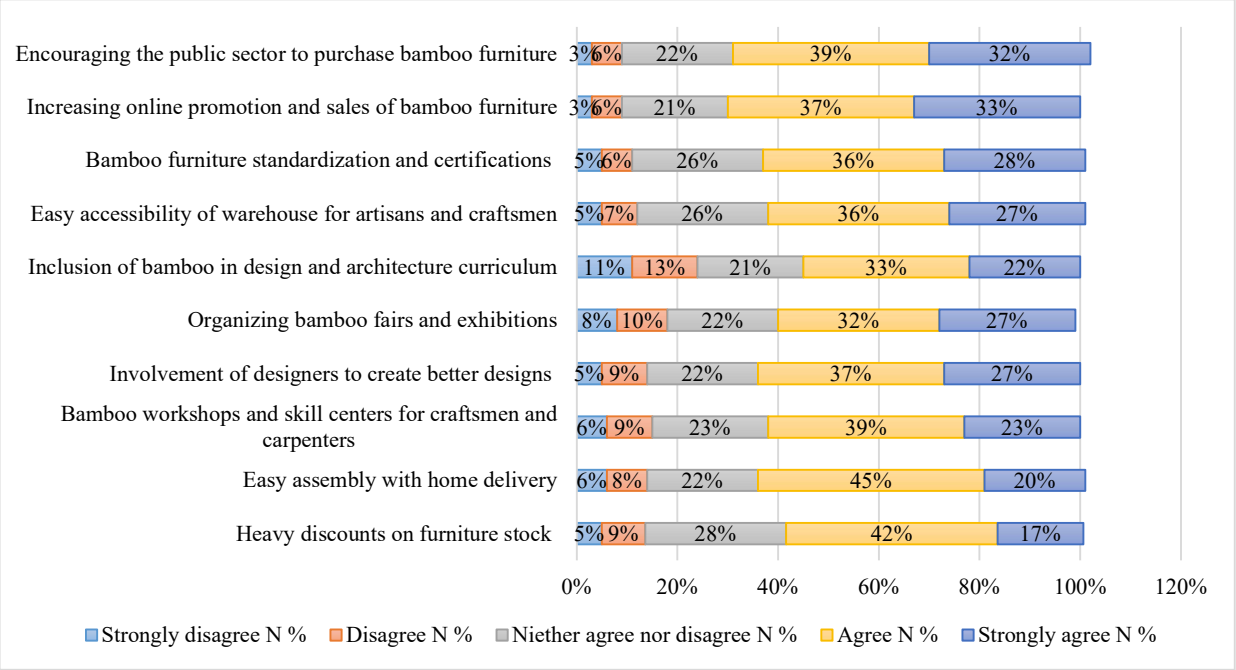
in knowledge =(+) attitude change

As culture strongly influence the whole society ,so lack of awareness about a products or material among a small group leads to its negative associations among that group and delivery the same perception to the society as a whole. Whereas awareness or increase in knowledge leads a positive attitude, delivering to the positive association among group and same to the whole society subsequently.

6.5.4.2 The preferable measures considering the buyer behaviour , beliefs that can be adopted to increase the awareness and commercialization of bamboo furniture. -(CF1.1)

Further evaluating to the commercialization measures considering the cultural influences and the factor that buyer think , can connect them to bamboo furniture industry . In above context 10 variable derived and responses evaluated on scale of “Strongly agree to strongly disagree” parameter on 5 point Likert scale to draw a measure which can evolve better design and generate awareness of bamboo furniture among the buyers .

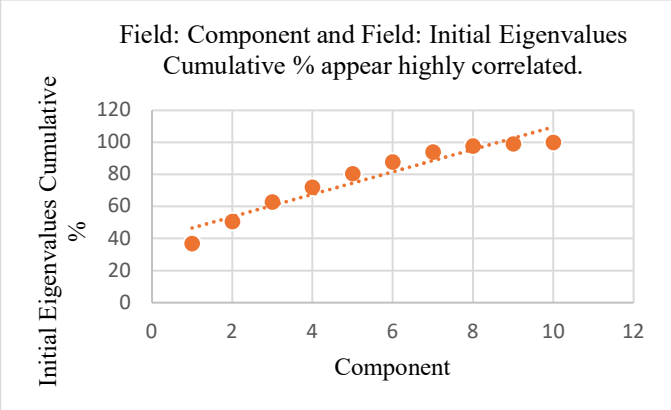
	Strongly disagree		Disagree		Nether agree nor disagree		Agree		Strongly agree	
	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %
Heavy discounts on furniture stock	18	5%	33	9%	106	28%	162	42%	65	17%
Easy assembly with home delivery	22	6%	31	8%	83	22%	171	45%	77	20%
Bamboo workshops and skill centers for craftsmen and carpenters	22	6%	35	9%	87	23%	151	39%	89	23%
Involvement of designers to create better designs	20	5%	34	9%	84	22%	141	37%	105	27%
Organizing bamboo fairs and exhibitions	31	8%	40	10%	86	22%	122	32%	105	27%
Inclusion of bamboo in design and architecture curriculum	43	11%	49	13%	81	21%	127	33%	84	22%
Easy accessibility of warehouse for artisans and craftsmen	18	5%	25	7%	98	26%	138	36%	105	27%
Bamboo furniture standardization and certifications	19	5%	21	6%	101	26%	137	36%	106	28%
Increasing online promotion and sales of bamboo furniture	13	3%	22	6%	79	21%	143	37%	127	33%
Encouraging the public sector to purchase bamboo furniture	11	3%	21	6%	83	22%	148	39%	121	32%



Graph 28: Preferable measures increase the awareness and commercialization

For measuring the strength of the relationship among variables and analyse correlation matrix of the variables in the dataset diverges significantly from the identity matrix Bartlett test of sphericity is used. The test evaluates that data reduction technique is suitable for further analysis . On above variable Bartlett's test of sphericity is performed by taking $\alpha = 0.05$. The derived p-value is less than 0.05, which signify the factor analysis is valid.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.805
Bartlett's Test of Sphericity	Approx. Chi-Square	1467.026
	df	45
	Sig.	.000



Below table of communalities depicting the variance among variables , here communality value more than 0.5 is considered for further analysis. Our communality tables values is ranging from 0.450 to 0.828 there is 82% of the variance in "Involvement of designer to create better design " is accounted for and 45% of the variance in "Bamboo workshops and skills centres for craftsmen and carpenters".

Communalities

	Initial	Extraction
C3-Heavy discounts on furniture stock which measures may be adopted to increase the commercialization of bamboo furniture.	1.000	.750
C7-Easy assembly with home delivery.	1.000	.547
C9-Bamboo workshops and skills centres for craftsmen and carpenters	1.000	.450
C1-Involvement of designers to create better designs	1.000	.828
C10-Organizing bamboo fairs and exhibitions	1.000	.491
C6-Inclusion of bamboo in design and architecture curriculum	1.000	.641
C4-Easy accessibility of ware house from artisans and craftsman	1.000	.717
C5-Bamboo furniture standardization and certifications	1.000	.691
C2-Increasing online promotions and sales of bamboo furniture	1.000	.507
C8-Encouraging the public sector to purchase bamboo furniture	1.000	.818

Extraction Method: Principal Component Analysis.

The below table of (PCA) initially extracted 10 factors , the components with high Eigenvalues represents is considered .Here initial eigenvalues 10 variables and after running factor analysis

in SPSS, we got 3 factors explaining the 10.14 % of the variance. As per the eigenvalue greater 1 selection rule we are considering only 3 components having Eigenvalues of at least 1 i.e. "Involvement of designers to create better designs", "Increasing online promotions and sales of bamboo furniture", "Heavy discounts on furniture stock" and as other components having low quality scores hence they will not be assumed.

(Our 10 variables to measure 3 underlying factors)

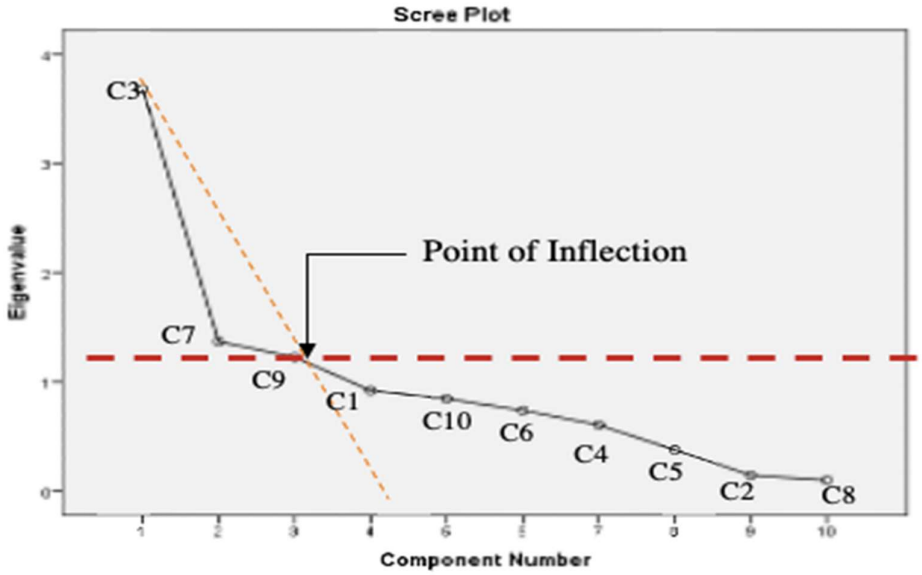
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.963	39.627	39.627	3.963	39.627	39.627	3.163
2	1.463	14.628	54.255	1.463	14.628	54.255	3.120
3	1.014	10.140	64.395	1.014	10.140	64.395	1.189
4	.872	8.720	73.115				
5	.745	7.455	80.570				
6	.630	6.304	86.874				
7	.526	5.264	92.138				
8	.349	3.494	95.632				
9	.245	2.454	98.086				
10	.191	1.914	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

The scree plot below is a graph of the eigenvalues against all the considered factors . The graphs is determining , factors to retain the eigenvalue against the component number. The values in the first two components C3 and C7 of the Extraction Sums of Squared Loadings are immediately above. From the third and fourth component C9 and C1 the line is almost getting flat, meaning each successive component is accounting for smaller and smaller amounts of the total variance. Therefore ,will be keeping only those principal components whose eigen value are greater than 1 .Components with eigenvalue of less than 1 accounts for less variance and of little use.



The unrotated factors loading , which have correlation between the variable and the factor have been extracted in below table . The possible values range from -1 to +1. The higher the absolute value of the loading, the more the factor contributes to the variable. We have extracted three variables wherein the 10 items are divided into 3 variables according to the most important items which are similar responses in component 1 and simultaneously in components 2 and 3. The loadings less than 0.3 are suppressed. To have precise computation of each factor component the presence of cross loading i.e., one factor measuring more than one component is used.

Component Matrix[a]

	Component		
	1	2	3
Heavy discounts on furniture stock Which measures may be adopted to increase the commercialization of bamboo furniture	.537	-.667	
Easy assembly with home delivery.	.473		.567
Bamboo workshops and skills centres for craftsmen and carpenters	.478		.469
Involvement of designers to create better designs	.810	-.400	
organizing bamboo fairs and exhibitions	.631		
inclusion of bamboo in design and architecture curriculum	.548		-.578
Easy accessibility of ware house for artisans and craftsman	.629	.565	
Bamboo furniture standardization and certifications	.674	.485	
Increasing online promotions and sales of bamboo furniture	.623	.320	
Encouraging the public sector to purchase bamboo furniture	.793	-.428	

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

The table is showing the loadings i.e. extracted values of each item under 3 variables of the 10 variables with three factors extracted. The above cross tabulation loading depicting "Involvement of designers to create better designs" has very high factor loading from other components. "Encouraging the public sector to purchase or mandatory the usage of bamboo furniture in public building" came as second major variable buyers consider can generate awareness of bamboo among the Indian society. Therefore, for further impact analysis and measurement "Involvement of designers to create better designs will be considered.

Evaluating four factors (personal, social, cultural, and psychological factor) that affecting buying and selling behavior in repercussion of attitude, market understanding, causes, belief, buyers' behavior, skill, and monetary evaluation of involved stakeholders in assessing commercialization. Computing analysis of these variables, the design of furniture came as most determinant factor. Therefore, as per field study, survey analysis and experts' opinions the components assessed are material attributes which state to the non-availability of bamboo, designer intricate detailing, skill development and training accessibility, involvement of designers and customization are the prime variable of low commercializations. Formulizing all the above derived variables "product design" derived as the main assessing factor. Considering field study and experts' opinions the design of furniture further evaluated with developed variable "Design intervention" and analyzed with questionnaire survey to study "RQ5 Impact of design intervention intervention" and "RQ6 the role architect, interior designers play in the promotion of bamboo furniture in India". The below model developed studying various construct involved with product adoption and commercialization, derives that product design is one of prime variable for product to motivate the users for their adoption.

LC. Low Commercialization
PD: Product Design
MA: Material Attributes
DD: Designer Detailing
SD : Skill development
DI : Designer Involvement
PP : Product personalization

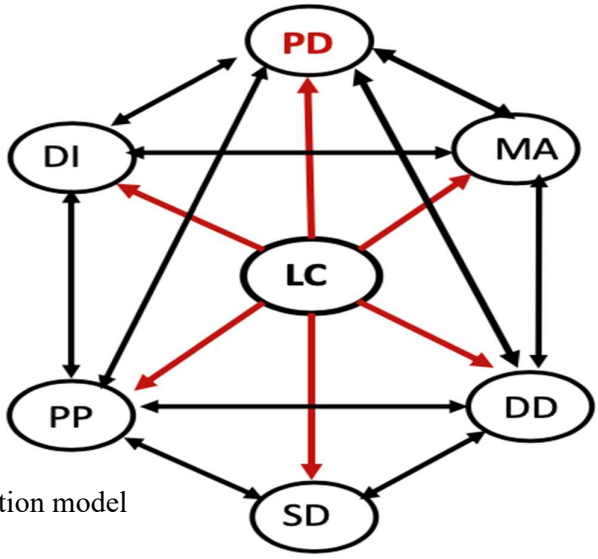


Figure 71: Proposed product commercialization model
Source :The Authors own adaption

6.5.5 Design Intervention (DI)

As explained in earlier section 4.6.5, the design intervention is a concept, which allows for a wider range of conceptual alternatives to be explored. This is a process that intervenes in and interrupts existing status quos towards altered (desired) states[40]. The term "intervention" refers to a set of sequenced planned actions or events intended to help an organization increase its effectiveness. The criteria that effective intervention defines, the extent which fits the needs of the industry and the degree to which it is based on causal knowledge of intended outcomes. The entire study is divided into 2 parts primarily studying the various intervention and secondly the evaluating the intervention impact by prototype .The study of intervention carried with 384 respondents in selected study area ,the process of intervention is defined using 5 constructs which follows identifying or defining the problem, planning and taking course of action to solve , Diagnosing and studying the consequence involved , Conceptualizing the suitable parameter and lastly identifying general finding and evaluating the proposed model.

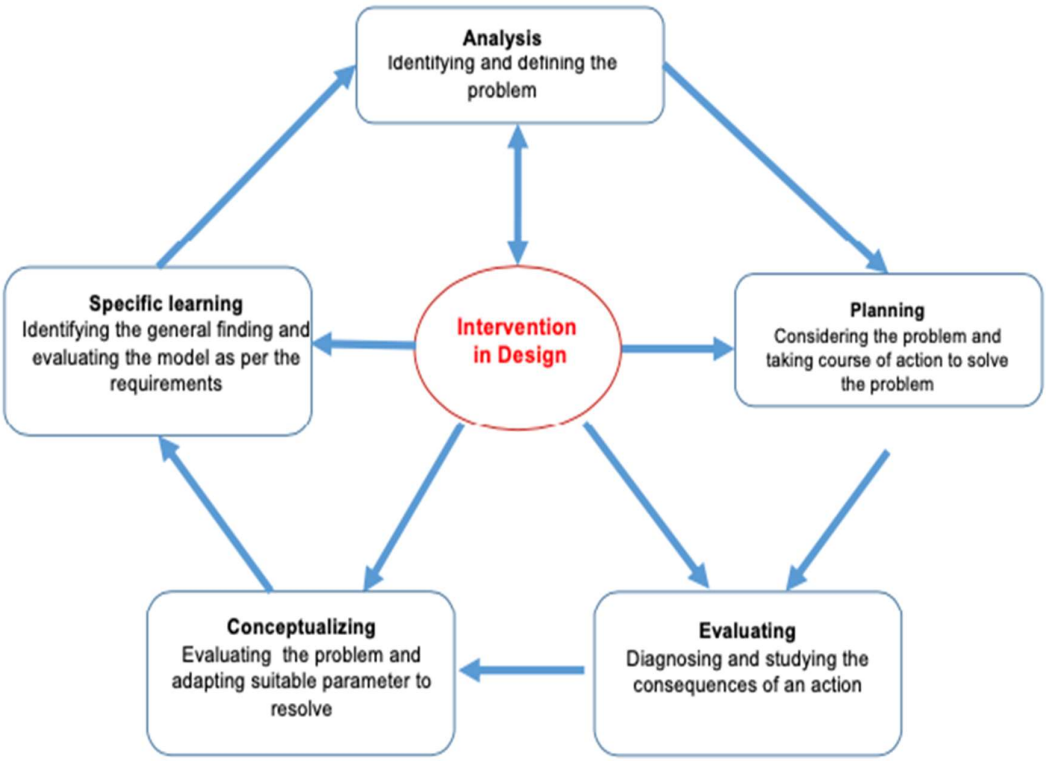
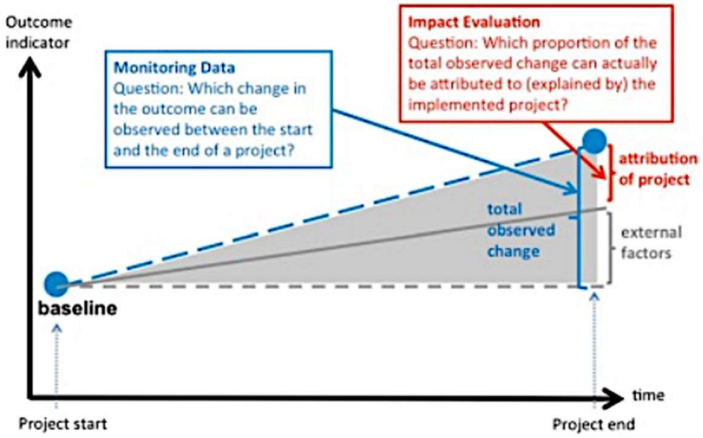


Figure 72: Planning constructs of Design Intervention
Source: Authors own Adaptations

[40] Adapted from https://www.igi-global.com/dictionary/agency-at-play-for-collective-impact-in-human-services-systems/104366

As the intervention is based on, Impact Evaluation that aims to assess the proportion of observed change which is attributed to the promotion of bamboo furniture. The Impact evaluation is about the assessing how the intervention evaluated affects outcomes and whether these effects are intended or unintended.



Impact evaluation
Evaluator= Consumers
Impacts = Positive or Negative, Significant or Insignificant

Figure 73: Impact evaluation model
Source: Swiss agency for development and cooperation SDC

The study involved evaluations of impact to measure changes on buyer's choice attribute to for particular project .As impact evaluations quantifying the effect of a project on big overarching development goals that are only indirectly related to a programme[41] . Evaluating the buyer & seller behaviour, field review and industry expert feedback some of the design based intervention developed for further evaluation follows -

- Need of Pack flat with easy assembling and dissembling
- Multiple functional furniture.
- Modern and contemporary Design.
- Light in weight.
- Durability.
- Termite and moth resistance.
- Aesthetically appealing.
- Adequately finished
- Customized to personal taste and requirement.
- Eco- friendly
- Easy and Local availability.
- Easy Repairing and maintenance free.

Considering above components, 10 variables derived from interview discussion and survey , which further evaluated with 384 respondents on selected study area and deceived responses are

[41] Adapted fromhttps://ethz.ch/content/dam/ethz/special-interest/gess/nadel-dam/research/Impact Evaluations EN 170201.pdf

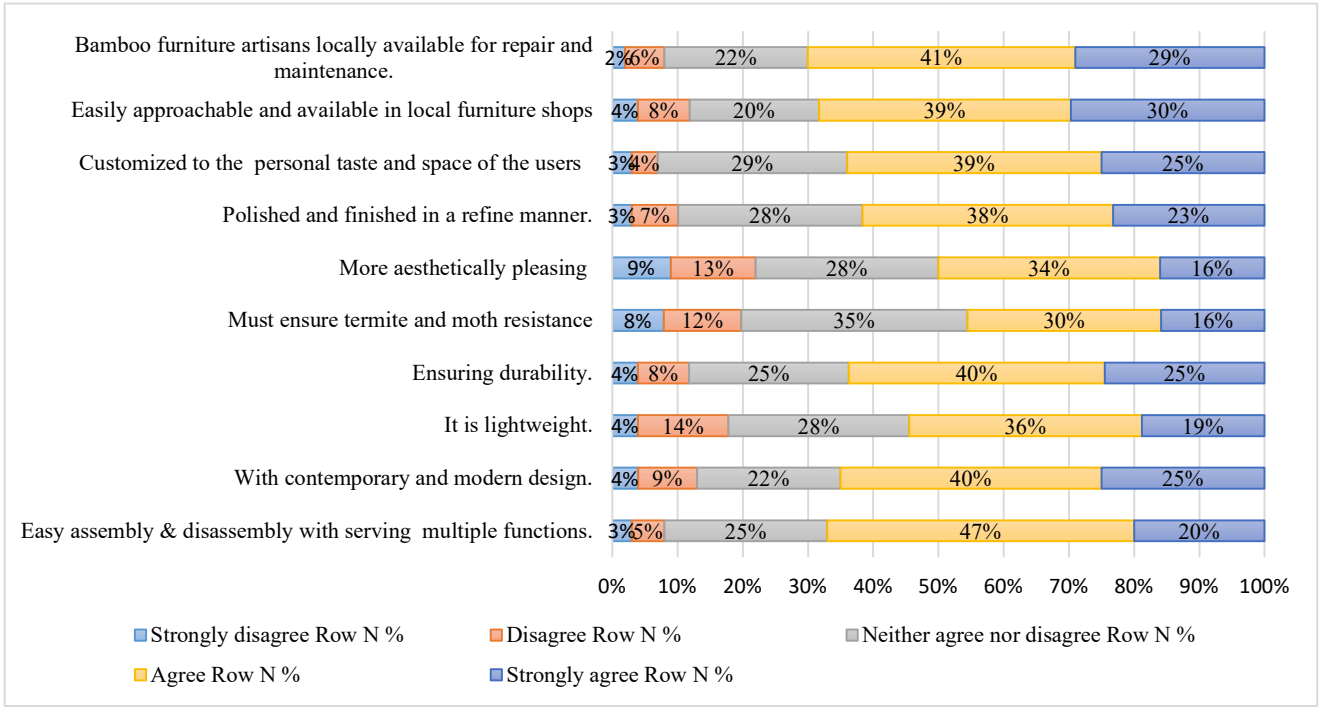
evaluated on scale of "Strongly agree to strongly disagree" parameter on 5 point Likert scale. The responses draw the main design intervention to commercialize bamboo furniture among Indian buyers.

6.5.5.1 Major Interventions can be incorporated in Design for increasing commercialization and adoption among Indian buyers. -(DI1)

In earlier sections analysing various parameter the design is derived as main influencing components affecting commercialization of furniture. Further studying the buyer and sellers preference and material attributes, the furniture designing needs users based intervention to get promulgate it in Indian market .Based on feedback by buyers and industry professionals some above mentioned design based intervention are further constructed as evaluating components.

These components are buyers response towards inventive measure to promote design intervention in bamboo furniture ,which are analysed and presented basing on the buyer belief and attitude, 6 variables derived from interview discussion and survey , which further evaluated with 384 respondents on selected study area to ascertain the whole state sample . The deceived responses are evaluated on scale of "Strongly agree to strongly disagree" parameter on 5 point Likert scale. The responses draws main causes of low commercialization of bamboo furniture on basis of the buyers behaviour and beliefs.

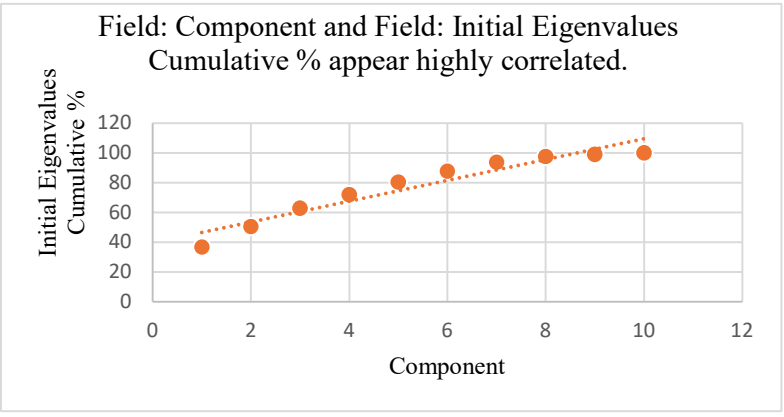
	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %
Easy assembly & disassembly with serving multiple functions.	10	3%	19	5%	96	25%	181	47%	78	20%
With contemporary and modern design.	16	4%	34	9%	84	22%	153	40%	97	25%
It is lightweight.	15	4%	52	14%	108	28%	137	36%	72	19%
Ensuring durability.	14	4%	29	8%	94	25%	153	40%	94	25%
Must ensure termite and moth resistance	29	8%	45	12%	135	35%	114	30%	61	16%
More aesthetically pleasing	33	9%	51	13%	108	28%	131	34%	61	16%
Polished and finished in a refine manner.	13	3%	28	7%	109	28%	146	38%	88	23%
Customized to the personal taste and space of the users	11	3%	15	4%	111	29%	151	39%	96	25%
Easily approachable and available in local furniture shops	15	4%	30	8%	76	20%	149	39%	114	30%
Bamboo furniture artisans locally available for repair and maintenance.	9	2%	22	6%	85	22%	157	41%	111	29%



Graph 29: Major Interventions in Design for increasing commercialization and adoption

The strength and relationship among variables and analyse correlation matrix of the variables in the dataset diverges significantly from the identity matrix ,Bartlett test of sphericity is used. The test is evaluating that data reduction technique suitability for further analysis . On above variable Bartlett's test of sphericity is performed by taking $\alpha = 0.05$. The derived p-value is less than 0.05, which signify the factor analysis is valid.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.601**
Bartlett's Test of Sphericity	Approx. Chi-Square	1696.128
	df	45
	Sig.	.000



The table below of communalities depicting the variance , here communality value more than 0.5 is considered for further analysis. As our communality values range from 0.242 to 0.860 there is 86% of the variance on "Easy assembly & disassembly with serving multiple functions" is accounted for and 24% of the variance for "Light in weight ".

Communalities

	Initial	Extraction
C1-Easy assembly & disassembly with serving multiple functions.	1.000	.860
C2-With contemporary and modern design.	1.000	.825
C10-It is lightweight.	1.000	.242
C9-Ensuring durability.	1.000	.373
C8-Must ensure termite and moth resistance	1.000	.384
C7-More aesthetically pleasing	1.000	.494
C5-Polished and finished in a refine manner.	1.000	.760
C3-Customized to the personal taste and space of the users	1.000	.822
C4-Easily approachable and available in local furniture shops	1.000	.793
C6-Bamboo furniture artisans locally available for repair and maintenance.	1.000	.725

Extraction Method: Principal Component Analysis.

In below table the Principal Component Analysis (PCA) initially extracted 10 factors , the components with high Eigenvalues represents is considered .The initial eigenvalues has all the 10 variables after running factor analysis in SPSS, we got 3 factors explaining the 12.262 % of the variance. As per the eigenvalue greater 1 selection rule factor less >1, will not be considered. So we are considering only three components i.e. "Easy assembly & disassembly with serving multiple functions", Secondly having "contemporary and modern design" and lastly "polished and finished in a refine manner" as these components are having Eigenvalues of at least 1 ,while other component are having low quality scores hence are not assumed.

(Our 10 variables to measure 3 underlying factors)

Total Variance Explained

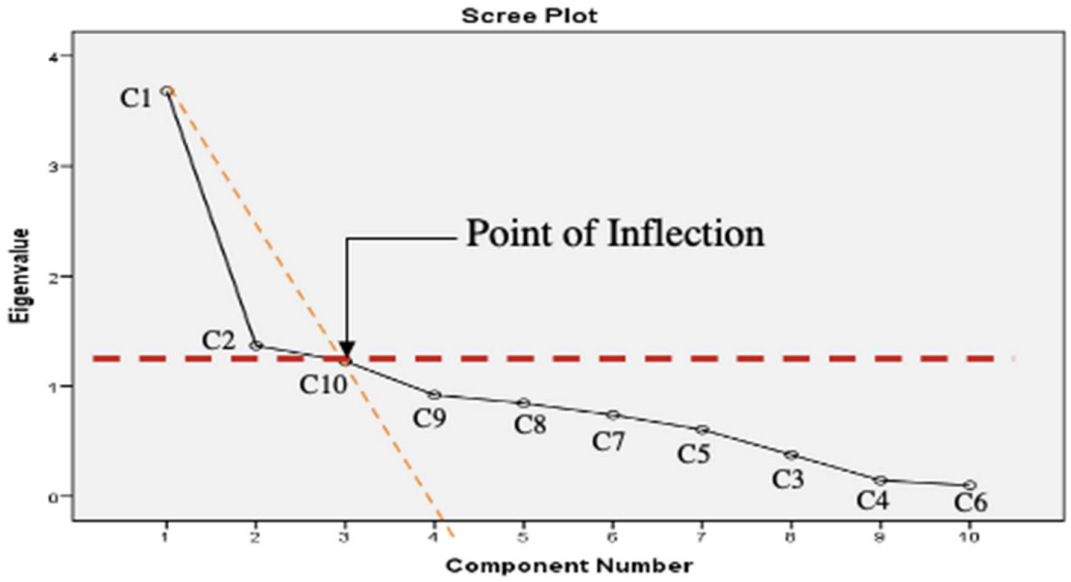
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	3.681	36.806	36.806	3.681	36.806	36.806	2.693
2	1.368	13.680	50.486	1.368	13.680	50.486	2.507
3	1.226	12.262	62.748	1.226	12.262	62.748	2.291
4	.920	9.195	71.944				
5	.845	8.447	80.391				
6	.738	7.382	87.773				
7	.605	6.047	93.820				
8	.376	3.761	97.581				
9	.144	1.437	99.018				
10	.098	.982	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Plotting all the above components on the scree graph below the values in the first two components of the Extraction Sums of Squared Loadings are immediately above. From the third and fourth

component the line is almost getting flat, meaning each successive component is accounting for smaller and smaller amounts of the total variance. Therefore ,will be keeping only those principal components whose eigen value are greater than 1 .Components with eigenvalue of less than 1 accounts for less variance will not be considered and analysed further.



The unrotated factors loading , which have correlation between the variable and the factor have been extracted in below table . The possible values range from -1 to +1.

Component Matrix[a]

	Component		
	1	2	3
Easy assembly & disassembly with serving multiple functions..	.709	.449	.390
With contemporary and modern design.	.652	.329	-.537
It is lightweight.	.320	.344	
Ensuring durability.	.573		
Must ensure termite and moth resistance	.518		.339
More aesthetically pleasing	.490		.481
Polished and finished in a refine manner.	.685	-.575	
Customized to the personal taste and space of the users	.687	-.612	
Easily approachable and available in local furniture shops	.681		-.512
Bamboo furniture artisans locally available for repair and maintenance.	.638	.320	.346

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

The above table is indicating the loadings i.e. extracted values of each item under 3 variables of the ten variables on the three factors extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. We have extracted three variables wherein the 10 items are divided into 3 variables according to the most important items which are similar responses in component 1 and simultaneously in components 2 and 3. The loadings less than 0.3 are suppressed. To have precise computation of each factor component the presence of cross loading i.e., one factor measuring more than one component is used. As per the cross-loading "Easy assembly & disassembly with serving multiple functions" is very high shown in table below from other components. It is evaluated Indian furniture buyers look for multi functionality with easy assembly and disassembly while buying furniture for their spaces Therefore, for analyzing the impact of the stated Design intervention assessed by survey, a chair prototype designed with bamboo assessing the buyer's need of multifunctionality, easy assembly and disassembly, modern user-friendly design.

6.5.5.2 Analysing the derived intervention's by prototype chair model

Understanding the importance and necessity of the various furniture, chairs are assessed as one of the most important and used residential and contract furniture pieces. Analyzing to this usability, the designing of chair is considered for further evaluations. The basic design of the chair is being conceptualized analyzing the end users' responses towards the design intervention they need while opting some furniture for their spaces. As per the end user's multi- functionality with easy assembling and disassembly are the prime requirements buyers consider in design. Considering the various sub-components and analyzed factors from the survey, it has been observed that middle age to elderly people are major furniture buyers. In view of the evaluated factors, needs, basic ergonomics and sustainability as a design criteria a chair from bamboo is been designed.

The basic design form of the chair conceptualized from the yoga posture "ek pada urdhva dhanurasan" symbolize to the human strength and stability which is one of the initial considerations of any furniture shown in figure -72

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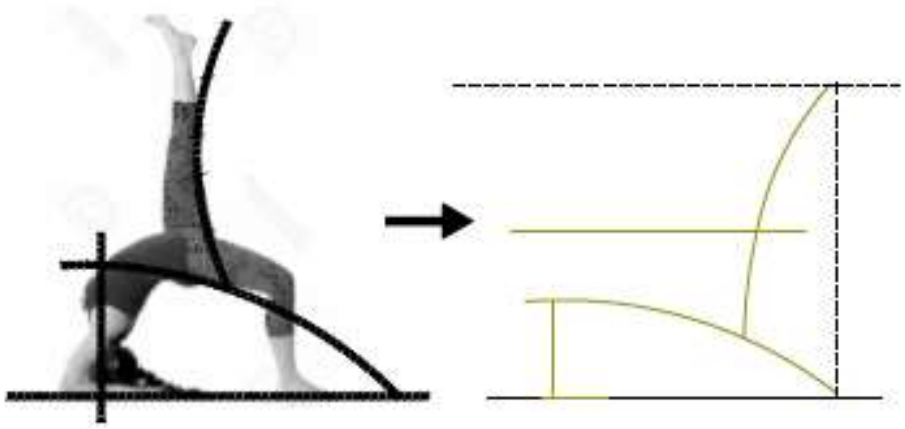


Figure 74: Conceptualization of prototype design
Source: Authors own Adaptations

Studying human ergonomics, angle and basic resting posture we ascertain that 120 degree is the most appropriate angle. Analysing this criteria, a Zero gravity relaxing chair is designed from bamboo considering human comfortability , multifunctionality and sustainability . The Backrest and seat surface is being given an angle of 120 degree to rejuvenates and support the spine. This angle will help in expanding the lungs capacity and have a deep breathing shown in Figure-73. To prevent jack-knifing the knee and the hip angle is being kept greater than 90 degree. High seating angle at the front will help in slow down the blood circulation in front legs. Handrest have been kept at 90 degree to give a straight incline support to the armrest.

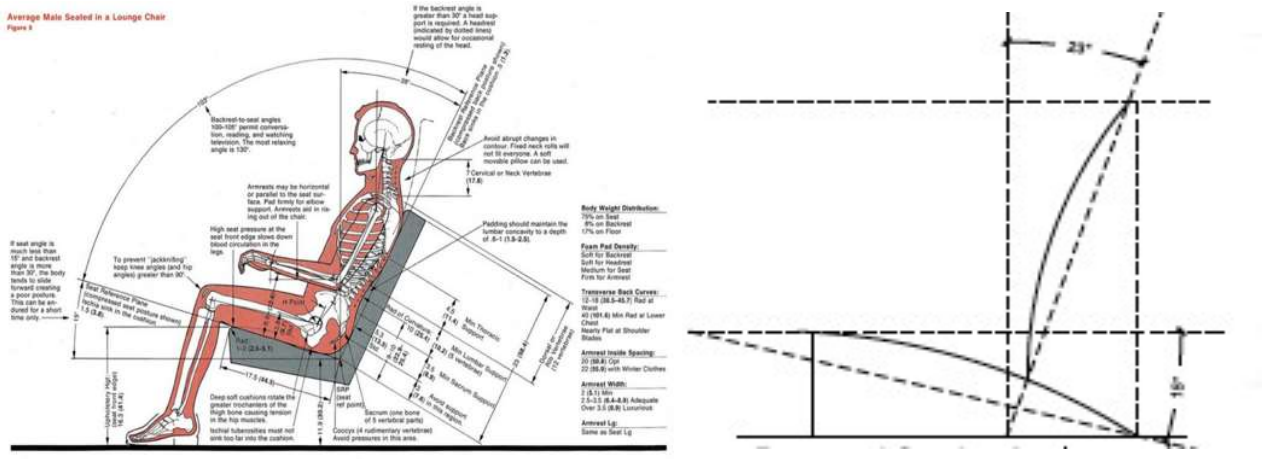


Figure 75: Human ergonomics and seating angle single line design
Source: Left (Muhammad Zainudin Nazha, n.d.), Right Authors own adaptations

Optimizing the use of bamboo over wood ,the bamboo species found adequate considering physical and mechanical properties are Dendrocalamus stocksii which is a solid bamboo species and Bambusa Bamboos hollow bamboo. For framing of the chair solid bamboo species Dendrocalamus stocksii and Dendrocalamus strictus is used . The chair is conceptualized with sizing 700x1100mm with seating placed at 450mm height turning overall height to 1400mm. The chair frame ,handrest and back supports shown below is made from 100mm dia solid bamboo poles joined together to attain desired strength and stability. The basic form of chair is designed considering easy assembly & disassembly and understanding multifunctionality of furniture as the main design preferences of the buyers the design of chairs is assessing to solve two ways functionality . Chair can be used for day to day sitting purposes and can be easily converted into recliner whenever needed just by an open able foot panel . The design of the panel adequately elevate the foot rest to an angle rejuvenates the lungs capacity and have a deep breathing .With easy operational foot panel it add to space saving and can be easily assembled or dissembled by the users.

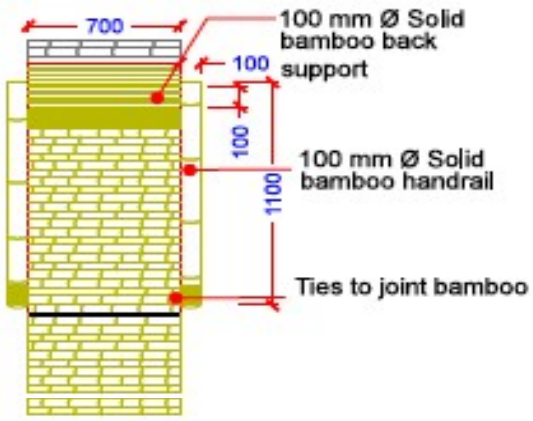


Figure 76 :Plan with open foot panel
Source: Author own adaptation

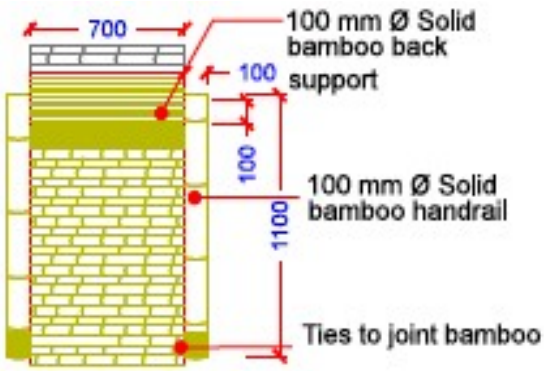


Figure 77:Plan with closed foot panel
Source: Author own adaptation

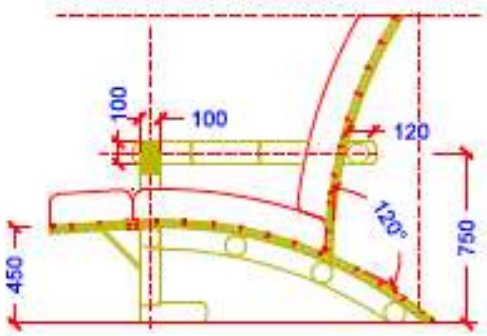


Figure 78: Reclining chair in side elevation with open foot rest.
Source: Author own adaptation

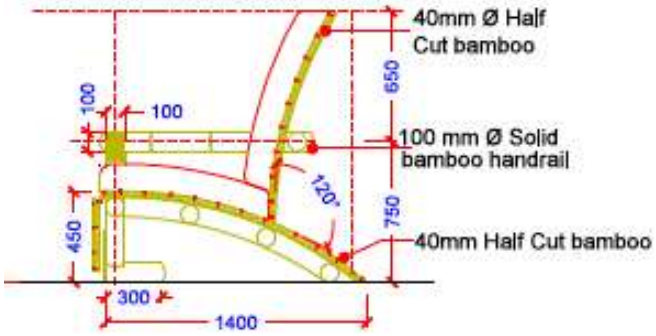


Figure 79:Reclining chair in side elevation with closed footrest.
Source: Author own adaptation

The basic form of the chair is designed, adapting the human body distribution statistics under which 70% of the seat,9% on the backrest and 21% of footrest are considered. The chair's backrest is designed at an angle of 120 degrees to give users a comfortable seating angle. The basic design of the handrest and seating supports are positioned at an angle of 90 degrees to give the armrest and legs a straight upright position, as indicated in Figure 76 and Figure 77. The handrest of the chair is crafted from 100mm Ø solid bamboo, positioned at 750 mm height, adjoining vertical support solid and horizontal bamboo supports. The backrest and seating are made from 40 mm diameter half-cut bamboo interlaced together with 20mm Ø half-cut bamboo stripes. Additionally, the seating base is supported by a solid 70-80mm diameter bamboo culm placed equidistantly at the bottom. At the same time, the backrest is supported by solid bamboo poles, which can be seen in Figure 78. The half-cut bamboo slat is placed together from the front and is supported by four S.S. metal stripes from the back, placed equidistantly. Simple Butt joints and Tennon mortise with fish mouth joints are used for basic joinery detailing.

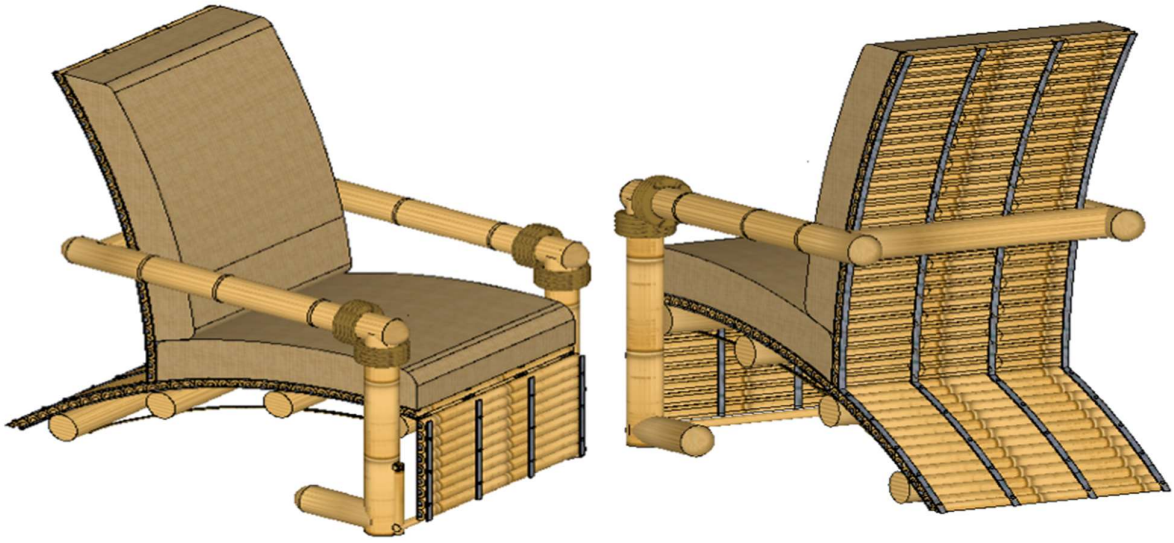


Figure 80 :3D prototype of zero gravity reclining chair
Source: Author own adaptation

The chair is traditionally crafted and can be easily get converted to recliner by just opening foot panel, giving easy extended support to the footrest. The handrest is supported by a U-shaped member, as marked in Figure 79. The operating mechanism of the foot panel is marked as detail at A indicates to the support member provided below the foot panels angled to j hook attached to the foot panels from both sides to give easy operating mechanism. The foot panel can be easily dropped down when not in use by just removing the U-shaped member down from the j-hook as

detailed in Figure 80 and Figure 81. The chair is upholstered with bamboo based fabric and semi-hard cushioning to minimize trochanters of the thigh bones causing tension to the hip muscles and giving a comfortable posture .

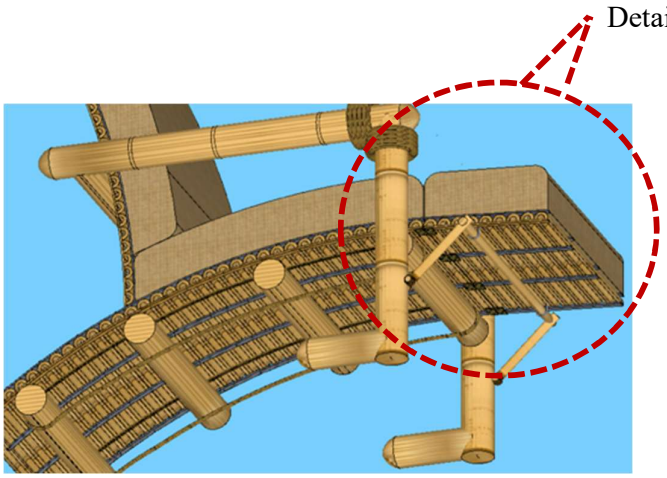


Figure 81: Joinery mechanism of foot rest
Source: Author own adaptation

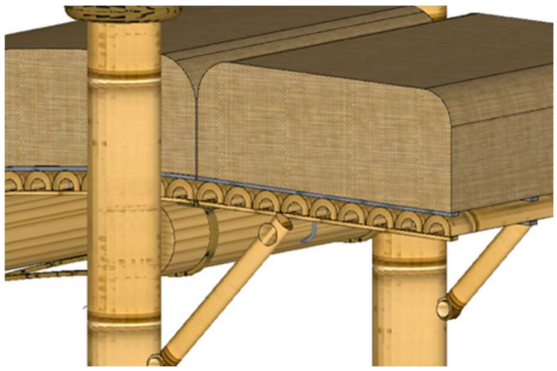


Figure 82: Blow up detail of joinery mechanism foot rest
Source: Author own adaptation

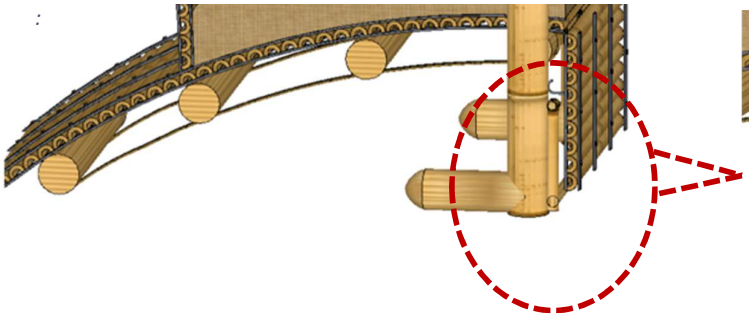


Figure 83: Joinery mechanism of foot rest
Source: Author own adaptation

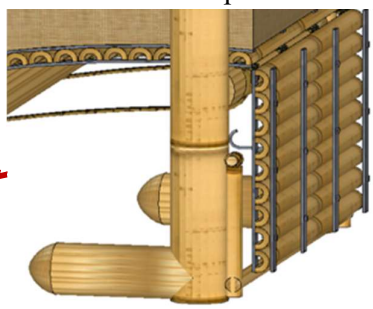
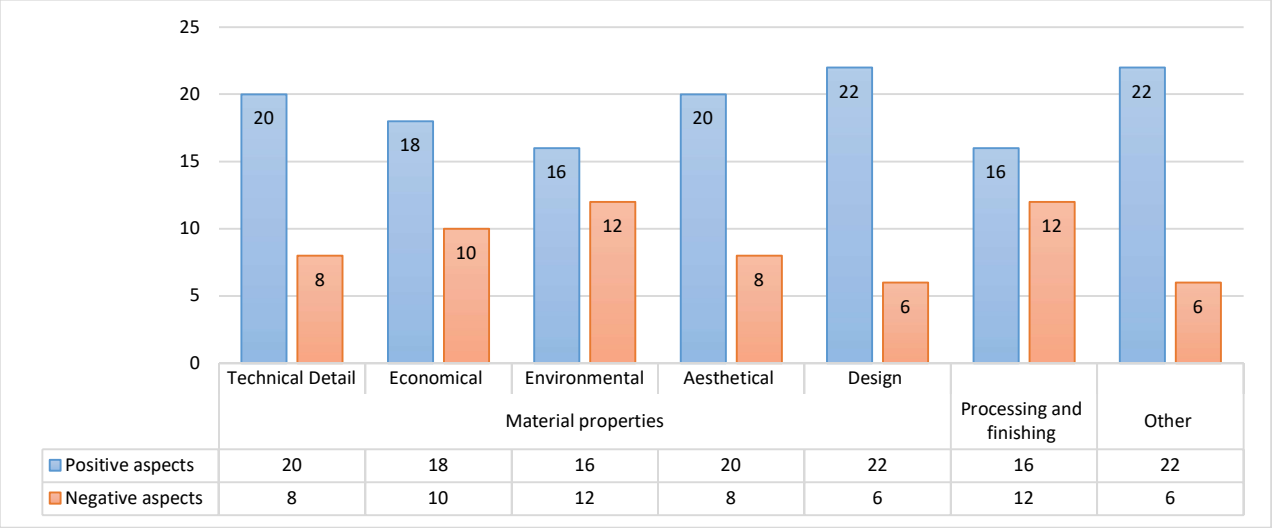


Figure 84 : Blow up detail of joinery mechanism foot rest
Source: Author own adaptation

6.5.5.3 Evaluation of product prototype

To understand the impact of the evaluated design-based intervention, the manufacturer and buyers evaluate the prototype design of the chair incorporating the stated intervention. The chair is evaluated by 28 respondents positively and negatively, which include furniture manufacturers and buyers responses. The evaluation is done on 2 major parameters, which primarily include material properties, sub evaluated on technical, economic, environmental, aesthetics & design aspects and secondly, the processing &finishing detailing.



Graph 30: Technical evaluation of Chair by Manufacturer and users

The deceived feedback on the chair design by 28 respondents, which includes 13 users, 6 furniture manufacturers and 9 designers/industry experts, highlights both positive and negative aspects. The chair design is positively appreciated for its strength, durability, multifunctionality, and pocket environment friendliness, But it also has some improvising critics for shaping, processing parts, and availability. The chair design was observed getting easily processed with existing woodworking machines and has a high potential of getting market acceptability.

		Positive aspects (number of responses)		**Negative aspects (number of responses)**
Material properties	**Technical Detail**			
	High hardness	6	Difficult in shaping	4
	Flexibility and elasticity	4	Bulky	2
	Hard	4	Difficult to Repair	2
	Strong & sturdy	4		
	Dimensional stability	2		
	Economical			
	Pocket Friendly	18	Transport cost little more because of inadequate road conditions and remote availability	10
	Environmental			
	Eco- friendly	16	Manual Processing	12
	Aesthetical			

	Beautiful colour, texture and shine	20	More colours	8
	Design			
	Multi- Functional	12	Local Availability	6
	Comfortable and Trendy	4		
	Easy Assemble and Di-assemble	6		
Processing and finishing	Good processability with existing wood working machines	16	Unawareness towards details	6
			Poor adhesion of lacquer and paints on outside layer	4
			Vulnerability for splintering during processing	2
Other	High potential of market acceptability	12	Not acceptable as it do not the satisfy needs	6
	Moderate acceptability	10		

Table 5: Technical evaluation of Chair by Manufacturer and users

Evaluating the feedback the design is further scored , considering the quality , production costs, pricing and characterization as pr the specified comments by the respondents . It was observed that design is simple , durable yet multifunctional. The chair can be easily processed by local bamboo artisans and doesn't require to attain any advance skill upgradation or machinery . The basic manufacturing cost of chair analysed is Rs 4000 /- which is quite effective and have good payback period . The chair has good market if the ergonomics is optimized and production be made more efficient (transport industrial production)

The chair is design published under patent number : **IN202211029295** is aiming, to optimize the use of bamboo over wood for furniture making and the Indian furniture buyers need improvised modern design and look for multifunctional furniture. Analysing the design and suggestive feedback by the stakeholders it was observed that design and material improvising is one of the inventive measure to promulgated bamboo furniture in Indian market . There is a **need of design intervention using composite bamboo** to influence the market for bamboo over the wooden furniture. The prototype evaluation signifies to the **"Users exigency inclined design intervention has a significant positive impact on commercialization of bamboo furniture".**

POTENTIAL			
QUALITY		**SCORE**	**SUGGESTION FOR IMPROVISION**
Functionality & use	Weight	+/-	The design is a combination of hollow and solid stems , resulting in a heavy chair equivalent to any solid wood chair
	Durability / Sturdiness	++	Simple yet sturdy and Durable construction.
	Functionality	++	The product multi-functional considering human ergonomics .
	Repairing	+/-	Simple yet sturdy and Durable construction. But some consumers and artisans pointed that for repairing there is need of bamboo artisans
Aesthetics properties	Quality and Design	++	The design of the chair is highly appreciated by the consumers and manufacturer
	Looks and Appearance	+/-	Some consumers will appreciate the bamboo look of some will find it too dull.
PRODUCTIONS COSTS			
	Transportability	+/-	Possible to demount and assemble after transport; however, the stems take up a lot of space.
	Manufacturing costs	+/-	Based on manufacturing though the design and corresponding production is relatively simple, the combination with a SS frame needs skilled hands.
COSTING AND PRICING			
	Current market potential	++	Nice trendy reclining chair, which should not be too expensive in manufacturing costs (estimation of 4000/piece).
	Future market potential after optimization	+	If the ergonomics can be optimized and production can be made more efficient (transport, industrial production) the market potential of this product is high in medium to high end markets.
INNOVATIVE CHARACTER			
	Utilization of specific properties of bamboo	+	Use of strength and length of bamboo stem in back support. Use of bamboo stems as construction material in the legs and supports (use of mechanical properties of bamboo) which is 100% biodegradable.
	Contribution to new image of bamboo	-	This design does not help bamboo to lose its colonial image but it can be easily crafted with engineered bamboo
	Level of process innovation (processing and manufacturing technology)	+/-	The techniques implemented show bamboo can bend very well, which can serve as a competitive advantage as compared to wood. Innovative connections that use the bamboo stem in combination with SS result in a strong and completely biodegradable solution for person looking for comfortable and pocket friendly option.
	Overall future market potential of new processing technology (if applicable)	+	The mere application gives a completely new feeling to the bamboo stem. The combination of hollow and solid bamboo can work very well in furniture.

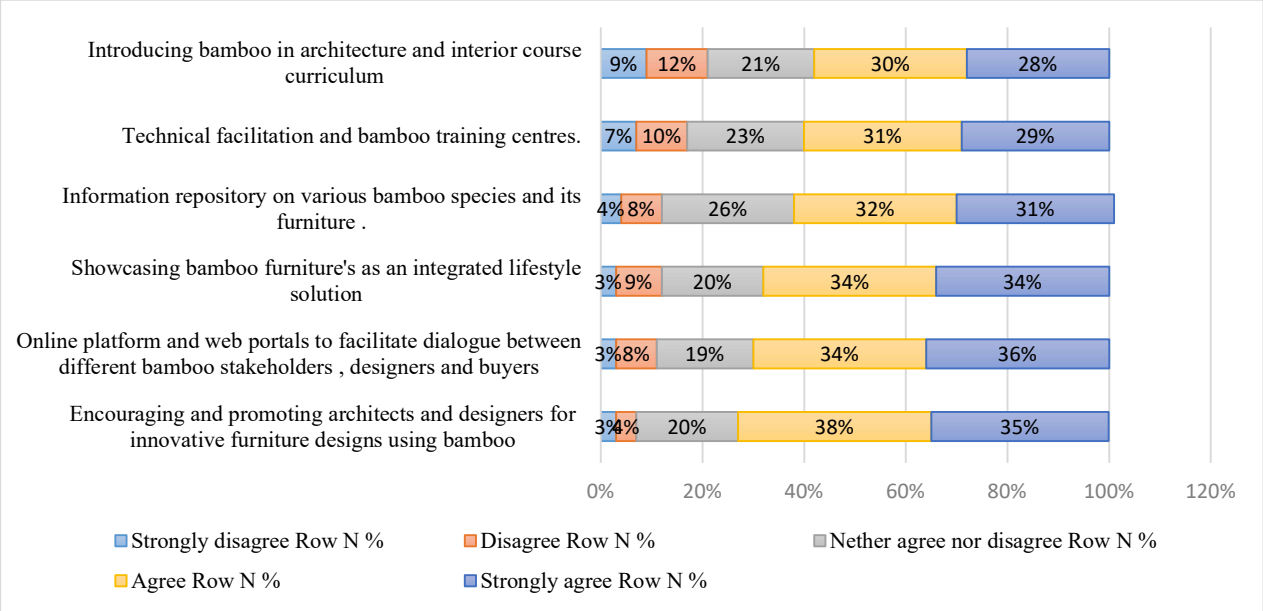
Table 6: Users based evaluation of prototype model

6.5.5.4 Inventive measure that can promote design intervention in bamboo furniture for commercializing it among buyers.-(DI2)

Furthermore though in earlier sections the improvising in design derived as main intervention needed to promote bamboo furniture , further analysing the design based intervention on basing the buyers response personal and social traits, “knock down (easy assembly & disassembly) serving multiple functions came up as major buyer based design intervention positively affect the commercialization of bamboo furniture .Considering the buyer subjective aspects on prototype design model some components evaluated as an possible inventive measure to promote design intervention for further analysis

Analysing the buyers response towards inventive measure to promote design intervention in bamboo furniture is analysed and presented basing on the buyer belief and attitude, 6 variables derived from interview discussion and survey , which further evaluated with 384 respondents on selected study area to ascertain the whole state sample . The deceived responses are evaluated on scale of “Strongly agree to strongly disagree” parameter on 5 point Likert scale. The responses draw main causes of low commercialization of bamboo furniture on basis of the buyer’s behaviour and beliefs.

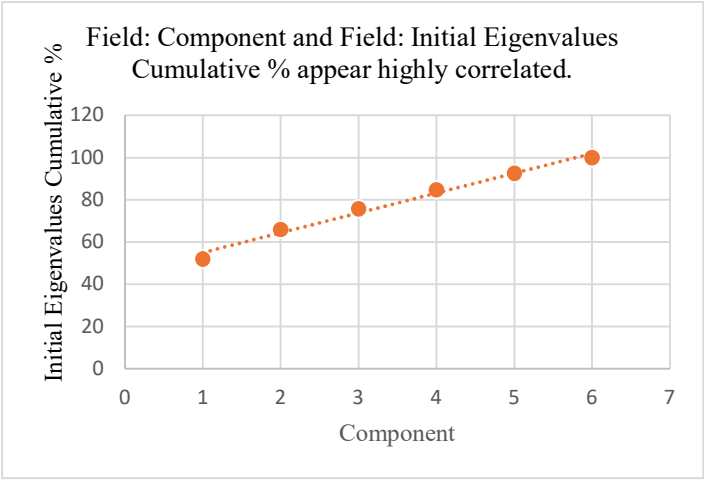
	Strongly disagree		Disagree		Nether agree nor disagree		Agree		Strongly agree	
	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %	Frequency	N %
Encouraging and promoting architects and designers for innovative furniture designs using bamboo	10	3%	16	4%	77	20%	147	38%	134	35%
Online platform and web portals to facilitate dialogue between different bamboo stakeholders , designers and buyers.	13	3%	30	8%	71	19%	131	34%	139	36%
Showcasing bamboo furniture's as an integrated lifestyle solution	12	3%	33	9%	77	20%	132	34%	130	34%
Information repository on various bamboo species and its furniture .	14	4%	31	8%	98	26%	121	32%	120	31%
Technical facilitation and bamboo training centres.	27	7%	37	10%	90	23%	119	31%	111	29%
Introducing bamboo in architecture and interior course curriculum.	34	9%	46	12%	80	21%	115	30%	109	28%



Graph 31: Inventive measure that can promote design intervention

The strength and relationship among variables and analyse correlation matrix of the variables in the dataset diverges significantly from the identity matrix ,Bartlett test of sphericity is used. The test is evaluating that data reduction technique suitability for further analysis . On above variable Bartlett's test of sphericity is performed by taking $\alpha = 0.05$. The derived p-value is less than 0.05, which signify the factor analysis is valid.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.849
Bartlett's Test of Sphericity	Approx. Chi-Square	663.960
	df	15
	Sig.	.000



The table below of communalities depicting the variance , here communality value more than 0.5 is considered for further analysis. As our communality values range from 0.515 to 0.776 there

is 78% of the variance on "Focusing in product design, customization flexibility" is accounted for and 51% of the variance in "bamboo furniture not giving modern appearance

Communalities

	Initial	Extraction
C1-Encouraging and promoting architects and designers for innovative furniture designs using bamboo.	1.000	.628
C5-Online platform and web portals to facilitate dialogue between different bamboo stakeholders , designers and buyers.	1.000	.480
C4-Showcasing bamboo furniture's as an integrated lifestyle solution.	1.000	.494
C3-Information repository on various bamboo species and its furniture	1.000	.505
C2-Technical facilitation and bamboo training centres.	1.000	.559
C6-Introducing bamboo in architecture and interior course curriculum	1.000	.452

Extraction Method: Principal Component Analysis.

In below table the Principal Component Analysis (PCA) initially extracted 6 factor, the components with high Eigenvalues represents is considered .The initial eigenvalues has all the 10 variables after running factor analysis in SPSS, we got one factors explaining the 51.969% of the variance. As per the eigenvalue greater 1 selection rule, we are considering only one components i.e. "Encouraging and promoting architects and designers for innovative furniture designs using bamboo" as these components are having Eigenvalues of at least 1 ,while other component are having low quality scores hence are not assumed.

(Our 6 variables to measure 1 underlying factors) .

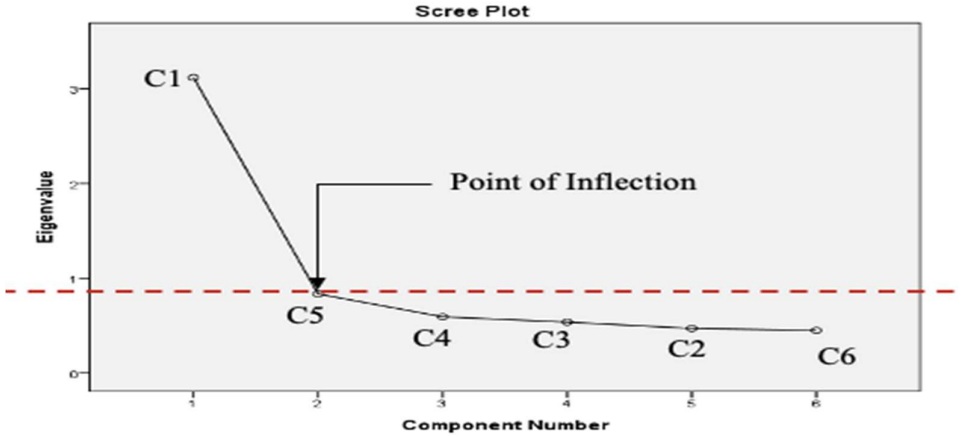
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.118	51.969	51.969	3.118	51.969	51.969
2	.834	13.900	65.870			
3	.592	9.874	75.743			
4	.537	8.943	84.686			
5	.470	7.835	92.521			
6	.449	7.479	100.000			

Extraction Method: Principal Component Analysis.

Plotting all the above components on the scree graph below the values in the first row components of the Extraction Sums of Squared Loadings are immediately above. From the second component the line is almost getting flat, meaning each successive component is accounting for smaller and

smaller amounts of the total variance. Therefore ,will be keeping only one components whose eigen value are greater than 1 .Components with eigenvalue of less than 1 accounts for less variance will not be considered and analysed further



The unrotated factors loading , which have correlation between the variable and the factor have been extracted in below table . The possible values range from -1 to +1.

Component Matrix[a]

	Component
	1
Encouraging and promoting architects and designers for innovative furniture designs using bamboo.	.792
Online platform and web portals to facilitate dialogue between different bamboo stakeholders , designers and buyers.	.693
Showcasing bamboo furniture's as an integrated lifestyle solution	.703
Information repository on various bamboo species and its furniture	.711
Technical facilitation and bamboo training centres.	.748
Introducing bamboo in architecture and interior course curriculum	.672
Extraction Method: Principal Component Analysis.	
a. 1 components extracted.	

The above table is indicating the loadings i.e. extracted values of each item under 1 variable of the six variables on the one factor extracted. The higher the absolute value of the loading, the more the factor contributes to the variable. We have extracted one variable wherein the six items are divided into one variable according to the most important items which are similar responses in component 1. The loadings less than 0.3 are suppressed. To have precise computation of each factor component the presence of cross loading i.e., one factor measuring more than one

component is used. As per the cross-loading **"Encouraging and promoting architects and designers for innovative furniture designs using bamboo**" is very high shown in table below from other components. Evaluating buyers and industry experts' response the inventive measure that can promote design intervention in bamboo furniture to commercializing it among Indian buyers is by encouraging and promoting architect and designers to innovate and improvise their furniture design.

6.5.6 Conclusion

This chapter assesses bamboo furniture commercialization in the Indian market, considering behaviour and intangible parameters from buyers' and sellers' perspectives. The intangible parameters were analysed from field surveys and buyers' and sellers' preferences and perceptions. Lack of design in bamboo furniture is a major concern as market demands for multi-functional and customizable design, which eventually raises demand for wooden furniture, leading to the loss of biodiversity and affecting the eco-footprints of the country. Studying all the viable parameters, it is understood that bamboo furniture has a huge potential for improvement. Further, the willingness of the bamboo artisans, manufacturers and designers to improve and customize their designs is one of the distinctive reasons to upgrade the commercialization of bamboo furniture from the buyer's perspective.

CHAPTER 7

Results and Discussion

This chapter briefly discusses the results of the study in the selected region, considering major urban areas and bamboo regions of the country and the data collected from the bamboo stakeholders and users. The variable results of the study are simplified with eleven statements to understand the impact of various variables on commercialization. Further analyzing the significance of all the various suitable recommendations and suggestions are discussed.

7.1 Introduction

Despite current globalization and industrialization, the furniture industry had badly leveraged the wood and marred the built-in environment. The advantages of using bamboo instead of wood cannot be denied for upgrading the social, economic and environmental development. With the increase of rapid increase in the furniture market, the buyer's based demand has turned up the furniture which can not only serve the necessities of the consumers but also add multifunctionality. The excessive use of wood to satisfy the buyer's needs is advertising the country's biodiversity. However, the global furniture market is trying to replace the usage of wood with bamboo to rejuvenate the built-in environment from the perspective of users. Various guidelines, measures and policies are formulated worldwide, including India, but apparently, the adaptation of this measure in India still needs a focused approach. To upgrade bamboo furniture commercialization, the buyers' and sellers' behaviour with bamboo furniture needs to be addressed either by directly involving the buyers in interacting with the artisans or by involving designers to analyse the buyers' needs and come up with adaptative designs to adhere to their specifications.

7.2 Research finding

The study investigates the effectiveness of design interventions that specifically could promulgate the commercialization of bamboo furniture among Indian buyers. The study aims to analyse the buyer needs for bamboo furniture to strengthen its commercialization. Creating and promoting user-specific designs that can encourage buyers to value bamboo furniture more than opting for any other wooden furniture. The impact of all the parameters with respect to stakeholders' behaviour in 3 major urban areas and three bamboo growing areas were analysed, and the core intervention was further evaluated on the prototype design. The proposed interventions focused and evaluated.

- What intervention is significant to make bamboo furniture adopted among buyers?
- To what extent the proposed intervention is successful in prototype design?
- What are the pivotal factors influencing the success and failure of derived intervention, and what strategic refinement is needed to refine the intervention's effectiveness?

7.2.1 Interpretation from field study of bamboo furniture commercialization in selected areas of India

The objective of this section of research was to identify the factors affecting bamboo furniture commercialization in India and the positive impact of design intervention. The outcome of this study provides insights on the users perception on bamboo furniture. The results from below study depict that all four constructs variables i.e. personal (PF) social (SF), cultural (CF) , psychological (PSF) of buyers and sellers significantly influence commercialization and indicate to design intervention (DI) has positive impact on commercializing bamboo furniture in India .

Statement-1: The income of the consumers is parallel mediator to commercialize bamboo furniture.

The users income which is a personal constructs always impact positively or negatively business. The micro-economics states that income effect the consumer's optimal consumption pattern, change in income is being observed in the demand if the good . The rise in the income , increases the demand of normal good , but lowers the demand of inferior good[42] .

Income Effect	Nature of Good X	Demand of Good X
(+) ve	Normal	⇧
(-) ve	Inferior	⇩
(0) No effect	Neutral	No Change in the quantity of demand

Figure 85 : Income effects on purchase
Source: (Ali Khan & Chawla , 2014)

Surveying the buyers income it is observed that 31% have substantial income level and rest of were found with moderate level of income .Though income has a positive effect on normal goods which includes furniture and commodity, indicating to a direct relationship between to demand . As per the degree of substitution effect by looking at the cross price elasticity , as the price of bamboo furniture is low ,the buyers substitute away from wooden furniture that are relatively more expensive to bamboo furniture . Therefore on basis of above study the users income is an mediator for the adoption and commercialization of bamboo furniture.

H_{01}: The income of the consumers is not a parallel mediator to commercialize bamboo furniture and do not have a significant impact on its adoption.

[42] The changes in the optimal consumption pattern of the users caused by changes in income so changes are being observed in the quantity of goods purchased where price is kept constant. Here the users is in better-off when the optimal consumption combination is located on a higher indifference curve and vice versa. Adapted from :https://iaeme.com/MasterAdmin/Journal_uploads/IJM/VOLUME_5_ISSUE_11/10120140511008.pdf

H_{11}: The income of the consumers is a parallel mediator to commercialize bamboo furniture and has a significant impact on its adoption **.**

To predict the income as a parallel mediator to commercialize bamboo Regression analysis with collinearity is conducted. For predicting commercialization which is an dependent variable, based on the users income which is an independent variable, regression analysis is done , to ascertain the impact of independent variable on dependent one . Here for evaluating the model , collinearity statistics is used where the "R" value shown in the model summary table below depicts the simple correlation. The derived value 0.104, denotes a negligible degree of correlation of 10.4%.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.104[a]	.011	.008	1.308

a. Predictors: (Constant), B

Analysis of Variance (**ANOVA**) is used to analyse significance of the regression equations fits the to the data

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	7.148	1	7.148	4.176	.042[b]
	Residual	652.173	381	1.712		
	Total	659.321	382			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), Buyers Income						

Evaluating the equation the regression model achieved statistical significance, since the p-value is less than commonly used significance level 0.05 (F, 4.176; p =0.042<0.05). Here we see lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that the "**income of the consumers do acts as parallel mediator to commercialize bamboo furniture and has a significant impact on its adoption**". Therefore giving buyers a budget-friendly option of bamboo furniture as compared to wood can induce the production and popularity of bamboo furniture among significant sections of society forming a change in perception and preference. Hence buyer income is an parallel mediator to commercialize bamboo in Indian market.

Multicollinearity Test using Variance Inflation factor

Coefficients [a]												
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3.044	.312		9.748	.000					
	B	-.189	.093	-.104	-2.044	.042	-.104	-.104	-.104	1.000	1.000
a. Dependent Variable: Commercialization											

Based on the coefficients value, collinearity statistics obtained Variance Inflation factor (VIF) value is 1.000 which is between 1 to 10 and hence concluded that there is no collinearity symptoms.

Statement-2: Consumers awareness and perception significance on the adoption and commercialization of bamboo furniture.

The buyer's psychological represents the perception and awareness towards a certain product or materials . The perception depends upon the feelings ,beliefs and opinions .The perception of users follow three stages i.e.. Sensing under which they accumulate knowledge from social and personal influencer's, organising under which the buyers categorize the critiques and compare with the other substitute's and finally reacting which is totally based upon internal and external stimuli .Evaluating these three phases impact of customers' perception is equipped positively . Though it is difficult to capitalize all the contributing factor but surveying certain parameter discussed in chapter-6, the buyers it has been over revved that users consider that they have lack of awareness towards bamboo .Evaluating the buyers psychologically it is observed that factual knowledge about the products , past memories and market trends creates a belief about the products .Further the significance of buyers belief and mindset influence on commercialization and adoption of furniture is analysed using Analysis of Variance.

H_{02}: Consumers awareness and perception towards bamboo does not have a significant impact on the adoption and commercialization of bamboo furniture.

H_{12}: Consumers awareness and perception towards bamboo does have a significant impact on the adoption and commercialization of bamboo furniture.

To predict the awareness and perception buyers significance on adoption of bamboo furniture bamboo regression analysis with collinearity is conducted. To analyse the commercialization

which is an dependent variable. Based upon the psychological factors of the users i.e. Beliefs , perception and general awareness which are the independent variable, regression analysis is done , to ascertain the impact of independent variable on dependent one . Here for evaluating the model , collinearity statistics is used where the "R" value shown in the model summary table below depicts the simple correlation. The derived value 0.100, denotes a negligible degree of correlation of 10.0%.

Model Summary				
Model	**R**	**R^2**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.100[a]	.010	.007	1.663
a. Predictors: (Constant), B				

Analysis of Variance (**ANOVA**) is used to analyse significance of the regression equations fits the to the data .

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	10.741	1	10.741	3.883	.049[b]
	Residual	1056.592	382	2.766		
	Total	1067.333	383			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), Consumers awareness and perceptions						

Evaluating the equation the regression model achieved statistically significant , since the p- value is less than commonly used significance level 0.05 (F, 3.883; $p=0.049<0.05$). Here we have lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that the "**consumers awareness and perception towards bamboo does have a significant impact on the adoption and commercialization of bamboo furniture".** Therefore understanding the study model the buyers look for a product which relate to their feelings , pay attention to their feedback , listen and reply to their needs. Buyers perception strongly focused on personalization and bio directional communication which positively or negatively impact the adoption and commercialization of furniture , depending upon frequency of utilization of personal information and feedbacks .

Multicollinearity Test using Variance Inflation factor

Coefficients[a]											
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3.581	.391		9.150	.000					
	B	.229	.116	.100	1.971	.049	.100	.100	.100	1.000	1.000
a. Dependent Variable: Commercialization											

Based on the coefficients value, collinearity statistics obtained Variance Inflation factor (VIF) value is 1.000 which is between 1 to 10 and hence concluded that there is no collinearity symptoms.

Statement-3: Predicting a defined staged approach in design (Design Intervention) to facilitate commercialization of bamboo furniture.

The intervention allows a wider range of conceptual alternatives intended to help an organization to increase its effectiveness. As the intervention defines , the extent to fits the needs of the industry and the degree modification based on causal knowledge of intended outcomes. The evaluation of design intervention and its impact is based ,considering users' needs . It aims to assess the proportion of observed change which is attributed for the promotion of bamboo furniture. As impact evaluation is all about the assessing how the intervention affects outcomes and whether these effects are intended or unintended. In the earlier chapter the basic parameter of design based intervention is already been discussed . Considering the specified constructs the intervention buyers consider , needed to promote bamboo furniture is studied . In significance of studied parameters influence on regulating commercialization Analysis of Variance test is used for testing the below formulated hypothesis .

H_{03}: Design interventions do not have a positive impact on facilitating commercialization of bamboo furniture.

H_{13}: Design interventions do have a significant impact on facilitating commercialization of bamboo furniture.

To predict the design intervention significance on regulating commercialization and adoption of bamboo furniture regression analysis with collinearity is conducted. The commercialization studied on the basis of various parameter from all these set parameter, the design is specified as the main concerned construct by the users and industry experts. Therefore to study commercialization which is an dependent variable based upon the design based intervention specified by the users which are the independent variable actually affects the adoptions of bamboo furniture , the regression analysis proposed on the model to understand the impact of independent variable on dependent one . Here for further evaluating the model , collinearity statistics is used where the "R" value achieved in the model summary table below depicts the simple correlation. The derived value 0.533 signifies a degree denotes a moderate degree of correlation of 53.3% with positive association.

Model Summary				
Model	**R**	**R^2**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.533[a]	.284	.282	.521
a. Predictors: (Constant), C2				

Further analysis of the significance of the regression equations fits the data or not the Analysis of Variance (**ANOVA**) is proposed.

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	41.079	1	41.079	151.371	.000[b]
	Residual	103.667	382	.271		
	Total	144.747	383			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), C2 Design intervention						

Evaluating the equation, the regression model achieved statistically significant since the p-value is less than commonly used significance level 0.05 (F, 151.371; $p = 0.000<0.05$). Here we have lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that the "**Design interventions do have a significant impact on regulating commercialization of bamboo furniture".** Studying the model on the basis of the users feedback, the design intervention is the most significant factor to regulate commercialization of bamboo furniture as substitute of wood in Indian furniture market .Formulating the buyers feedbacks and personal information in conceptualizing the customized users specific design significantly promote commercialization of bamboo furniture in Indian market.

Multicollinearity Test using Variance Inflation factor

Coefficients[a]											
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	2.139	.127		16.837	.000					
	C2	.414	.034	.533	12.303	.000	.533	.533	.533	1.000	1.000
a. Dependent Variable: Commercialization											

Based on the coefficients value, collinearity statistics obtained Variance Inflation factor (VIF) value is 1.000 which is between 1 to 10 and hence concluded that there is no collinearity symptoms.

Statement-4: Mechanical and physical properties (characteristics) of bamboo furniture could regulate the commercialization.

As intervention defines , the extent of design fitting to the needs and the degree modification based on causal knowledge of intended users . Simplifying the design intervention and its impact, it is understood that product attributes help the potential users to understand objective and subjective details helping their buying decisions .The basic characterisation of product is divided into two categories of tangible and intangible, helping the users in comparing and purchase decisions. The familiarity to the product characteristics is observed influencing the users self - construal's ,observing characteristics as an important parameter influencing adoption the Mechanical and physical characteristics of bamboo significance on regulating commercialization is evaluated and tested using Analysis of Variance test to understand it effect on users.

H_{04}: Characteristics of bamboo furniture do not have a significant impact on regulating its adoptions.

H_{14}: Characteristics of bamboo furniture do have a significant impact on the regulating adoption of bamboo furniture.

Predicting the significance of physical and mechanical properties, the basic characteristics of bamboo on regulating commercialization and adoption of bamboo furniture the regression analysis with collinearity is conducted. Though commercialization is studied on the basis of various parameter from which the design is specified as the main concerned construct by the users and industry experts. Therefore to study adoption and commercialization as an dependent

variable based upon mechanical and physical characteristics as independent variable, the regression analysis proposed on the model to understand the impact of independent variable on dependent variable and its significance on the adoptions of bamboo furniture. Here for further evaluating the model , collinearity statistics is used where the "R" value achieved in the model summary table below depicts the simple correlation. The derived value 0.101 signifies a negligible degree of correlation of 10.1%.

Model Summary				
Model	**R**	**R** ^{2}	**Adjusted R Square**	**Std. Error of the Estimate**
1	.101[a]	.010	.008	1.710
a. Predictors: (Constant), C2				

Further analysing the significance of the regression equations fits the to the data or not the Analysis of Variance (**ANOVA**) is proposed .

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	11.408	1	11.408	3.902	.049[b]
	Residual	1116.840	382	2.924		
	Total	1128.247	383			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), C2 Mechanical and physical properties (characteristics)						

Evaluating the equation the regression model achieved statistically significant , since the p- value is less than commonly used significance level 0.05 (F, 3.902; p =0.49<0.05). Here we have lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that the **"Characteristics of bamboo furniture do have a significant impact on the regulating adoption of bamboo furniture".** Studying the model on the basis of the users feedback ,the characteristics i.e. physical and mechanical properties is important constructs users consider at the time of purchase of furniture .Though the characterization of bamboo furniture ascertain the substitution of wood in all aspects has ascertained in section 2.2.5, it awareness needs to be commercialize by simplifying to better design and educating the buyer to significantly promote bamboo furniture in Indian market.

Multicollinearity Test using Variance Inflation factor

Coefficients[a]												
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	3.817	.417		9.154	.000					
	C2	.218	.110	.101	1.975	.049	.101	.101	.101	1.000	1.000
a. Dependent Variable: Commercialization											

Based on the coefficients value, collinearity statistics obtained Variance Inflation factor (VIF) value is 1.000 which is between 1 to 10 and hence concluded that there is no collinearity symptoms.

Statement-5: Minimalistic multi-functional design support in regulating adoption and commercialization bamboo furniture

The design from the above study is driven as the most influencing factor affecting commercialization of bamboo furniture . Understanding the users design based preferences as per the survey study, it is observed that rapid urbanization boosting the growth of the furniture market , making users getting shifted from traditional furniture to the contemporary. Studying the users taste & their preference for simplicity , clean lines, monochromatic palette and more functional designs directed towards to users proclivity for minimalistic forms. " **Less is more**" minimalistic mantra given by German architect and furniture designer **Ludwig Mies Van Der Rohe** defining furniture to be clear and simple but not boring, thriving the essence of functionality[43] . Observing survey study constructs and users behaviour minimalistic design forms for furniture studied as an important parameter can influence buyer , in significance of regulating commercialization of bamboo furniture using minimalistic design form below statement evaluated and tested using Analysis of Variance test to understand it effect on users

H_{05}: The minimalistic multi-functional design do not significantly impact in regulating adoption and commercializing bamboo furniture

[43] Proponents of minimalism believe on condensing the content and form of a design to its bare essentials reveals the true 'essence . The Minimalism furniture form is an approach where the design elements are simplified to their essential and functional components.Adaptedhttps://www.elledecor.com/design-decorate/interior-designers/a27471472/minimalist-interior-design-tips/

H_{15}: The minimalistic functional design significantly impact in regulating adoption and commercializing bamboo furniture

Evaluating the significance of minimalistic design furniture on regulating commercialization and adoption of bamboo furniture the regression analysis with collinearity is conducted. The commercialization of bamboo furniture is studied by various parameter, as the design is specified as the main concerned construct by the users and industry experts. Therefore all the sub parameter of design is evaluated ,to study commercialization as dependent study variable based upon the minimalistic functional design specified by the users as an independent variable. To study its effects on the regulating adoptions of bamboo furniture the regression analysis proposed on the model to understand the impact of independent variable on dependent one . For further evaluating the model , collinearity statistics is used where the "R" value achieved in the model summary table below depicts the simple correlation. The derived value 0.256 signifies a negligible degree of correlation of 25.6 %.

Model Summary				
Model	**R**	**R^2**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.256[a]	.066	.063	.595
a. Predictors: (Constant), B				

Further analysing the significance of the regression equations fits the to the data or not the Analysis of Variance (**ANOVA**) is proposed .

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	9.484	1	9.484	26.783	.000[b]
	Residual	135.263	382	.354		
	Total	144.747	383			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), B Minimalistic design						

Evaluating the equation the regression model achieved statistically significant , since the p- value is less than commonly used significance level 0.05 (F, 26.783; p= 0.00<0.05). Here we have lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that the **"minimalistic multi-functional design significantly impact in regulating adoption and commercializing bamboo furniture".** Considering the famous quote by Apple founder Steve Jobs **"Design is not just what it looks and feels like, Design is how it works."**

The, furniture is not just about the appearances approach but thriving to the essence of its multifunctionality.

Studying the model on the basis of the users feedback ,the minimalistic multifunctional design is the significant factor to regulates commercialization of bamboo furniture as substitute of wood in Indian furniture market .Formulating the buyers feedbacks and personal information ,having the reductive design elements, without ornamentation or decoration, using monochromatic palette in developing multi-functional forms significantly promote commercialization of bamboo furniture in Indian market.

Multicollinearity Test using Variance Inflation factor

Coefficients[a]											
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	2.960	.140		21.140	.000					
	B	.215	.042	.256	5.175	.000	.256	.256	.256	1.000	1.000
a. Dependent Variable: Commercialization											

Based on the coefficients value, collinearity statistics obtained Variance Inflation factor (VIF) value is 1.000 which is between 1 to 10 and hence concluded that there is no collinearity symptoms.

Statement-6: Product standardization, branding and certification positively support to commercialize and increase bamboo furniture adoption.

Product standardization, its branding and certification is the perpetual process of identifying , creating and managing the cumulative assets for shaping the perception of products in users mind**.** As per Tom Goodwin "branding are essentially pattern of familiarity ,meaning ,fondness and reassurance that exists in the mind of people"[44]. Adding standardization and certification to any product not only increase the business value but it most importantly creates trust among the users . To understand the necessity of brand association to furniture for boosting the growth of the furniture market and making users getting shifted from wooden to the bamboo furniture .Therefore impact of standardization and certification on commercializing bamboo furniture among Indian furniture buyers is studied as an important intervention .Observing other study

[44]Branding not only makes an impression on consumers but distinguishing from the competitors and assuring the users towards there better choice. It built true representation of a product adapted from https://www.brandingmag.com/2015/10/14/what-is-branding-and-why-is-it-important-for-your-business/

constructs and users behaviour towards adding standardization, branding and certification to bamboo furniture studied as an important parameter for influencing buyer .In significance of evaluating the commercialization of bamboo furniture by adding brand association below statement evaluated and tested using Analysis of Variance test to understand it effect on users .

H_{06}: Adding Standardization, branding and certification to bamboo furniture do not significantly support in its commercialization and adoption among users .

H_{16}: Adding Standardization, branding and certification to bamboo furniture significantly support in its commercialization and adoption among users.

Evaluating the significance of standardization, branding and certification of furniture on regulating commercialization and adoption of bamboo furniture the regression analysis with collinearity is conducted. The commercialization of bamboo furniture is studied on various parameter. Considering the design as the main construct by the users and industry experts, adding branding and certification to bamboo furniture is further evaluated as sub supporting parameter, to evaluate commercialization as dependent variable based upon the adding standardization and branding as an independent variable. Further studying its effects on the regulating adoptions of bamboo furniture the regression analysis proposed on the model to understand the impact of independent variable on dependent one . For further evaluating the model , collinearity statistics is used where the "R" value achieved in the model summary table below depicts the simple correlation. The derived value 0.485 signifies a moderate degree of correlation of 48.5 %with positive association.

Model Summary				
Model	**R**	**R^2**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.485[a]	.235	.233	.938
a. Predictors: (Constant), C2				

Further analysing the significance of the regression equations fits the to the data or not the Analysis of Variance (**ANOVA**) is proposed .

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	103.073	1	103.073	117.213	.000[b]
	Residual	335.917	382	.879		
	Total	438.990	383			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), C2 Bamboo furniture standardization and certifications						

Evaluating the equation the regression model achieved statistically significant , since the p- value is less than commonly used significance level 0.05 (F, 117.213; p =0.00<0.05). Here we have lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that the **"Adding standardization, branding and certification to bamboo furniture significantly support in its commercialization and adoption among users".** Studying the model on the basis of the users feedback ,the branding and certification to bamboo and its by-products is one of the significant factor whose association can regulates commercialization of bamboo furniture as substitute of wood in Indian furniture market .From the buyers feedbacks and personal information ,the brand association generates trusts and satisfaction which significantly help to regulate the demand of bamboo furniture in Indian market

Multicollinearity Test using Variance Inflation factor

Coefficients[a]											
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1.334	.229		5.835	.000					
	C2	.656	.061	.485	10.826	.000	.485	.485	.485	1.000	1.000
a. Dependent Variable: Commercialization											

Based on the coefficients value, collinearity statistics obtained Variance Inflation factor (VIF) value is 1.000 which is between 1 to 10 and hence concluded that there is no collinearity symptoms.

Statement-7: Online promotion, bamboo design fairs and exhibitions can enhance commercialization of bamboo furniture.

Online promotion , fairs and exhibitions are the practice of leveraging channels to spread a awareness about a products or services to its users [45]. These channels are viable to measure the impact as well as users interact and respond to the product .These platforms not only the most possible measure to educate the users, but can also change the users perception towards the products and convert them to a viable buyers .Therefore to understand association of initiating e-promotion and exhibition for boosting the growth of the bamboo furniture market and making users getting shifted from wooden to the bamboo furniture the model is further studied as an

[45] Online promotion and fairs creates opportunities to grow the presence and build their users. The marketing can become impersonal, due to the virtual nature of message and content delivery to a desired users .Adopted fromhttps://www.optimizely.com/optimization-glossary/online-marketing/ - :~:text=A key benefit of using,website or landing page experience.

important influencing parameter. Observing other supporting study constructs, e-promotion, fair , exhibitions are one of important supporting sub-construct for generating awareness and getting society familiar to the bamboo furniture .In significance of evaluating the commercialization of bamboo furniture by generating awareness through e-platforms ,exhibition and fair below statements are evaluated and tested using Analysis of Variance test to understand it effect on Indian bamboo furniture market .

H_{07}: Online promotion, bamboo furniture fairs and exhibitions do not significantly enhance commercialization bamboo furniture**.**

H_{17}: : Online promotion, bamboo furniture fairs and exhibitions do significantly enhance commercialization bamboo furniture**.**

Evaluating the significance of online promotion, bamboo furniture fairs and exhibitions on regulating commercialization and adoption of bamboo furniture , the regression analysis with collinearity is conducted. The commercialization of bamboo furniture is studied on various parameter. Though the design is the main construct as per the users and industry experts, but its awareness is also sub supporting parameter to commercialize furniture bamboo among the buyers. Therefore commercialization is evaluated as an dependent variable based upon the independent variable as instigating its online promotion ,exhibition and fairs . Studying its effects on the regulating adoptions of bamboo furniture further , the regression analysis is proposed on the model to understand the impact of independent variable on dependent one . Therefore for evaluating the model , collinearity statistics is used where the "R" value achieved in the model summary table below depicts the simple correlation. The derived value 0.482 signifies a moderate degree of correlation of 48.2 % with positive association.

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	**.482a**	**.232**	**.230**	**.945**
a. Predictors: (Constant), C2				

Further analysing the significance of the regression equations fits the to the data or not the Analysis of Variance (**ANOVA**) is proposed .

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	103.170	1	103.170	115.464	.000[b]
	Residual	341.327	382	.894		
	Total	444.497	383			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), Online platform to facilitate dialogue between different bamboo stakeholders						

Evaluating the equation the regression model achieved statistically significant , since the p- value is less than commonly used significance level 0.05 (F, 115.464a; p =0.00<0.05). Here we have lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that the **"Instigating online promotion, bamboo furniture fairs and exhibitions do significantly enhance commercialization bamboo furniture".** Studying the model on the basis of the users feedback, instigating online promotion, bamboo furniture fairs and exhibitions can improvises the awareness and can change the perception of bamboo furniture . Adding e-promotion and fairs can educate the buyers about the new possibilities of bamboo and available furniture designs innovations which could possibly initiate bamboo furniture as substitute of wood.

Multicollinearity Test using Variance Inflation factor

Coefficients[a]											
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**	**Correlations**			**Collinearity Statistics**	
		B	**Std. Error**	**Beta**			**Zero-order**	**Partial**	**Part**	**Tolerance**	**VIF**
1	(Constant)	1.497	.231		6.495	.000					
	C2	.656	.061	.482	10.745	.000	.482	.482	.482	1.000	1.000
a. Dependent Variable: Commercialization											

Based on the coefficients value, collinearity statistics obtained Variance Inflation factor (VIF) value is 1.000 which is between 1 to 10 and hence concluded that there is no collinearity symptoms.

Statement-08: Connecting to the designers and consumers by bamboo artisans and manufacturer in fabricating initial design, support in promoting adoption and commercialization bamboo furniture.

The design is not only about the product it is always about the people who use it . Defining a designing of product it follows two critical ways one is interface which state **how people use** the product and second is identity which state **how people perceive** the product. The users like to

connect to a product that have broader prospect to solve most of their functional needs , more efficiently at a lesser cost[46]. Connecting the designer ,users and artisan's in conceptualizing a product not only initiates a better design , but it also create to more users preferable designs .Interconnecting designers , consumers and artisans is a viable to measure through which all stakeholders can interact and respond to the specific design .Adding suitable e-platforms for interconnecting all stakeholders not only the most possible measure to educate the users, but can also change the users perception towards the bamboo furniture and converting them to a viable buyers .Therefore initiating web portals ,mobile applications and exhibition fairs boost in the growth of the bamboo furniture market and making users elevated towards bamboo furniture Observing other supporting study constructs, e-promotion, fair , exhibitions as one of important supporting sub-construct for generating awareness and getting society familiar to the bamboo furniture the model is further studied as an important influencing parameter In significance of evaluating the commercialization of bamboo furniture connecting designers ,consumers to bamboo stakeholders below statements are evaluated and tested using Analysis of Variance test

H_{08}: Connecting designers and consumers to bamboo artisans & manufacturer in executing design , do not significantly promote the adoption and commercialization bamboo furniture.

H_{18}: Connecting designers and consumers to bamboo artisans & manufacturer in executing design , significantly promote the adoption and commercialization bamboo furniture

Evaluating the significance of connecting designers and consumers to bamboo stakeholder's in executing design can promote commercialization and adoption of bamboo furniture , the regression analysis with collinearity is conducted. The commercialization of bamboo furniture is studied on various parameter and design is the main construct as per the users and industry experts, but connecting all the stakeholders through viable platform to alleviates the discussion and understand preference is observed as sub supporting parameter to commercialize bamboo furniture among the buyers. Therefore commercialization is evaluated as an dependent variable based upon the independent variable as instigating Connecting designers and consumers to bamboo artisans in executing design . Studying its effects on the regulating adoptions of bamboo furniture further , the regression analysis is proposed on the model to understand the impact of independent variable on dependent one . Therefore for evaluating the model , collinearity statistics

[46] The fixed cost curve is a negative sloped curve illustrating the relationship between the average fixed cost incurred at a. certain output level .

is used where the "R" value achieved in the model summary table below depicts the simple correlation. The derived value 0.457 signifies a moderate degree of correlation of 45.7% with positive association.

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.457[a]	.209	.184	.43629
a. Predictors: (Constant), Connecting designers and consumers to bamboo artisans & manufacturer in executing design				

Further analysing the significance of the regression equations fits the to the data or not the Analysis of Variance (**ANOVA**) is proposed .

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	1.610	1	1.610	8.459	.007[b]
	Residual	6.091	32	.190		
	Total	7.702	33			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), Connecting to the designers and consumers can help you to produce better designs.						

Evaluating the equation the regression model achieved statistically significant , since the p- value is less than commonly used significance level 0.05 (F, 44.649; p =0.007<0.05). Here we have lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that **the "Connecting designers and consumers to bamboo artisans & manufacturer in executing design , significantly promote the adoption and commercialization bamboo furniture".** Studying the model on the basis of the users feedback, instigating viable platforms to connect designers , consumers to bamboo stakeholder's in design formulation can improvises the available bamboo furniture models and can help buyers to have their own customized design of bamboo furniture These platforms help the designer's and bamboo stakeholder to understand the users demand more adequately and adding new possibilities to initiate bamboo furniture commercialization in Indian market.

Statement-09: The existing government promotional measure and incentives can enhance adoptions of bamboo furniture.

Government promotional measures and incentives are implemented for the welfare of the society . India has huge untapped potential in the bamboo sector and to tap these resources government

has announced centrally sponsored schemes. These supportive measure plays a crucial role in solving many socio-economic problems . To upgrade bamboo industry many such schemes are developed to reduce vulnerability of bamboo industry and giving employment opportunities for skilled and unskilled persons . The government strategies involved are majorly focusing on strengthening the domestic cultivation of bamboo . These scheme need to be redefined focusing on furniture production and promotions . It is crucial that these funding should made assessed by the rural artisans . Observing, government promotional measure and incentives as important supporting sub-study construct which could play crucial part in generating awareness and enhance the adoption of bamboo furniture .The model is further studied to understand its significance on commercialization , therefore statements are further evaluated and tested using Analysis of Variance test .

H_{08}: Exiting government promotional schemes and incentives do not have a significant impact on the commercialization of bamboo furniture.

H_{18}: Exiting government promotional schemes and incentives do have significant impact on the commercialization of bamboo furniture.

Evaluating the significance of government promotional schemes and incentives in executing commercialization and adoption of bamboo furniture , the regression analysis with collinearity is conducted. The commercialization of bamboo furniture is studied on various parameter as per the users and industry experts, the government supportive schemes is studied as sub supporting parameter in commercializing bamboo furniture .The commercialization is evaluated as an dependent variable and government supportive scheme are predicting independent variable. Further to study predictors variable impact on the regulating adoptions of bamboo furniture , the regression analysis is proposed on the model.

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.204[a]	.041	.012	.48030
a. Predictors: (Constant), Need of government promotional schemes and incentives				

Further analysing the significance of the regression equations fits the to the data or not the Analysis of Variance (**ANOVA**) is proposed .

Analysis of Variance ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.320	1	.320	1.385	.248[b]
	Residual	7.382	32	.231		
	Total	7.702	33			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), Need of government promotional schemes and incentives						

Evaluating the equation the regression model achieved statistically insignificant, since the p-value is more than commonly used significance level 0.05 (F, 1.385; p=0.248>0.05). Here we have statistically insignificant difference in the mean therefore the study accepts the null hypothesis stating that **the "Existing government promotional schemes and incentives do not have a significant impact on the commercialization of bamboo furniture."** Studying the model on the basis of the user's feedback these schemes and common facility centre are not easily accessible .Understanding to the cruciality of production of bamboo furniture it is important that these artisans should get aware of these schemes and must avail easy remittance.

Statement-10: Self assembly flat pack with personalized and intricate detailing can improvise commercialization and adoption of bamboo furniture.

Studying the various parameters affecting the commercialization of bamboo furniture, the design is derived as one of the most influencing constructs. The foundation of furniture design is centred around the users . Understanding the user's behaviour , habit ,wants , needs and frustration design of furniture needs to ground up. Where the personalization establishes a connection between users and products, as it allows users to choose the elements such as colour, design , functionality of the furniture. The flat pack system comes with easy affordability and space storage possibility .As per the articles published by Rae White in Forbes "**The users are reaching at a level where personalization is not only a perk for those consumers who are keenly aware of their wants and needs, there are instances where problems outside of not finding exactly what they want are being solved."** Studying to the buyers and sellers behaviours towards major design based intervention parameters, the buyers preferred the furniture that could be easily assembled , flat pack with their personalized and intricate detailing. Observing the sub-construct for generating adoption of bamboo furniture, the model influence is further studied with significance to evaluate the commercialization of bamboo furniture, the statement is further evaluated and tested using Analysis of Variance test.

H_{010}: Self-assembly flat pack with personalized and intricate detailing do not significantly impact commercialization and adoption of bamboo furniture.

H_{110}: Self-assembly flat pack with personalized and intricate detailing significantly improvise commercialization and adoption of bamboo furniture.

Evaluating the significance of understanding the impact of self-assembly flat pack with personalized and intricate detailing in promoting commercialization and adoption of bamboo furniture , the regression analysis with collinearity is conducted. Though the commercialization of bamboo furniture is studied on various parameter and design evolved as one of the main construct as per the users and industry experts. Therefore to understand the commercialization with respect to various sub construct of design , self-assembly flat pack with personalized and intricate detailing model is evaluated using regression analysis . Evaluating the impact of independent variable on dependent one ,observing commercialisations as dependent variable and analysing it with self-assembly flat pack with personalized and intricate detailing as an predicting independent variable, collinearity statistics is used where the "R" value achieved in the model summary table below depicts the simple correlation. The derived value 0.718 signifies a high degree of correlation of 71.8 % with positive association

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.718[a]	.515	.500	.215
a. Predictors: (Constant), Demand of multifunctional , modern and intricate design.				

Further analysing the significance of the regression equations fits the to the data or not the Analysis of Variance (**ANOVA**) is proposed .

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	1.572	1	1.572	34.040	.000[b]
	Residual	1.478	32	.046		
	Total	3.050	33			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), Self-assembly flat pack with personalized and intricate detailing						

Evaluating the equation the regression model achieved statistically significant , since the p- value is less than commonly used significance level 0.05 (F, 34.040; p=0.00<0.05). Here we have lack of data for supporting the null hypothesis, therefore the study accepts the alternative hypothesis stating that **the "Self-assembly pack flat with personalized and intricate detailing significantly improvise commercialization and adoption of bamboo furniture".** The model

studied on the basis of the users feedback easy to assembled flat pack with personalized and intricate detailing in design improvises the available bamboo furniture models and can help buyers to have their own customized furniture and initiating bamboo furniture commercialization in Indian market.

Statement-11: Regional availability of specific furniture crafting bamboo species can impact adoption and commercialization of bamboo furniture.

Studying to the various parameter affecting commercialization of bamboo furniture, the bamboo furniture crafting is always determined to be species specific , as all the Indian bamboo species cannot be used for furniture making. Some of the common species specifically adequate for crafting furniture are Bambusa tudla, Dendrocalamus Brandisii, Dendrocalamus Giganteus, Dendrocalamus Strictus, Thyrsostachys Oliveri etc and most of these species are found in north east region of India .Being region specific availability sometimes these species needs get transported . As the design impact the success or failure of the furniture in market and bamboo furniture design is species specific. Considering essences of State or region-specific species availability impact on commercialization the model influence is further studied as important significant parameters and tested using the Analysis of Variance test.

H_{011} Region specific bamboo species availability does not have significant impact adoption and commercialization of bamboo furniture.

H_{111}: Region specific bamboo species availability significantly impact commercialization and adoption of bamboo furniture.

Evaluating the significance of region specific species availability in promoting commercialization and adoption of bamboo furniture , the regression analysis with collinearity is conducted. Though the commercialization of bamboo furniture is studied on various parameter and understanding design as one of the main observed construct its impact is studied with the respect to availability of bamboo species. As bamboo furniture making is skilled based crafts , which needs specific bamboo species as per their physical and mechanical properties to crafts traditional or engineered bamboo furniture. Therefore to analyse the commercialization impact with respect to region specific species availability ,the model is evaluated using regression analysis . Evaluating the impact of independent variable on dependent one ,observing commercialisations as dependent variable and analysing it with region specific species

availability as an predicting independent variable. Further analysing the significance of the regression equations fits the to the data or not the Analysis of Variance (**ANOVA**) is proposed .

Analysis of Variance ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Between groups	86.848	21	4.136	.835	.654[b]
	Within groups	59.417	12	4.951		
	Total	146.265	33			
a. Dependent Variable: Commercialization						
b. Predictors: (Constant), Availability specific species of bamboo						

Evaluating the equation the regression model achieved statistically insignificant , since the p-value is far more than commonly used significance level 0.05 (F, .835; p=0.654>0.05). Here we have lack of data for supporting the alternative hypothesis, therefore the study accepts the null hypothesis to **"Region specific bamboo species availability does not have significant impact on adoption and commercialization of bamboo furniture.".** Studying the model on the basis of the users feedback, the regional availability of specific furniture crafting bamboo species doesn't plays significant role in commercialization of bamboo furniture as bamboo is an humble grass which abundantly available in India . Being rich with bamboo biodiversity , the raw material is easily available .There is only need of proper processing and manufacturing hubs Epitome, Indian plywood industries research training institute(IPIRTI) to channelize the raw materials into bamboo furniture, products or processed bamboo boards , adding new possibilities to initiate bamboo furniture commercialization in Indian market.

7.3 Interpretation from hypothesis testing

Hypothesis	R (correlation)	F value (var.)	p-value (sig.) < 0.05	Signifi.	Results	Collinearity Statistics	Decision
Analysing factor most relevant key successor to support the commercialization of bamboo furniture							
The income of the consumers is parallel mediator to commercialize bamboo furniture.	0.104[a] [Negligible Correlation]	4.176	.042[b]	Yes	Accepts the H_1 that The income of the consumers is a parallel mediator to commercialize bamboo furniture and has a significant impact on its adoption.	Tolerance = 1.000 VIF. = 1.000	The provision of bamboo furniture as a cost-effective alternative to wood could catalyze its production and increase its popularity among socio-economic strata with a preference for furniture choices that are commensurate with their income levels. Therefore, the **wood furniture populace can potentially shift to bamboo furniture by adding income as an additional approach** while designing.
Consumers' awareness and perception of the significance of the adoption and commercialization of bamboo furniture.	0.100[a] [Negligible Correlation]	3.883	.049[b]	Yes	Accepts the H_1 that consumers' awareness and perception do have a significant impact on the adoption and commercialization of bamboo furniture	Tolerance = 1.000 VIF. = 1.000	Analysing the hypothesis in accordance with the study, the perceptions of b**uyers are heavily influenced by the aspects of personalization and bi-directional communication**. The degree of interpersonal information, perspectives, and utilization **feedback can create both positive and negative** impacts on the adoption and commercialization of products. Therefore, **the extent of consumers' awareness and perception will impact the frequency of bamboo furniture utilization** and it is imperative for bamboo furniture retailers to be mindful of the frequency and degree to which they utilize personal information and feedback in their marketing.
Predicting a defined staged approach in design (Design Intervention) to facilitate commercialization of bamboo furniture.	0.533[a] [Strong Correlation]	151.37	0.000	Yes	Accepts the H_1 Design interventions do have a significant impact on regulating the commercialization of bamboo furniture.	Tolerance = 1.000 VIF. = 1.000	Analysing the hypothesis in relevance to the study and regression analysis states that predicting the design-based intervention approach regarding user feedback can significantly regulate the commercialization of bamboo furniture. Conceptualizing user-specific prototype designs based on various expected design intervention feedback stated the results of market acceptability both by users and manufacturers. The results significantly delve into **improvising design staged approach** to

							commercializing bamboo furniture in the Indian market **as an important parameter which can only independently initiate the acceptance of bamboo as a substitute for wood among Indian urban buyers.**
Analysing the most viable intervention based on the design and cognizance to commercialize bamboo furniture							
The mechanical and physical properties (characteristics) of bamboo furniture could regulate commercialization.	0.101[a] [Negligible Correlation]	3.902	0.049	Yes	Accepts the H_1 Characteristics of bamboo furniture do have a significant impact on the regulating adoption of bamboo furniture".	Tolerance = 1.000 VIF. = 1.000	Analysing the hypothesis, the mechanical and physical properties of bamboo furniture in regulating commercialization in accordance with the study states that commercialization as an dependent variable upon mechanical and physical characteristics of material. ,The regression analysis proposed on **the model signifies its importance on the adoptions of bamboo furniture but the observed difference is not substantial** to clearly predict the characteristics based intervention can act as **mediator to supporting adoption** but it cannot initiate the commercialization among Indian buyers .
Minimalistic multi-functional design support in regulating adoption and commercialization bamboo furniture	0.256[a] [Moderate Correlation]	26.783	0.000	Yes	Accepts the H1 minimalistic multi-functional design significantly impact in regulating adoption and commercializing bamboo furniture".	Tolerance = 1.000 VIF. = 1.000	Analysing the design based hypothesis i.e. adding Minimality multi-functionality to bamboo furniture design could regulate commercialization in accordance with the study the regression **analysis proposed on (income, cognizance and design)** factor state highly significance on design . The brief sub analysis delves commercialization highly acceptable as the difference obtained analysing the hypothesis "**multifunctionality and minimalistic design" is high stating its strong impact to initiate the commercialization** among Indian buyers .
Product standardization, branding and certification positively support to commercialize and increase bamboo furniture adoption	0.485[a] [Strong Correlation]	117.213	0.000	Yes	Accepts the H_1 "Adding standardization, branding and certification to bamboo furniture significantly support in its commercialization and adoption among users"	Tolerance = 1.000 VIF. = 1.000	Analysing the hypothesis, adding standardization, branding and certification to bamboo furniture can support its adoption .In accordance with the study and the regression analysis proposed states that the standardization, branding and certification is an substantial **parameter which gives a customer assurance of quality and authenticity** of the material and adds the addition value to the products. The analysis instigates that proposed

							hypothesis is an parallel mediator in supporting commercialization and adoption of bamboo furniture .
Online promotion, bamboo design fairs and exhibitions can enhance commercialization of bamboo furniture.	0.482[a] [Strong Correlation]	115.464	0.000	Yes	Accepts the H_1 "Instigating online promotion, bamboo furniture fairs and exhibitions do significantly enhance commercialization bamboo furniture	Tolerance = 1.000 VIF. = 1.000	Analysing the hypothesis "Instigates to online promotions, bamboo furniture fairs and exhibitions can significantly enhance commercialization bamboo furniture. In accordance with the study and the proposed regression analysis **supports on elevating bamboo promotional measures by adding bamboo harts, fairs and exhibition** not only **can create awareness** but can also significantly instates the **changes in the users perception and preferences** .
Connecting to the designers and consumers by bamboo artisans and manufacturer in fabricating initial design, support in promoting adoption and commercialization bamboo furniture.	.457[a] [Moderate Correlation]	8.459	.007[b]	Yes	Accepts the H_1 Connecting designers and consumers to bamboo artisans & manufacturer in executing design , significantly promote the adoption and commercialization bamboo furniture".	Tolerance = 1.000 VIF. = 1.000	The hypothesis analysis in accordance with the study and the proposed regression analysis to understand the extent of commercialization by Connecting to the designers and consumers to bamboo artisans and manufacturer in fabricating design, states that connecting all the stakeholder to each other in executing designs can **improvising the available bamboo furniture models** and helping to understand each other design requirements. The proposed hypothesis is an augmenting factor in **facilitating better designs and new possibilities for initiating Indian bamboo furniture to Global market** .
The existing government promotional measure and incentives can enhance adoptions of bamboo furniture.	.204[a]	1.385	.248[b]	No	Accepts the H_0 "Existing. government promotional schemes and incentives do not have a significant impact on the commercialization of bamboo furniture."	Tolerance = 1.000 VIF. = 1.000	The hypothesis analysis states the existing government promotional schemes and incentives are not significant enough to commercialize the bamboo furniture among urban buyers . The policy and schemes proposed need a upgradation understanding the buyers and sellers context . The model proposed by government has technical and social barriers which are not facilitating the sellers and adversely affecting not only the quantity but quality of productions. Therefore **upgrading and facilitating more accessible incentives , promotional schemes can parallelly supports** the bamboo based industry but the current promotional measures are insufficient to generate the

							commercialization of bamboo furniture .
Self assembly flat pack with personalized and intricate detailing can improvise commercialization and adoption of bamboo furniture.	.718[a] [Strong Correlation]	34.040	.000[b]	Yes	Accepts the H_1 Self-assembly f pack flat with personalized and intricate detailing significantly improvise commercialization and adoption of bamboo furniture	Tolerance = 1.000 VIF. = 1.000	The hypothesis analysis in accordance with the study and the proposed regression analysis states that the **personalization establishes a connection between users and products** . The users are reaching at a level where personalization is a perk for manufacturer which allowing buyers to **find exactly what they want are being solved and getting connected to the product** . Self-assembly ,flat pack with personalized and intricate detailing were the predicted variable by the users adding these variables to prototypes design resulted to acceptance and appreciation of the proposed chair .Evaluating the response delves that modern buyers look for personalized multifunctionality with furniture nowadays . So adding design with **material upgradation can commercialize** bamboo furniture in in Indian sub urban region .
Regional availability of specific furniture crafting bamboo species can impact adoption and commercialization of bamboo furniture.		.835	.654[b]	No	Accepts the H_0 that Region specific bamboo species availability does not have significant impact on adoption and commercialization of bamboo furniture.".	Tolerance = 1.000 VIF. = 1.000	Hypothesis analysis and studying the model on the basis of the users feedback, India typography has abundance of bamboo species but regional availability of specific furniture crafting bamboo species is still has limited access. Therefore to analyse the commercialization impact with respect to region **specific species availability is an important factor** to study to understand the growth and typology of bamboo **but it doesn't significant instigates on commercialization** of bamboo furniture .

7.4 Interpretation from field study of urban and bamboo growing region in India

While considering ANOVA test , it is observed that all equitable and intuitive parameters, has variance in the mean scores is statistically significant .Studying commercialization by evaluating buyer and seller behaviour (BSB) on five parameter i.e. cultural (CF), social (SF), personal(PF) ,psychological factor (PSF) and Design Intervention(DI) .Further interpretation the parameters by ANOVA test reveals to :

- Personal(PF) : Evaluating the sub constructs of buyer personal characteristics stating their income , considerations and perception's as PF1.1, PF1.2 and PF1.3 , Summarizing the variance mean scores with statement 1& 4 , the analysis significates the buyers personal traits like incomes , their beliefs towards the durability ,strength and other physical properties as an parallel mediator in adoption of bamboo furniture derived to be statistically significant. The means score significates that income of the buyers and material characteristics influence the buying decisions and regulating commercialization of bamboo furniture .

- Social(SF) : Evaluating the social factors sub constructs to study the impact of social influences on commercialization .The study parameters SF1.1, SF1.2 includes the skill level of involved intermediaries , regional availability of bamboo species ,existing support and assistance from the local bodies and users preferences . Summarizing the survey responses ,the variance mean scores of the statement 9 & 10 signifying the existing government promotional schemes & incentives to commercialize bamboo furniture and regional availability of specific furniture crafting bamboo species is found statistically insignificant .The social constructs to be statistically insignificant in commercialization of bamboo furniture and need to be redefined focusing on furniture production and promotions .

- Cultural (CF) : As the culture factor is the framework of user beliefs, expressive symbols, and values which define their feelings to make their judgments. Studying cultural sub constructs towards the bamboo as an material and its influences on commercialization .The study parameters CF1.1 analyses the users cultural beliefs and viable factors influence considering the users behaviour and influence's during a purchase of furniture . Summarizing the survey study the variance mean scores of the statement evaluating the significance of involved cultural factor supporting commercialization of bamboo furniture derived to be statistically significant. The means score derives that cultural factor is a societal belief based upon prestige & esteem, **by online promotion, exhibition and adding product standardization, branding and certification increase the bamboo furniture visibility among users** stimulating the buying decisions and commercialization

- Psychological factor (PSF) :Studying psychological factor basis like users learning motivation ,feeling ,attitude and belief's impact on bamboo furniture commercialization .Evaluating the study parameters PSF1.1, PSF1.2, the preferable choice of the buyers and the factors contemplate buyers while buying any furniture in the statement 2 and 10. The variance mean

scores of the statement analysing the significance of psychological factor supporting commercialization derived to be statistically significant. The means score derives that personalized and intricate detailing with self-assembly flat packing stimulates built-in perception while influencing the buying decisions and stimulating the adoption of bamboo furniture .

- Design Intervention (DI) : Evaluating the derived variable design intervention in regard to parameters considered for commercialization, the survey study summarized to users preference minimalistic multifunctional design and Impact of connecting designers ,consumers and bamboo stakeholders together to a customised design . Analysing the parameters DI1, DI2 the preferable buyer's choice and the factors contemplate buyers while buying any furniture studied in the statement 3, 5 and 8 depicting the impact and preferred intervention . The variance mean scores of the statement analysing the significance of psychological factor supporting commercialization derived to be statistically significant. The means score derives that **desiderate modern yet affordable desig**n and c**onsumer centred intervention in design** improve market competitiveness and commercialization of bamboo furniture .

The overall evaluation of the study provides insights into India's colossal bamboo biodiversity due to its topography. Still, despite being the second largest producer globally, the country cannot tap these resources into revenue. The meticulous analysis and consideration of various variables to address the study's first objective reveal interconnected factors contributing to the restrained utilization of bamboo. The **consumers' awareness and perception** towards the material were evaluated as major hindering reasons. The study identified the current perception of urban buyers about the material as its limited availability in the local market and considered bamboo as "poor man timber". The lack of awareness was observed both at the buyers' and sellers' end. The technological and skill barrier among the artisans was observed to be affecting not only the quality but production supply. The generated demand was not satisfied by the sellers, and the production quality produced was inadequate to complement the urban interiors, resulting in a perception of outcast production in the market. In context to the second and the prime objective of the study, the factors analysed considering Buyer and seller behaviours (BSB) which was majorly affecting the adoption of bamboo furniture was the design. As per the users, the prevailing designs were not well-idolized as per the users' specifications. A brief evaluation of factors stated on **perceiving design staged approach** for stimulating the commercialization. Further understanding broad segments of design stages and evaluating the significant impact of the

intervention to stimulate the commercialization, some desired subsets studied on basing the consumer's demand. The study delves into amplifying minimalistic and multi-functional furniture design, which can exert a substantial consumer demand. Further, analysing the buyers' perspectives and to understand the viability of the pointed concerned. A prototype design model was prepared and evaluated, hinging all the inferred variables, to measure the impact of the derived design intervention and understand its extent on commercialization. Scrutinizing the model and the suggestion turned **Design to be one of the significant stimulating factors,** and **the bamboo furniture industry needs personalised multifunctional furniture to stimulate the adoption among urban buyers.** The study conclusively determined that the urban furniture market is predominantly dominated by engineered wood. It is imperative to note that adding engineered bamboo to the Indian market can be undeniably adopted as a viable substitute for furniture.

The bamboo industry is cycled on two major wheels: buyers and sellers. Studying the seller's perspective inferred the need for two additional nodes: **dedicated designers and adequate promotions.** The face-to-face interaction highlighted the elevating and upgrading of design and promotional measures, which can only be bridged by adding suitable interactive portals where dedicated designers can get involved. Although the government has promotional measures and incentives but relating to current scenarios of artisans and manufacturers, the proposed policy and measures still need upgradations that can easily support the **monetization of bamboo furniture and its artisans.** Overall, the study concluded on improvising consumer's personalized designs serving multifunctionality design is one of the key stimulators to promoting the commercialization of bamboo. The end users' perception is a spur in forming an attitude towards the material; a positive or negative attitude highly impacts the commercialization of the product.

7.5 Interpretation of bamboo furniture commercialization from users' perception in the study area

- As per the survey study, variable responses from buyers and sellers users in urban and bamboo regional areas, personal(PF), cultural (CF), and social (SF), are considered the mainstay for supporting bamboo furniture adoption in Indian markets.
- Psychological factor (PSF) and Design Intervention (DI) is analysed to be the most influencing factors affecting the users' buying decisions. Studying the prototype model and evaluating the user's preferred design-derived intervention revealed that **" Protean designs promote bamboo**", i.e. **multifunctional design-based intervention significantly commercializes bamboo furniture in India.**

- Prototype analysis also affirmed that the use of composite bamboo could offer adequate substitution for wood, and the integrated composite bamboo-based furniture model has a potential market. A definite enhancement of the stated parameters can positively impact bamboo furniture commercialization in Indian sub-sectors.

7.6 Conclusions

Overall, the study evaluated all the interventions and concluded that improving design with user-based personalization with multifunctionality could stimulate the commercialization of bamboo. The end users' perception is a spur in forming an attitude towards the material; a positive or negative attitude highly impacts the commercialization of the product. The study's outcome is based on analyzing the personal variables of the buyers and sellers, considering their age, gender, living structure, preferable buying choices, and material perception, which are substantial supportive mediators to address RQ1 and RQ2—identifying buyers' perception as the major mediator that influences the buying decision. The leading cause of the low acceptance of bamboo furniture is adhering to its wide raw material availability; bamboo furniture has limited buyers' easy access and has a rare local availability. It is sometimes tricky for adequate buyers willing to buy bamboo furniture to find a source, leading them to switch to easily approachable and viable alternatives to adhere to their demands. Addressing the critical fact of the expansive availability of bamboo, the study highlighted that awareness among buyers and sellers about the material is an aspect affecting its comprehensive promotion in the market. Understanding the current perception and the factors hindering widespread adoption, it becomes apparent that significant ideation to advance commercialization is to explore the design elements. Identifying the factors that consumers prefer wood over bamboo is the intricate design elements and adding detailed elements in the bamboo furniture can input the commercialization. The approach involves recognizing the intricate details to reshape the perceptions and elevate bamboo furniture in its competitive market.

Though skill is paramount in forming a linchpin, the artisans' excellence and skill level directly influence the caliber's and precision of their work. Addressing RQ3 and RQ4, small, micro and medium-scale bamboo furniture manufacturers face constraints and suggestive modifications involving a socio-context, which includes many direct and indirect initiators. Evaluating bamboo crafting and workmanship skills, the study reveals that they are remote spread and homestead skills in India. Being a source of livelihood to most of the families, it is a year-round working. Studying the involved locals and artisan perspectives, the major constraints contexed that

advanced skill development training sessions and programs are far and difficult to access. Some other individual limiting factors highlighted were technological barriers and the unavailability of adequate species. As a society, the lack of awareness about products or materials among a small group leads to negative associations, delivering the same perception to society. Knowledge leads to a positive attitude, delivering a positive association and building a buoyant demand. Adding a positive image by the involvement of designers in creating better designs and encouraging the public sector to mandate the use of bamboo furniture in public buildings can generate awareness of bamboo among society. In addition, training modules for technological upskilling and using e-platforms in remote regions vitalize the gaps in bamboo manufacturing units. The change in aspirations of the end users is essential to bridge the gaps between the production and the demand for bamboo furniture in India, and remodeling the policy as per state-wise needs can initiate local access to bamboo furniture for all as impact Evaluation aims to quantify the effect and assess the proportion of observed change which is attributed to the promotion of bamboo furniture. The buyer & seller behavior covered different interventions, but the common core factor analyzed is the design paucity. The demand and supply side ceded 12 new strategic measures that might lead to the commercialization of bamboo furniture in the future. However, the impact analysis of the derived intervention done on prototype design effectuated that adding multifunctionality to engineered bamboo is the intervention the bamboo furniture market in India is anticipating in future to make withstand as a substitute for wood in the market.

7.7 Recommendations from findings

The bamboo furniture industry in India has been constrained to small-scale cottage industries and there is a gap seen between the processing knowledge of bamboo and its awareness among the users. The furniture industry consumes only 1% share because of these gaps. From the above study, it is observed that the government-framed policy needs modification to promote bamboo furniture among the buyers; some strategic suggestions suggested towards the framed government policy are highlighted the below table. This suggestion will help in defining demand from the consumer's end and supply from the artisan’s end. Some suggestions that can be addressed in policy framing taking various attributes in account, to up-scale existing as well

AGENCY	Policy	Suggestion

Ministry of Environment and Forests with State Forest Departments. **State and Local Forest Departments.**	Forest Conservation Act 1980 (FCA) -Classifies bamboo as a non-timber minor forest produce. It vests the right of ownership and the right to collect use and dispose of bamboo in the forest-dwelling communities, as a part of their traditional rights.	• The FRA restricts the development of bamboo industry by **attempting to vest the right to trade in bamboo in the tribals**. • Modification of forestry **policy is highly region-specific, rather than species-specific**. • This system offers targeted development of designated to bamboo regions. **Whereas classification-Based Forest Management sorts all forests into protected vs. commercial, which offers flexibility and federal-state cooperation.**
Ministry of Environment and Forests with State Forest Departments.	Indian Forest Act, 1927 (IFA) - Ban bamboo felling in private forests and transportation on private lands without permits/ licenses Forest Conservation Act, 1980.	• Require all states (by directive) to immediately amend existing State forest laws and rules to recognise Bamboo as a Minor Forest Produce and abolish Transit Pass requirements levied on the same. • **Establishing a fixed routes** along which Forest produce may be exported from Bamboo forests, **and adding single checkpoints** wherein Forest produce **must be checked for source and whether rights for felling exist.**
State Bamboo Missions (SBM's) or Bamboo Development Authorities	Coordination with State Level Handicraft promotion organisations to promote traditional handicraft product through State level ventures.	• **Leverage EPCH's Handicrafts Exhibitions and shows as well as expertise for Export Promotion in improving quality of Bamboo Handicrafts and for export promotion.** Eg: Tripura has been able to achieve success in this field through **coordination between the Tripura Bamboo Mission and PURBASHA,** its handicrafts promotion organization.
National Mission on Bamboo Applications	Establishment of B2B portals and popularising of existing portals such as indianbambooallinall. org in order to facilitate contact between individual sellers and develop vertical linkages in the industry	• The **B2B sites are the best means of facilitating contact between consumers and producers** of Bamboo products and intermediates. Governments can **popularise and incentivise the enlistment of local small-scale enterprises on these sites.** A pre-requisite to this is, of course, provision of electricity and internet access to Bamboo growing regions, which is limited in India today.
National Bamboo Mission, Ministry of Agriculture	Promotion of cooperative and commercial plantation based Bamboo farming, through collaboration with MoEF and financial institutions such as NABARD	• **NBM is envisioned as a nodal agency at the National level for all requirements of financial and other assistance required for the establishment and functioning of Plantations.** Framed with intent to develop a cooperative Farming sector leading to economies of scale due to productive size of landholdings suitable for intensive cropping, proven successful in China

as future bamboo furniture to meet latest urban taste follow

Table 7: Suggestion for policy improvising

7.8 Strategies

The awareness towards sustainability directly impact on product design and its development approaches. Which gradually leading to the new design sustainable design measures .The designers' link their design to their product users, who plays a key role in the analysis of products design (Charter & Tischner, 2001). However, as this thesis focuses on commercialization of bamboo furniture in India because of expected environmental sustainability concerns , studying the potential value of the bamboo as an material and evaluating its contribution to the socio-economic development, some niches is observed in markets due to the disconnection between the

users and the bamboo manufacturers which is not letting the bamboo market expand . Some strategies for demand and supply side that can alleviate the bamboo furniture market follows

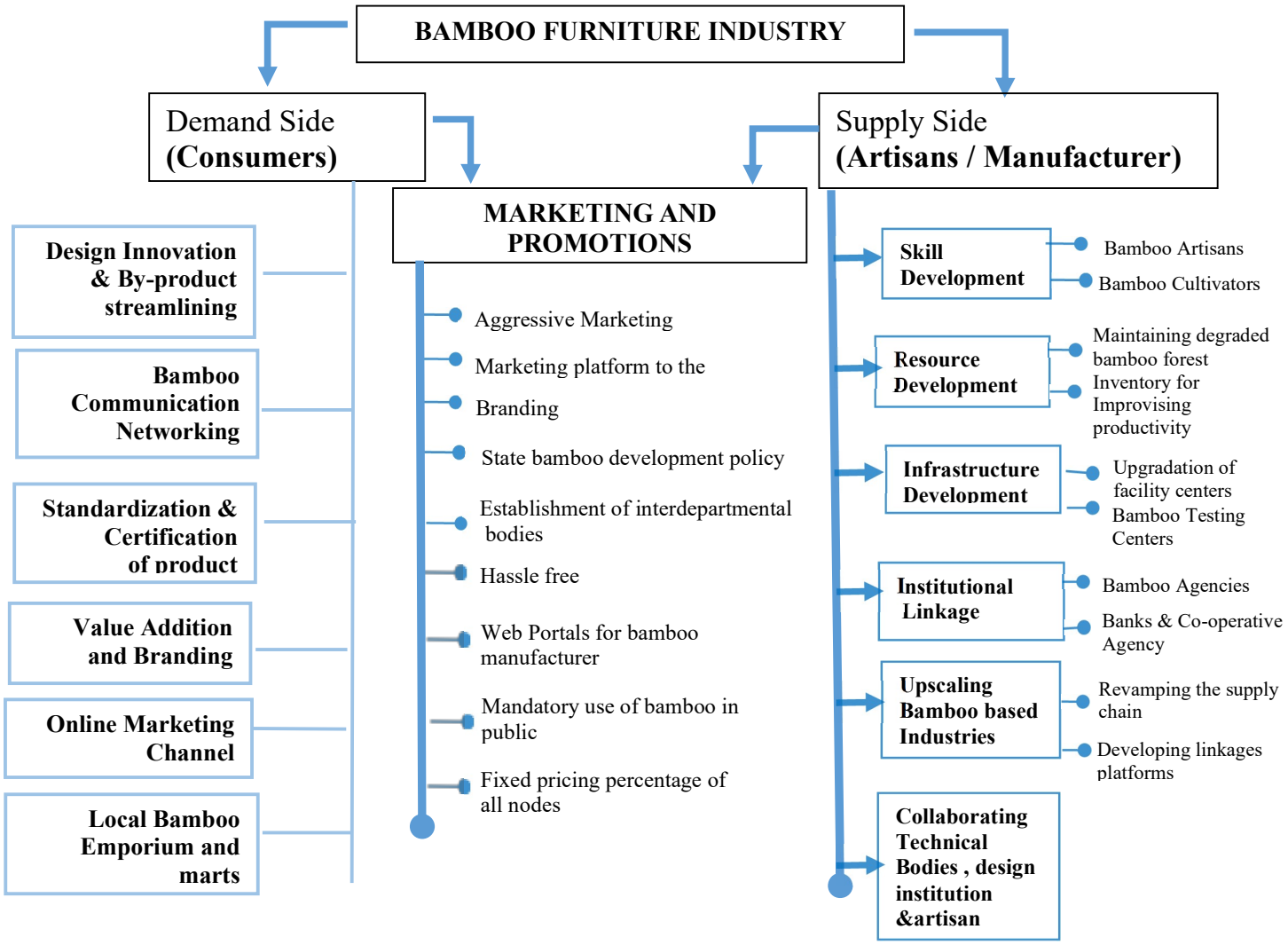


Figure 86 Strategies recommended for improvising design and commercialising bamboo furniture.
Source: Authors own adaptation

Training modules development for the rural artisans focusing on identify the **deficiencies of current practices can help them adopt newer technologies easily.** Studying the prototype model The potential market for bamboo furniture value chain in India seems weak. The study states that Indian bamboo furniture value chain has 2 critical missing nodes **dedicated designers and adequate promotions.** Additionally to bind the gap the industry needs some amendments and upgradation at consumers end and bamboo artisans / manufacturer end. The value chain in India has weak consumer centred design nodes and below strategies can string these nodes.

Design development directions needed in Bamboo Furniture

- Adequate development strategies for upscaling **:**

  The bamboo furniture principles design states on minimizing the consumption of energy and resources to curtail the burden on nature. Ascertaining the problems of sustainable design, bamboo furniture should be demonstrated as the ecological design strategy and should put forward as a resolution to the problems. The bamboo furniture promotion by forming retails outlets, mandatory usage percentage in government organisation with green star point rating should considered strategically. The life cycle design of bamboo furniture can be ascertained as a material of future. (Centre for Bamboo Initiatives at National Insitute of Design (NID), 2007).

- The design should be more individualized:

  The study result briefed that young to middle age group are the main stream furniture buyers , unifunctional furniture is becoming more and more difficult to meet the needs of modern people as these buyers look for multifunction designing. Hence the design of the bamboo furniture should break the traditional image and adapt users customization , taste and ergonomic. The design of the bamboo furniture should be individualized as per users.

- Adequate promotion and Marketing platform to the Artisans:

  Artisans need a marketing platform and skills development centre in urban and rural area . Establishing bamboo emporiums and marts can provide artisans and entrepreneurs a platform for showcasing their product and interacting with experts. Though bamboo furniture industry suffers from inability of the craftsmen to understand the changing markets or inaptitude in using internet. Some bamboo fairs also be organised regularly in urban centres such as Bhopal , Indore and New Delhi but still not only promotion of these fairs must be aggressively considered .

- Structured Marketing Policy:

  The existing marketing policy is like the bamboo furniture industry, they are unorganised and unstructured. The structured marketing policies need to aggressively facilitate in building linkages between bamboo production and output. These policy will help to bind the consumers and the artisans as well as help to create massive and consistent awareness about bamboo as an eco-friendly timber replacement material .The frequent seminars, workshops, training programmes needs to planned and operationalized with the help of national and local bodies like **NITI Avog and National bamboo Mission.** Upbringing this development will help in up

scaling the existing as well as future bamboo furniture to meet latest urban taste.

- State wise Bamboo development policy:

  The proposed measure need a significant remodelling as per state wise needs to increase the access to bamboo furniture for all .Involving the expansion of the states wise bamboo industry , the problem that arises is symptomatic of over-centralization.

  Each state and sector follows varied path of development, face different gaps and share different risk which cannot be addressed at common policy platform [47]. Proclaiming a common model cannot viably addressed the individual issues .There is a need of different policies , templates for cooperation to judge the success and failures and give a frame work of incentives and subsidies which can encourage the setting up bamboo enterprise .

- Adding certification and Branding Programme:

  With the growing digitalization now a day's people buy brand rather than product. Adding certification or branding helps in adding trust and connect with customers emotionally. By adding branding and labelling to bamboo furniture can add essential value factors inducing those buyers who look for branding and labelling and time of purchase .These approach can also induce international trades and buyers to invest and collaborate . Just by adding as certification or brand name help to give a Holistic approach to the sustainability.

- Skill oriented training :

  Furniture making itself is skill oriented crafts and when it comes to bamboo furniture its production, processing, utilization and marketing aspects needs a specialised skilled approach .The training modules development for the rural artisans focusing on identify the deficiencies of current practices can help them adopt newer technologies easily. The skilled training programmes needs to initiate by the locals NGO's , National Bamboo Mission, Institute of Forestry and Department of Forest Training Division to commercialize s bamboo furniture making them skilled towards modern working practices , modern tools and equipment's .

- Hassle free productions and Transportations:

  Transportation and hassle free connectivity is subsequently important not only for the promotion but for the distribution as well. As different aspects of "bamboo" are dealt by

[47]As per Harsh Shrivastava report the states have followed varied paths to development, proclaiming models of their own. But these have been limited to administrative initiatives and infrastructure improvement, and not presented a new imagination of governance itself .adapted from https://indiatogether.org/institutions-op-ed .

various Ministries/ Departments in Government of India leading to streamlining various obstacles such as transit passes, mandi taxes etc. [48]There is need to facilitates a pan-India bamboo permit, to eliminate the need for multiple permits for all bamboo species. The liberalization on the regulatory regimes encourages the farmers and other private individuals for cultivation of bamboo on non-forest land in the country.

- Tax control:

  The tax duty on import and export for bamboo raw materials and bamboo furniture should be subsidized to release the unwanted burdens imposed by government in transportation. The Bamboo Furniture comes under HS Codes which includes 94015100, 94039000, 94038100, 94036000 for which government levied 5%, 12%, 18% and 28% of GST on export duty depending upon HS Code. The implementation of GST and levying tax @ 5% on bamboo and 18% on bamboo and cane furniture, the local industry badly affecting the locals and their livelihood too.[49] Goods & Service Tax Council(GSTC) should initiate on exempting raw bamboo and reduce 12% tax bamboo and cane furniture.

- Craftsmen should encouraged and educated :

  Artisans and local craftsmen's should be promoted and moreover encouraged for creating creative bamboo furniture's in there homesteads . They should also be educated about commercial viable species and certification of bamboo products .The government should initiate the certification process to these artisans by collaborating with manufacturer and introducing website , mobile apps and web portals for promoting bamboo furniture among consumers .

[48] Though bamboo taxonomically a grass and was treated as tree by the Indian Forest Act, 1927. This act was leading the transit permit of bamboo grown even outside the forests. The Amendment in Indian Forest ordinance, 2017 promulgated on 23.11.2017 amended the section 2(7) of the Indian Forest Act, 1927 omitting the word "bamboos" from the definition of tree. This has encourage bamboo cultivation in non-forest land and removed the restriction on felling and transport of bamboo not grown inside . But still huge mandi taxes and duties are imposed on the local producers and distributors . Adapted from https://www.downtoearth.org.in/news/forests/pan-india-transit-permit-for-bamboo-soon-59870

[49] As per https://arunachalobserver.org/2017/11/11/bamboo-cane-furniture-gst-rate-slashed-18-12/ report bamboo cultivation reduces the pressure on timber and if bamboo and cane industry is not patronized then illegal deforestation will increase as wooden furniture also attracts 18% GST

Studying all the parameter it is observed that design is one of the possible variables that are affecting the commercialization. The Indian buyers when comes to furniture looks for minimalistic yet multifunctional designing. The users preference based prototype chair design is also significantly accepted by the users with some minor swap, which states that momentous implementation of user's preference can induce the interest. The strategically approach towards innovative design ,aligning to users 'personalized' interest can emerge Indian bamboo furniture globally .

7.9 Study limitation

As every study impacted with some constraints , this research study also came up with some potential limitations . Though the effects are estimated on the basis of observational studies and the study initiated in two parts involving users and manufacturers . As the research was based on understanding bamboo furniture industry some subjects were remotely located and it was difficult to get connected to them for face to face interaction While conducting the study another major obstacles was collecting data which was difficult due to region specific language and it's become difficult to communicate to the local artisans in local regional language as they were not literate to understand basic terminology .Moreover identifying bamboo artisans in metropolitan region was also difficult footstep as most of the artisans were not specifically working on bamboo, they were generally profound using bamboo , cane , rattan and wicker .Though initially it was conceptualised to go for an online survey but some respondents were not enough educated to understand the basic questions posted to them so the face to face interaction was further conducted which was primarily time consuming and exorbitant. While surveying the users some repose was observed influenced due to unawareness about the material .

7.10 Future Research

The insights of this study has drawn the attention to the future research on initiating designing residential furniture based upon the users preference from engineered bamboo such laminated bamboo, reconstituted densified bamboo, and bamboo boards and further analysing it life cycle cost analysis and payback period in comparison to wood to give Indian buyers who are looking upon the residential furniture a new viable alternative to engineered wood at cost effective pricing

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Appendix-01. Questionnaire for Field study of furniture end users

Study on commercialization Bamboo furniture industry in India and impact of Design based Intervention

1. Gender *

Mark only one oval.

- ◯ Male
- ◯ Female

2. State / Region *

_____

3. Age *

Mark only one oval.

- ◯ 18 - 29 years
- ◯ 30 - 39 years
- ◯ 40 - 49 years
- ◯ 50 - 59 years
- ◯ More than 60 years

4. Qualification *

Mark only one oval.

- ◯ Diploma
- ◯ Graduate
- ◯ Post Graduate
- ◯ Other: _____

5. Employment type *

Mark only one oval.

- ◯ Full Time
- ◯ Part-Time
- ◯ Not employed

6. Marital Status *

Mark only one oval.

- ◯ Married
- ◯ Unmarried
- ◯ Divorced

7. Department *

Mark only one oval.

- ◯ Hospitality
- ◯ Human resource
- ◯ Sales and Marketing
- ◯ Finance
- ◯ Engineering
- ◯ Academics
- ◯ House wife
- ◯ Govt. sector
- ◯ Others

8. Family Type *

Mark only one oval.

- ◯ Joint
- ◯ Nuclear

9. Income level (per month) *

Mark only one oval.

- ◯ Less than Rs. 25000
- ◯ Rs. 25000 - Rs. 50000
- ◯ Rs. 50000 - Rs. 75000
- ◯ Rs. 75000 - Rs. 100000
- ◯ Rs. 100000 and above

Part B: Analysing the reasons for bamboo not being used as a furniture material

On a scale of 1-5, please indicate the degree to which you agree to the statements given below based on your experience. (1=Strongly Disagree, 2=Disagree, 3= Neither Agree nor Disagree, 4= Agree, 5=Strongly Agree)

What are the reasons you consider for bamboo not being adopted for furniture making instead of wood in Indian urban market .

	1	2	3	4	5
Bamboo furniture needs to incorporate intricate designer details.	◯	◯	◯	◯	◯
Quality of bamboo furniture is low in comparison to wood furniture.	◯	◯	◯	◯	◯
Do you think bamboo furniture is highly susceptible to fire in comparison to wood?	◯	◯	◯	◯	◯
Bamboo furniture need high maintenance and can invite termite infestation.	◯	◯	◯	◯	◯
Bamboo furniture are more expensive to than wood furniture.	◯	◯	◯	◯	◯
Bamboo furniture lacks in design in comparison to the word furniture.	◯	◯	◯	◯	◯
It gives a feeling of traditional style of interior.	◯	◯	◯	◯	◯
Is bamboo difficult to maintain in comparison to wood furniture?	◯	◯	◯	◯	◯
Engineered bamboo furniture is not easily available like engineered wood.	◯	◯	◯	◯	◯

10. What are the factors that you consider while looking for furniture? *

Mark only one oval.

- ◯ Heavy Discounts
- ◯ Aesthetically pleasing
- ◯ Home delivery
- ◯ Eco-Friendliness
- ◯ Modern and Intricate Design
- ◯ Branding from renowned furniture's brands
- ◯ Local availability

11. Does bamboo furniture fit all these factors considered by you while purchasing furniture? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

12. What is your perception towards using bamboo for making furniture? *

Mark only one oval.

- ◯ Cheap
- ◯ Non-durable
- ◯ Coarse
- ◯ Bulky
- ◯ Traditional
- ◯ Not easily available.

Part C: Assessing the factors causing low commercialization of the bamboo furniture's in India

On a scale of 1-5, please indicate the degree to which you agree to the statements given below based on your experience. (1=Strongly Disagree, 2=Disagree, 3= Neither Agree nor Disagree, 4= Agree, 5=Strongly Agree)

On basis of your perception and knowledge what factor are causing to the low commercialization and adoption * of Bamboo furniture among Indian buyers

	1	2	3	4	5
Bamboo Furniture is minimalistic.	◯	◯	◯	◯	◯
It lacks colour choice.	◯	◯	◯	◯	◯
It lacks fine finishing as compared to wooden furniture.	◯	◯	◯	◯	◯
Bamboo furniture does not give a modern appearance.	◯	◯	◯	◯	◯
Adding bamboo as furniture material can perceive in promoting environmental friendliness	◯	◯	◯	◯	◯
Available bamboo furniture is not durable	◯	◯	◯	◯	◯
Not aware about the benefits of utilising bamboo furniture	◯	◯	◯	◯	◯
Bamboo is an poor men's timber and cannot be place in modern furniture market	◯	◯	◯	◯	◯
Bamboo furniture doesn't not have better outlets for promotions	◯	◯	◯	◯	◯
Adding branding is important for bamboo furniture?	◯	◯	◯	◯	◯
Engineered bamboo manufacturing unit can help in promoting bamboo as an wood alternative.	◯	◯	◯	◯	◯
Furniture should be easy to assemble and dissemble	◯	◯	◯	◯	◯
Focus needed on product design and flexibility while selecting furniture.	◯	◯	◯	◯	◯
The design of bamboo furniture available in the market is outdated and archaic in comparison to wood.	◯	◯	◯	◯	◯

Which distributions

15. What is your perception on the causes that why bamboo is not being commercialized in Indian urban market? *

Mark only one oval.

- ◯ Lack of modern design
- ◯ Lack of branding and certification
- ◯ Lack of finishing
- ◯ Lack of colours, patterns and texture
- ◯ Lack of intricate design
- ◯ Too minimalistic
- ◯ Lack of awareness amongst consumers
- ◯ Non-availability of raw material

Measures you consider may be adopted to increase the commercialization of bamboo furniture? On a * scale of 1-5, please indicate the degree to which you agree that if the following inventive steps can help in promoting bamboo furniture (1=Strongly Disagree, 2=Disagree, 3= Neither Agree nor Disagree, 4= Agree, 5=Strongly Agree)

	1	2	3	4	5
Heavy discounts on furniture stock	◯	◯	◯	◯	◯
Easy assembly with home delivery	◯	◯	◯	◯	◯
Bamboo workshops and skill centres for craftsmen and carpenters	◯	◯	◯	◯	◯
Involvement of designers to create better designs	◯	◯	◯	◯	◯
Organising bamboo fairs and exhibitions	◯	◯	◯	◯	◯
Inclusion of bamboo in design and architecture curriculum	◯	◯	◯	◯	◯
Easy accessibility of warehouse for artisans and craftsmen	◯	◯	◯	◯	◯
Bamboo furniture standardization and certifications	◯	◯	◯	◯	◯
Increasing online promotion and sales of bamboo furniture	◯	◯	◯	◯	◯
Encouraging the public sector to purchase bamboo furniture	◯	◯	◯	◯	◯

17. From where do you prefer to buy your furniture? *

Mark only one oval.

- ◯ From a local craftsmen or carpenter
- ◯ Showrooms with good branding and design
- ◯ Designer showrooms of foreign brands
- ◯ Local furniture shops selling affordable products
- ◯ Online store (Pepperfry, Urbanladder, Fabfurnish etc)

Part D: Design Interventions

On a scale of 1-5,please indicate the degree to which you agree to purchase bamboo furniture based on the following design interventions. (1=Strongly Disagree, 2=Disagree, 3= Neither Agree nor Disagree, 4= Agree, 5=Strongly Agree)

Which major Interventions that you considered should incorporated in designing for increasing commercialization and acceptance.

	1	2	3	4	5
It can be easily assembled and serves multiple functions.	◯	◯	◯	◯	◯
It have a contemporary and modern design.	◯	◯	◯	◯	◯
It is lightweight.	◯	◯	◯	◯	◯
It ensures durability.	◯	◯	◯	◯	◯
It is termite and moth free.	◯	◯	◯	◯	◯
It is more aesthetically pleasing than PVC or wood.	◯	◯	◯	◯	◯
It is polished and finished in a better manner.	◯	◯	◯	◯	◯
It can be customised according to personal taste and space.	◯	◯	◯	◯	◯
It is easily available in local furniture shops	◯	◯	◯	◯	◯
Bamboo artisans locally available for repair and maintenance.	◯	◯	◯	◯	◯

19. Does bamboo furniture have the ability to incorporate all these above design interventions? *

Mark only one oval.

◯ Yes
◯ No
◯ Maybe

20. What can be the measure inventive steps that can be introduced to promote design intervention in bamboo furniture for commercializing it among Indian Buyers (On a scale of 1-5, please indicate the degree to which you agree that if the following inventive steps (1=Strongly Disagree, 2=Disagree, 3= Neither Agree nor Disagree, 4= Agree, 5=Strongly Agree)

Mark only one oval per row.

Mark only one oval per row.

	1	2	3	4	5
Encouraging designers for innovative designs using bamboo	◯	◯	◯	◯	◯
Online platform to facilitate dialogue between different bamboo stakeholders	◯	◯	◯	◯	◯
Showcasing bamboo as an integrated lifestyle solution	◯	◯	◯	◯	◯
Information repository on bamboo	◯	◯	◯	◯	◯
Technical training centres	◯	◯	◯	◯	◯
Introducing bamboo in architecture and interior course curriculum	◯	◯	◯	◯	◯

Appendix-02. Questionnaire for field study bamboo artisans/manufacturer

The major goal of this questionnaire is to collect important information from artisans and manufacturers wi to bamboo furniture. The questionnaire provided below is chosen as a data collection instrument for the res project named "Study on commercialising Bamboo furniture industry in India" The primary goal of this quest is to gather artisans and manufacturers opinions on factors that impact the commercialisation of the Bamb furniture industry in India. As a result, responders are asked to pay close attention to all of the questions. Pl assured that the information gathered from this questionnaire will be used solely for research purposes and kept strictly secret.

1. Name *

_____

2. State/ Region *

_____

3. Age *

Mark only one oval.

- ◯ 0 - 20 years
- ◯ 21 - 30 years
- ◯ 31 - 40 years
- ◯ 41 - 60 years
- ◯ 61 years and above

4. Education *

Mark only one oval.

- ◯ Up to Class 4
- ◯ Class 5-8
- ◯ Higher Secondary
- ◯ Graduate and above

5. How wages are paid to workers? *

Mark only one oval.

- ◯ Daily wages
- ◯ Weekly basis
- ◯ Monthly basis
- ◯ Target basis
- ◯ Others (specify) _____

6. Monthly income *

Mark only one oval.

- ◯ Less than Rs. 5,000
- ◯ Rs. 5,000 - Rs. 10,000
- ◯ Rs. 10,000 - Rs. 15,000
- ◯ Above Rs. 15,000

7. Are you traditionally into this industry? *

Mark only one oval.

- ◯ Yes
- ◯ No

8. How many years of experience do you hold in the bamboo industry? *

Mark only one oval.

- ◯ Up to 5 years
- ◯ 6 - 10 years
- ◯ 11 - 15 years
- ◯ 16 - 20 years
- ◯ More than 20 years

9. Where do you sell your bamboo products/furniture? *

Mark only one oval.

- ◯ Local Market
- ◯ Urban Market
- ◯ Online
- ◯ All of above

Part B: Bamboo Furniture's Commercialisation

Based on experience, outline the extent to which you agree or disagree with the statements below. (SD = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree)

What are the major prospectus and constraint as per your experience bamboo industry is facing or the area that are need to be improvised for commercializing bamboo furniture in India

10. Who all are the customers for your bamboo products/ furniture? *

Mark only one oval.

- ◯ Locals
- ◯ Traders
- ◯ Exporters
- ◯ Government agencies
- ◯ Branded furniture chain
- ◯ Urban Indian market
- ◯ Foreign consumers

11. Which of the following species of bamboo do you use for making furniture? *

Mark only one oval.

- ◯ Bhaluka,Boro bans, Wamna, Beru, Barak –Bambusa Balcooa
- ◯ Kotoha, Illi mula, Kanta bans,Mungil ,Mullu- Bambusa Bambos
- ◯ Bengal Bamboo, Jati Bahn, Mritinga , spineless Indian bamboo- Bambusa Tulda
- ◯ Tama Bamboo /Bans- Dandrocalamus hamiltonii
- ◯ Lathi mula ,Kanak kainch - Thyrsostachys oliveri
- ◯ Lathi Bans,Kanka kara,SandapaVedru,Karal,Kallan mula-Dendrocalamus hamiltonii
- ◯ Others (Please specify)_____

12. Does your setup / industries face competition from large established units? *

Mark only one oval.

- ◯ Yes
- ◯ No

13. Are you aware of the government schemes supporting bamboo products /furniture production and manufacturing? *

Mark only one oval.

- ◯ Yes
- ◯ No

14. Have you gone under any skill development programme to make bamboo products and f

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ If Yes, please specify _____

15. Which financial sources do you use for funding the bamboo furniture business? *

Mark only one oval.

- ◯ Loan from Co-operative banks / Societies
- ◯ Loan from Commercial Banks
- ◯ Borrow from moneylenders & relatives
- ◯ Self-financing
- ◯ Government Grant / Subsidy

16. Does your bamboo setup/ industries face involvement of intermediaries (Dalal)? *

Mark only one oval.

- ◯ Yes
- ◯ No

17. Is it necessary to take licenses for bamboo furniture transportation? *

Mark only one oval.

- ◯ Yes
- ◯ No

18. Statements *

Mark only one oval per row.

	SD	D	N	A	SA
The government has made significant efforts for advancing the bamboo furniture industry.					
The government provides incentives and subsidies for undertaking entrepreneurship in the bamboo industry.					
Do you think government policy on bamboo transportation sales and promotion needs improvements.					
Do you need proper road networking and transporting for bamboo products and raw material?					
One can easily avail of loans from the banks and other regulated financial institutions for funding their bamboo furniture business.					
There is an adequate storage facility available for the storage of raw bamboo.					
There are sufficient promotional measures needed for promoting bamboo furniture.					
Direct markets, traders, newspapers and digital platform keeps you updated about bamboo furniture industry.					
For increasing the sales of bamboo furniture and products, pertinent investment in advertisements is done.					
The adequate bamboo species for raw material to bamboo furniture and products is easily available in the market.					
There is a lack of skilled artisans that can produce bamboo products and furniture.					
Bamboo furniture /product artisans need better technological developments and training for producing better designs.					
The bamboo furniture and product making work is not just seasonal, instead, it is year-round.					
Storing finished bamboo products and furniture is easy.					
International fairs, exhibitions and digital marketing can be an innovative steps to promote bamboo furniture					
Skill development and Training programmes is needed in your area to promote bamboo					

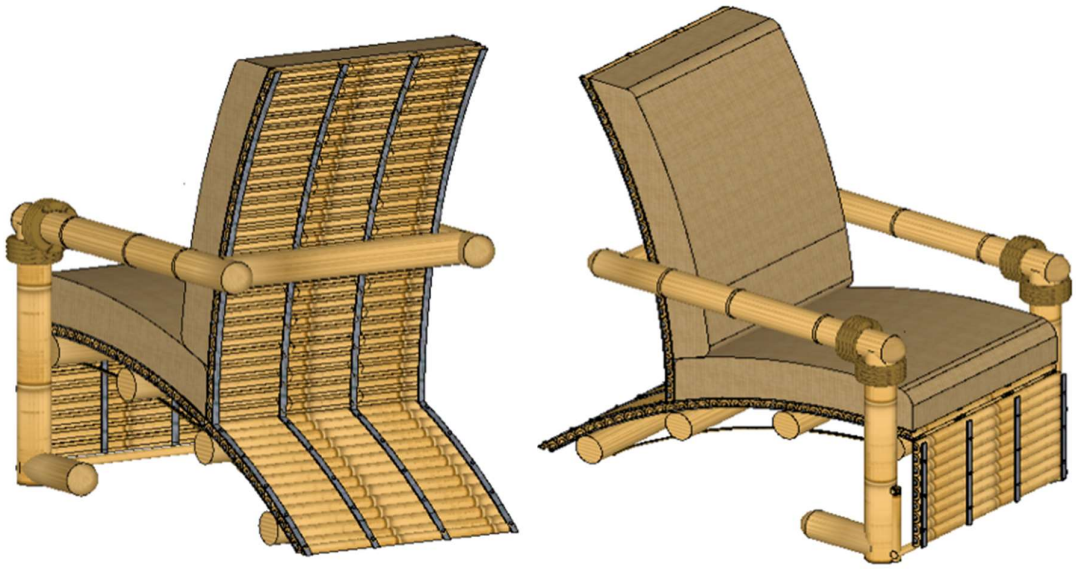
APPENDIX-03:Questionnaire for Prototype Evaluation

1. **Name …….**

2. **Gender**
   Male
   Female

3. **Age**
   18 - 29 years
   30 - 39 years
   40 - 49 years
   50 - 59 years
   More than 60 years

4. **Evaluating the model as**
   Consumers
   Manufacturer
   Designers
   Industry experts



Questionnaire for prototype evaluation	
To understand user perception and perspectives on bamboo furniture and what are the varied factors that affect these decisions. The statements are framed keeping user perception in mind and the participants are requested to indicate. Please select any one from below considering your preference and assessment.	
How do you mark the stability of chair design .(Select any one)	**Mark**
• It has High hardness	
• It has Flexibility and elasticity	
• It seems hard	
• I believe it is strong & sturdy	
• It has Dimensional stability	

• I think it will face difficulty in shaping	
• It seems bulky	
• Difficult to Repair	
How you mark the chair design economically .(Select any one)	
• Pocket Friendly	
• Transport cost little more because of inadequate road conditions and remote availability	
How you consider the model for environment. .(Select any one)	
• Eco- friendly	
• Manual Processing	
How do you consider the design of chair design .(Select any one)	
• It looks multi-Functional and satisfy my needs	
• Looks Comfortable and trendy	
• It is not Local available	
• It is easy to Assemble and Di-assemble	
How do consider the basic Processing and finishing chair as per design	
• Good processability with existing wood working machines	
• Unawareness towards details	
• Poor adhesion of lacquer and paints on outside layer	
• Vulnerability for splintering during processing	
How you mark its market acceptability	
• High potential of market acceptability	
• Moderate acceptability	
• No acceptability as it do not the needs	

Please add additional comments or improvement you suggest in space provided below

……
……
……

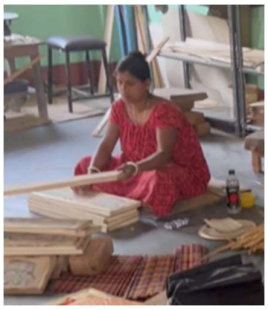
APPENDIX-04. Surveyed Bamboo Artisans and Manufacturer

Badal Debnath
Bamboo Furniture & Products Manufacturer
Tripura (Agartala)

Chandan Dey
Bamboo Manufacturer
Tripura (Agartala)

Shaymoli Deb Verma
Bamboo Artisan /Trainer (Purbasha)
Tripura (Agartala)

Bijoy Krishan Pal
Bamboo Growers /Trader
Tripura (Agartala)



Ranu Pegu
Bamboo Artisan
Tripura (Agartala)

Md.Tebullah Khan
Ph:9954896558
Bamboo Artsian
Assam

Sumeet Debnath
Modern Handicraft Bamboo Products Manufacturer
Tripura (Agartala)

Biswamati Payeng
Bamboo Artisan
Tripura (Agartala)

Debashish Khound
Ph:7002783861
Bamboo Artisan
Assam

Upen Pathak
Ph: 8474840541
Bamboo Artisan
Assam

Bishnu Jyoti Barua
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Bamboo Artisan
Assam

M.Lokendra Singh
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Bamboo Artisan
Manipur

Babul Rai
Ph:8474840541
Bamboo Artisan
Manipur

Asim Upen
Ph: 9366801567
Bamboo Artisan
Manipur

Pradeep Das
Ph:7637040630
Bamboo Artisan
Assam

Ashwin Das
Ph:9957946753
Bamboo Artisan
Assam

Appendix-05. List of Publications, Conferences and Patent

S. No.	Title of paper with author names	Name of journal / conference	Published date	ISSN no/ vol no, issue no	Indexing in Scopus/ Web of Science/UGC-CARE list
1.	Bamboo Infoline in Himachal Pradesh- Analysing The Current Status of Furniture Industry and Artisans Authors: Priyanka Shukla Dr. Mahendra Joshi	Global Emerging Innovation Summit-2021 by LPU	April,2021		Conference presentation
		Benatham Books (Dr. Dharam Buddhi)	November ,2021	ISSN 9781681089027	Scopus
2.	* Study Of Consumers Perception Towards Bamboo Furniture In India . Authors**:** Priyanka Shukla Dr. Mahendra Joshi	International Conference on Materials for Emerging Technologies (ICMET-21)	22-09-2022		Conference presentation
3.	Social, Environmental And Economic Impact Of Promoting Bamboo Furniture Industry In India. Authors: Priyanka Shukla Dr. Mahendra Joshi	Journal of Bamboo and Rattan, Kerala Forest Research Institute. Vol. 19, Nos. 2, pp. 27 - 37	Accepted:October,2020 Published :May , 2021	ISSN : 15691594	Web of Science
4	Literature Review On The Bamboo As A Sustainable Material For Interiors With Its Potential And Market Assessment Authors: Priyanka Shukla Dr. Mahendra Joshi	Journal of Emerging Technologies and Innovative Research Volume 7,pp. 317-322	August, 2020	ISSN : 2349-5162.	UGC CARE - II
5	Empirical Study on Indian Bamboo furniture industry and the urban furniture consumers perception Authors**:** Priyanka Shukla Dr. Mahendra Joshi	Journal of Harbin Engineering University Volume 4, No7. 2341-2352	August, 2023	ISSN : 1006-7043	Scopus

6	**A Sustainable and comfortable Bamboo Chair **(Patent)**	**Patent Number : IN202211029295**	27.05.2022		
7	***Eco-friendly bamboo refrigerator "Bambcool" **(Patent)**	**Patent Number : IN202211029295**			

*Paper presented in Conference, Certificate attached and further publication is under process.

** Published patent