B.Tech.- Project
on
Revenue Management- part1
Subscription on bamboo products
(Project Code : I6)

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Abstract

Bamboo is commonly considered as a green and environmentally friendly material. It seems that the use of bamboo as green building materials in the Indian construction industry is quite limited. This paper gives an examination of the hurdles preventing the successful use of bamboo products and explains the advantages of using them in order to explain this occurrence and encourage the use of the products.There are fifteen distinctive barriers that have been observed, such as government departments working ineffectively. The categorization of barriers from a driving-driven perspective is conducted using the Cross-impact Matrix Multiplication Applied to Classification method, and study on the hierarchy structure among characteristic barriers is performed using the interpretive structural modeling approach. Comparing this categorization to more conventional barrier analysis techniques, it offers a distinct pattern for the typical barriers. The findings result in helpful resources for policy makers and practitioners to use as they establish successful policies and methods to encourage the use of bamboo products.

We present solutions in areas such as Communication, Customer Relationship Management, Product, and Organizational Strategy, in order to improve the subscription model retention rates and overall results. For that the subscription model should consider delivering a more personalized service and content to its customers, run a stronger email marketing strategy, rethink its portfolio, and share the subscription model values and mission with its community.

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Introduction

1.1 Background/Motivation

Bamboo is a typical green material that is quick to grow, light in weight, strong, and safe for the environment. It is a very adaptable material with various applications, including building, clothing, food, and fuel. It is a high-growing, renewable grass that is sustainable, has good mechanical properties, and has the potential to replace plastic-based furniture. In India bamboo has 136 species in which few are commercially significant. Nearly 39% of all bamboo is grown in the NorthEast Region, while Madhya Pradesh has the largest area devoted to bamboo farming. Indian companies that produce high-quality bamboo goods include Kerala State Bamboo Corporation, Mutha Industries Beco, The Bamboo Bae, Codesustain, and Madake. These companies made products of bamboo like Hairbrush, toothbrush, Pen, Earbuds, tea cups, straw, bottle, Hat, Bamboo Speakers, Baskets etc.

1.2 Introduction to the problem being addressed in the project

We aim to solve the following question with this project: How to Improve Customer Retention and Lifetime Value on Subscription-Based Models? For this, we conducted a survey on the market's subscription service for bamboo items. We were able to get meaningful data from the poll regarding customer turnover, motives, and real-time value. In addition, we held a focus group session in order to make more accurate recommendations based on relevant feedback from customers' perspectives.

Subscription-based models have grown in relevance and presence in customers' daily routines, thus we see this business model as a potential for various brands to enter a new subscription market. With a new perspective on customer-centric tactics and a disruptive approach to ownership. These new business models are measures that companies must consider when evaluating their strategy and customers, such as retention, churn, and customer lifetime value.

Following the poll, we will conduct a literature study on subjects relevant to our final results and recommendations for bamboo goods. Our review will cover the following themes. - Subscription-based Model; Subscription Models for Future Generations, Shared Economy, and Access-based Products; Green Products and Green Consumption; Customer Relationship Management and Customer LifeTime Value; Retention, Churn Rate, and Acquisition Costs; Customer-centric Strategy; and Storytelling as an Engagement Strategy.

We will be able to understand the key retention challenges using the survey data, as well as learn about the bamboo products consumers' purchasing characteristics. Later, we combine

this information with the insights gleaned from the focus group session to identify certain commonalities in customer behavior on which we will base our final suggestions.
The Problems we address in our project have some technology related problems, transformation problems, financial and marketing problems, production system problems and manufacturing problems.

- Technology related problemsare poor adhesives, less reliable in connection, requirement for preservation, poor durability, difficulty in quality control, highly susceptible to fire , requirement for preservation etc.
- Transformation related problems are poor quality of bamboo supply, low volumes of bamboo supply, lack of availability of trained labors, lack of access to input in production, fragmentation of industry etc.
- Financial and marketing related problems are improper distribution of subsidy, shorter period of repayment of loan, insufficient amount of loan, unable to pay the borrow capital, etc.
- Production system based problems are inconsistencies in legislation and regulation ,volatility in market prices, low interest in commercial modeling etc.

1.3 Overview of the thesis

This project aims to study the motive and barrier of subscription on bamboo based products, bamboo products and their Pricing .How subscription-based business models can improve their retention and customers lifetime value.

We developed a survey to understand the market scenario of items made of bamboo and user opinions on them in order to develop an effective strategy.We will be able to determine the need for Bamboo products, certain critical stages of retention and consumption patterns, and insightful information about consumer behaviors and buy profiles from the survey results. Understanding the point at which a customer churns, the reasons behind this decision, and how the subscription model can increase a customer's lifetime value were some of the crucial concerns that needed to be addressed.

We offer solutions to boost subscription model retention rates and overall performance in areas including communication, customer relationship management, product development, and organizational strategy. In order to do this, the subscription model should think about providing its users with more individualized services and information, implementing a more effective email marketing plan, reevaluating its portfolio, and communicating its values and mission to its community.

Literature Survey

2.1 Barriers

It's essential to understand the use of bamboo products for eco-friendly in order to promote its application.We have mainly classified into 6 category such as Technology ,Transformation Financial & Marketing barrier ,Production system barrier ,Manufacturing and Policy related barrier.Theoretical and practical studies on bamboo materials confronted technology-related barriers, such as mechanical strength and durability. Application-related barriers were issues that businesses or industries faced in the real world, such as a lack of industrialization in the manufacturing process, high material costs, and a shortage of skilled workers. Policy measures or procedures, such as incentive programmes, that encouraged or restricted growth of the bamboo sector were referred to as "policy-related barriers.
Details of these barriers are listed in Table 2.

Table 1: Barriers affecting the bamboo products

Category	Barrier	Category	Barrier
Technology Related	• Requirement for preservation • Poor durability • Difficulty in quality control • Highly susceptible to fire • Inadequate bamboo processing techniques • No software to assist analysis and design	Production System	• Inconsistencies in Legislation and Regulation • Lack of attention to variety Management Volatility in Market Prices • Low Interest in commercial forestry • Lack of Market information • Insufficient baseline data
Transformation	• Poor Quality of Bamboo Supplied • Low volumes of Bamboo supply • Lack of availability of trained labours • Lack of access to input in production	Manufacturing	• Less availability of labour • Increasing labour charges • Increasing input cost • Change in natural condition
Financial and Marketing	• Improper sanction of loan • Unable to pay the borrowed capital • Price is not proportionate with cost of cultivation • Underdeveloped market • Poor quality perception • Lack of Awareness	Policy Related barrier	• Lack of code of practice in the bamboo industry • Lack of incentive policy • No mechanism for technology transfer • No certification mechanism for bamboo materials

2.2 Motives

This plant, which has the quickest rate of growth in the whole globe, is beneficial to the environment and very helpful to those who wish to purchase high-quality goods. Despite being occasionally mistaken for a tree, bamboo is essentially a grass. Nothing could be further from the truth. This may seem like a crude material to utilize for objects like bowls and cutting boards.

The benefit can be classified into five categories:

1. low-cost: It is generally appreciated that the cost of the raw bamboo products is low.
2. large-scale and fast growth : Public acceptance of bamboo harvesting is higher than that of wood harvesting. Bamboo is a typical renewable and green material due to its vast volume and quick development.
3. lightweight and high strength: In some circumstances, bamboo is more tensile and flexible than steel. This is an alternate and renewable material since it is lightweight and strong.
4. environmentally friendly : Not only do bamboo materials lessen the strain on non-renewable construction materials that are running out, but they also help save energy, cut CO2 emissions, and boost carbon storage.
5. social benefit: The use of bamboo can boost employment options for local workers and their earnings.

Table 2 : Benefits of bamboo products

Category	Benefits
Product system and Manufacturing	● Fast growth in raw materials ● Higher mechanical strength ● Less Energy use in production system ● Economical advantage because of shorter rotation ● Consumption of CO2 and release of oxygen ● Pliable, lightweight, excellent tensile strength ● Low cost ● Renewable and Biodegradable ● Sequestering carbon ● Low embodied energy ● Creating less pollution in production ● Good resistance against bending ● Durable and easy to use in its natural state with less processes ● Easy to obtain ● Simple technical knowledge required ● Good strength ● Beautiful in its appearance Multiple uses in ● Building construction

Table :3 Characteristic barriers restricting the bamboo application in India Sector

S.no	Representative Barriers	Barriers
1.	• B1	• Durability
2.	• B2	• Knowledge about bamboo application
3.	• B3	• Industrialization for production
4.	• B4	• Ineffective action by government departments
5.	• B5	• Standards and specifications
6.	• B6	• Enterprise participation
7.	• B7	• Research and development (R&D)
8.	• B8	• Production Costs
9.	• B9	• Education
10.	• B10	• Traditional bias against bamboo application
11.	• B11	• Limited market for bamboo application
12.	• B12	• Certification mechanism for bamboo materials
13.	• B13	• Code of practice in bamboo industry
14.	• B14	• Incentive policy
15.	• B15	• Technology transfer mechanism

2.3 Adoption Barrier & their application

Durability (B1):

The main consideration for bamboo utilization, particularly in structural construction, is its durability. Untreated moth, rust, and mildew are frequent threats to bamboo materials, which compromises the materials' mechanical qualities. As a result, the material is frequently thought to have low durability.

Knowledge about bamboo application (B2) :

It seems that information about bamboo uses was dispersed. The design, building, and upkeep of using bamboo were not governed by any organised theory or process. For bamboo building upkeep, there was no efficient approach.

Industrialization for production (B3):

The cost of production is quite expensive because there is currently no industry for processing bamboo resources. It is widely acknowledged that industrialisation may assist increase product quality, lower production costs, eliminate waste in building, and expedite the construction process.

Ineffective action by government departments (B4) :

The encouragement of the use of bamboo materials should be heavily influenced by government policy, particularly in the early stages of promotion. government agencies didn't promote people enough.

Standards and specifications (B5) :

If there are appropriate norms and requirements, the quality of bamboo application will be safeguarded. The prerequisites for the widespread use of bamboo were the norms and requirements. The lack of norms and requirements helps to grow clients' lack of trust in bamboo use.

Enterprise participation (B6):

In India, there are incredibly few businesses that are involved in the bamboo material market. A few businesses saw the potential market for bamboo products and began to prepare their entry into the sector, but there were relatively few of them. Lack of business engagement results in a sluggish market, and businesses won't be drawn to technical progress.

Research and development (R&D) (B7) :

One of the challenges to increasing the effectiveness of bamboo manufacturing is a lack of thorough research and development (R&D). The quality of bamboo materials can be improved, labour costs can be decreased, and manufacturing efficiency can be increased using R&D in technical equipment and procedures. The range of bamboo's applications is expandable.

Production Costs (B8):

Since bamboo grows fast, raw bamboo products are more affordable than other materials. The labor-intensive nature of processing raw bamboo material including cutting, transporting, processing, and building means that bamboo products lose their economic advantage. As a result, bamboo production suffers from low efficiency and high labour expenses.

Education (B9):

There are no programs offered to instruct architects, engineers, or craftspeople in the use of bamboo. In India, there is a little market for bamboo products, and neither colleges nor universities nor vocational training centers offer pertinent instruction. There weren't many people working on bamboo building projects.

Traditional bias against bamboo application (B10) :

According to conventional thinking, bamboo materials are mostly utilised in economically underdeveloped regions to build simple housing for the local populace. The materials are often processed simply, which lowers their cost but gives them a poorer durability.

Limited market for bamboo application (B11) :

There are few consumers of bamboo products in the building industry. Customers are mostly unaware of the advantages of bamboo houses since the material receives little attention. However, due to their insufficient understanding of the materials, designers frequently do not recommend bamboo as a building material.

Certification mechanism for bamboo materials (B12) :

A method of attesting that a certain kind of product or material complies with quality standards is certification. For items made of bamboo material, there aren't any pertinent certification criteria in India yet. Despite the fact that bamboo is frequently cited as a green building material.

Code of practice in bamboo industry (B13) :

A typical code of conduct in the construction industry includes sanctions against businesses that violate accepted business procedures as well as restrictions on unethical or unlawful market conduct. In India, there is no such code of conduct regarding the use of bamboo.

Incentive Policy (B14):

It is crucial for the government to implement various incentive programmes designed to motivate businesses to engage in the bamboo material industry. Because of the tight government requirements, the protracted payback periods for subsidies and tax refunds, and the low tax refund rate, a small number of businesses viewed such incentive measures as useful.

Technology transfer mechanism (B15):

One of the most straightforward and efficient ways to encourage economic development through the use of cutting-edge technologies is technology transfer. The transfer or dissemination of technology from its original locations to a larger distribution among additional consumers constitutes this process.

Methodology

3.1 STRUCTURAL SELF-INTERACTION MATRIX (SSIM)

For analyzing the criteria a contextual relationship of "leads to" is chosen here. For developing contextual relationships among variables, expert opinions based on management techniques such as brainstorming were considered. For expressing the relationship between different factors for coordination and responsiveness in supply chain, four symbols have been used to denote the direction of relationship between the parameters i and j (here i< j):
V: parameter i will lead to parameter j;
A: parameter j will lead to parameter I;
X: parameter i and j will lead to each other; and
O: parameters i and j are unrelated.

Table 4: SSIM

	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
B1	O	O	O	O	O	V	O	O	O	O	O	O	O	O	
B2	O	O	O	O	O	O	X	O	O	O	O	O	O		
B3	O	O	O	O	O	V	O	V	O	O	O	O			
B4	V	V	V	V	O	O	V	O	O	V	V				
B5	O	O	V	A	O	O	O	O	O	O					
B6	O	A	A	O	O	A	V	V	V						
B7	O	O	O	O	V	O	O	O							
B8	O	O	O	O	V	O	O								
B9	O	O	O	O	V	X									
B10	O	O	O	O	V										
B11	O	O	O	O											
B12	O	O	O												
B13	O	O													
B14	O														
B15															

Adjacency matrix

An adjacency matrix is a square matrix that is used to describe a finite graph. Its elements show whether or not a pair of vertices in the graph are adjacent .According to the ISM method's principles, the qualitative description of the connection between two barriers may be converted into a binary matrix known as a "adjacency matrix," in which the qualitative description will be represented with either 1 or 0.

The rules for defining this expression are as follows: (P,Q: Barrier)

I. If P has a direct influence on Q, then (P, Q) entry in the adjacency matrix will be 1, else the entry will be 0;
II. If Q has a direct influence on P, then the (Q, P) entry in the adjacency matrix will be 1, else the entry will be 0;
III. If P has a direct influence on Q, and at same time Q has direct influence on P, then both the entries (P, Q) & (Q, P) in the adjacency matrix will be 1.

The fifteen typical barriers' contextual linkages. Do you believe that Barrier P directly affects Barrier Q?, the experts were asked when they did the pairwise comparison on the 15 obstacles. The final conclusions from expert perspectives were based on the axiom that "the minority gives way to the majority" since various experts may assess the relationship differently. An adjacency matrix was created as a consequence, showing the contextual links between the 15 sample obstacles.

Table: 5. The adjacency matrix (A) between 15 representative barriers.

A	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
B1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
B2	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
B3	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0
B4	0	0	0	1	1	1	0	0	1	0	0	1	1	1	1
B5	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
B6	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0
B7	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
B8	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
B9	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0
B10	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0
B11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
B12	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0
B13	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
B14	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
B15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Reachability Matrix

The SSIM has been converted into a binary matrix and it is called the initial reachability matrix by substituting V, A, X and O by 1or 0 as per condition. The substitution of 1s and Os are as per the following rules:

1. If the (i, j) entry in the SSIM is V, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
2. If the (i, j) entry in the SSIM is A, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
3. If the (i, j) entry in the SSIM is X, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1.
4. If the (i, j) entry in the SSIM is O, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

Table: 6. The reachability matrix (A) between 15 representative barriers.

R	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15
B1	1	1	0	0	0	1	1	1	1	1	1	0	0	0	0
B2	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0
B3	0	1	1	0	0	1	1	1	1	1	1	0	0	0	0
B4	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1
B5	0	1	0	0	1	1	1	1	1	1	1	0	1	0	0
B6	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0
B7	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
B8	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
B9	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0
B10	0	1	0	0	0	1	1	1	1	1	1	0	0	0	0
B11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
B12	0	1	0	0	1	1	1	1	1	1	1	1	1	0	0
B13	0	1	0	0	0	1	1	1	1	1	1	0	1	0	0
B14	0	1	0	0	0	1	1	1	1	1	1	0	0	1	0
B15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

3.2 LEVEL PARTITION

From the final reachability matrix, the reachability and antecedent set for each factor are found. The reachability set consists of the element itself and other elements to which it may help achieve, whereas the antecedent set consists of the element itself and the other

elements which may help achieving it. Then the intersection of these sets is derived for all elements.
The level partition of each barrier had to be determined before the hierarchy structure between the 15 barriers could be established. Tables 7 and 8 provide the results of the level partitions of the 15 barriers and include columns for reachability set, antecedent set, intersection set, and level.

3.2.1 Reachability Set

The barrier itself and the other obstacles it reached—collectively referred to as reachable barriers—made up the reachability set for a given barrier. In Table 6's reachability matrix, a barrier's reachable barriers were those having a value of 1 in the row corresponding to that barrier. When it came to Barrier 1, for instance, its attainable barriers were B2, B6, B7, B8, B9, B10, and B11. B1, B2, B6, B7, B8, B9, B10, and B11 made up the reachability set for B1. As a consequence, it was possible to acquire the reachability sets for each barrier, as displayed in Table 7's "Reachability set" column.

3.2.2 Antecedent Set

The barrier itself plus the other obstacles that it reached, also known as reached barriers, made up the antecedent set for a given barrier. The barriers that were reached for a single barrier were those that had a value of 1 in the column that corresponded to that barrier in Table 6 reachability matrix. For instance, when it came to Barrier 5, B4 and B12 were among the obstacles that were reached. So, B4, B5, and B12 made up the antecedent set for B5.

3.2.3 Intersection Set

The common barriers from the reachability set and antecedent set made up the intersection set for a particular barrier. For instance, B1 in Table 6 made up the intersection set for B1. As a consequence, all barriers' intersection sets were discovered, as displayed in Table 7 .
The process of partition analysis is discussed as follows:

Table 7: Level 1 Partition

Barrier	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,2,6,7,8,9,10,11	1	1	
2	2,6,7,8,9,10,11	1,2,3,4,5,6,9,10,12,13,14	2,6,9,10	
3	2,3,6,7,8,9,10,11	3	3	
4	2,4,5,6,7,8,9,10,11,12,13,14,15	4	4	
5	2,5,6,7,8,9,10,11,13	4,5,12	5	
6	2,6,7,8,9,10,11	1,2,3,4,5,6,9,10,12,13,14	2,6,9,10	
7	7,11	1,2,3,4,5,6,7,9,10,12,13,14	7	L1
8	8,11	1,2,3,4,5,6,8,9,10,12,13,14	8	
9	2,6,7,8,9,10,11	1,2,3,4,5,6,9,10,12,13,14	2,6,9,10	
10	2,6,7,8,9,10,11	1,2,3,4,5,6,9,10,12,13,14	2,6,9,10	
11	11	1,2,3,4,5,6,7,8,9,10,12,13,14	11	
12	2,5,6,7,8,9,10,11,12,13	4,12	12	
13	2,6,7,8,9,10,11,13	4,5,12,13	13	
14	2,6,7,8,9,10,11,14	4,14	14	
15	15	4,15	15	

Table 8: Level 2 Partition

Barrier	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,2,6,7,8,9,10	1	1	
2	2,6,7,8,9,10	1,2,3,4,5,6,9,10,12,13,14	2,6,9,10	
3	2,3,6,7,8,9,10	3	3	
4	2,4,5,6,7,8,9,10,12,13,14,15	4	4	
5	2,5,6,7,8,9,10,13	4,5,12	5	
6	2,6,7,8,9,10	1,2,3,4,5,6,9,10,12,13,14	2,6,9,10	
7	7	1,2,3,4,5,6,7,9,10,12,13,14	7	L2
8	8	1,2,3,4,5,6,8,9,10,12,13,14	8	
9	2,6,7,8,9,10	1,2,3,4,5,6,9,10,12,13,14	2,6,9,10	
10	2,6,7,8,9,10	1,2,3,4,5,6,9,10,12,13,14	2,6,9,10	
11		1,2,3,4,5,6,7,8,9,10,12,13,14		
12	2,5,6,7,8,9,10,12,13	4,12	12	
13	2,6,7,8,9,10,13	4,5,12,13	13	
14	2,6,7,8,9,10,14	4,14	14	
15	15	4,15	15	

Table 9: Level 3 Partition

Barrier	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 2, 6, 9, 10	1	1	
2	2, 6, 9, 10	1, 2, 3, 4, 5,6,9,10,12,13,14	2,6,9,10	L3
3	2, 3, 6, 9, 10	3	3	
4	2, 4, 5, 6, 9, 10, 12, 13, 14	4	4	
5	2, 5, 6, 9, 10, 13	4, 5, 12	5	
6	2, 6, 9, 10	1, 2, 3, 4, 5,6,9,10,12,13,14	2,6,9,10	L3
9	2, 6, 9, 10	1, 2, 3, 4, 5,6,9,10,12,13,14	2,6,9,10	L3
10	2, 6, 9, 10	1, 2, 3, 4, 5,6,9,10,12,13,14	2,6,9,10	L3
12	2, 5, 6, 9, 10, 12, 13	4, 12	12	
13	2, 6, 9, 10, 13	4, 5, 12, 13	13	
14	2, 6, 9, 10, 14	4,14	14	

Table 10: Level 4 Partition

Barrier	Reachability Set	Antecedent Set	Intersection Set	Level
1	1	1	1	L4
3	3	3	3	L4
4	4,5,12,13,14	4	4	
5	5,13	4,5,12	4	
12	5,12,13	4,12	12	
13	13	4,5,12,13	13	L4
14	14	4,14	14	L4

Table 11: Level 5 Partition

Barrier	Reachability Set	Antecedent Set	Intersection Set	Level
4	4,5,12	4	4	
5	5	4,5,12	5	L5
12	5,12	4,12	12	

Table 12: Level 6 Partition

Barrier	Reachability Set	Antecedent Set	Intersection Set	Level
4	4,12	4	4	
12	12	4,12	12	L6

Table 13: Level 7 Partition

Barrier	Reachability Set	Antecedent Set	Intersection Set	Level
4	4	4	4	L7

3.3 Identification of Level Partition between Barriers

The barriers for which the reachability set and the interaction set were the same were discovered using the analysis mentioned above. For instance, Table 7 shows that B11 had the same intersection set and reachability set. This wall was classified as a Level 1 wall. The Level 1 barrier, B11, would be removed from Table 7 in further examination in accordance with ISM principles. The remaining barriers described in Table 8 were the only ones used to execute the subsequent partition procedure. Level 2 barriers, namely B7, B8, and B15, will be discovered by evaluations of the reachability set, antecedent set, and intersection set in Table 8.

Table 14: Summary of level partition results

Levels	Barrier
L1	B11—Limited market for bamboo application
L2	B7—Research and development (R&D) B8—Production Costs B15—Technology transfer mechanism
L3	B2—Knowledge about bamboo application B6—Enterprise participation B9—Education B10—Traditional bias against bamboo application
L4	B1—Durability B3—Industrialization for production B13—Code of practice in the bamboo industry B14—Incentive policy
L5	B5—Standards and specifications
L6	B12—Certification mechanism for bamboo materials
L7	B4—Ineffective action by government departments

3.4 Willingness to pay

The study aimed to investigate the willingness to pay on the hypothesis on bamboo products' consumer subscription model. The study assumes a mixed-methods approach and online surveys' as the primary data collection technique. Both structural multi-group analyses and structural equation modeling were used to answer the research questions. Ethical considerations, including data privacy, were enhanced while recruiting the participants. Further details of the study are presented in detail under the following subsections of this

chapter: data collection, instrumentation, data analysis procedures, and ethical considerations.

3.4.1 Sample and data Collections

The study's primary data collection technique was questionnaires distributed online via Google surveys. The technique was used for its ease of administration and data extraction. Also, disseminating the questionnaires online ensured the procedure was cost-efficient. Most questions in the questionnaires were closed for faster response collection. However, the final question on feedback was open, and participants were required to fill out a short answer. Samples were recruited in the study through a simple random sampling technique to reduce bias since every sample in the population had an equal chance of selection. Samples were required to be residents of India and had at least prior experience using bamboo products as the primary inclusion criteria. Questionnaires were sent out via Whatsapp texts, 200 of them were duly filled. The online survey was conducted in October 2022, and the collection of responses continued up to early November.

3.4.2 Instrumentation

The questionnaire contained a description of the study and a definition of key instructions required in filling out the survey, including how to use the rating scales. The questionnaire was further divided into different segments. The first segment targeted the demographics of the samples, including their name, gender, age, education level, annual income, state, occupation, and location type. Subsequent sections captured critical questions necessary to assess the hypothesis. These questions detailed the participants' general purchasing behavior of bamboo products, satisfaction levels, how provided characteristics affect their purchase decisions, everyday bamboo products in their households, frequency of purchase of the items, how well they agree on the provided reasons for low usage of bamboo products, knowledge on the toxicity of plastics, the level of value on environment and health upon using bamboo and the budget they would dedicate on bamboo products. Also, data on features the consumers deemed necessary to be included in the subscription plan was collected. Finally, a section was provided for optional feedback.

3.4.3 Ethical consideration

Since the study involved human participants, several ethics were considered. Participation in the study was purely based on voluntary and informed consent. The participants were not coerced to enroll in the research. Prior to the commencement of the study, all the relevant information about the survey was shared, including its purpose, impacts, and possible effects on the research participants. Equally, all the personal data collected in the study was kept

private and restricted from any unauthorized handling or usage outside the study's boundaries.

Binary classification predicts willingness to pay using unsupervised learning was modelled.
1- will be willing to buy
0- will not be interested in buying

Training parameters- all except for the name, email, and suggestions

- Which of the following bamboo products are you aware of that are used in day-to-day life at your home, town and village?- find the number of products selected and greater the number of products higher is the likelihood of 1(willingness to buy)

- How frequently do you purchase the type of bamboo products listed below?The drop down describe the frequency types (based on the usage):
  Daily- highest willingness to buy
  Weekly-likelihood of willing to buy is present but less than daily users
  Monthly- likelihood of willing to buy is present but less than weekly users users
  Seasonal, Festivals or occasions, Buyed once- likelihood of willing to buy is present but less than monthly users
  Never - 0(wont be willing to buy)
  Willingness to buy
  daily>weekly>monthly>seasonal, Festivals or occasions, Buyed once> never

- ***Rate*** *the below-mentioned qualities as per the level of their importance according to you(if* you want to use or purchase?*).*

  The higher the score on qualities more likely the person is likely to buy the product
  Willingness to buy based on score-
  5>4>3>2>1>N/A

- On a scale of 1 to 10, how much do you agree that offering bamboo products as a subscription service will enhance the consumption of bamboo products at home?
  Higher the score more will be the willingness to buy

- Are you aware of the toxicity of Plastics and non-stick wares in long use?
  Response as yes means willing to buy
  No means not willing to buy

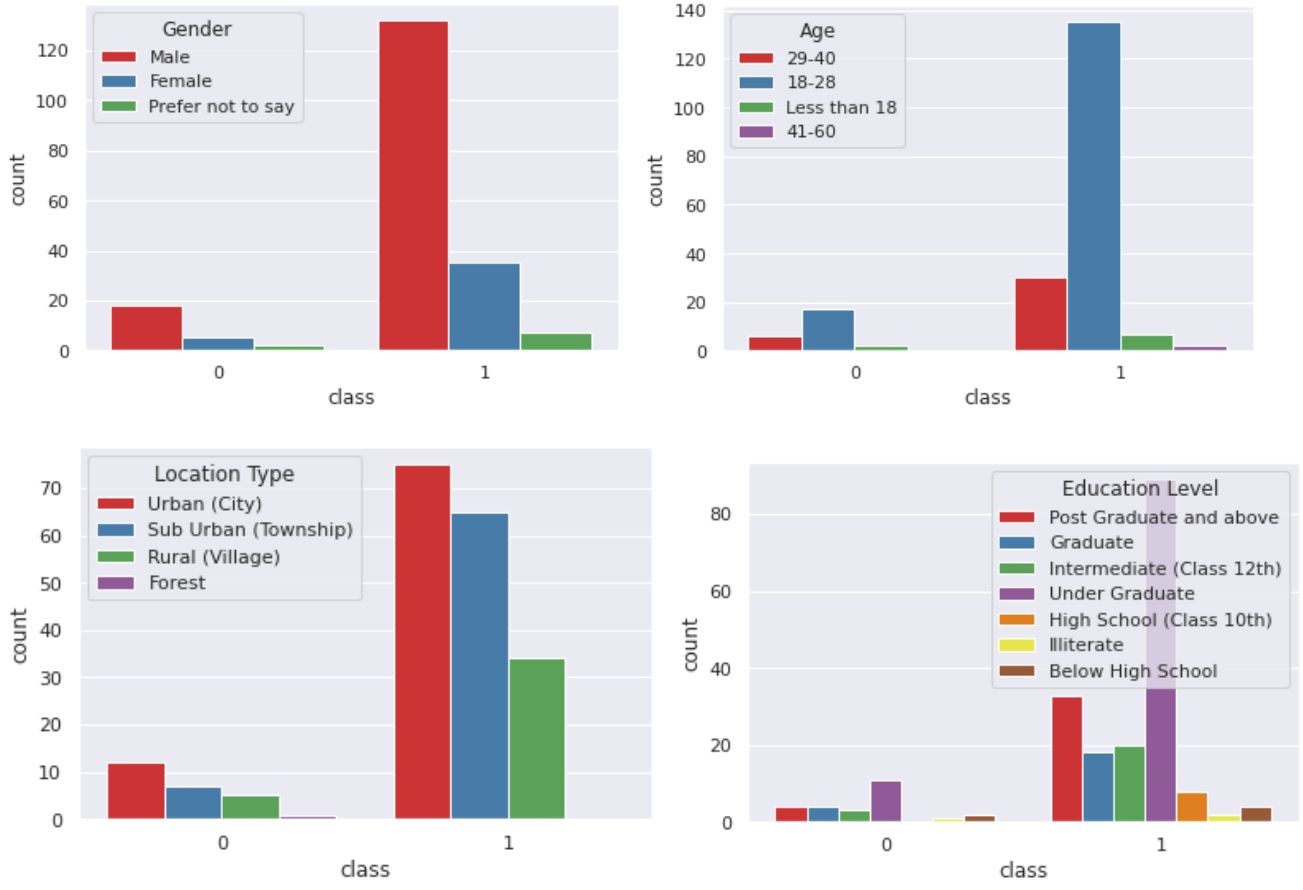
- How much money (Indian Rupee) would you like to spend for the subscription of bamboo products with the following features:

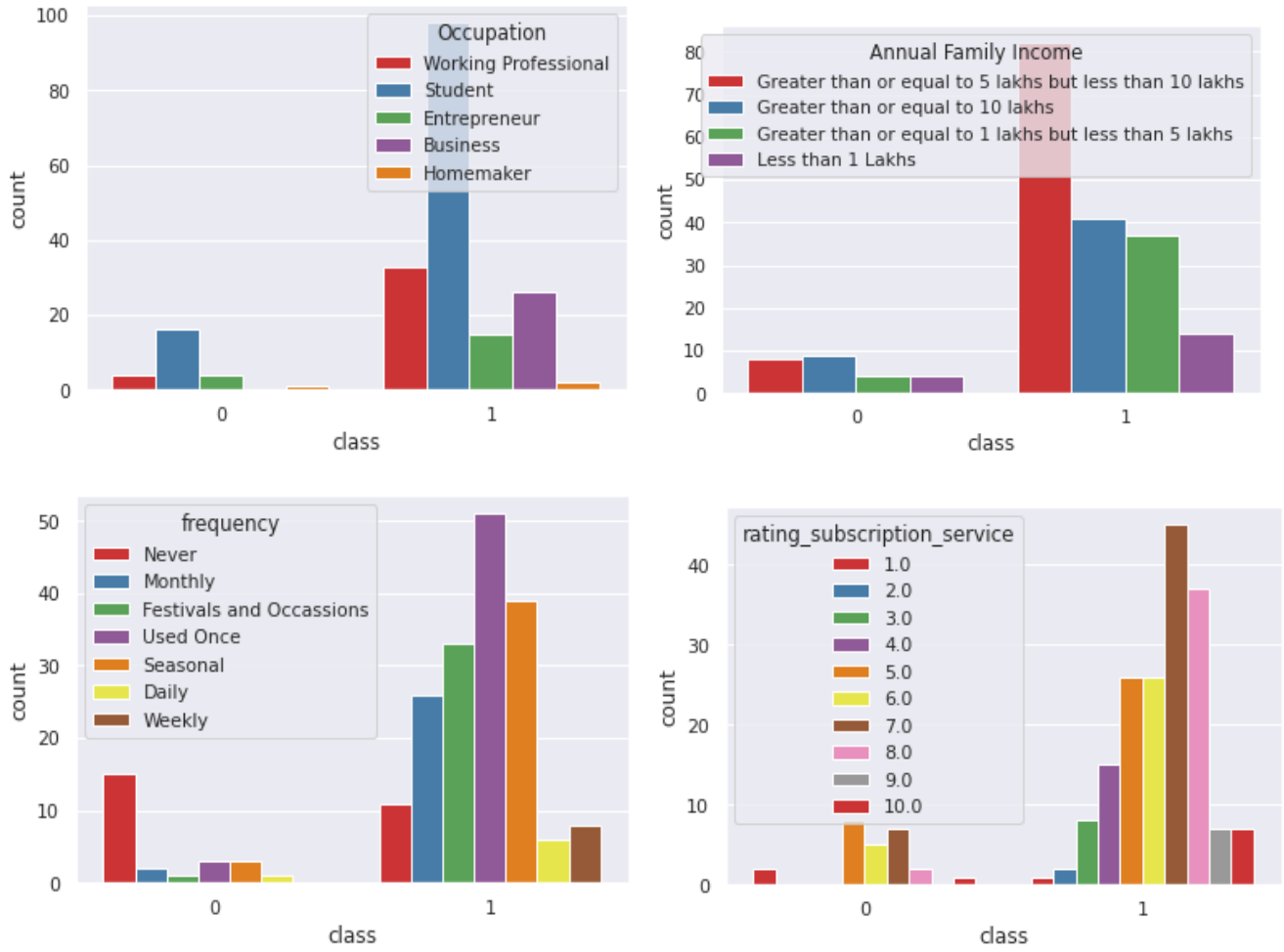
  More they are willing to pay for the subscription more likely are them to buy
  Option D> option c> option b> option a
  15% more> 10% more> 5% more> same

- Other parameters like gender, age, mode of buying(online, offline etc.), , education level, state, location type, annual family income to used as it is in the model.

3.4.4 Statistical Analysis of Data

Before Modelling the survey to determine willingness of people to subscribe, statistical analysis was done to understand the data and its variation. Then preprocessing of data was done so as to model the parameters of survey into the classifiers





Implementation of Logistic Regression and SVM

The implementation of these models is done via two approaches, firstly via applying the classifier directly and another one by implementing the model from scratch defining all the basic parameters like cost function, optimization and error function from scratch.

Theoretical Modeling of Classifiers

1. Logistic Regression

Logistic Regression is a supervised learning algorithm that is used when the target variable is categorical. Hypothetical function h(x) of linear regression predicts unbounded values. But in the case of Logistic Regression, where the target variable is categorical we have to strict the range of predicted values. Consider a classification problem, where we need to classify whether an email is spam or not. So, the hypothetical function of linear regression could not be used here to predict as it predicts unbound values, but we have to predict either 0 or 1.

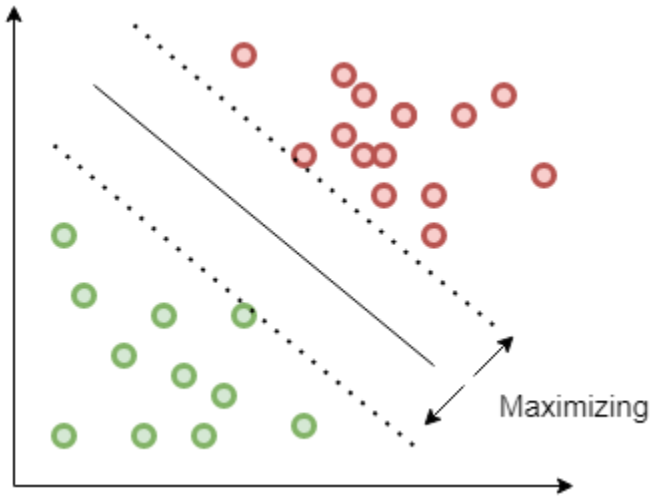
To do, so we apply the sigmoid activation function to the hypothetical function of linear regression. So the resultant hypothetical function for logistic regression is given below :
h(x) = sigmoid (wx + b)
Here, w is the weight vector. x is the feature vector. b is the bias.
sigmoid(z) = 1 / (1+e(z))

Mathematical Intuition:

The cost function of linear regression (or mean square error) can't be used in logistic regression because it is a non-convex function of weights. Optimizing algorithms like i.e gradient descent only converge convex function into a global minimum.
So, the simplified cost function we use :
J = -ylog(h(x))- (1- y)log(1- h(x)) here, y is the real target value h(x)= sigmoid(wx + b)
For y = 0, J = -log(1- h(x)) and y = 1, J= - log(h(x))
This cost function is because when we train, we need to maximize the probability by minimizing the loss function.

2. SVM

We looked at the working of SVM in detail in previous articles, but to give a quick understanding of the goal of SVM let's explain it! The main goal of SVM is the maximization of margins between two different classes. That means that you want to make sure that as many points in one class are on one side of the decision boundary and as many points in the other class are on the other side.
When this happens, all points with a higher degree of separation will be correctly classified while all points with a lower degree of separation will be misclassified.



So when the marginal distance between these two classes is at their maximum, they become the optimal solution for maximizing margin and minimizing risk. As such, it becomes a lot easier to classify new points without any error because they can just be placed on either side

of the decision boundary based on which class it belongs to. If there are errors though then there's always something called regularization which allows us to penalize models so that they generalize better for new data points.

The equation for Soft Margin SVM
The regularization term for SVM will look like this:

$$max\frac{2}{||w||} = max\frac{1}{||w||}$$
$$= min||w|| = min\frac{1}{2}||w||^2$$

This term is known as the regularizer which we need to use for maximizing the margin and minimizing the loss. When adding two terminologies for our gradient descent to work, ie, the number of errors in training(C), and the sum of the value of error(**Σζ**) the equation can be written as:

$$\underbrace{\min \frac{1}{2}\|w\|^2}_{\text{regularizer}} + \underbrace{C_i \sum_{i=1}^{n} \xi_i}_{\text{error term}}$$

This particular error term added allows some classification errors to occur for avoiding overfitting of our model, ie, the hyperplane will not be changed if there are small errors in classification. This model is known as a Soft Margin SVM.
The Loss function we are using here is known as the Hinge Loss function which would look like this:

$$f(x) = max\{0, 1 - t\}$$

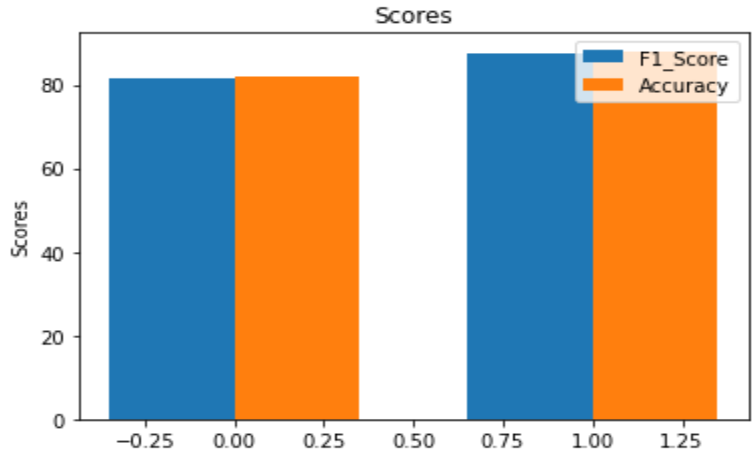
Let's rewrite the optimization term, including the Hinge Loss function:

$$\underbrace{\min \frac{1}{2}\|w\|^2}_{\text{regularizer}} + \underbrace{C_i \sum_{i=1}^{n} \max\left\{0, 1 - y_n(w^T x + b)\right\}}_{\text{error term}}$$

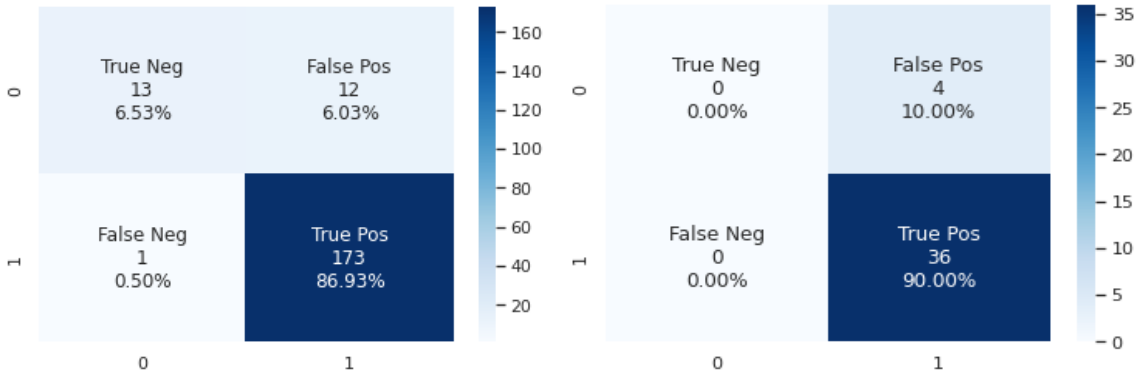
This is the term we need to optimize using our gradient descent algorithm in order to obtain parameters w(weights) and b(bias)

Results and Discussion

1. This is the result obtained by implementing the two classifiers are as follows-



Logistic Regression SVM



Logistic Regression SVM

Using the graphs above we can compare the accuracies of the models above. The F1 score of the models as represented above gives us insights into true positive, true negative, false positive, false negative rate. SVM performs better that logistic regression in our dataset.

2. Implementation of Logistic Regression and SVM from Scratch using Python

Code-
https://colab.research.google.com/drive/1xug66shabnmCThZjBOFU2R9If5ClmxFU?usp=sharing
In this implementation a mathematical model is created from scratch defining all the relevant errors and functions.

1. Logistic Regression

Accuracy on test set by mathematical model : 90.0
Accuracy on test set by sklearn model : 92.5

2. SVM

Accuracy on test set by mathematical model : 90.0
Accuracy on test set by sklearn model : 90.0

Conclusion

Benefits of bamboo items, in this study, are examined from the angles of large-scale and quick growth, lightweight and high strength, affordability, environmental friendliness, and social benefits. This application has had to overcome a number of obstacles. This study identified 15 distinct barriers. These obstacles were organized in a hierarchy using the ISM technique. It was discovered that the main difficulty preventing the use of bamboo goods in India was the government department's poor activity. In addition, impediments to the use of bamboo materials included codes of conduct for the bamboo industry, standards and specifications, durability, industrialization of production, and certification processes for bamboo materials. A small market for bamboo applications, production costs, research and development costs, production costs, knowledge of bamboo applications, enterprise participation, education, and traditional prejudice against bamboo products were some of the barriers that had strong dependencies on other barriers.

In a project we have try to model the willingness of people to subscribe to bamboo base products using two models: firstly logistic regression and second is the support vector machine. The models are able to capture the variation of parameters via the survey very well and capture the data in a very good manner. It has given very high accuracy and F1 scores on their performance. According to both the models around 80 to 90% of the people will be willing to buy subscription based bamboo products. After implementing the model we have also analyzed the results statistically by observing how the willingness of people is changing with varying demography, age, income status and the educational level. Using this information we will have a target customer's characteristics like which state they belong to, their income level etc.. This customer information is relevant to a model. We also have the states where bamboo production is taking place. With this data we will be able to model the logistic inventories of the bamboo subscription. Also we will be able to make a supply chain modeling using this data . As a prospective future project we can collect more data in the survey and then model the parameters more precisely.

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