Design Management Model for Early-Child-Care and Education (ECCE) Through Sustainable Toys

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

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Declaration

I hereby declare that the work contained in this thesis entitled "Design Management Model for Effective Implementation of Developmentally Appropriate Early-Child-Care and Education (ECCE) through sustainable toys" at the Department of Design, Indian Institute of Technology Guwahati, Assam. This work is done for the award of Doctor of Philosophy. It has not been submitted elsewhere for another degree or diploma.

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Certificate

This is to certify that the work contained in this thesis titled " Design Management Model for Effective Implementation of Developmentally Appropriate Early-Child-Care and Education (ECCE) through sustainable toys" submitted by **Mr. Soumen Das** to Indian Institute of Technology Guwahati for the award of the degree of the Doctor of Philosophy has been carried out under my supervision. This work has not previously been submitted for a degree or certificate from another institution.

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Abstract

This research aimed to explore and design sustainable bamboo toys aligned with the principles of Early Childhood Care and Education (ECCE), focusing on holistic child development while promoting eco-friendly practices. The study involved a detailed review of ECCE models, including prominent approaches like Montessori, Reggio Emilia, and Waldorf, alongside the Indian National Education Policy (NEP) 2020. This comprehensive review laid the foundation for integrating sustainability into ECCE frameworks, prioritizing the use of renewable materials and environmentally responsible practices. Additionally, the research delved into the current state of ECCE in India, especially the challenges faced by the Anganwadi system, such as limited access to quality toys and educational resources, and identified potential opportunities for integrating sustainable toys like bamboo into ECCE environments.

Integration of Sustainable Practices in ECCE

An integrative literature review was conducted to understand the multidimensional factors influencing ECCE. The review highlighted the importance of sustainability, not only in educational content but also in the materials used for tools like toys. It emphasized that integrating eco-friendly practices into ECCE frameworks would prioritize environmental responsibility while maintaining educational efficacy. Sustainable practices in ECCE include using renewable and environmentally friendly materials to enhance the educational experience. This approach would provide children with an eco-conscious learning environment and foster a sense of responsibility towards the environment from a young age. Moreover, the study pointed out the need for future research exploring ECCE models that incorporate sustainability as a central parameter, an area which remains largely unexplored.

Role of Toys and Development of Bamboo Toys

Toys play a critical role in child development, supporting cognitive, social, emotional, and physical growth. However, the use of plastic in toy production has raised significant environmental concerns. This study examined the importance of developmentally appropriate toys, focusing on their roles in enhancing various aspects of child development. The research found that while toys are crucial for children's education and development, the negative environmental impact of plastic toys has led to an increased demand for sustainable alternatives. This study introduced bamboo as a viable material for producing eco-friendly toys that align with developmental goals. Bamboo toys are not only biodegradable but also provide

a sustainable alternative to plastic, contributing to environmental conservation while serving developmental purposes. Further research in this area could explore refining bamboo toy designs, exploring sustainable packaging, and expanding the range of bamboo-based toys for broader use in ECCE.

Design Management Model for Introducing Bamboo Toys in ECCE

A key outcome of this research was the development of a design management model for introducing bamboo toys into ECCE. This model mapped the value chain of bamboo toys and identified the roles of various stakeholders, including artisans, educators, and entrepreneurs, in creating an ecosystem for sustainable toy production. The study proposed that a collaborative approach between stakeholders—such as designers, government agencies, and local communities—could foster innovation in bamboo toy production. The model emphasized the potential for creating jobs and generating livelihoods in local areas through the development of innovative bamboo toys. It also highlighted opportunities for expanding the bamboo industry in India, particularly in the northeastern regions, where bamboo resources are abundant. This approach could help boost local economies while promoting sustainable production practices.

Strategic Integration of SDGs

This research aligns with several Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 8 (Economic Growth), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 17 (Partnership for the Goals). The development of bamboo toys in ECCE settings supports these goals by providing eco-friendly, sustainable products that foster children's development while contributing to environmental sustainability. Additionally, the production of bamboo toys can generate local employment and economic growth, particularly in rural areas. By linking toy production to the SDGs, this research encourages a holistic approach to sustainable development that benefits both children and local communities.

Utilization of Existing Common Facility Centers (CFCs) for Enhancing Sustainability

Another significant aspect of the study was the exploration of utilizing existing Common Facility Centers (CFCs) in bamboo clusters for the production of value-added products like bamboo toys. These CFCs, which are designed to support local craftsmanship, can play a vital role in scaling the production of sustainable bamboo toys. By leveraging these existing

facilities, the research proposed that the production of bamboo toys could be expanded in a sustainable manner, increasing the utilization of local resources while providing artisans with access to modern tools and technologies. This approach would enhance the sustainability of CFCs and promote the economic viability of the bamboo industry in India.

In conclusion, this research provides a comprehensive roadmap for introducing sustainable bamboo toys into ECCE, addressing both educational and environmental challenges. By integrating bamboo toys into ECCE, the study offers a promising approach to enhancing child development, promoting environmental sustainability, and fostering economic growth in rural areas.

Chapter 1

Introduction: Significance of ECCE and sustainable toys for tomorrow

Chapter 1

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In recent years, there has been a growing recognition of the importance of early childhood care and education (ECCE) in shaping the trajectory of a child's development. The recognition that play, and in particular play that is supported by toys, plays a vital role in supporting cognitive, social, and emotional development throughout the formative years is essential to this knowledge since it is the foundation of this understanding. However, despite this recognition, there is a significant worry that needs to be addressed: the harmful effects on the environment and the long-term viability of the toys that are commonly seen in early childhood settings. This thesis sets out on a quest to solve this concern by putting forward a Design Management Model with the intention of a successful implementation of developmentally appropriate early childhood care and education (ECCE) through the use of environmentally friendly toys. By diving into the convergence of design management, early childhood education, and sustainability, the purpose of this project is to pave the way for the development of learning spaces that are both environmentally responsible and enriching for young children.

In this introduction, we will discuss the rationale behind the necessity for such a model, examining the serious environmental concerns that are currently confronting our planet, the significance of early childhood education, and the essential role that toys play in promoting the development of children in a holistic manner. Furthermore, we will emphasize the potential of sustainable toy design to not only reduce the amount of damage done to the environment but also to fit with broader educational and social goals, thereby providing the framework for a complete investigation of the Design Management Model that has been presented. Through a multidisciplinary lens, this thesis endeavors to contribute to the evolving discourse surrounding sustainable practices in early childhood education, offering insights, strategies, and frameworks to support educators, designers, policymakers, and stakeholders in their efforts to create nurturing, inclusive, and environmentally responsible ECCE environments.

1.1 Introduction to ECCE and its significance

The initial six years of a child's existence, referred to as the early childhood stage, are universally recognized as the most crucial period for lifelong development due to the very high pace of growth throughout this time. Recent neuroscience research has yielded compelling evidence of 'critical periods' during early childhood, especially within the first three years, essential for the formation of synaptic connections and the comprehensive development of the brain's potential (Nagel, 2020). Research has also indicated that if these early years are not supported by, or embedded in, a stimulating and enriching physical and psychosocial environment, the chances of the child's brain developing to its full potential are considerably and often irreversibly reduced (Taylor & Rogers, 2005). This finding immediately places a very large percentage of children in the developing world in poverty contexts 'at risk', in terms of their life chances. This early childhood era is crucial for establishing enduring social and personal habits and attitudes. The logical conclusion is the paramount significance of investing in early years to create a supportive environment for every child, establishing a solid foundation for life, which is both a fundamental right of every child and a factor that will influence the quality of a nation's human capital (Rajput, 2021).

Children learn through their own experiences by observing others, trial and error, repetition, imitation and identification. These experiences are very important for the children to achieve their development goals. Developmentally appropriate pedagogy is very important for giving children a quality experience. Quality experience can be achieved in many ways, for example, by minimal adult interference while child is exploring and experimenting; encouraging a child while performing a challenging activity; letting the child to enjoy the happiness of achievement by giving opportunity, guidance and support in a safe and secure environment; facilitating a child to adapt in a collective environment by cooperation, listening, sharing and empathising with the member of the group. A child's only occupation is play, so it makes sense to learn or achieve everything while playing. So, a curriculum design has to be based on play and activity where children can freely explore their own and adult remains just as a facilitator. While playing and performing the activities the child will unknowingly develop their developmentally appropriate goals.

Research indicates that creativity, adaptability, problem-solving skills, and discipline are essential for success in both academic and professional pursuits (Goertz, 2000). Executive functions (EFs) are vital, encompassing essential capabilities such as adaptive thinking, planning, self-monitoring, self-regulation, working memory, time management, and organizational abilities. Research suggests that executive functions encompass the cognitive manipulation of ideas,

providing thoughtful responses instead of impulsive reactions, and the ability to adapt viewpoints, resist temptations, and maintain attention (Diamond, 2016). These are core skills critical for cognitive, social, and psychological development, success in school and in life, and development of mental and physical health (Diamond, 2016). These executive functions can be developed throughout the early childhood (Anderson, 2001). Research also shows that these executive functions help to develop mathematical skill in the preschool age (Espy et al., 2004). These executive functions are very important for critical academic development which are numeracy & speech development during childhood (Espy et al., 2004). Differences in executive functions among children will result in mathematic performances among children in later stage in life.

Research shows that during the adulthood, these executive functions monitor, regulate, and guide our cognitive functions & behaviour (Espy et al., 2004). So if a generation has to be changed then the intervention needs to be done during childhood. If the youth population energy has to be driven towards the positive direction then the early childhood care and development has to be developmentally appropriate. This might be very important for the policy makers to invest more in the ECCE which automatically improve the human capital of the future generation. The executive functions can be trained and not a birth phenomenon. Various popular curriculums, their teaching methodologies and the outcomes are analysed with these above lenses.

1.2 Toy industry worldwide

According to fortune business (2023) “the global toys market is projected to generate more than $120 billion in sales by 2023, with a CAGR of over 4%”. Global consumer confidence and rising household incomes support market growth. Due to economic growth, APAC, Latin America, Middle East, and Africa are likely to provide market participants lucrative opportunities. China produces almost 70% of toys worldwide, making it vital to the business. However, new European import laws may hinder Chinese toy exports, which could affect market dynamics. America sells 41% of toys, Europe 29%, Asia/Oceania 30%, and Africa 1%. The sector has been affected by children's choice for more complex vido games electronics (The Business Research Company, 2024). Children are replacing their toys more often, increasing demand for new and inventive products. To meet changing consumer tastes, toy and game makers must innovate and enhance technology. The desire for sustainable products has expanded, making wooden baby toys, plastic-free activities for kids, recycled plastic bath toys, and organic cotton stuffed animals more popular. “The retail channel accounts for over 50% of total sales in 2017 and is expected to grow with a CAGR of over 2% during the projected

period". Department stores, local chain stores, independent toy shops, catalogue merchants, and other untracked businesses contributed to this expansion.

Category segmentation covers dolls, games & puzzles, building, outdoor & sports, and others. Groups include 0-3 years, 3-5 years, 5-12 years, and 12-18 years. The distribution channels are retail, specialized stores, mass market players, other outlets, and internet. In conclusion, the worldwide toys market will be driven in the upcoming years by factors such as shifting consumer preferences, economic expansion in strategic countries, and emerging concepts like sustainability. Market players in Africa, the Middle East, Latin America, and Asia Pacific should benefit. New import regulations from Europe, however, might alter market dynamics and Chinese toy exports. Toy and game manufacturers need to employ technology, innovate, and take sustainability and customer preferences into account in order to remain competitive. The primary distribution channel is retail, and targeting and strategy are aided by market segmentation by category, age group, and distribution channel.

1.3 Indian Toy market

ILO Consulting (2020) examined the Indian toy business. As part of Make in India, the Indian government's "Atmanirbhar Bharat" goal during the first pandemic wave affected the sector. According to IMARC Group, the Indian toy sector grew to $1.23 billion in 2020. Furthermore, "it is expected to grow at a substantial Compound Annual Growth Rate (CAGR) of 12.2 percent during the next five-year, from 2021-2026". Although affordable, high-quality, and eco-friendly Indian toys are available, 70% of the market still relies on imported toys from China. The urge for technologically advanced goods may overwhelm the benefits of locally manufactured toys (ILO Consulting, 2020).

China dominates manufacturing in the Rs 2-lakh-crore global toy sector, while the US leads consumption. In China, toys sell for almost Rs 1.4 lakh crore annually (Intrepid Sourcing and Services, 2023). Unbranded Chinese toys make over 90% of the Indian toy market and do not meet safety, quality, or channel criteria . Chinese toys are cheaper, therefore price-conscious Indians like them. However, the market for branded toys is growing, and Hamleys and Toys R Us have several outlets nationwide. These companies target well-informed, indulgent parents with more money who will pay more for better products. Hamleys has 127 outlets in India, whereas Toys R Us has 12 with ambitious 2020 and beyond growth plans. Amazon and Flipkart are providing doorstep delivery in smaller areas without having physical businesses.

Gogna's (2020) analysis estimates the Indian toy sector at US$ 38.1 billion in 2020, with a CAGR of 9.6% until 2023, according to Statista. "Prime Minister Narendra Modi supports the toy

industry and encourages start-ups to make India a global toy production hub". However, cheap imports have significantly impacted India's toy industry, requiring prompt regulatory response. Increased consumption is due to the diverse offerings in the Indian toy business. We can roughly classify India's toys into three groups. First category includes big global toy brands, which account for 15% to 20% of the Indian market. These toys are known for their creativity, high prices, and features like music, light, robotics, AI, and AR. The second group, 15–20% of the market, is Indian brands that offer simpler, cheaper toys with basic functionality. The third and largest type is unbranded low-cost imports from China, which make up 60–70% of the Indian toy market. Unbranded toys rule the unorganized wholesale toy business.

In its 2020 study India toy story-an outline, IBEF stated that India's toy sector accounts for less than 1% of the world market and is worth Rs 5,000–Rs 6,000 crore. It holds 25% of India's toy market, whereas Chinese toys dominate 75%. After deregulation, Chinese toys took dominated the Indian market, but not always. Over the past 30 years, several toy factories have closed due to their inability to compete with Chinese toys, notably electronic toys. The government is promoting region-specific toys in well-known toy clusters nationwide to boost the local toy production business. These toys assist local toymakers and are geographically specific. New toy designs, especially for special needs children and environmentally friendly toys, are encouraged by the government. Participants are invited to make eco-friendly, non-toxic toys using recycled or biodegradable materials.

India is a vast playground including toys constructed from many elements such as wood, metal, rubber, polymer, fabric, fiber, and wood pulp. Budni-Rewa, Kondapalli, Chitrakoot, and Channapatna are renowned centers for toy manufacturing (Sinate et al., 2023). Artisans diligently preserve them. Until the 1980s, the majority of Indian children utilized toys manufactured domestically. The United States, United Kingdom, France, Italy, Japan, and Germany provided 10% of India's toy imports. The economy's opening in 1991 transformed all aspects, including the play of youth. Chinese toys dominated the market. Despite the popularity of wooden toys, children favored motorized toys imported from China. India attempted to compete but was unsuccessful as China emerged as the preeminent hub for toys. Labor rules, tax issues, insufficient technology, and inadequate governmental incentives hindered major industrial enterprises from entering the area. In contrast to China's integrated manufacturing facilities, India's small enterprises circumvented economies of scale. China manufactures around 75% of toys globally. Numerous Indian toymakers ceased production of toys post-1991 and began selling imported alternatives.

The NPC(2017) found that India has over 4000 toy makers, including a few multinational ones. Small and cottage businesses dominate the Indian toy sector, which is fragmented with only 3% of corporations being important participants. Delhi, Mumbai, Punjab, Uttar Pradesh, Haryana, Tamil Nadu, and central state clusters are manufacturing hubs. Maharashtra, Uttar Pradesh, and Karnataka dominate the toy market, followed by Tamil Nadu, Gujarat, Telangana, and Andhra Pradesh. The Indian toy industry is separated into the "organised" sector, which makes up around one-third of the market, and the "unorganised" part. The organized market is growing faster than the unorganised sector, at 35% vs 15%. Currently, domestic makers serve only 20% of the Indian toy market, while 80% is imported, mostly from China and Italy.

Made in India toy store would facilitate the accelerated growth of local, developing Indian manufacturers. The launch aligns with the Indian government's objective to optimize the potential of Atmanirbhar Bharat. A newly established toy store in India enables artisans to present innovative, locally crafted toys. The store debut aligns with the Indian government's objective of "Atmanirbhar Bharat," signifying self-sufficiency. The store will support the success of emerging Indian companies and artisans. The store's traditional Indian toys department include Chowka Bara, Pitthu/Lagori, and Lattu (wooden spinning tops), and the handmade toys section showcases dolls and toys crafted by artisans from Channapatna, Thanjavur, and Varanasi, emphasizing Indian craftsmanship and distinctive designs.

Chawala (2021) reported that the ‘Toycathon2021’ invites innovative, dynamic solutions and participation from start-ups, MSMEs, educational institutions, and industry players to boost toy manufacturing in India, guided by the Prime Minister's 2020 ‘Aatma Nirbhar Bharat Abhiyan's goal of self-reliance and a stronger domestic industrial base.

The nine themes chosen for the 2021Toycathon were:

I. Indian culture, history, knowledge, ethos II. Learning, education, and schooling
III. Social and human values
IV. Occupations and specific fields
V. Environment
VI. Divyang-friendly
VII. Fitness and sport
VIII. Out-of-the-box, creative and logical thinking
IX. Rediscovering/redesigning traditional Indian Toys

1.4 Classification of Traditional Indian Toys

Static toys are crafted items that encompass figurines of dolls, animals, birds, men, women, deities, and representations of various trades, such as milkmaids and potters, as well as themes

related to everyday events like marriage, bullock cart races, and folk dances. These toys are predominantly constructed from materials such as wood, metal, clay, leaves, bamboo, and paper, utilizing locally established crafting techniques.

Dynamic toys are mobile and auditory toys. They are dynamic, creative toys. Although dynamic toys are uncomplicated, they convey messages clearly and directly. Their subjects frequently exhibit humor, such as a warrior in combat, a boxing wrestler, a dancing jester, an acrobat performing somersaults, a chirping and soaring sparrow, a croaking frog, a buzzing bee, and a galloping horse. All these themes are appreciated by young children. The simplicity of the toy's design is beneficial since it incorporates an element of surprise.

These toys are made by craftsmen with locally available materials. With the introduction of plastic, now most of the toys are imported from China and gradually the traditional toys are getting phased out. If we need to save our traditional toys then they need to be promoted among children and the future generation need to be exposed to the adverse impact of plastic in their life and to the world, so concept of sustainable environmental friendly toys is to be introduced.

1.5 Rationale for sustainable toy design in ECCE

Toy market is ever growing in the globe. The growing use of toys, which are made for short life cycle and then disposal has contributed towards landfill and hence environmental pollution. The concept of sustainability started getting highlighted among general public by release of ‘Silent Spring’ , published by 1962 by Rachel Carson (Lear, 1993). Increased awareness about sustainability and public pressure has led companies to work on improving their products on sustainability lenses and has also put pressure on government to respond with new policies. In 1987, the UN Environment Commission Report set the tone for sustainability efforts to follow. More commonly known as the Bruntland report, it defined sustainable development as *‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’* (Lear, 1993). The fundamental principle of sustainability is development that considers economic, environment, and social issues, which is often referred as the three pillars of sustainability (Hansmann et al., 2012; Purvis et al., 2019; Schoolman et al., 2012).

A research was done on Life Cycle Assessment (LCA) of the environmental impacts of common children toys like Lego, Barbie, Jenga, plush dog, plush dog with battery and Marble Frenzy. The research indicates that highest GHG (Greenhouse Gas) emissions happens due to the use of acrylonitrile butadiene styrene (ABS) plastic, the wood as a material for toys has highest acidification, however indicates low GHG emissions. Plastic has a higher impact than wood, but

type of plastic has different level of GHG emissions. ABS and polyvinylchloride (PVC) composition was having lower impact than nylon granulate and other plastics. Most of the toys are made for short term use and then disposal and thus they form part of landfill. Even when toys are made of recyclable material with more longevity, however, due to their complex design and chemical additives cause toys to be rated as medium to low recyclable.

So, both material and design need to be taken care of for making toys recyclable and have less negative impact on environment. Sometime it has also been observed that changing the manufacturing process has also reduced the energy consumption for production and thus reduced the environmental burden on production (Rangaswamy et al., 2018).

Focusing on sustainable toy design aligns with broader environmental, social, and educational goals, reflecting a conscious effort to address pressing global challenges. By prioritizing sustainability in toy manufacturing, we acknowledge the finite nature of our resources and the urgent need to mitigate environmental degradation. Sustainable toy design reduces the environmental footprint associated with traditional toy production processes, which can promote preservation of natural ecosystems and biodiversity. By using renewable and eco-friendly materials and design process, we can minimize waste generation and contribute to a healthier and sustainable planet for future generations.

Moreover, sustainable toys will not only function as effective tool for instructions, but also will imbibe values of environmental care and responsibility in children. Through play, children will cultivate an understanding of sustainability challenges and develop the capability for making informed decisions that will advantage both society and the environment in the future. Sustainable toy design will promote inclusivity and equity by guaranteeing access to safe and developmentally appropriate toys for all children, irrespective of socioeconomic position in the society.

The emphasis on sustainable toy design will lead to product innovation. Through this, the future generation will develop a more fair, resilient, and ecologically aware society. Integrating sustainability into all facets of toy design and manufacture facilitates a more promising and sustainable future for future generations.

The majority of toy manufacturers in India are part of the unorganized sector, which consists of medium- to small-scale businesses that frequently employ no more than five people. India's manufacturers are adept in producing a variety of toys, such as puzzles, board games, plush toys, plastic toys, and pull-along toys. "In addition to classic toys like dolls, wooden carts, and unbranded plush toys, Indian consumers are now drawn to a new generation of toys that draw inspiration from

social media trends and pop culture around the world." India already has a long history of producing handicrafts, and the sector is essentially thriving in every state. Due to their rich history and distinctive regional arts, Indian handicrafts are highly sought after and valued globally. The northeast is renowned for its bamboo crafts, which are supported by the region's raw material abundance.

1.6 Literature Review

The literature discuss under following heading.

1.6.1 Chemicals used in toys and harmful effects on children

Modern toys, particularly those made from plastic, often contain a variety of chemical compounds—many of which pose serious health risks to children. Among the most concerning are phthalates, used as plasticizers to make toys more flexible. These chemicals have been linked to endocrine disruption and developmental problems, especially in toys produced before the enforcement of stringent safety regulations (Bekki et al., 2024; Xue et al., 2007). Flame-retardants such as OctaBDE, DecaBDE, and HBCD, intended to reduce fire hazards, can accumulate in body tissues and negatively affect the nervous and hormonal systems (Aurisano et al., 2021; Becker et al., 2010). In addition, heavy metals like lead, mercury, arsenic, and cadmium have been found in paints, coatings, and batteries in some toys. Lead is particularly dangerous, known to impair brain development, while cadmium is associated with reproductive toxicity (Al Kindi & Ali, 2020; Guney & Zagury, 2012; Rebelo et al., 2015). Other harmful additives—including synthetic fragrances, colorants, and stabilizers—are frequently used in costume toys, especially those made from polyvinyl chloride (PVC) (Marichal-Lopez, 2015; Ziarsolo, 2023). Of particular concern is the use of recycled plastic, which can introduce unintended toxic substances like dioxins and brominated flame retardants, especially when sourced from electronic waste. Studies show that toys made from black recycled plastic may contain chemical levels comparable to hazardous waste, posing additional risks when mouthed by children (Guney et al., 2020; Ionas et al., 2014; Turner, 2018).

Children are especially susceptible to the adverse effects of these chemicals due to several physiological and behavioral factors. Their growing bodies, higher metabolic rates, and tendency to explore the world by mouthing objects result in greater absorption of toxins per unit of body weight compared to adults. Many of these chemicals—such as bisphenols (BPA), phthalates, PFAS, and certain flame retardants—have been associated with serious health outcomes, including

hormonal imbalances, neurodevelopmental disorders, cancer, and organ damage (Di Pietro et al., 2023; Flaws et al., 2020; Haverinen et al., 2021).

1.6.2 Challenges due to technology in toy manufacturing

The toy manufacturing sector is experiencing a significant shift driven by emerging technologies such as automation, artificial intelligence (AI), and advanced production systems (Badiuzzaman & Rafiquzzaman, 2020; Parschau & Hauge, 2020). Automation has streamlined many repetitive tasks—ranging from assembly and packaging to quality assurance—by employing robotic arms and high-speed machinery that operate with greater precision and consistency than manual labor. This not only enhances productivity but also minimizes human error. AI and machine learning are further transforming operations by optimizing production workflows, anticipating maintenance requirements, and facilitating product customization based on consumer data (Shaikh, 2025). While these innovations improve efficiency and output quality, they also present challenges. One of the most critical concerns is their impact on employment: as factories increasingly rely on automated systems, the demand for low-skilled labor diminishes (Aghion et al., 2023; Krzywdzinski, 2017; Vermeulen et al., 2018). In its place, there is a growing need for workers proficient in robotics, programming, and systems management, signalling a shift toward a more technically skilled workforce.

1.6.3 Challenges faced by toy artisans in India

India's toy manufacturing industry faces a wide range of structural and operational challenges, most notably its fragmented and unorganized nature. Approximately 90% of the sector comprises micro and small enterprises, with over 4,000 manufacturers operating largely outside formal industry structures. This high degree of fragmentation results in significant inefficiencies in production, inconsistent supply chain practices, and limited market reach, making it difficult for these enterprises to compete with large domestic or international players (PWOnlyIAS, 2024).

Another key barrier is the dependence on outdated technology and infrastructure. A large segment of Indian toy artisans continue to rely on traditional, labor-intensive production methods and obsolete machinery (Patil, 2025; Rane et al., 2023). Moreover, the sector suffers from inadequate infrastructure, including poorly equipped manufacturing facilities, limited

quality testing labs, and unreliable logistics support, all of which constrain scalability and modernization.

Another critical concern is the sector's dependence on imported raw materials, such as specialized plastics, electronic components, and decorative accessories. This dependency inflates production costs and exposes artisans to global supply chain disruptions. Competing with cheap, mass-produced imports—particularly from China—becomes increasingly difficult under these constraints, as imported toys often benefit from economies of scale and established distribution networks.

Workforce-related issues also pose a serious limitation. The toy sector in India suffers from a persistent shortage of skilled labor in areas like toy design, mold-making, and product development. The lack of dedicated educational institutions and formal training programs for toy-making inhibits artisans' ability to innovate or adapt to market changes (Rane et al., 2023). Coupled with low wages, minimal job security, and high attrition rates, the workforce remains unstable and underprepared to meet industry demands. Market access and branding remain underdeveloped areas. Traditional and handmade toys, despite their cultural and aesthetic value, account for a marginal share of the total market (R. A. Kumar & Rohilla, 2024; Patil, 2025). Artisans often lack the necessary skills or resources to build strong brands or tap into high-potential urban and global markets. As a result, they struggle to create awareness or generate demand for their products.

Chapter 2

Research Gap, aim and objectives and research methodology

Chapter 2
Research Gap, aim and objectives and research methodology

2.1 Research Gap & Research Questions

2.1.1 Research Gap

Research Gap 1: There is lack of studies on introduction of sustainable bamboo toys in developmentally appropriate Early-Child-Care and education in context of north-east India in particular and India in general

Research Gap 2: There is lack of researches on livelihood generation from sustainable bamboo toys as value added product of bamboo in context of north-east India

2.1.2 Research Questions

Table 2.1 Research questions and gaps

Research Question	Associated Research Gap
RQ1: What are the key characteristics and principles of various ECCE models (e.g., Montessori, Reggio Emilia, Waldorf, Tools of the Mind) across different educational settings (International, Private, public sponsored, Anganwadi)?	Research Gap 1
RQ2: How are toys integrated into the curriculum and pedagogical practices of ECCE programs and what are the long term effect of developmentally appropriate toys on children's educational outcomes and success in later stages of schooling?	Research Gap 1
RQ3: What are the key stakeholders involved in policymaking for Early Childhood Care and Education (ECCE), how can their perspectives be integrated into the development of policies for bamboo toys, and how can the adoption of these toys promote environmental sustainability, economic empowerment, and social equity in line with sustainable development goals?	Research Gap 1
RQ4: How can bamboo handicrafts from Northeast India be innovatively designed and marketed as educational toys to	Research Gap 2

enhance their appeal and integrated to meet the current trends in educational toy market?	
RQ5: What is the level of acceptability, the attitudes and preferences of educators, parents, and children towards bamboo toys in ECCE settings?	Research Gap 2
RQ6: What are the key benefits and unique value propositions of bamboo toys for ECCE providers and parents nationally and internationally (e.g., sustainability, safety, educational benefits)?	Research Gap 2

2.2 Aim, Objective & Significance

2.2.1 Aim

The aim of the study is to formulate a design management strategy for developmentally appropriate early childhood care and education (ECCE) through sustainable toys with special emphasis to policy design, business design, and design entrepreneurship.

2.2.2 Objectives

1. To study the model for Early-Childhood-Care and Education (ECCE).
   - To study the curriculum and pedagogy of ECCE
   - To study the management system, human resource skill and challenges for ECCE

2. To Study the role of toys for effective implementation of developmentally appropriate Early-Childhood-Care and Education (ECCE)
   - To study existing toys in ECCE and their alignment with curriculum and pedagogy
   - To study the existing toys in terms of developmentally appropriateness

3. To study the value chain of bamboo toys as a sustainable intervention in ECCE
   - To study the present status of bamboo toys in India and abroad
   - To explore the possibilities of introduction of bamboo toys in ECCE
   - To design and develop a range of bamboo toys for educational purposes
   - To study effectiveness and consumer acceptance of the diversified bamboo toys in ECCE

4. To formulate the policy and strategy for effective implementation of bamboo toys in ECCE

5. To formulate business model for design driven enterprises to introduce and implement bamboo toys in ECCE

2.3 Research Design

The research employs a **mixed-method approach**, integrating qualitative and quantitative techniques to achieve a comprehensive understanding of Early-Child-Care and Education (ECCE) models, sustainable toy design, and the value chain of bamboo toys in educational contexts. The entire research was conducted in three phases. Following are the different phases:

- **Exploratory & Descriptive Research**: In this phase various ECCE models and curriculum, focusing on the educational significance of toys has been studied. Both secondary and primary research was conducted. As part of secondary research, extensive literature review has been conducted to understand various ECCE model and curriculum globally, special focus was given to toys. As part of primary research extensive interviews were conducted. These interviews were conducted among teachers, parents, artisans, and entrepreneurs. Observation on children playing with bamboo toys were recorded.
- **Research by design**: In this phase, the focus was on the design and development of various sustainable bamboo toys (e.g., Jenga, shape puzzle, spindle box), the detail of design and development process can be found in the chapter 4. the phase involves designing and prototyping, followed by product testing. Initially, schools were visited to understand the kind of toys they use on day to day basis for child development and then existing toys made of wood and plastic were explored. Few toys were selected which has multiple uses, has a long life and can be used primarily in institutional setting. Meetings were done with bamboo artisans & raw material suppliers on what form of bamboo raw materials can be used, what are the design challenges, adhesive to be utilised, tools required and time required to develop each of the prototypes. Once the prototypes were developed, they were taken to schools and observations were made from child playing with these toys, reviews were taken from teachers and parents on various parameters.
- **Design management Research**: This phase involves testing the toys within the ECCE environment, gathering feedback from educators, parents, and children to inform a strategy for broader implementation. Initially, all the stakeholders associated in bamboo toy development were studied, relevant policies and schemes were reviewed. Finally, Business Model Canvas has been considered as a framework for introducing bamboo toys in ECCE.

Phase 1: Literature Review and Contextual Analysis

The initial phase encompassed an exhaustive examination of literature pertaining to ECCE models and sustainable toy manufacturing. The review encompassed an examination of the New National Education Policy (NEP 2020) and its effects for Early Childhood Care and Education (ECCE).

The literature study was crucial and helped in understanding the study within current knowledge, supporting the research gaps, and providing a theoretical framework for the incorporation of sustainable toys into early childhood care and education. The analyzed models included educational frameworks such as Montessori, Reggio Emilia, and Tools of the Mind, providing insights into the adaptation of developmentally appropriate practices for the Indian educational system.

The literature review included research publications, governmental reports, and policy documents was performed to collect data. For research publication different search engines were used to find the relevant publication in database such as Scopus, web of science and google sholar. This study facilitated in identification of the fundamental ideas that underpinned both Early Childhood Care and Education (ECCE) and sustainable toy design, establishing a foundation for subsequent study.

Phase 2: Development of Sustainable Bamboo Toys

In the phase, different toys were developed with bamboo as a primary material. The prototyping, and testing of bamboo toys, including Jenga, form puzzles, spindle boxes, and Mikado. The toys were chosen for their developmental significance and sustainability potential.

Workshops were convened with toy designers, artisans, and educators to collaborate create the prototypes. The production methods encompassed multiple stages, including grinding, sanding, drilling, and polishing, the details of development has been presented in the chapter 4.

Later in this phase, testing was done children that were aged between 3 to 6 years. This assessment helped the evaluation of the toys on their educational merit, safety, with developmentally appropriate practices. The observation was done while children were playing the toys, further feedback were taken from the children, educators and parent to identify weather they liked toy designs.

A detailed description of the testing procedures including:

- **Participant Profile**: 20 children aged 3–6 across three ECCE institutions (2 Anganwadi centers and 1 private preschool).
- **Duration**: Each toy was used in a structured play environment for 3–5 sessions per child.
- **Parameters Evaluated**:
    - Engagement and attention span while playing
    - Motor coordination and handling ease
    - Feedback in the form of liking and disliking of the toy.
    - Observation of collaborative or independent play behavior
- Parents were also asked for the feedback for the toy.

Phase 3: Policy and Business Model Development

In this phase, different government policies were studied that support such business, the focus was on Indian and Northeastern states. The study concentrated on formulating policy suggestions for the use of sustainable bamboo toys into ECCE environments. The policy analysis phase evaluated current government initiatives, including those from the Ministry of Micro, Small & Medium Enterprises (MSME) and the National Livelihood Mission, to synchronize the research findings with established governmental frameworks.

Later, a Business Model Canvas was developed through workshops that included businesses, bamboo cluster officials, and craftspeople. This strategy focused on the sale of bamboo toys while ensuring the enterprise's economic and sustainability. The study provided a scalable strategy for integrating bamboo toys into educational environments and consumer markets through the development of a structured business model.

This phase supported that the research results were practical and congruent with government efforts, facilitating both educational transformation and the improvement of rural livelihoods.

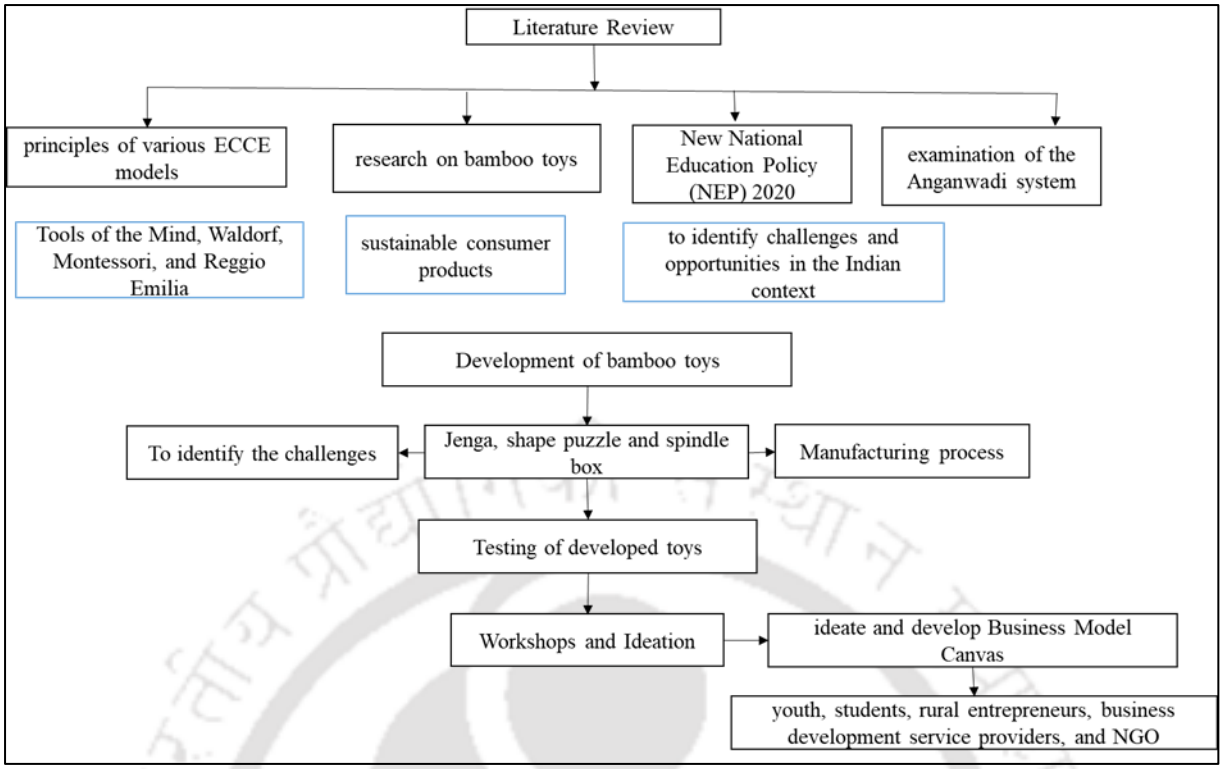


Figure 2.1 Work flow

Chapter 3

Result and Discussions: Reimagining play by integrating bamboo toys in ECCE and its impact

Chapter 3

Result and Discussions: Reimagining play by integrating bamboo toys in ECCE and its impact

This section discusses the various results of the present thesis

3.1 ECCE impact

Research has shown that quality ECCE program is very important for the optimal development of a child for it to succeed in the school and in life. If India has to take advantage of its demographic dividend, then it has to focus on development of future generation which is only possible if the country provides quality ECCE at early childhood level for achieving the optimal developmental goals for each child. India is having almost 23% (Approximately 24 crores as per census of 2011) of its population in the age group of 0-9 years. In this research an attempt has been made to identify the developmental goals of an early child age group. This identification will help the policy makers to think critically on how to improve the ECCE programs which are being run at present.

For achieving success, the developmental goals need to be achieved at an optimal level. Five developmental goals have been identified which later gives success in school (Meloy & Schachner, 2019). These five developmental goals are socio-emotional development, cognitive development, language & literacy development, mathematical & scientific reasoning skill, and physical development. Socio-emotional development is a skill through which a child engages itself with adults & peers, recognizes, express, and regulates their own emotions and respond appropriately to the emotions of others and develop social skills and understanding. Cognitive developmental skill is the skill through which a child develops its cognitive executive function such as holding and manipulating information in their minds, sustaining their attention on a task, shifting their attention when appropriate, and controlling their impulses. Language & literacy skill are the skills, which will help children in developing communication skill and strengthening the foundation of a good reader and writer in later part of life. Mathematical & scientific reasoning skill will help the

children to develop sense of numeracy and geometry and is the foundation of scientific inquiry skill development. Physical development skill is the one which help the child to develop its motor skills and explore their environment and interact properly with people and things.

3.1.1 Historical Context of Early Childhood Care and Education (ECCE)

There have been many discussions & debates on various preschool curriculums particularly on appropriate play, teacher directedness and individualization (Nourot, 2005). No doubt that play has been the focus of imparting developmental training to the young children in all the methodologies, however the time a child should be exposed to play during the school hours and to what extent an adult can interfere while a child is doing the play has always been the major topics of debate (Singer et al., 2006). There are various researches on understanding the effectiveness of various curriculums among the children in the public schools in the USA which are mainly meant for low income families and disadvantageous children due to social issues amongst their parents. These researches are on various skill developments like social development, emotional development, physical, mental, numeracy and literacy (Meloy & Schachner, 2019), the research are for various curriculums like High/Scope's curriculum (Meloy & Schachner, 2019), Montessori, Direct Instruction, DARCEE, and traditional nursery school (Meloy & Schachner, 2019), Montessori, Direct Instruction, traditional nursery school, and the Community Integrated Program (Meloy & Schachner, 2019), and, Direct Instruction and Mediated Learning (Meloy & Schachner, 2019). Such kind of researches based on the curriculum adapted in context of Indian schools is limited. The limited availability of researches in this area motivates further research to be done on understanding the different popular curricula, methodologies of teaching, outcome of such curricula, understand the challenges in implementation various curricula and study the mostly adapted curricula in the public preschools in India.

3.1.1.1 Tools of the mind

The Tools of the Mind (Tools) curriculum was developed by Bodrova and Leong (Bodrova & Leong, 2024), based on the theories and practical insights on cognitive development of Vygotsky (Vygotsky, 1978). The curriculum promotes self-regulation through various activities. This is based on a certain set of belief on how children develop and learn. Children not only develop the self-regulation but also develop the academic skill of literacy & numbers. Play planning is an important aspect of the curriculum for the ECCE students. While planning for a play the children discusses in a group and decides the role they would play during the set

up. This initial plan helps children to act purposefully which is the beginning of becoming a self-regulated learner. The play planning also develops literacy. While planning for the play the children initially draw the plan of who will do what during the play. According to the Vygotskian model drawing is the precursor of writing. These drawing are discussed among each other and then they make the entire plan. The drawing & discussion with the tools approach is the beginning of scaffold writing. The sound one hears in the word they speak in their native language can be the start of writing. The native language is always promoted to the children for initial scaffold writings. Learning Plans allow children to plan the work they will accomplish each day, and set individual learning goals for the week. Activities are designed in such a way that children are engaged in a playful manner, with purposeful learning along with a partner or small group of children. The instructors file the individual Learning Records which children complete and file in individual folders. Each child has a 'Study Buddy' who helps the child to remember what was there in the plan. The instructors checks to ensure that a child has completed the planned activity, looks at their learning record, and explains to how and where goals are being met. This develops self-learning skill in the children. The tools of mind approach prepare a child to be self-learner and when they graduate from the ECCE they are prepared self-learner which is important for the school & later life success. This approach implementation needs specific training of the teachers.

3.1.1.2 Theatrical method

One of the paper namely *'Creating a Culture of Collaboration: The Conception, Design, and Evolution of a Head Start Theatre-in-Education Program'* from Youth Theatre Journal of Routledge publisher describes how theatrical approach in early child teaching methodologies can have positive impact on learning (Mages, 2010). This study is done in the Head Start initiative which is a program of the United States, Department of Health and Human Services that provides comprehensive early childhood education, health, nutrition, and parent involvement services to low-income children and families. The Head Start initiative was often criticised for its inadequacy in enriched language and literacy environments (Zigler & Styfco, 2010). To address this drawback, the Creative Arts Team's Early Learning Through the Arts (ELTA), New York City Wolf Trap Program has developed Head Start theatre-in-education (TIE) program designed to foster the linguistic, perspective-taking, and imaginative skills among the young participants.

The children who performed poor in oral language in the beginning at school were found to experience in reading difficulties and reading difficulties became the obstacle in the success of

student later in the school (Griffin et al., 1998). In this research the pre-schoolers were made to participate in dramas, they were observed and after the drama, their performance were discussed. The teachers also participated in the dramas. Through this methodology, the teachers and students developed listening and speaking skills, while the issues addressed in the stories encourage group problem solving, cooperation, creativity and critical thinking. Children from middle class families have access to many books for reading while poor families cannot afford of giving books to their children, which results in poor reading skill among children of those families (Griffin et al., 1998). Reading books motivates children to perform pretend plays, which help in language development and perspective taking and imagination. However, children from low socio economic families have less exposure to these activities (Smilansky, 1968). The ELTA has rich linguistic context and deliveries through drama engages children in that context. Drama helps in development of children perspective-taking , problem solving (Hume & Wells, 1999) and conflict resolution (Giffin & Yaffe, 1999). Dramas helps children to develop their ability to identify a problem depicted in the drama, find solutions to address the problem and cooperate with everyone for implementing the solutions. Thus problem-solving skills of the children develop through the drama approach. Children who are exposed to role play more are better in considering & understanding the perspective of others, which lead to their development of imagination and ability to understand others (Harris, 2000). Thus the drama/theatrical approach can be an innovative approach for developing language skill, perspective-taking, imagination, creativity & problem-solving skill of the children. Implementation of such program need special training of the educators.

3.1.1.3 Waldorf approach

Waldorf education was founded by Rudolf Steiner, an Austrian scientist and philosophical thinker. In the year 1919, he found a school for the employees of the Waldorf-Astoria cigarette factory in Stuttgart, Germany. The vision was that this new kind of school would educate human beings able to create a just and peaceful society. It brought coeducational (bringing boys and girls together in the classroom), open to children of any background (without entrance examination), comprehensive (from preschool level through high school), and independent of external control (a self-governing administrative unit). Waldorf is a well-defined model with every school administratively independent (Tschurenev, 2021). The educational focus is on bodily exploration, constructive and creative play, and oral (never written) language, story, and song. On a given day, children might do such things as sing songs, paint with watercolors, color with wax crayons, cook, hear a story told with puppets, go on a nature walk, work in the garden, build with wooden blocks, or make houses using play stands and cloth. Through these

activities, they become deeply engaged and develop powers of concentration and motivation. A significant portion of the school day is devoted to uninterrupted imaginary play. The teacher presents a curriculum that has structure and sequence but that relies on lessons unaccompanied by textbooks. This approach fosters an integrated, multi-sensorial approach to learning and expression, with more emphasis on oral listening and memory than is found in other early childhood models for the primary years. In this approach, everything is introduced as a story and after listening to the story the children documents their own lessons whatever they have learned. Whether it is numeracy, literacy, music, crafts, foreign language, etc., everything is introduced with stories. Children are self-learners and they themselves create their lesson books. The Waldorf teacher generally plays a performance role in the classroom as he or she leads or models many whole-group activities involving integration of the academic and the art. The teacher is also a moral leader, seeking to provide an intimate classroom atmosphere with a sense of harmony and full of themes about caring for the community and for the natural and living worlds. The teacher needs a classroom in which children can bring together their thinking, feeling, and willing, no matter what their personalities and temperaments.

3.1.1.4 Montessori Method

Dr. Maria Montessori was the first lady physician of Italy, who after developing an innovative method of working with children with disability, founded a children house in a slum area in Italy. Her methodology became popular to other part of the world after fascist regime declared Montessori as a wrong method and she moved out of Italy. Her approach became popular among the elite class people in India during the British era. However, educational reformers brought this approach to public since 1945 and based on this method, the today's Anganwadi system was developed. The child seeks sensory input, regulation of movement, order, and freedom to choose activities and explore them deeply without interruption in a carefully prepared (serene and beautiful) environment. In this approach a concept is introduced with demonstration from adult whenever an individual or group is ready. There are specific equipment for demonstration of practical life, sensorial, mathematics, language, science and geography, and art and music. This is a much individualised approach where a child is helped while doing activity with very minimal support. The Montessori teacher plays the role of a director in the classroom as children individually or in small groups engage in self-directed activity. The teacher's goal is to help and encourage the children, allowing them to develop confidence and inner discipline so that there is less and less needs to intervene as the child develops. It is believed that interrupting children when engaged in purposeful activity interferes

with their momentum, interest, and inner workings of thought. Educators need to have the equipment and skill of developing some equipment locally for demonstration. Specific trainings need to be imparted to teacher for implementing such curriculum.

3.1.1.5 Regio Emillia Approach

Reggio Emilia is the name of a city in northern Italy where educators, parents, and children began working together after World War II to reconstruct society and build a system of municipal preschools and infant-toddler centres. It started from Italy and gradually expanded throughout Europe and now increasing its presence in Asia, Australia, North America, and other parts of the world (New, 2000). Programs in Reggio are family centered and serve children at infant-toddler and preschool levels (Gandini & Edwards, 2001), with first priority given to children with disabilities or social service needs. Unlike Montessori & Waldorf method this does not follow a formal approach and instead educators in Reggio approach speak their evolving experiences. Teachers follow the children's interests and do not provide focused instruction in reading and writing; however, the children develops literacy skill as they record and manipulate their ideas and communicate with others. The Reggio teacher plays a role balancing between engagement and attention. Based on careful and sensitive listening, observation/documentation, and reflection with other adults, the teachers serve as resources and guides to the children.

In all ECCE approaches, it is found that documentation by teachers/educators plays a very important role in professional development of teachers; the documentation leads in making ECCE visible to parents which would help in transmitting ECCE knowledge and experiences to parents which would affect parents' conception about their children, learning and quality of ECCE, this would further make the curriculum and implementation visible to authorities and policy maker. It improves the pedagogical process, teachers can find it easy to revisit a particular child past and pedagogical documentation increases participation according to literature (Rintakorpi, 2016). This also increases the power/strength of communication to parents and policy makers and finally documentation leads to improve a child-centred pedagogy.

3.1.2 ECCE in Rural India (Anganwadi)

Since 1914 onwards information about Montessori methodologies and development of ECCE in Italy reached India through various publications, but such education were restricted to only the elite class. During the British era innovative preschool method was prevalent only among the children of elite class. It was only in 1945, Tarabai Modak, politician and an education

reformer founded the Gram Bal Shiksha Kendra or Rural Education Center. Modak adapted the most innovative pedagogy in the field of child education, which according to her was Montessori Method.

This initiative was for rural, marginalised and poor children in India and was in line with the Gandhian vision of rural reconstruction (Kumarappa, 1952). Modak, and the association she had co-founded, the Nutan Bal Shikshan Sangh (NBSS), or New Child Education Society, were later credited to have both, 'Indianised', and 'ruralised' early childhood education (Deshpande et al., 1979). These initiatives brought the most marginalised children into the modern system of ECCE. From these experiments, in 1975, the institution of Anganwadi emerged, which in today's India provides integrated child development to millions of children. Today this program is described as the world's largest early childhood government sponsored programme for the poor. The entire initiative was on volunteer based by rural female, which even today is going on the similar lines and Anganwadi workers even today struggle for their recognition and salaries to match at par with teachers, while instead of salaries they get honorarium.

Anganwadis combine informal preschool education with basic public health interventions for mothers and children, including health and nutrition education, the provision of supplementary nutrition, immunisation, health check-ups, and referral services. So, even after decades, the system which was created to give high quality ECCE among the marginal, rural and poor children, it remained as an institutional infrastructure for the delivery of essential governmental health and social welfare services (Bhavnagri, 1995). The management in the Anganwadi system has put more focus on health and social services rather than early childhood education (Arora et al., 2006). For the effective implementation of developmentally appropriate ECE (early childhood education) in rural communities, the Anganwadi system, which is the only system for providing ECE at community level, has to be ready with the proper educators and management focus has to be brought in for such implementation.

The new NEP approved in July 2020 has brought ECCE under formal system of education. This policy has brought 5+3+3+4 system instead of the previous 10+2 system. As per this approach the early childhood care and education has to be provided between the age group of 0-8 years of age (Zero to Eight years). NEP 2020 has developed National Curriculum and Pedagogical Framework (NCPF) for children up to 8 years of age in two parts viz. Sub-framework for children 0-3 years and Framework for children 3-8 years. Many of the great indigenous traditions of India, especially those developed over millennia in the Early Childhood Care and Education that includes art, stories, poetry, games, songs and more, are aptly embedded in the curriculum. NEP-2020 will

serve as a guideline for parents and childcare institutions. There will be standalone Anganwadi centres, Anganwadi centers affiliated to primary schools, pre-primary schools will be affiliated to primary schools and teachers will be appointed who are specially trained in the curriculum and teaching for ECCE.

For universal access to Early Childhood Care and Education, Anganwadi Centers will be strengthened with high quality infrastructure, play equipment and well trained Anganwadi teachers. It is suggested that every child before the age of 5 years to go to a "preparatory class" with an ECPA (Early Childhood Progaram Aid) qualified teacher. According to the new policy, learning in a preparatory class should mainly be based on game-based learning. It will be focused on developing cognitive, social and mental abilities as well as early literacy and numeracy skills. A 6-month certification program will be conducted in ECCE for qualified Anganwadi teachers of 10 + 2 and above and one year diploma program for those with low academic qualifications. These upskilling classes are proposed to be conducted both online or offline so that training can go without any disruption and the Anganwadi workers can receive the education without interfering in their regular work. ECCE will be introduced in phases in tribal areas and in all formats of the alternative school. The responsibility for ECCE curriculum and pedagogy will lie with MHRD. The planning and implementation of childhood care and education curricula will be jointly managed by the Ministries of HRD, Women and Child Development (WCD), Health and Family Welfare (HFW) (National Council of Educational Research and Training, 2022).

3.1.3 Model for ECCE: Curriculum & Pedagogy, Management system, Human Resources and Challenges

Early childhood is a critical period in human development, laying the foundation for lifelong learning, behaviour, and health. This period is from birth to around eight years is when the brain undergoes rapid development in areas such as language, motor skill, cognition and socio-emotional resilience. Curriculum focuses on play-based learning, hand-on activities, and exploration to stimulate children's natural curiosity and creativity. Curriculum and pedagogy are designed based on cultural diversity to promote inclusivity and also emphasizes a child-centered approach. Strong management systems ensure efficient operations, resource allocation, and quality assurance. They establish policies, standards, and procedures that uphold child safety, staff professionalism, and program effectiveness. Human resources are pivotal in ECCE's success, skilled and trained educator create nurturing and stimulating learning environment that promote growth and learning. Continuous professional development enhances their skills in classroom management, curriculum implementation, and collaboration

with families and community stakeholders. However, challenges of funding, quality assurance within diversity, inclusivity, complex regulatory framework and involving parents and caregivers in children learning environment exist in the system.

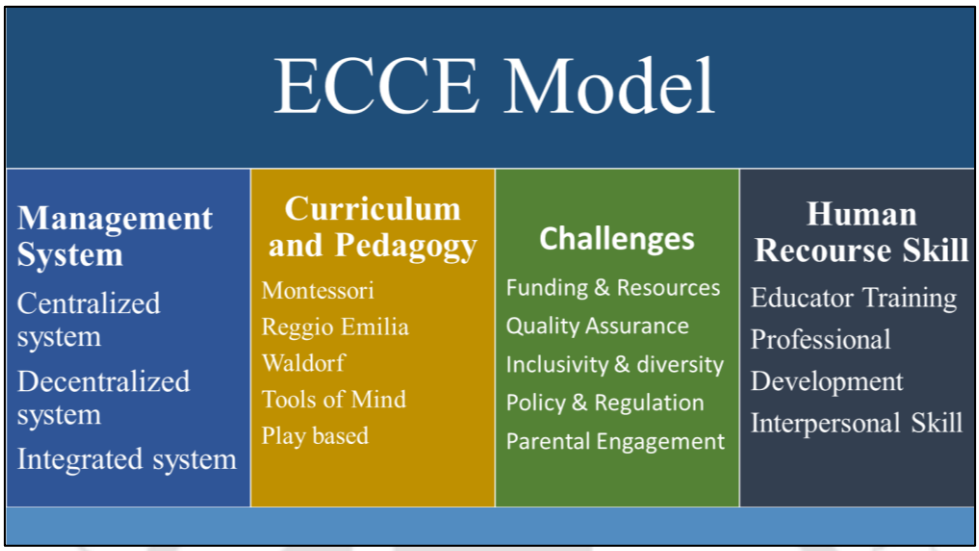


Figure 3.1 ECCE Model

3.2 Importance of play and toys in early childhood

Play is an integral part of life for a child. Through this lens the children experience the outside world. For this reason, educational institutes' uses play as a tool for teaching children at early child educational institutes. Educational toys have become the most effective tool for teaching various concepts to children since childhood. While playing, children are developing neurological foundation, which will enable problem solving, language & creativity. The learning is in terms of how to relate to others, how to calibrate their muscle & bodies, and how to think in abstract ways. It is said that a child who is not being stimulated with play and has got only few opportunities will not develop the full neural connections & pathways which will be required later in the life for further learning (Sutton-Smith, 2001). One of the paediatrician, Dr. Ari Brown, says that free play is very important for the brain development, learning problem solving skill, think creatively, develop motor and reasoning skill, free play also engages children to learn how to engage themselves which is also a great skill (Healey et al., 2019).

Play is very important in the development process because it contributes to the cognitive, physical, social, and emotional well-being of children and youth. Play enhances the progress of early development from 33% to 67% by increasing adjustment, improving language and reducing

social and emotional problems (Fisher, 1992). Children who are having more access to toys at infant age is found to have developed more intellectual when they reach the age of 3 irrespective of sex, race and social class (Elardo et al., 1975). All the literature reviews reveals that play is very important for the development of a child, however with the changing lifestyle and urbanisation, children have lesser available free time to play. Among the childcare experts and education professionals it is now started getting focused on re-introduction of the free play in education system (Elkind, 2008).

3.2.1 Various toys targeted for different developmental goals

Toys help not only in child's cognitive and emotional development but also in developing values (Goldstein, 1994). In fact, a large number of toys convey different values among children. The values can be social, gender, environment, religious values, etc. The toys which are for cognitive development are designed in a manner that their learning outcomes are well defined and so is the design process, however, value conveying toys are very indirect. There was a survey conducted by Blakemore and Centers in (2005). In this survey, 125 toys were selected and studied in details and it showed that 70% of the toys either represented feminine or masculine attribute and remaining 30% toys were gender neutral. These gender neutral toys were mainly associated with developing skills like physical, cognitive, artistic and expressive skills. The most interesting fact of the study was that the educational toys for physical or motoric development, the criteria of designs were well defined such as safety, fun, offering challenge, interactive, ease of use, adaptable, etc. (Hinske et al., 2008), but there were no such defined criteria for toys imparting value education. So, it is a challenge to design the criteria for conveying values and keeping the main goal of cognitive & motoric development. This research attempts to identify the guidelines to be kept in mind while designing a toy keeping in mind of cognitive, motoric and sustainable value development. The age group taken in consideration is 1 year to 5 years. According to Piaget, there are four stages of cognitive development (Piaget, 1972): sensorimotor (0 to 24 months), preoperational (2-7 years old), concrete operational (7- 11 years old) and formal operational (adolescence – adulthood). In this study we focus on the preoperational stage and the study the concept develops in this stage. This stage is further divided into different phases keeping the backdrop of developments happening at this phase.

At the age between 12 months to 24 months the children walk, jump, pull, push, carry and play parallel to another child rather than interact with each other. Their small muscle also develops at this stage and as a result they try to scribble, poke, and insert objects in hole. First they try with

round object in circular hole and gradually when they masters this, then they target the next stage of challenge of inserting other shape object in different shape holes matching the angles, they grasp different objects, hold them, pick them and do different activities. At this stage 'pretend play' is very common among them. In their world of imagination and creativity, they start pretending different things for what they see in the environment. They are in the world of creativity. For example, a very common things which they observe at home is adults having tea in cups and when they see things which has cup hole like cap, lid of a bottle, toy set of kitchenette, etc. as a part of pretend play, they start offering tea in them to adults and when they adults say that they are taking tea, the child say how can they take tea so fast because they prepared tea just now and is hot. At this stage they develop perceptual, imaginative and creative skill by imitating different situation through imitation of plays.

Table 3.1 Guidelines for Toys Intended for 12 to 24 Months

Goals: Skill improvement	
Gross Motor	Swings, stairs, backyard gym
Walk, jump, run, push, pull, carry	Obstacle courses (tubes, tunnels, boxes) Large balls 1.75 in. (44.5 mm) in diameter or greater
Balance	Activity tables (water, sand) Bubbles
Ride tricycle, run, jump	Scooters and later tricycles
Fine Motor	Blocks, nesting cups
Stacking, inserting, grasping, holding, eating with utensils	Pop up boxes Activity boards Ring stackers
Perceptual Motor	Picture books of heavy cardboard or plastic
Drawing, painting, kicking/hitting a ball, catching Imitation play	Games ° Follow the leader ° Music and dance

At the age between 24 months to 36 months, the children refine their large and small muscle skill. They run, jump from height and hang from arms. In this age they push, pull and steer well. With their developed fine motor skill they are able to manipulate small objects and draw. Children at this age understand numbers and counting. They enjoy learning pattern, sequences, order & sizes, textures and shapes. Children of this age group develops vocabulary skill and learns rhymes, recognizes characters and start watching cartoon shows on television and reads story books.

Table 3.2 Guidelines for Toys Intended for 2- to 3-Year-Old Children

Goals: Practice for Skill Refinement	
Gross Motor	Playground equipment
	Wagons, scooters, tricycles
Fine Motor	Dough, finger paints, water colors
	Simple shape sorters
Balance	Large connecting blocks
	Large plastic balls and bats
Perceptual-Motor	Wading pool and water toys
	Toy kitchens, lawn mowers, tools, grocery cart,
Imitation Play:	phone
"Realistic"	Dolls that can be bathed, fed, changed
representations	Stuffed animals
	Simple story books and 3 to 5 piece puzzles
	Play sets of people, cars, animals

Children of the age group between 3 years to 5 years develop their gross and fine motors skill further. At this stage children take risks and try to test their skills. With improved fine motor skill, children now grip pencil, able to cut with scissors, manipulate computer mouse and plays with string beads. Children start going to preschools and starts interacting with their peers and begins socializing. They draw various paintings now and creativity is important for them now. Children at this stage start enjoying dramatic plays with costumes and props (Harrell et al., 1997). One can notice gender differences in their play and assumption of roles. They now choose few different toys according to gender.

Table 3.3 Guidelines for Toys Intended for 3 to 5 Years

Goals: Improve Skills, Encourage Imagination	
Creativity and	Dress-up clothing and costumes
dramatic play	Life-size play houses and forts
	Toy cash registers, money, food, cars, tools,
Toys for fantasy or	carriages, dolls, etc.
representational play	Push, pull, and riding toys
	More complex shape sorters
Realistic detail and	Pegs, pegboards, and hammers

working parts	Crayons, paper, blunt-tipped scissors
	Connecting blocks or logs
Gross, fine,	Toy musical instruments
perceptual motor, and	Recorded songs to sing and dance along
balance skills	Games of chance
	Books, puzzles with more pieces
Games of chance not	Computer games or activities
strategy	

3.2.2 Role of toys in effective implementation of developmentally appropriate ECCE

Play serves as a fundamental aspect of early childhood development, providing a platform for exploration, experimentation, and social interaction. Play-based learning experiences support children's cognitive, social, emotional, and physical development in an integrated manner. Different types of play include:

- Sensorimotor play: Exploring through sensory experiences and movement

Sensorimotor play involves children exploring the world around them through sensory experiences and movement. This type of play allows children to engage their senses, such as touch, sight, and hearing, as they interact with different objects and textures. Through sensorimotor play, children develop fine and gross motor skills, spatial awareness, and coordination. Activities like digging in sand, splashing in water, and climbing on playground equipment are examples of sensorimotor play that stimulate children's sensory development while encouraging physical activity and exploration.

- Pretend play: Engaging in imaginative and symbolic play scenarios

Pretend play which is also known as symbolic or imaginative play engages children to create and act out fictional roles, situations, scenarios or narratives. Pretend play cultivates creativity, craftsmanship, language development, decision-making, problem-solving abilities including social skills in children.

These types of acts allow children to explore different viewpoints, emotions and social roles as they engage in role-play scenarios. Children may fancy/pretend to be characters from novels/stories and act out banal/routine scenarios like being police or bankers, may be teachers or cooking or doctor visits, or create any other elaborate fantasy worlds with their fellow ones. Symbolic play provides ample opportunities for children to learn how to

articulate their emotions, thoughts and ideas, and experiment with various social narratives and explore the sensory world around them in a creative and safe manner.

Imaginary role-playing helps children to build their own perspective of the social world according to their innate consciousness, which in turn gets moulded as they engage themselves in various imaginary scenarios. Moreover, their creativity and social skills develop manifold, which boosts a strong and crafty mindset allowing the child to explore his/her inherent personality through the pretend play. These types of acts also help the child to build a strong social character which becomes evident as he/she grows up. These imaginary environments created by the child are boosters for building a necessary social perspective about the world around him/her.

- Constructive play: Building and creating with various materials

Constructive play, as per its name, involves children using various materials to create, craft, build, and manipulate objects and structures. These types of acts boost hands-on spatial reasoning skills, exploration, and problem-solving capabilities in children. Through constructive play the child learns about various concepts such as cause-and-effect relationships, stability, balance and symmetry. Building with lego/blocks, stacking cups/boxes, re-arranging alphabetical/numerical blocks and solving puzzles are some examples of constructive play activities that builds and promotes a decent and specific set of motor skills, spatial awareness, and creativity. Constructive play also grooms cooperation and collaboration, as children work and craft together with their fellow companions to strategize, plan and execute their designs while sharing ideas and resources to achieve common goals.

These constructive plays help children foster a crafty and organized mindset allowing them to learn leadership roles as they engage themselves in these scenarios. Children also learn how to put all the pieces together to get a plan work in real-time situation. This helps them to foster a very crafty and structured mindset.Social play: Interacting and collaborating with peers and adults

- Social play encompasses interactions between children and their peers or adults, involving cooperation, communication, and collaboration. This type of play provides opportunities for children to develop social skills, empathy, and emotional regulation as they navigate social interactions and relationships. Social play takes various forms,

including cooperative games, role-playing, storytelling, and group activities. Through social play, children learn to take turns, share resources, negotiate conflicts, and work together towards common objectives. Social play also promotes language development, perspective-taking, and the formation of friendships, laying the foundation for positive social interactions and relationships throughout life.

Play-based learning experiences support children's cognitive, social, emotional, and physical development in an integrated manner. Toys stimulate children's curiosity, imagination, and creativity, providing opportunities for open-ended exploration and experimentation. By offering a diverse range of toys that reflect children's interests, abilities, and cultural backgrounds, ECCE programs create enriching learning environments that promote holistic child development and lay the foundation for lifelong learning. However, most of the toys are made of plastic and due to the short lifecycle of toys, the used toys goes to landfill which is creating pollution and has become a global concern. Because of the growing environmental awareness, consumers, these days are getting inclined to sustainable products. Therefore, there is a need developing for sustainable toys. There are different types of toys and each toy addresses a different developmental goal. While studying toys in terms of their developmental appropriateness, its been noticed that following aspects are considered in developmental appropriateness: age-appropriate features, multi-sensory engagement, open-ended play and social and emotional learning.

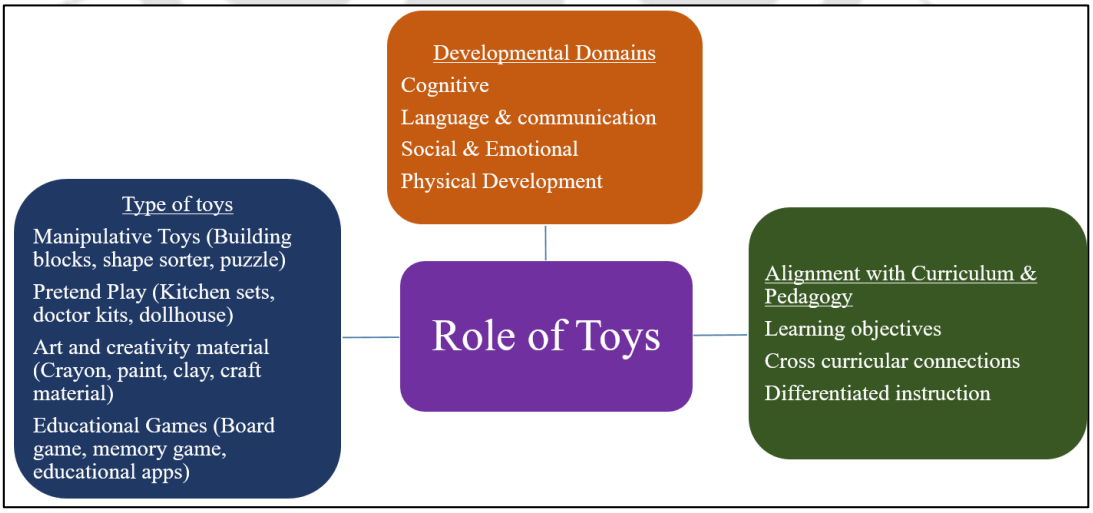


Figure 3.2 Role of Toys

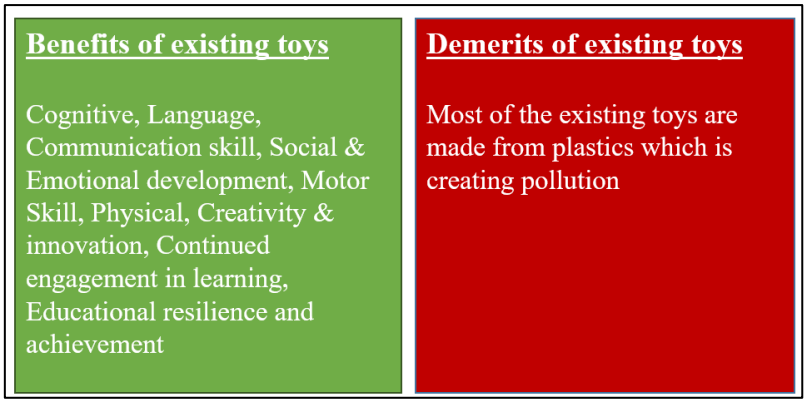


Figure 3.3 Benefits and Demerits of Toys

3.3 Bamboo toy as a sustainable intervention in ECCE

3.3.1 Developmentally Appropriate Early-Child-Care and Education (ECCE) Practices

Early childhood is a critical period of rapid growth and development, forming the bedrock for lifelong learning and well-being. In acknowledgment of this, Developmentally Appropriate Practices (DAP) in Early-Child-Care and Education (ECCE) have emerged as a guiding framework to ensure that educational experiences resonate with children's individual developmental needs, interests, and capacities. This essay embarks on an exploration of the principles and practices of DAP in ECCE, with a focus on curriculum, pedagogy, the role of play, and the significance of toys in nurturing holistic child development.

Developmentally Appropriate Practices (DAP) in ECCE encompass a set of guidelines grounded in research and theory in child development, education, and psychology. DAP emphasizes the importance of creating learning environments that are attuned to children's diverse backgrounds and developmental stages. Key principles of DAP include:

- Respecting children's autonomy and individuality
- Cultivating nurturing and supportive learning environments
- Recognizing the significance of social and emotional development
- Integrating play-based and hands-on learning experiences
- Collaborating with families and communities
- ECCE Curriculum and Pedagogy:

The ECCE curriculum aims to foster children's holistic development across multiple domains, including cognitive, language, social, emotional, and physical growth. A developmentally appropriate curriculum is adaptable, responsive, and scaffolded to meet the varied needs and interests of young learners. Pedagogy in ECCE underscores active, child-centered learning experiences that encourage inquiry, exploration, and creativity. Educators serve as facilitators, guiding children's learning through meaningful interactions, open-ended questioning, and purposeful teaching strategies.

3.3.2 The Significance of Toys in ECCE

Toys play a crucial role in Early-Child-Care and Education (ECCE), serving as tools for learning, exploration, and development. Since play is the only occupation of a child, a toy will always play an important role in developing a child through play. Developmentally appropriate toys are carefully selected to support children's play experiences and promote various aspects of their development, including cognitive, social, emotional, problem solving and physical skills. These toys develop various aspects in a child. They stimulate children's curiosity, creativity, and imagination, while providing opportunities for open-ended exploration and experimentation. Further, toys facilitate peer interactions, cooperation, and communication, fostering social skills and collaborative play. For developing a foundation for lifelong learning, ECCE programs need to create an learning environment will promote a holistic child development through a diverse range of toys that reflect children interests, abilities and background.

Effective toys in ECCE possess the following characteristics:

- Safety and durability
- Open-ended and adaptable play possibilities
- Alignment with learning objectives and developmental goals
- Representation of diverse cultures and experiences

3.3.2.1 Cultural Considerations in Toy Design

Human society heavily relies on social and cultural diversity which includes ethnicity, religion, language, customs, and traditions. In toy designing, it is necessary to felicitate and acknowledge the social and cultural identities and experiences of children from various

backgrounds. Integrating features of cultural variety into toy designing enables the designers to craft and develop such items that reflect children's real-time experiences and honor their distinct identities and touchpoint various aspects of their social lives and environments.

Toys are not just playthings; they are symbolic of a higher benchmark in a society. They are cultural embodiments of the beliefs, traditions and values of society. Cultural issues/problems in toy design are vital for developing play-items that appeal and motivate children from diverse backgrounds and origins, and foster representation and inclusivity . This peruses and emphasizes the essence of cultural factors in toy designing and asserts the vitality of incorporating cultural diversity in toy production.

Representation is an essential element of cultural consideration in toy designing. Toys ought to have diverse perspectives, characters, imagery, and themes that represent the multicultural environment/society in which children exist. When kids are able to imagine themselves reflected in the things they play with, it encourages them, boosts their morale and helps them feel like they belong. Moreover, an exposure to different representations in toys cultivates comprehensive thinking, empathy, and cultural awareness among young minds from various cultural backgrounds.

Originality is another vital cultural consideration in toy designing. Toys must authentically and respectfully portray cultural customs, traditions, and symbols. Toy designers ought to have healthy discussions with cultural specialists and do their homework to make sure their creations/products are respectful to different cultures. Authentic depiction in toys fosters children's comprehensiveness of diverse cultures and cultivates reverence and appreciation for the world's variety that exists around them and to treat everyone equally well.

Furthermore, cultural factors in toy design enclose representation, inclusivity and accessibility. Toys should be comprehensively accessible to children of all abilities, irrespective of their ethnic, social or cultural background or physical features. Designers must acknowledge that language, sensory demands, and physical limitations are very crucial as well as critical while developing toys to guarantee inclusive games for all children.

To conclude, cultural considerations are innate to toy designing, which in turn shape the way children interpret and engage with the environment/society around them. By integrating cultural diversity, representation, genuineness, inclusivity, and accessibility into toy designing, the designers can create products that can inspire, educate, empower and entertain children from diverse cultural backgrounds. Lastly, culturally inclusive toys have the potential to boost and promote cross-cultural comprehensiveness, appreciation and empathy, contributing towards a more harmonious and inclusive world around us. This will encourage children to learn how

diversity plays a crucial role to build a society that unites us despite all the variety that exists. After all, "diversity in all its forms, is the path to greatness."

3.3.2.2 Parental Involvement and Support

Parental involvement and support plays a crucially paramount role in children's progress, development and learning, specifically during the initial juvenile years. The significance of parental involvement in supporting child development to encourage appropriate play and learning has always been indispensable for the society. While focusing on how sustainable toys can be incorporated into domestic environments to promote parental engagement is very critical as well as vital in today's world.

Parents are the most influential metors in a child's life. They shape the fundamental attributes of a child's behavior, psychology, attitude and beliefs from an initial age. Various research consistently and recurrently shows that parental involvement positively and highly affects a child's academic and social achievements, socio-emotional development, and overall progress in life. In the context of play and learning, parents play a pivotal role in creating an enlightening, supportive and enriching environment at home that stimulates child's creativity, inquisitiveness and exploration.

In other words parents are those teachers for children who can foster and support developmental and appropriate play-learning experience by providing access to a variety of toys and materials that boosts open-ended exploration and creativity at home. Sustainable toys are usually made from eco-friendly materials and are designed to promote imaginative or creative play and problem-solving for children. These sustainable play-items offer a superlative opportunity for parents to engage their children in comprehensive play experiences that can nurture their creativity, social mindset, environmental consciousness and a playful-domestic atmosphere. By choosing sustainable toys, parents not only promote environmental awareness but also showcase their responsibility towards the global environment by providing children with excellent quality, safe, and developmentally appropriate play-materials.

Integrating sustainable toys into domestic environments can promote parental engagement by cultivating collaborative play and shared experiences between parents and their children. Parents can show their active participation in play activities, asking open-ended questions, providing guidance, mentorship and grooming children's creativity and craftsmanship, critical thinking and fundamental decision-making skills. Sustainable toys also provide opportunities for parents to discuss important concepts such as environmental consciousness, conservation, recycling, and

sustainability in age-appropriate ways thereby helping and guiding their children in developing a sense of stewardship and responsibility towards the planet as well as our society.

Furthermore, parental involvement in children's play and learning transcends beyond providing toys and materials. Parents can foster a nurturing, engaging and supportive environment that values and promotes play, creativity, and exploration. By building positive attitudes towards learning, inquisitiveness, and problem-solving, parents can inspire and motivate children to engage themselves in comprehensive play experiences that boosts their systemic development and progress as a whole.

In conclusion, parental involvement and support are not only crucial but also critical for promoting developmentally appropriate play and learning in early childhood. By integrating sustainable toys into domestic environments and actively engaging in play activities with their children, parents can create very enriching and meaningful learning experiences that foster creativity, curiosity, and environmental consciousness. Ultimately, parental involvement not only enhances children's development and well-being but also strengthens the bond between parents and children, laying the foundation for extensive learning and positive relationships that can last a lifetime.

3.3.3 Sustainable Toy Design Principles

Sustainable toy design principles are the guidelines that says the toys are generated with minimal environmental impact, ensuring they are eco-friendly, safe, and durable. The toy industry is now a concern for global pollution and is gradually shifting towards sutainable solution because of the increased environmental awareness among consumers. According to these principles, eligibility of being sustainable demands that the material used for manufacturing toys should be natural material, or recycled or bio-based materials. These toys need to take care of the aspects of the toy's lifecycle, from material selection to manufacturing processes and end-of-life considerations, so that they do not become health hazard for users.

3.3.3.1 Environmental Considerations in Toy Design

Environmental considerations in toy design involve assessing the environmental impact of various aspects of the toy's lifecycle. The design needs to be cradle to cradle and not being cradle to grave design. The various aspects include proper selection of raw materials, minimal waste during manufacturing processes, selection of packaging materials, transportation, and end-of-life disposal. The design objective is to reduce the consumption of resource, optimal use of energy, minimal greenhouse gas emissions, and minimal waste generation throughout

the toy's lifecycle. For example, using recycled materials or sustainably sourced wood reduces the demand for virgin resources and helps conserve natural habitats.

3.3.3.2 Material Selection and Lifecycle Analysis

Material selection is the prime aspect of sustainable toy design. Selection of the proper material, which are environmentally friendly, such as certified sustainable wood, bamboo, recycled material or recycled plastics, or organic fabrics. Lifecycle analysis involves assessing the environmental impact of materials from sourcing to disposal. This assessment helps to evaluate various aspects like resource depletion, energy consumption, greenhouse gas emissions, and waste generation during the entire life of the product. Further, selecting the materials with lower environmental footprints and conducting lifecycle assessments, designers can make informed decisions to minimize the environmental impact of their toys.

3.3.3.3 Eco-friendly Manufacturing Processes

Sustainable toy designers prioritize eco-friendly manufacturing processes that minimize environmental harm. This includes reducing energy consumption, water usage, and emissions, as well as implementing waste reduction and recycling initiatives. For example, using energy-efficient machinery, renewable energy sources, and water-saving technologies in manufacturing facilities helps reduce the carbon footprint of toy production. Additionally, implementing closed-loop systems to recycle manufacturing waste and using non-toxic, water-based adhesives and finishes further enhance the eco-friendliness of the manufacturing process.

3.3.3.4 Designing for Durability and Safety:

Sustainable toys are designed to be durable, long-lasting, and safe for children to use. Designers prioritize quality craftsmanship, sturdy construction, and non-toxic materials to ensure that toys withstand rough play and meet stringent safety standards. By designing toys that are built to last, designers reduce the need for frequent replacement and minimize waste generation. Furthermore, designing toys with rounded edges, non-toxic paints, and child-safe components ensures that they are safe for children to play with, promoting their health and well-being.

By incorporating these sustainable toy design principles, designers can create toys that not only provide hours of fun and enjoyment for children but also minimize their environmental impact and contribute to a more sustainable future.

3.3.4 Inclination of consumer towards sustainable products

The concerns for environment with respect to consumer product have been growing among the users. This has attracted the attention of both practitioner and academics. With the growing influence of social media, the concern for environment is being widely spread. Consumer's intention and motivation of buying sustainable products over non-environment friendly products is very different (Zahid et al., 2018). Factors affecting green product purchase decision among Indian consumers were studied and they were identified, which would help in segmentation of the customer for green toys. It was identified that, support environmental protection, drive for environmental responsibilities, green product experience and social appeal made Indian consumers to opt for green products (P. Kumar & Ghodeswar, 2015).

To understand the consumer's inclination towards green products in the other geography, a paper on determinants of green product buying decision among young consumer in Malaysia was studied. The result indicated that environmental consciousness, eco label, price and advertising influence on consumer buying decisions (Tan et al., 2019). The growing concern about sustainable product have co-evolved sustainable packaging concept. Presently pollution from plastics, packaging-related waste, declining air, soil and water quality, climate change and other challenges are influencing packaging industry. However, unless sustainable packaging drives sales or reduce cost, companies would not implement it across despite their intention on sustainability (Boz et al., 2020). Considering the negative environment impact of plastic toys and its damaging effect on ecosystem, specifically on children growth and development, it is very important to understand the consumer behavior towards sustainable toys. Majority of the green literature are about consumer behavior towards products like clothing, home durable, personal care, food, cosmetic and automobile. However, not much work on consumer behavior towards eco-friendly toy for children. One of the study with 174 respondent revealed that buyers value eco-friendly attribute of green toys and ready to pay a premium on prices for eco-friendly toys. This study has valuable implication for government and toy makers to uplift the green toy market in India (Saini et al., 2024).

3.3.5 Value added products from bamboo

Bamboos are used for a great variety of purposes, especially in East and Southeast Asia. The seeds of some species are eaten as grain, and the cooked young shoots of some bamboos are eaten as vegetables, especially in Chinese cuisines. The raw leaves are a useful fodder for livestock. The pulped fibers of several bamboo species, especially Dendrocalamus strictus and

Bambusa bambos, are used to make fine-quality paper. The jointed stems of bamboo have perhaps the most numerous uses; the largest stems supply planks for houses and rafts, while both large and small stems are lashed together to form the scaffoldings used on building-construction sites. The stems are also split up to make buckets and pipes or are used to make furniture, flooring, walking sticks, fishing poles, garden stakes, and other utensils. Some species of bamboo are used as ornamentals in landscape gardens. The fine-grained silica produced in the joints of bamboo stems has been used as a medicine for centuries under the name tabasheer. East Asian artists, poets, and epicures have long celebrated the beauty and utility of bamboo in paintings and verse.

Table 3.4 Value added product of bamboo

Bamboo structures	Resorts, Bridges, Fencing, Pavilions, floors, residence, gates etc.
Bamboo furniture	Chair, stools, tables, beds, easy chairs, screens etc.
Bamboo interiors	Bamboo blinds, curtains, table mats, floor mats, car seat covers etc.
Bamboo handicrafts	Lamps, Wall clocks, Flower vase, hand fans, candle holders, etc.
Bamboo products	Helmets, skateboards, bamboo laptop cover, mobile cover, incense sticks, etc.
Bamboo textiles	All kinds of garments, bamboo clothes
Bamboo crockeries	Bowls, Vases, Trays, Plates, Glasses, Spoons, etc.
Bamboo transport	Bamboo boat, bamboo cycle, bamboo canoe etc.
Musical instruments	Flute, Gungura etc.
Food processing	Bamboo juice, bamboo beer, bamboo shoot dishes, medicines etc.
Bio-energy	Fire wood, Briquettes, charcoal, bio-ethanol, bio-fuels, gas

Source- Booming Bamboo (INBAR), Green Gold (NBM)

Studies show that toy development from bamboo is almost negligible and not much mentioned on literature. The bamboo toy industry is in nascent stage and is developed only for research purpose and prototypes are developed for testing. Raw bamboo is the major component of bamboo industry in India. Assam is the biggest supplier of raw bamboo to the domestic market in India (Chanu, 2023). Paper, biofuel and scaffolding are the major sector consuming the raw bamboo. Bamboo industry in high value added product in India is still in its nascent stage and unprocessed raw bamboo is a dominant product in the domestic market.

3.3.6 Researches on bamboo toys

Play being the most important part of child life, various schools and early child care centres are using play as a tool for teaching the concept and development of children. A variety of toys are used for the purpose and most of these toys are made of plastics and wood. However, during the pandemic we have noticed that there was disruption in the supply chain and as a result many of such toys became unavailable in many markets. Some of these toys though are now available on ecommerce platform and can be delivered at many locations. Still a majority of the people cannot buy them because of lack of awareness and also many others cannot afford them. Bamboo, as a rapidly renewable, biodegradable, and low-impact material, offers significant environmental benefits by reducing dependence on plastic and synthetic alternatives, aligning with sustainable production practices (SDG 12). Its local availability and the presence of skilled artisans in regions like Northeast India present an untapped opportunity—though bamboo toy-making is not yet popular, growing consumer use can stimulate demand, generating additional income and encouraging eco-friendly manufacturing. Culturally, bamboo is deeply rooted in Indian traditions, and using it in toy-making not only introduces children to indigenous knowledge systems but also fosters local pride, emotional connection with artisans, and a sense of community. Over time, these experiences can inspire future entrepreneurship, policy support, and global promotion of regional crafts. Educationally, bamboo toys enhance sensory and cognitive development, promoting values like sustainability and community-consciousness from an early age. Moreover because of its inherent property i.e. bamboo is strong, straight, flat, hard, easy to divide, easy to shape, easy to work and easy to transport, makes bamboo as a suitable material for making various toys & equipment.

A research on Design of sustainable bamboo toys for preschool children in Department of Design Engineering of TU Delft university further makes it logical for studying the bamboo toys for preschool as the raw material is available in many rural areas. Tre Vang company which is a small scale bamboo factory in Vietnam has developed a construction game (Marble Runs) with solid bamboo. This toy was prepared for the preschool in Netherlands. Children play in group where they construct the entire game by fixing small pieces in particular slots. The children create marble runs with various pieces in the set which stimulate their creativity & reasoning. This helps to develop the hand-eye coordination of the children. The solid bamboo makes the product attractive. The product is hand-made, which makes it good connect between producer & consumer and consumer and product (Teh, 2010).

Another research was conducted on the utilization of local bamboo-based materials for innovation of playing and creating media in children of preschool age. This study was done by Department of Product Design, Duta Wacana Christian University, Yogyakarta, Indonesia. The play which was considered here was puzzle because the puzzles are very good for motoric skill development of children and improve the coordination for hands and eyes. Bamboo was used as a material due to the lack of availability of play and creative media in the Amongsiwi playgroup, Panggungharjo village, Bantul. The entire idea was to use local available materials in the form of puzzle. These puzzles were made from a particular bamboo variety called Cedani Bamboo. The research was on collecting data, analyse the problem, product development and testing the product on a group of children. On performing the test, 76% of the test group responded positively by creating various shapes of animal, car, robot, etc. with the puzzle components (Purwanto, 2020).

These bamboo toys if produced in bulk at low cost then these can be very useful for the rural community. It is also possible to develop such toys by the artisans in the local community. It will boost the artisans in the community and give a feeling of playing with natural materials among the children. Due to the abundant availability of bamboo in north east region and very skilled artisans in the region, it makes sense to research in this area further and explore various opportunities for innovative bamboo toys for ECCE and preparing for an atmanirbhar bamboo toys for ECCE in the local level.

3.3.7 Design Management Model

Design management plays a pivotal role in shaping the development and implementation of innovative solutions across various domains. In the context of Early-Child-Care and Education (ECCE), the integration of design management principles with sustainable toy design presents an opportunity to create enriching learning experiences for young children while promoting environmental consciousness. This essay explores the framework for a Design Management Model that integrates ECCE practices and sustainable toy design, highlighting its key components and providing case studies or examples to illustrate its application.

3.3.8 Integration of ECCE Practices and Sustainable Toy Design

The integration of ECCE practices and sustainable toy design involves aligning educational objectives, pedagogical approaches, and sustainability principles to create developmentally appropriate and environmentally conscious learning experiences for young children. Sustainable toy design principles, such as material selection, eco-friendly manufacturing

processes, and designing for durability and safety, are integrated with ECCE practices to promote holistic child development while fostering environmental stewardship.

3.3.9 Framework for Design Management in ECCE

The framework for Design Management in ECCE encompasses a systematic approach to conceptualizing, developing, and implementing sustainable toy design initiatives within early childhood educational settings. This framework involves collaboration between educators, designers, manufacturers, policymakers, and other stakeholders to ensure that toys meet the educational, developmental, and sustainability goals of ECCE programs.

3.3.10 Key Components of the Model

- Needs Assessment: Conducting a comprehensive needs assessment to identify the educational, developmental, and environmental needs of children in ECCE settings.
- Design Brief: Developing a design brief that outlines the objectives, requirements, and constraints of the sustainable toy design project, incorporating input from educators, parents, and children.
- Concept Development: Generating creative concepts for sustainable toys that align with ECCE practices and sustainability principles, considering factors such as age appropriateness, play value, and cultural relevance.
- Prototyping and Testing: Building prototypes of sustainable toys and conducting rigorous testing to evaluate their functionality, safety, and appeal to children.
- Production and Distribution: Implementing eco-friendly manufacturing processes to produce sustainable toys at scale, ensuring compliance with sustainability standards and ethical practices.
- Evaluation and Feedback: Assessing the effectiveness of sustainable toys in ECCE settings through ongoing evaluation and feedback from educators, parents, and children, and making iterative improvements as needed.

3.3.11 Details of the Design Management Model

The ECCE (Early Childhood Care and Education) model is an approach to early childhood education that focuses on the holistic development of children from birth to eight years old. This model emphasizes nurturing care, education, health, and nutrition to support children's overall well-being during their formative years. Design management plays a pivotal role in shaping the development and implementation of innovative solutions across various domains. In the context of Early-Child-Care and Education (ECCE), the integration of design management principles with sustainable toy design, aligning to UN sustainable goals and livelihood generation presents an opportunity to create enriching learning experiences for young children while promoting environmental consciousness and creating employment opportunities. The integration of ECCE practices and sustainable toy design involves aligning educational objectives, pedagogical approaches, and sustainability principles to create developmentally appropriate and environmentally conscious learning experiences for young children. Sustainable toy design principles, such as material selection, eco-friendly manufacturing processes, and designing for durability and safety, are integrated with ECCE practices to promote holistic child development while fostering environmental stewardship.

Initially, all the stakeholders involved in introducing bamboo toys in ECCE were identified.

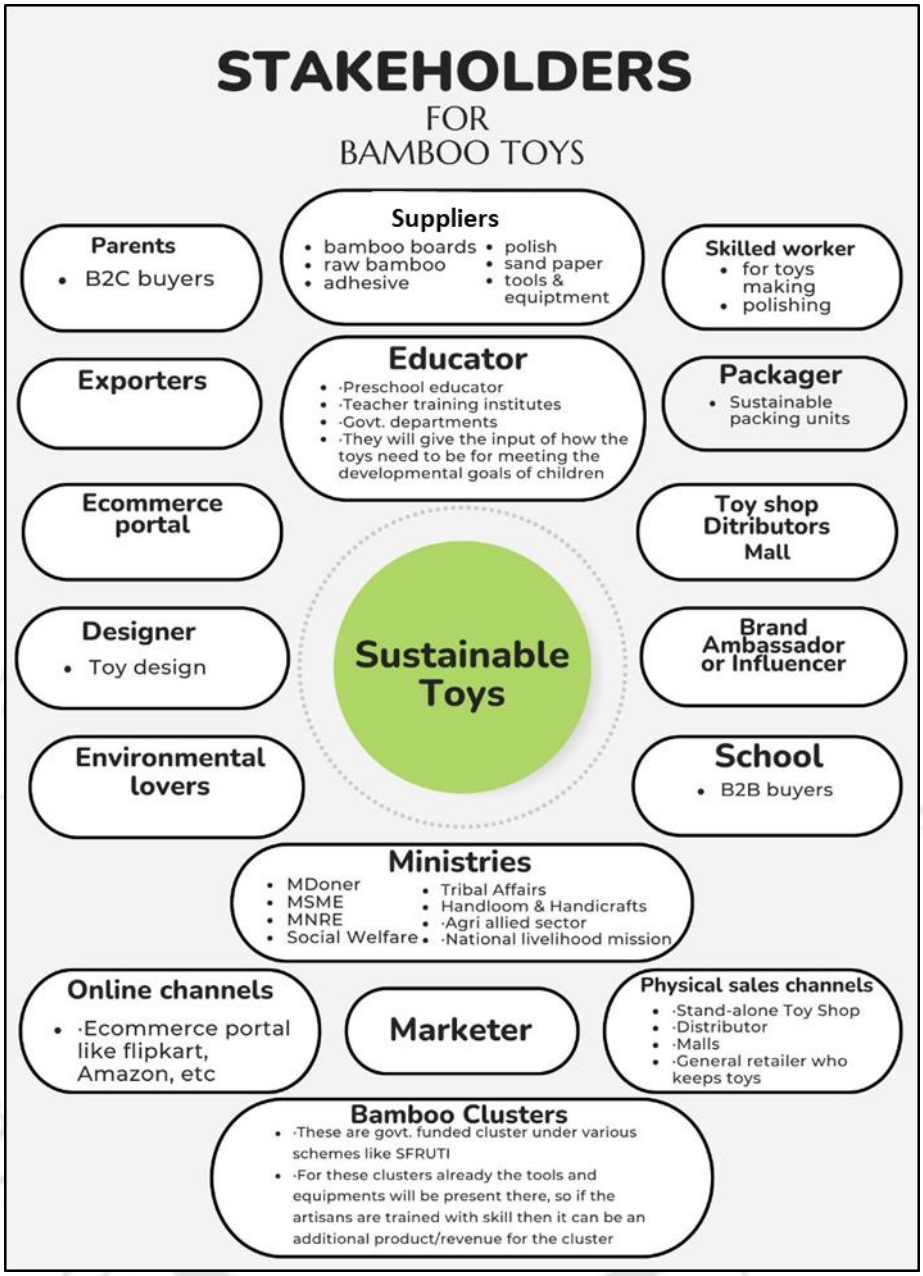


Figure 3.4 Stakeholder mapping

Then general toy design principles which encompass a set of guidelines and considerations that aim to create engaging, safe, and developmentally beneficial toys for children were listed. Further Sustainable toy design principles were identified and these principles were considered while designing the prototype.

Table 3.5 General toy design Principles

Safety	Age Appropriateness	Durability and Quality	Educational Value	Engagement and Playability
Inclusivity	Environmental Sustainability	Functionality and Versatility	Aesthetic Appeal	Feedback and Iteration

Table 3.6 Sustainable toy design Principles

Material Selection	Durability and Longevity	Minimal Environmental Impact	Design for Disassembly and Recycling	Local Sourcing and Production
Biodegradability and Composability	Educational and Developmental Value	Packaging and Marketing	Certifications and Standards	Continuous Improvement and Innovation

Integration of ECCE practices with principles of sustainable toys design have a profound impact on children's development and environment stewardship and aligned towards global objective of Sustainable Development Goals.

Table 3.7 Sustainable development goals

SDG	Integration	Impact
SDG 1: No Poverty SDG 8: Economic growth	Holistic development, engagement of rural Community, educator, parents, small-scale producer, artisans and entrepreneurs	Job creation, new market creation, Enterprise development, Stimulate PPP model, new economic opportunity
SDG 3: Good health and well-being	ECCE setting, sustainable material in toys	Safer, non-toxic alternatives for children's health & well-being
SDG 4: Promoting Quality Education	Learn through play, Holistic development, Innovative design & material (These toys include puzzles, building blocks, etc.)	Lifelong learning, critical thinking, logical reasoning, cognitive, emotional, social & community engagement
SDG 5: Gender Equality	Inclusive toys irrespective of gender	Break gender barrier

SDG 12: Responsible Consumption & Production	ECCE settings, Sustainable material, promoting importance of sustainable practices	Behavioural change, Choices as consumer & citizen, create global citizenship, reducing waste and environmental impact
SDG 13: Climate Action	Sustainable sourcing for toys used in ECCE settings	Environmental awareness for long term, foster a sense of responsibility towards the environment.
SDG 15: Life on land	ECCE setting with toys made from sustainable material	Restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
SDG 17: Partnership for the Goal	Multi-stakeholder, global cooperation, community engagement	Environmental awareness, Global citizenship, Economic opportunities, Innovation, improved SCM, New market

Presently, many products are developed using bamboo but toys (Teh, 2010) made from bamboo as material (Purwanto, 2020) is limited and still in the research phase. Creating livelihoods from bamboo toys involves leveraging the sourcing, manufacturing, and distribution processes associated with bamboo-based products. Bamboo toys can be an additional revenue generation source for artisans and clusters working on bamboo. It can also be a new idea for enterprise development for entrepreneurs and thus create jobs.

Table 3.8 Bamboo toys for revenue generation

Jobs	Entrepreneurship	Income generation	Community Development	Environmental Stewardship
• Cultivation • Processing • Design • Distribution	• Skill development • Processing unit • Sustainable packaging • Marketing agencies	• Fair trade • Income diversification	• Infrastructure • Education & Healthcare	• Sustainable Practices • Climate Resilience livelihood

Chapter 4

Sculpting Bamboo Toy: Development, testing and strategies to implement bamboo toys in ECCE

Chapter 4

Sculpting Bamboo Toy: Development, testing and strategies to implement bamboo toys in ECCE

Triangulating toy design principles, sustainable development goals and livelihood generation through bamboo toys, a few toy prototypes were created using bamboo as material and then they were tested with children in ECCE settings. Three bamboo-based toys were developed and tested: Jenga, shape puzzle and spindle box. It outlines the comprehensive manufacturing process and the subsequent testing phases to ensure these toys meet the required safety and quality standards.

4.1 Process of manufacturing Bamboo Toys

While developing the prototype, the raw material of bamboo boards were sourced from a factory in Assam and mat boards were sourced from Meghalaya. The prototype was developed by a skilled carpenter who gives training to artisans for skill development. While working on the prototype it was difficult to find vegetable glue which are non-toxic as the toys are made for small children. As per the technical person who worked on prototype development, the skill can be trained to artisans and the above toys can be produced by local artisans provided they have the machineries.

Cutting

Machine drilling

Drilling with hand tool

Measuring

Grinding

Putting Adhesive

Sanding

Polishing

Drying

Figure 4.1 Development process of prototypes of Bamboo toys

4.2 Overview of Bamboo Toys prototypes and Their Educational Benefits

A detailed description of the bamboo toys, focusing on how each toy is played with and the educational advantages they offer. Each toy has been carefully designed to align with Developmentally Appropriate Practices (DAP) in Early Childhood Care and Education (ECCE), promoting both cognitive and motor development in children. Additionally, the chapter provides a brief historical context for each toy, illustrating how these classic toys have been adapted into sustainable bamboo versions.

4.2.1 Tangram Puzzle

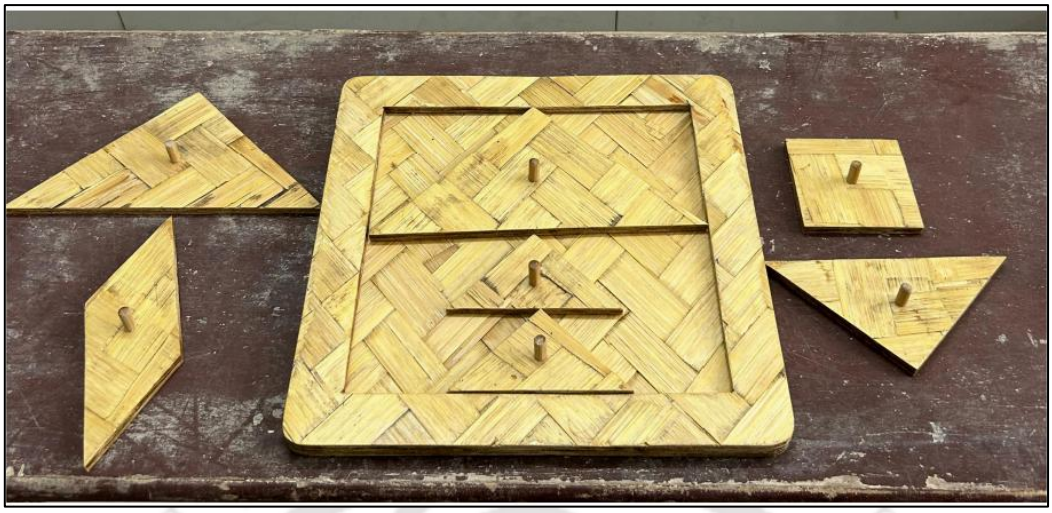


Figure 4.2 Tangram puzzle

The tangram puzzle is originated in China and gain popularity in Europe and North America in 19th century. It has simple design and enhance creativity, focus and understanding of basic shapes.

The Tangram Puzzle consists of seven flat, geometric pieces known as "tans". These pieces include:

- Two large triangles
- One medium triangle
- Two small triangles
- One square
- One parallelogram

How to Play: The Tangram Puzzle consists of seven geometric pieces which include two large triangles, one medium triangle, two small triangles, one square, and one parallelogram. The task is to develop or make specific shapes using all seven pieces without overlapping the tangs. Children can either use a guidebook with various designs or create their own inspired shapes. The pieces can be rotated or flipped to fit together, but they must touch without overlapping.

Gameplay:

Step. 1 Choosing a Shape

The child starts by selecting a target shape or design from the guidebook or by deciding to create their own shape. Common shapes that they can takes are animals, objects, or geometric figures like a house, boat, or bird.

Step 2. Arranging the Pieces

The child then arranges the seven geometric pieces to match the selected design. This can be done by rotating the pieces clockwise or anticlockwise or flipping in any direction, but all pieces touch each other without any overlapping.

Step 3. Ensuring No Overlap

The child should make sure that all pieces fit together without any gaps between tang, and no pieces overlapping. This encourages careful thinking and attention to detail.

Step 4. Challenges

If the child is comfortable with the basic designs, they can try completing more complex shapes or even create their own. For a fun challenge, the child can attempt to solve the puzzle without looking at any solutions or guides, boosting creativity and problem-solving skills.

4.2.1.1 Educational Benefits of the Tangram Puzzle

The Tangram Puzzle is an educational tool that has been used to enhance a variety of cognitive and developmental skills in children. It plays a significant role in early childhood education, as it helps develop:

1. Problem-solving Skills

   Children must figure out how to arrange the seven geometric pieces to form a specific shape. This requires logical thinking and the ability to visualize different configurations.

2. Creativity

   While the puzzle can be solved by following specific patterns, it also allows children to create their own shapes and designs, encouraging creative thinking and imagination.

3. Hand-eye Coordination

   Rotating and fliping the pieces and arranging them in various configurations requires fine motor skills and coordination, which are crucial for young children as they develop.

4. Geometry and Mathematical Concepts

   In drawing or sketch all the complex sketch and design starts with geometrical shapes. The Tangram Puzzle introduces children to basic geometric shapes and

relationships and how to use them to make some meaningful shape. By manipulating triangles, squares, and parallelograms, children gain a better understanding of how shapes can combine to form new ones.

4.2.2 Fraction Puzzle

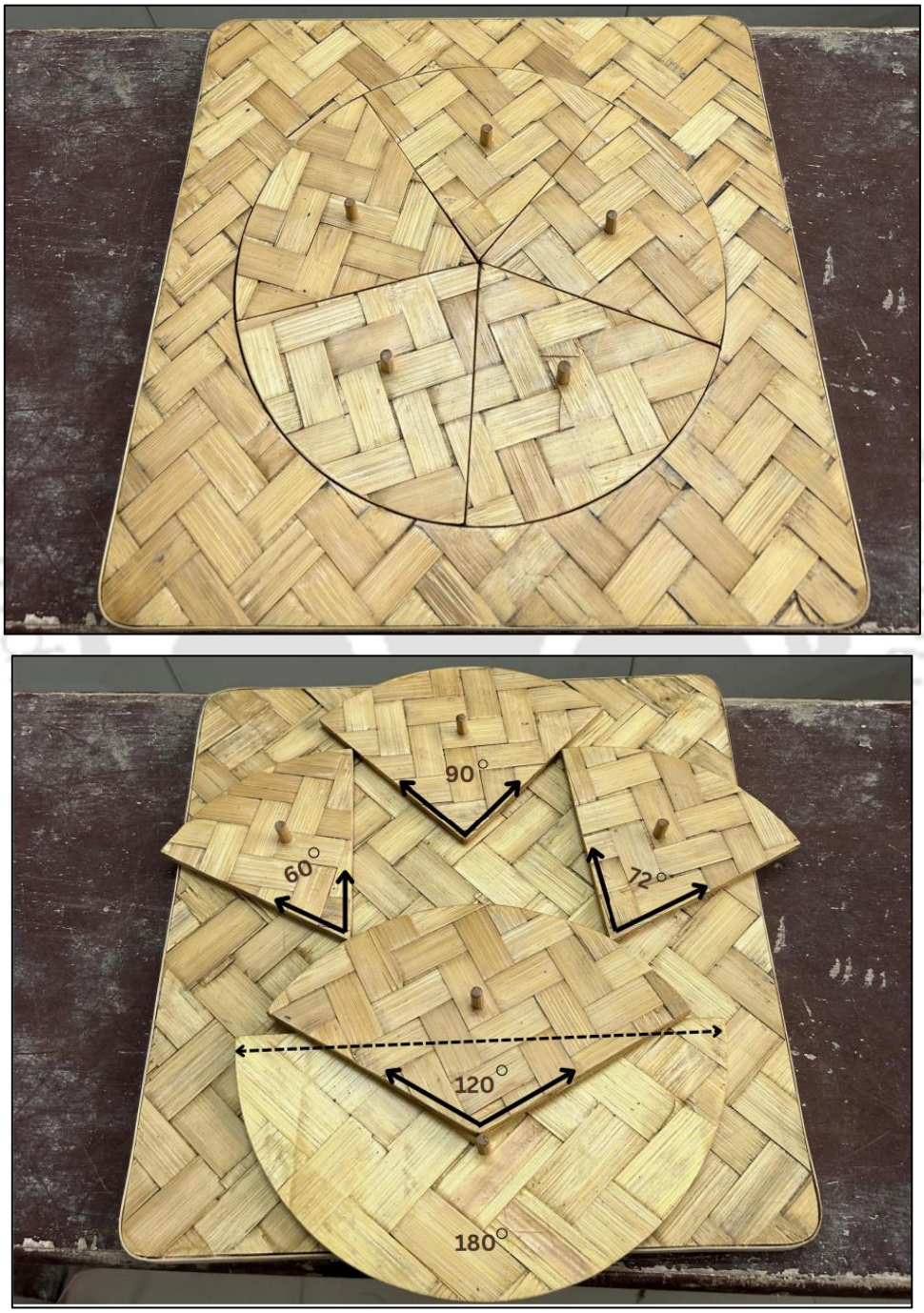


Figure 4.3 Fraction Puzzle

The Fraction Puzzle is designed to teach children the concept of fractions in a fun, interactive, and visual way. Unlike traditional methods of teaching fractions through written symbols or equations, the Fraction Puzzle let children to physically manipulate fraction pieces to understand how parts relate to a entire shape. These puzzles are often used in early childhood education as a hands-on approach to math learning.

How to Play: The Fraction Puzzle helps children understand basic fraction concepts through color-coded, proportionally-sized pieces that represent different fractions (e.g., 1/2, 1/3, 1/4). Children match fraction pieces to form whole shapes or experiment with combining fractions. For example, two 1/2 pieces create a whole, or a child may combine 1/2 and 1/4 pieces to explore fraction addition.

Pieces

The puzzle typically includes pieces representing various fractions, such as:

- **Whole** (1)
- **Half** (1/2)
- **Thirds** (1/3)
- **Quarters** (1/4)
- **Other Fractions** (e.g., 1/5, 1/8, etc.)

Each fraction piece is color-coded and sized proportionally to visually represent different parts of a whole. The pieces can be circular, rectangular, or other shapes that divide into equal parts.

Setup

- The child should play on a flat surface, where they can spread out the fraction pieces.
- If the puzzle comes with a board or template, it can be used to guide the child in placing the pieces correctly.

Gameplay

Step1. Introduction to Fractions

Begin by introducing the child to the basic concept of fractions. For example, explain that a "half" represents one of two equal parts, and a "quarter" represents one of four equal parts.

Show the child how a whole piece can be divided into smaller fraction pieces, such as two halves or four quarters.

Step 2. Matching Fractions

The child is given several fraction pieces (e.g., 1/2, 1/3, 1/4) and asked to match them on the board or template to form a whole.

For example, the child can place two 1/2 pieces together to form one whole or place four 1/4 pieces together to complete the shape.

Step 3. Exploring Equivalent Fractions

As the child becomes more familiar with the puzzle, they can experiment with combining different fractions to see how they relate.

For example, the child can place 1/2 and 1/4 pieces together and learn that they do not make a whole, or combine 1/2 and 1/2 to understand that two halves make a whole.

This helps the child understand equivalent fractions (e.g., 2/4 = 1/2) in a visual, hands-on way.

Step 3. Solving Fraction Problems

Once the child is comfortable with the basics, more complex problems can be introduced. For example, you might ask the child to combine 1/3 and 1/6 pieces to see how many fractions are needed to make a whole.

For older children, you can ask them to experiment with fraction addition and subtraction using the puzzle pieces (e.g., 1/2 + 1/4 = ?).

Step 4. Advanced Play

For children who have mastered the basics, you can challenge them by introducing more complex fractions or asking them to create specific fraction combinations. This helps deepen their understanding of fraction operations and equivalency.

4.2.2.1 Educational Advantages

- **Mathematical Understanding:** The puzzle provides a hands-on method to introduce children to fractions, teaching them about parts of a whole and equivalent fractions.
- **Problem-solving Skills:** Children develop critical thinking by experimenting with different combinations of fraction pieces to solve fraction-related problems.
- **Fine Motor Skills:** Manipulating the fraction pieces helps children refine their hand-eye coordination and dexterity.
- **Confidence in Math Proficiency:** Early exposure to fractions through interactive play fosters a positive attitude toward mathematics and builds confidence.

4.2.3 Jenga Toy

Figure 4.4 Jenga Toy

Jenga is a popular block-stacking game that challenges players to build a tower by carefully and mindfully removing and re-stacking blocks without causing the tower to fall. It is a game of physical skill, strategy, and patience that can be enjoyed by players of all ages. The name "Jenga" is derived from the Swahili word "kujenga," meaning "to build." The appeal of Jenga lies in its simplicity and its ability to engage players in a mix of concentration, fine motor skills, and strategic thinking, making it not only a fun activity but also an educational tool in early childhood development.

How to Play: Jenga toy has 54 bamboo blocks stacked in layers of three, with each layer oriented perpendicular to the previous one. The players has to carefully removing one block at a time from the tower and placing it on top without causing the tower to collapse. The hack is that the player can only use one hand to remove or place blocks.

Setup

- **Building the Tower**
    - To set up the game, all 54 blocks are stacked in levels of three, with each level's blocks arranged perpendicular to the previous level.

- To create the tower, alternate the direction of the blocks as you stack.
- The blocks should be stacked as tightly and evenly as possible to form a sturdy tower.

Gameplay

Step 1. Taking Turns

- Players take turns removing one block from any level of the tower, except the topmost completed layer.
- The block must be removed using only **one hand**. Players can switch hands during their turn but may not use both hands simultaneously.

Step 2. Placing the Block

- After removing a block, the player must place it on top of the tower, following the same alternating pattern (perpendicular to the level below).
- The block must be placed on the topmost level and cannot be placed in the middle of an incomplete row.

Step 3. No Skipping Turns

- Players cannot skip their turn. They must remove and place one block during each turn, even if it seems risky.

Step 4. Assessing the Tower's Stability

- Players should carefully assess the tower's stability before deciding which block to remove. Some blocks may be looser than others, and removing the wrong block could cause the tower to collapse.

Step 5. Game Over

- The game ends when the tower collapses, either during a block removal or while placing a block on top. The player whose action causes the tower to fall loses the game. The winner is the last player to successfully complete their turn before the tower falls.

4.2.3.1 Educational Advantages

- **Concentration:** The game requires players to focus intently while removing and stacking blocks, improving their ability to concentrate.
- **Social Skills and Communication:** Jenga is typically played in a group setting, encouraging communication, turn-taking, and cooperative play.
- **Patience and Perseverance:** The game requires careful planning and patience to avoid causing the tower to fall, promoting perseverance.

- **Fine Motor Skills:** Handling the small blocks with precision helps children develop fine motor control and hand-eye coordination.
- **Problem-solving Skills:** Jenga challenges players to assess the stability of the structure and make strategic decisions on which block to remove.

4.2.4 Spindle Box

Figure 4.5 Spindle box

The Spindle Box is an initial Montessori mathematics activity in which the child learns to recognize a printed numeral and correspondingly match a discrete quantity of spindles to the designated number on the board box. It is a mathematical resource comprising elongated, unmarked wooden spindles. The box contains 10 sections, each labeled with numbers 0-9 on the rear side.

The box comes with a set of spindles, which the child uses to represent the corresponding number of spindles in each compartment. The tool helps children understand the relationship between numerals and physical quantities, making abstract concepts like "zero" and "five" easier to grasp.

The Spindle Box has remained a fundamental tool in early childhood education, widely used in Montessori schools and other educational settings to promote independent learning and early numeracy. Traditionally made from wood, modern versions often use bamboo, which is a sustainable alternative, aligning with environmentally conscious educational practices.

How to Play: The Spindle Box is a Montessori material designed to teach children counting and number recognition. It consists of two wooden boxes with compartments labeled 0 to 9 and 45

spindles. The child places the correct number of spindles in each compartment according to the corresponding number. The "0" compartment remains empty, teaching the concept of zero.

Pieces

The Spindle Box typically consists of:

- **One wooden (or bamboo) box** divided into **ten compartments** labeled with numerals 0 through 9.
- **45 spindles**, which are small wooden or bamboo rods used to represent quantities.

Setup

- Place the Spindle Box on a flat surface where the child can easily access both the box and the spindles.
- The spindles are placed in a pile beside the box.

Gameplay

Step 1. Introduction to Numerals

- Begin by introducing the child to the numerals on the box. Point out each numeral from 0 to 9, explaining that each number represents a specific quantity.
- Explain that the number "0" means there will be no spindles in that compartment.

Step 2. Counting the Spindles

- The child starts by taking one spindle at a time and placing the correct number of spindles into each compartment, starting from the number "1."
- For example, the child will place **1 spindle** in the compartment labeled "1," **2 spindles** in the compartment labeled "2," and so on, continuing until they place **9 spindles** in the compartment labeled "9."

Step 3. Understanding Zero

- The child is shown that the "0" compartment must remain **empty**. This introduces the concept of zero as representing nothing or an empty set, which is a critical foundation for understanding more advanced mathematical concepts later on.

Step 4. Visualizing Quantity

- As the child fills each compartment, they are able to see the growing quantities of spindles in the compartments, reinforcing the concept of numbers representing increasing quantities.
- Encourage the child to count out loud as they place each spindle, helping them associate the physical act of placing spindles with the verbal counting process.

Step 5. Order and Sequence

- After completing all compartments, the child can review their work by pointing to each number and the corresponding number of spindles in the compartments, reinforcing their understanding of number order and sequencing.

Step 6. Self-Correction

- The Spindle Box encourages independent learning. The child can self-correct by counting the spindles in each compartment and matching them with the corresponding number. If they have placed the incorrect number of spindles, they can easily adjust by adding or removing spindles as needed.

4.2.4.1 Educational Advantages

- Early Counting Skills: The Spindle Box helps children practice counting and understand the relationship between numbers and quantities.
- Number Recognition: Through repeated practice, children learn to associate written numerals with the correct number of spindles, enhancing their numerical literacy.
- Concept of Zero: The Spindle Box introduces the concept of zero in a concrete way, reinforcing the idea that zero represents no quantity.
- Fine Motor Skills: Handling the spindles and placing them in the correct compartments improves fine motor control and hand-eye coordination.
- Independent Learning: The Spindle Box encourages self-directed learning, allowing children to explore counting concepts at their own pace.

4.3 Testing of bamboo toys

Safety Testing: The primary concern in toy manufacturing is safety. Each bamboo toy underwent testing for splinters, sharp edges, and the presence of any harmful chemicals in the adhesives or polishes used.

Durability Testing: Durability tests were conducted to ensure the toys could withstand regular use without breaking or degrading. This involved subjecting the toys to stress tests, i.e. dropping them from various heights and applying pressure to test their structural integrity.

Playability Testing: The playability of each toy was evaluated by observing children interacting with them. This helped in assessing whether the toys were engaging and appropriate for their intended age group. Feedback from these sessions was used to make any necessary adjustments to the design or manufacturing process.

Figure 4.6 Testing with kids

4.3.1 Results and Feedback

The testing phase provided valuable insights into the performance and safety of the bamboo toys. The Jenga blocks were praised for their smooth finish and uniformity, which enhanced the gameplay experience and creativity. The shape puzzle received positive feedback for its engaging design and the precision of the pieces, it enhances the logical reasoning skill of a child. The spindle box was noted for its educational value, helping children with counting and holding the spindle increased fine motor skills. 79% of the participants liked Jenga, 74% liked shape puzzle and 72% liked spindle box.

- **Child Response**: Many children showed visible curiosity and sensory engagement when handling bamboo-based toys due to their unique texture. These toys were very new to the children as they have seen these for the first time ever, which created an inquisitiveness among children for these toys.

- **Safety and Durability**: The bamboo toys withstood repeated use with no significant splintering or breakage. Edges were smoothed post-feedback to eliminate minor abrasions. It was noticed that children often put their hands in mouth while playing with toy or sometime they even put the toys in their mouth. Unlike plastic toys the bamboo as material is non toxic, however, the dyes and adhesive are to be explored further for understand their toxic behaviour.

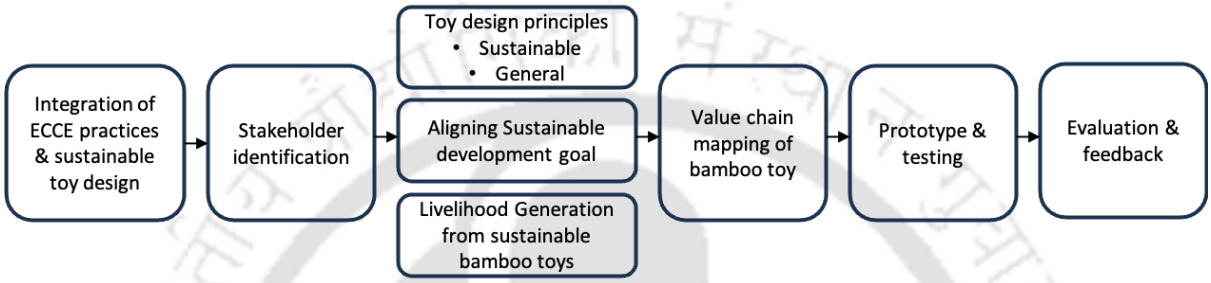
- **Cultural Recognition**: Teachers from rural centers noted that children connected more readily to the material due to its familiarity in household objects and crafts.

- **Interaction & Aesthetic appeal**: The form and texture were kept original and no colour was coated over them. However, children were engaged with this simple form as well,

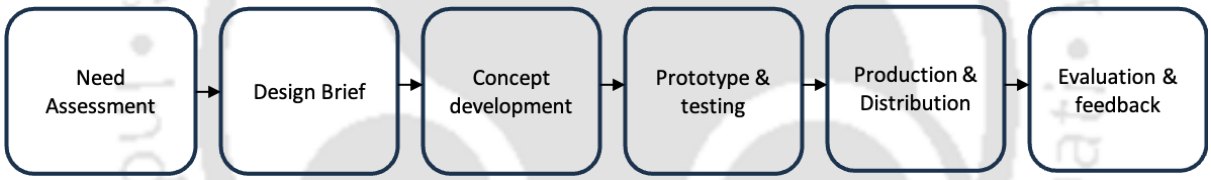
which shows that the natural texture of bamboo attracted children and the game was also engaging

Based on the feedback, minor adjustments were made to improve the toys further. For instance, additional sanding was performed on certain puzzle pieces to ensure an even smoother fit, and the polishing process was refined to enhance the durability of the spindle box.

Finally a Design Management model for introducing bamboo toys in ECCE was developed



Key component of the design management model:



4.4 Policy & strategy to implement bamboo toys in ECCE

Northeast India is rich in bamboo resources and traditional craftsmanship. The integration of bamboo toys into ECCE aligns with the New Education Policy (NEP) 2020's emphasis on play-based learning, addressing the need for safe, eco-friendly educational materials that support child development. To effectively implement bamboo toys in Early Childhood Care and Education (ECCE) settings across Northeast India, a comprehensive policy and strategy must be developed. This initiative will start with the formulation of safety standards and quality guidelines specifically tailored for bamboo toys, ensuring they meet the highest safety and educational criteria essential for young learners. This policy will aim to leverage local resources while fostering economic growth and community engagement. This policy will position Northeast India as a leader in innovative, sustainable early childhood education solutions. By integrating bamboo toys into ECCE, the initiative will not only enrich the educational landscape but also contribute to the region's economic and cultural vitality, ensuring a brighter future for its children and communities.

4.4.1 Key component of the policy

4.4.1.1 Safety standard and Quality guidelines

A comprehensive safety standards and quality guidelines for bamboo toys, which are accepted nationally and later on global standard need to be established to ensure they are safe, durable, and suitable for children in ECCE settings. North east can have revenue generation from exporting the bamboo toys in Europe, provided the safety and quality standards are maintained.

4.4.1.2 Training and Capacity Building

The artisans have rich craftmanship skills, however, there has not been toys development in the region during the past years. The specific skill of toy manufacturing which are developmentally appropriate for ECCE has to be developed among the artisans. For this, training programs need to be implemented for local artisans to enhance their craftsmanship in bamboo toy production, focusing on safety compliance, design innovation, and quality control. The region has a unique institute in the country which is The Design Department of IIT Guwhati and National Institute of Design Jorhat, these institutes can be can be the center for design and innovation for bamboo toys.

- **Curriculum Integration**
  Incorporate bamboo toys into the ECCE curriculum to promote interactive and engaging learning experiences, ensuring alignment with NEP 2020's focus on play-based education.
- **Community Engagement**
  Foster community involvement through workshops, awareness campaigns, and demonstration events, encouraging families to embrace bamboo toys as educational tools.
- **Partnerships:**
  Develop partnerships with local educational institutions, government agencies, and NGOs to facilitate resource allocation, support artisan networks, and promote the initiative.

Implementation Strategy

- **Pilot Programs**
  Launch pilot programs in selected anganwadi centers and ECCE institutions to test the integration of bamboo toys, gather feedback, and refine the approach.
- **Monitoring and Evaluation**
  Establish a framework for monitoring and evaluating the impact of bamboo toys on child development, community engagement, and artisan livelihoods. Use data to make informed policy adjustments.
- **Promotion and Awareness**
  Develop marketing strategies to promote bamboo toys, highlighting their educational benefits and cultural significance to encourage widespread adoption in ECCE settings.

4.4.2 Implementation strategy for Northeast India

Flowing strategies can be taken specifically for the Northeast India.

4.4.2.1 Strategies for Developing Sustainable Toy Manufacturing in North-east India:

1. Utilize Local Resources: Leverage the abundant bamboo and other natural resources in the region for sustainable toy production.
2. Community Workshops: Organizing workshops to train local artisans in sustainable toy-making techniques.
3. Partnerships with Educational Institutions: Collaborate with local schools and colleges to promote awareness of the benefits of sustainable toys in ECCE.
4. Government Support and Incentives: Leverage government schemes focused on entrepreneurship and sustainable development for funding and training.
5. Promotion of Traditional Craftsmanship: Incorporate traditional craftsmanship into toy design to appeal to both local and national markets.
6. E-commerce Platforms: Utilize online marketplaces to reach a broader audience, ensuring easy access to sustainable toys.
7. Focus on Ecological Education: Develop educational programs that emphasize the importance of sustainability and ecological responsibility in early childhood education.
8. Local Entrepreneurs: Encourage local entrepreneurs to start businesses focused on eco-friendly toys, providing training and resources.

4.4.3 Different schemes for north east India

The Indian government has launched several schemes and initiative to boost the bamboo based industries in the north-east region which include development of bamboo toys. The objective of these schemes is to harness the abundant bamboo resource of the region and promote the local economies, artisans and sustainable development. These schemes focuses on skill development, financial assistance, market linkages and export promotion. To put in a nut shell, below are the summary of the various schemes, the details of the schemes are listed in Appendix 2

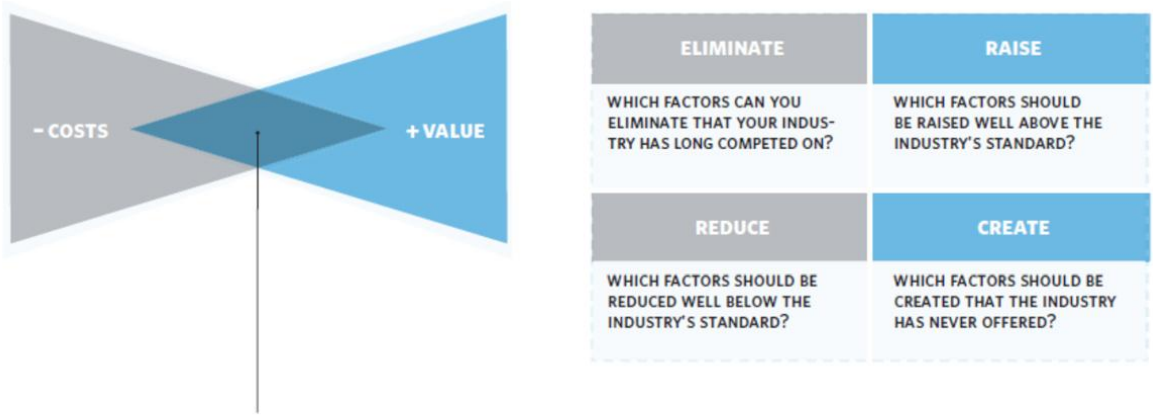
- Schemes for financial support: Schemes like NEIDS, PMEGP and MUDRA provide subsidised loan and funds which helps artisans and small enterprises to set up bamboo toy making units
- Schemes for skill development: Skill India and NEEDP equip artisans with the necessary skill to innovate and improve product quality
- Schemes for market access: Schemes like digital India and handicraft sector scheme helps in online sales and expanding market reach including export of products
- Assistance for entrepreneurial growth: Schemes like Startup India and Atal Innovation Mission supports the enterprises for innovation and new product like eco-friendly bamboo toys
- Schemes for employment generation: Schemes like MNREGA and PMEGP supports in creation of jobs and income generation in rural areas through bamboo based activities

4.5 Business model for design driven enterprise for introducing bamboo toys in ECCE

Various sessions on Business Model Canvas (BMC) were conducted among youths, management students, business development service providers at block level, rural entrepreneurs, government departments like Department of Rural Development & Panchayati Raj and other line Departments- SRLMs, Industries, etc. and individuals from NGO. These sessions were focused on developing business model canvas (Sparviero, 2019) for introducing bamboo toys in ECCE and selling through ecommerce portal, which is the present day most important channel for taking the product to different geographies and spread the business across the globe. These sessions were conducted in three different states, Assam, Meghalaya & Maharashtra.

Explaining BMC | Working in team to ideate on BMC | Assisting | Team presenting BMC

Figure 4.7 BMC Workshop



- Value Innovation - | - Four actions framework-

Figure 4.8 Blue ocean strategy (Strategy, 2015)

The below Business Model Canvas discusses the core structure of business. This gives a snapshot of how business will create, deliver and capture value. This is being developed based upon the strategy chosen for such business. The strategy then addresses how the business will compete, grow, differentiate and adapt. For this bamboo toy business, many of the strategies were studied, however, 'Blue Ocean Strategy' (Strategy, 2015)is found to be more relevant and has been applied. Blue Ocean strategy is about creating uncontested market space by offering innovative value proposition rather than competing in saturated market (Mesut, 2021; Ravindran et al., 2023). It focuses on value innovation i.e. simultaneously reducing costs and increasing customer value and simultaneously pursue differentiation and cost effectiveness.

Table 4.1 Alignment of Blue Ocean strategy with sustainability

Blue Ocean Principle	**Alignment with Sustainability**
Value Innovation	Encourages eco-friendly innovation that delivers both value to the customer and benefits to society (e.g., clean, circular design, etc.).
Uncontested Market Space	Enables sustainable businesses to lead in emerging markets before they become competitive.
Eliminating and Reducing Waste	Aligns with sustainability goals such as resource efficiency and reducing environmental impact.
Creating New Demand	Can educate and shift consumers toward sustainable behaviors (e.g., reusable products, etc.).

4.5.1 The Red Ocean Problem:

The Red Ocean Problem refers to the *existing, overcrowded toy market* dominated by mass-produced plastic toys, especially from China and large Indian manufacturers. Below is the breakdown of the Red Ocean Problem:

Issues	**Description**
Highly competitive market	The market is dominated by plastic toys from China and India
Price based competition	The toy seller has to compete on price and hence it hurts their margins
Low on uniqueness	Most of the toys are generis with little cultural or educational values
Environmental harm	The end life of the plastic toys contribute to landfill waste
Neglected artisans	Local craft people are not recognised, even if they are highly skilled

4.5.2 The Blue Ocean Opportunity:

We can create a new category of toys which is handcrafted, eco-friendly, educational toys developed in remote part of India i.e. north east India by the artisans

Unique selling point of these toys can be

- Made from natural bamboo, which is biodegradable, non-toxic, eco-friendly and sustainable
- The target segment is customer who is environmentally conscious which is a niche segment, the NGOs and CSR program who prioritise environment
- The designs are being created in collaboration with design schools like Department of Design of IIT Guwahati, NID Jorhat and artisans on discussions with educators, who are implementing the toys in school. This ensures that in addition to aesthetic appeal, educational learning values are also being incorporated
- Created by tribal/rural artisans and self-help groups who are highly skilled on craftsmanship and additional revenue generation from this business can create impact in their livelihood

4.5.3 Value Innovation:

Value innovation lies at the heart of the bamboo toy's strategic differentiation, aiming to simultaneously pursue differentiation and cost-effectiveness—hallmarks of the Blue Ocean Strategy. Rather than competing within the saturated plastic toy market, this business creates new value by offering handcrafted, eco-friendly, and educational toys rooted/developed in Northeast India's rich tribal/rural culture. This approach eliminates the industry's traditional focus on mass production and toxic plastic materials, while significantly raising the quality of craftsmanship, child safety, and educational content. The collaborations with institutions like NID Jorhat and Department of Design of IIT Guwahati incorporates innovative designs and academic relevance, adding both emotional and functional value. Meanwhile, costs are reduced by avoiding large-scale plastic molding infrastructure and mass media advertising, relying instead on artisan networks, organic outreach, and storytelling to reach a niche market. This combination—raising buyer value while reducing structural costs—forms the core of value

innovation, enabling the creation of a new category of toys that are not just playthings but tools for learning, cultural storytelling, and sustainable consumerism.

Increase (Value)	**Reduce/Eliminate(Cost)**
Education and cultural content	Mass advertisement budgets
Eco-conscious, biodegradable materials	Plastic molding infrastructure
Artisan authenticity	Uniform & mass market designs
Parent and educator trust	Dependence on imported (national & international) raw material

4.5.4 The four-action framework:

The Four Action Framework of Blue Ocean Strategy—Eliminate, Reduce, Raise, and Create—provides a structured method for reimagining the bamboo toy value curve and breaking away from the saturated plastic toy industry. In the case of this business, the framework has been applied to systematically reshape product and market boundaries.

- Eliminate: The business entirely eliminates the use of harmful plastic, synthetic chemicals, and toxic paints, which are dominant in conventional toys but pose significant risks to children's health and the environment. Mass production processes that rely heavily on automated plastic molding—common in the red ocean toy market—are also discarded.
- Reduce: The business reduces reliance on generic designs and high-volume packaging waste, while also minimizing the need for expensive mass media promotions. Instead, it emphasizes handcrafted uniqueness and storytelling, which resonate more deeply with environmentally conscious buyers.
- Raise: The product offering significantly raises the bar on artisanal quality, educational relevance, and child safety standards. Each toy is designed not just for play but to stimulate motor skills, cultural curiosity, and cognitive development, developed in consultation with design experts and early childhood educators.
- Create: Most importantly, the enterprise creates a new product category—*eco-cultural educational toys* that combine sustainability, craftsmanship, and pedagogical value. These are not merely substitutes for plastic toys but serve as cultural artefacts and learning tools rooted/developed in the tribal/rural and ecological richness of Northeast India.

Table 4.2 Four actions framework

Action	**Applied to Bamboo Toys**
Eliminate	Use of plastic, toxic paint, large-scale automation
Reduce	Generic design, packaging waste, mass media promotions
Raise	Artisanal quality, child safety, design innovation
Create	A new product category: eco-cultural educational toys with handcrafted aesthetics and educational utility

Table 4.3 Business model canvas

Key Partnerships

- Partnership with bamboo suppliers to ensure a steady supply of raw materials.
- Partnership with shipping and logistics companies for efficient delivery of the products to customers.
- Partnership with payment processing companies for secure and hassle-free payment transactions.

Key Activities

1. Sourcing high-quality bamboo materials.
2. Designing and manufacturing bamboo toys.
3. Creating and managing an e-commerce website for online retailing of toys.
4. Marketing and advertising campaigns to reach a wider audience.

Key Resources

1. Skilled designers and manufacturers for bamboo toys.
2. Access to sustainable and eco-friendly bamboo materials.
3. A strong online presence for e-commerce retailing.
4. Efficient supply chain management for timely delivery of products.

Value Propositions

1. Offering sustainable and eco-friendly bamboo toys.
2. Direct-to-consumer approach for lower prices and wider reach.
3. High-quality and unique designs of toys targeting developmentally appropriate goals.
4. Efficient customer service and hassle-free payment transactions.

Customer Relationships

1. Personalized customer service for inquiries and complaints.
2. Regular updates on new product releases and sales promotions.
3. Efficient order tracking and delivery notifications.
4. Opportunities for customer feedback and reviews.

Channels

1. E-commerce website for direct-to-consumer retailing.
2. Social media platforms for marketing and advertising campaigns.
3. Email marketing for customer engagement and retention.

Customer Segments

1. Environmentally conscious consumers.
2. Preschools and other ECCE bodies who buy toys.
3. Parents who do online shopping of toys.
4. NGOs and other international organizations.
5. Pediatric hospitals and daycare centers.

Cost Structure

1. Cost of raw materials and manufacturing.
2. Website development and maintenance costs.
3. Marketing and advertising expenses.
4. Shipping and logistics costs.

Revenue Streams

1. Direct-to-consumer sales revenue.
2. Revenue from repeat customers and customer referrals.
3. Revenue from sales promotions and discounts.
4. Revenue from institutional sales.

These workshops included different stakeholders like artisans, entrepreneurs, Business development service providers, Assam state Rural Livelihood Mission (ASRLM), National Institute of Rural Development (NIRD), North Eastern Handicraft and Handloom Development Corporation (NEHHDC), Indian Institute of Entrepreneurship (IIE), Management students from Marti Luther Cristian University, management graduates from Pune Institute of Business Management, Project management graduate of development sector at IIE, etc.

4.5.5 After doing multiple workshops the insight is summarised below

The business model for sustainable bamboo toys from Northeast India capitalizes on the rich craftsmanship of local artisans while addressing critical challenges in the global toy market, particularly the harmful effects of plastic toys. Utilizing sustainably sourced bamboo, these toys prioritize safety and health for children, employing non-toxic materials that ensure safe play. Collaborations with design institutions like NID Jorhat and the Design Department of IIT Guwahati drive design innovation, resulting in products that enhance logical reasoning, cognitive development, and motor skills among young children.

This initiative aligns with government efforts to promote indigenous products, particularly under Prime Minister Narendra Modi's focus on local craftsmanship and the recent ban on Chinese plastic toys. The establishment of toy clusters, supported by the Government of India, aims to facilitate collective growth among artisans, streamline production, and enhance market outreach, particularly in states like Meghalaya and Assam, where departments focused on development, such as the Ministry of Development of North Eastern Region (DONER), can significantly support local entrepreneurs.

E-commerce will be a crucial channel for reaching eco-conscious consumers both domestically and internationally. Ensuring compliance with EU and US safety norms will open avenues for exports, tapping into the burgeoning global market for sustainable toys, which is projected to reach over $120 billion by 2025, with the Indian toy market expected to grow significantly as well, currently valued at around $1.5 billion and projected to reach $3 billion by 2024.

Branding will focus on storytelling that emphasizes the cultural heritage of Northeast India, the artisans behind the products, and the sustainability of bamboo as a material. Promotion strategies will include social media campaigns, collaborations with eco-conscious influencers,

and partnerships with organizations that advocate for sustainable practices. Educational content will be developed to inform consumers about the environmental impacts of plastic toys and the developmental benefits of bamboo toys.

Marketing efforts will also incorporate workshops and community events, allowing parents and educators to engage directly with the toys and understand their educational value. Involving bureaucrats and local government departments can ensure alignment with broader developmental goals in the Northeast, fostering an ecosystem that supports artisans. By effectively implementing branding, promotion, and marketing strategies, this business model not only empowers local craftsmen but also contributes to a global movement towards sustainable consumption, positioning itself as a comprehensive and innovative approach to modern toy manufacturing.

4.5.6 Based on the summary, various section of the Business Model canvas is prepared which is mentioned below

4.5.6.1 Value Propositions

The value propositions were derived based upon issues in conventional toy market which were identified through interaction with stakeholders and secondary research(some references). Many testimonials from various stakeholders were collected and few of them are listed below.

"As a parent, I've become increasingly worried about plastic toys and the chemicals they might carry. These bamboo toys are a breath of fresh air—completely safe, beautifully made, and guilt-free. My daughter loves them, and I feel good knowing they're not harming the planet."
— **Dipika**, Mother of a 3-year-old, Hojai, Assam

"Our school integrateds few of Bamboo toys into early learning. These bamboo toys are not only safe but also promote hand-eye coordination, motor skills, and creative thinking. We've seen kids deeply engaged with them—much more than with electronic toys."
— **Nabonita**, Early Childhood Educator, Jalukbari, Guwahati

"What stood out to me was the story behind every toy. Each piece feels like it carries a bit of the Northeast with it—the artistry, the traditions, the soul. It's not just a toy, it's a cultural bridge. Moreover, most of the toys available in the market are of similar kind"
— **Dr. Tania**, Artisanal Gift Buyer, Guwahati

"It's amazing to see Indian-made toys getting it right—eco-conscious, beautifully crafted, and aligned with national efforts to promote indigenous industries. We've shown the images to some tourist at Goa airport and their feedback was encouraging and exciting, I being from north east region feel proud of these product."
— **Dr. Papiya**, Airport Public Health Officer, Goa Airport

"Most of the shops have similar toys made of plastics majority of which are from China and some from India. The price at which we need to sell is highly competitive and which hurt our

margins'
— **Trikhagni**, A toy seller from Guwahati

- **Eco-Friendly, Non-Toxic Toys**: Sustainable bamboo products free from harmful plastics.
- **Developmental Benefits**: Toys designed to foster logical reasoning, cognitive skills, and motor development.
- **Cultural Authenticity**: Unique designs reflecting Northeast India's rich heritage.
- **Fair Trade Practices**: Empowering local artisans and ensuring ethical production processes.
- **Government Support**: Alignment with initiatives promoting indigenous toys and addressing the ban on plastic imports.

4.5.6.2 Customer Segments

The business primarily targets eco-conscious urban parents, progressive educators, and ethical gift buyers who value environmentally friendly and educational toys. Additionally, it explores opportunities with institutional buyers such as CSR programs, NGOs, and ECCE centers for larger-scale impact. The segmentation is grouped into two categories, one for early stage market penetration and another for entering into international markets.

Early stage penetration customer segment: Educators and ECCE programs (both privately and government run) including NGOs and CSR programs

International market penetration: International organizations & schools and B2C customers through ecommerce

Table 4.4 Target new market segment

Customer group	**Why they fit**
Eco-conscious urban parents	Want safe, biodegradable toys
Preschools which follow montessori curricullum	Prefer natural learning materials
Online buyers (for gifting)	Looking for unique meaningful present
Ethical consumers (India & abroad)	Value sustainability and fair trade

NGOs, CSR and international organisation	Use toys for educational and impact programs and creating imact in communities
Tourists	High value souvenirs with cultural identity

- **Eco-Conscious Parents**: Families seeking safe, sustainable toy options.
- **Educators and ECCE Programs**: Institutions looking for quality educational toys.
- **Gift Givers**: Individuals interested in unique, meaningful gifts.
- **Sustainability Advocates**: Consumers committed to supporting local artisans and eco-friendly products.
- **International Markets**: Targeting EU and US consumers looking for sustainable toy options.

4.5.6.3 Key Activities

The success of the bamboo toy business hinges on a set of well-defined key activities that collectively enable value creation, delivery, and sustainability. At the heart of the operation is design and development, where collaborations with premier institutions such as NID Jorhat and IIT Guwahati foster innovation in creating safe, non-toxic toys that support early childhood development. This is closely supported by artisan training initiatives, which ensure that local craftsmen are equipped with the skills, safety standards, and design sensibilities necessary to meet both domestic and international expectations in specifically toy manufacturing. Here, the artisans are having bamboo craft skill but toy making skill is new to them, which requires training.

The production process, rooted in fair trade and traditional techniques, emphasizes handcrafted quality and cultural authenticity. These activities are reinforced through marketing and outreach, where consumer education plays a vital role in shifting preferences from plastic to bamboo alternatives. To reach a broader audience, a strong focus is placed on e-commerce management, leveraging digital platforms for visibility and direct sales. Furthermore, the model prioritizes export compliance, ensuring that all products meet stringent global safety regulations, particularly in EU and US markets.

Together, these key activities not only support the operational flow of the enterprise but also advance its mission to position bamboo toys from Northeast India as a globally competitive and ethically produced alternative in the sustainable toy market in the globe.

- **Design and Development**: Innovating non-toxic bamboo toys that promote logical reasoning, cognitive development, and motor skills.
- **Artisan Training**: Workshops on safety standards, design, and sustainable practices.
- **Production**: Handcrafting toys with a focus on quality and fair trade practices.
- **Marketing and Outreach**: Educating consumers about the adverse effects of plastic toys and the benefits of bamboo.
- **E-commerce Management**: Developing a robust online presence for sales and customer engagement.
- **Export Compliance**: Ensuring adherence to international safety norms for market entry.

4.5.6.4 Key Resources

The success of the bamboo toy enterprise is deeply rooted in the strategic mobilization of key resources, many of which are inherently unique to Northeast India. The region's abundant natural reserves of bamboo, particularly species like Dendrocalamus hamiltonii and Bambusa tulda, serve as the primary raw material—sustainably harvested and well-suited for crafting due to their flexibility, strength, and rapid renewability. This natural resource advantage is complemented by a rich pool of indigenous artisans, especially from Assam, Meghalaya, and Tripura, where bamboo craftsmanship is not only a livelihood but also a living tradition passed down across generations.

Building on this cultural capital, the enterprise leverages institutional design expertise through partnerships with the National Institute of Design (NID) Jorhat and the Department of Design at IIT Guwahati. These collaborations bring modern pedagogical insights and safety standards into toy design, aligning traditional techniques with contemporary consumer expectations. A reliable e-commerce infrastructure, supported by digital literacy programs and logistics partnerships, enables access to geographically dispersed markets—an important enabler in a region often constrained by transportation and connectivity challenges.

Additionally, the creation of a compelling brand identity rooted in the sustainability ethos and the cultural narratives of Northeast India (such as tribal folklore, nature motifs, and traditional

forms) forms a key intangible resource. Together, these physical, human, and intellectual resources form a coherent and context-specific foundation that not only supports operational execution but also aligns with the broader developmental goals of the region—such as rural employment, cultural preservation, and eco-friendly entrepreneurship.

- **Sustainable Bamboo**: High-quality, responsibly sourced bamboo.
- **Artisan Workforce**: Talented craftsmen skilled in bamboo toy production.
- **Design Expertise**: Collaborative efforts with design institutions for innovative and safe toy designs.
- **E-commerce Infrastructure**: A platform for reaching both domestic and international consumers.
- **Brand Identity**: A narrative that emphasizes sustainability, safety, and cultural heritage.

4.5.6.5 Key Partners

The bamboo toy initiative relies on a diverse network of key partners whose roles are critical in enabling sustainable production, design innovation, market access, and policy alignment. At the grassroots level, local bamboo artisans form the backbone of this partnership ecosystem, bringing generational expertise in bamboo craftsmanship from regions like Assam, Meghalaya, and Tripura. Their collaboration is supported by bamboo suppliers who ensure access to high-quality, sustainably harvested raw materials from community-managed forests and government bamboo plantations. To enhance design relevance and safety compliance, the enterprise partners with leading design institutions such as NID Jorhat and IIT Guwahati, which provide technical knowledge, user-centered design approaches, and product prototyping facilities.

Further support comes from NGOs and fair trade organizations operating in the region, will help formalize artisan networks, promote ethical labour practices, and facilitate training in safety and quality standards. The Government of India, particularly through initiatives under the Ministry of Textiles, DPIIT, and DONER, plays a key role by offering support for toy cluster development, export facilitation, and incentives under the 'Vocal for Local' and 'Make in India' campaigns. To ensure visibility and scalability, the business also engages with e-commerce platforms and export partners that provide access to eco-conscious consumers in both domestic and global markets. By integrating these diverse partnerships—ranging from

rural artisans to central ministries—the business model not only strengthens its operational capacity but also aligns with the broader developmental goals of Northeast India.

- **Local Bamboo Artisans**: Skilled craftsmen in Northeast India creating bamboo toys.
- **Bamboo Suppliers**: Sources for sustainably harvested bamboo.
- **Design Institutions**: Collaborations with NID Jorhat and the Design Department of IIT Guwahati for design innovation.
- **NGOs and Fair Trade Organizations**: Supporting artisans and promoting ethical practices.
- **Government of India**: Involvement in toy cluster development and indigenous product promotion.
- **E-commerce Platforms**: Online marketplaces targeting eco-conscious consumers.
- **Export Partners**: Facilitating compliance with EU and US safety norms for international sales.
- **Local Departments**: Engagement with bureaucrats and departments in Northeast India, including DONER, to ensure alignment with development goals.

4.5.6.6 Channels

Effectively reaching the right customers while staying true to the mission of sustainability and cultural authenticity requires a multi-pronged channel strategy. Given the geographical and infrastructural constraints of Northeast India, the bamboo toy enterprise strategically blends both digital and physical distribution channels to maximize accessibility and impact. The primary focus is on a dedicated e-commerce platform, which allows for direct-to-consumer sales while showcasing the story of the artisans and the eco-friendly nature of the toys. Complementing this are social media campaigns that serve as powerful tools not only for product promotion but also for educating consumers about the environmental and developmental benefits of choosing bamboo over plastic.

In addition to digital outreach, the business leverages retail partnerships with eco-friendly stores, children's boutiques, and toy shops in urban centers like Guwahati, Shillong, and metro cities across India. These outlets cater to walk-in customers and serve as important touchpoints for experiential marketing. Furthermore, the enterprise actively participates in local craft fairs, cultural festivals, and educational exhibitions, which provide direct engagement opportunities with conscious consumers, educators, and institutional buyers. For international expansion,

export platforms and partnerships ensure compliance with overseas standards while opening access to niche markets in the EU and North America. Together, these channels form a cohesive network that bridges the artisanal origins of the product with the global demand for sustainable, child-safe toys.

- **E-commerce Website**: A dedicated platform for showcasing and selling bamboo toys.
- **Social Media**: Campaigns highlighting the benefits of bamboo toys and stories of artisans.
- **Retail Partnerships**: Collaborations with eco-friendly retailers and toy shops.
- **Local Markets and Fairs**: Direct engagement with consumers at community events.
- **Export Platforms**: Channels for distributing toys in international markets.

Table 4.5 Distribution strategy

Channel	**Description**	**Strategic benefit**
Website	Dedicated e-commerce platform with storytelling, artisan bios, and sustainability content. Mobile-optimized and SEO-focused.	Branded e-commerce site like Amazon, Flipkart, etc
Social Media shops	Integration with Instagram, Facebook Shops, and WhatsApp Business for social commerce.	Builds community, drives impulse purchases, low-cost marketing
Online Marketplaces	Listings on Amazon Karigar, Etsy, Flipkart Samarth, and potentially Amazon Global.	Trusted platforms, access to ready markets
CSR & Development Programs	Channeling products through CSR, tribal welfare, and rural livelihoods programs under government and corporate partnerships.	Enhances impact, drives institutional sales
Pop-up Events & Fairs	Stalls at toy expos, handicraft fairs, and literature/sustainability festivals (e.g., Hunar Haat, Hornbill Festival, National Toy Fair).	Brand storytelling, consumer education, test-marketing
Government Emporiums & Khadi Stores	Listing under TRIFED, Tribes India, and Khadi India stores for heritage product promotion.	Boosts credibility, aligns with 'Vocal for Local' and Atmanirbhar Bharat

4.5.6.7 Customer Relationships

Building meaningful and sustained customer relationships is central to the long-term success of the bamboo toy enterprise, especially given its emphasis on sustainability, education, and ethical production. Unlike mass-produced plastic toys, bamboo toys appeal to a niche but growing segment of consumers who value authenticity, safety, and social impact. To nurture this connection, the enterprise adopts a relationship-driven approach that goes beyond transactional engagement. Through personalized marketing, the business will communicate the unique story of each toy—highlighting the artisan behind it, the cultural inspiration, and the environmental benefits—thereby fostering a sense of emotional ownership among consumers.

Digital platforms will serve as key relationship enablers, offering interactive spaces where eco-conscious parents, educators, and gift buyers can engage, ask questions, and share their experiences. The use of feedback mechanisms, such as surveys and user reviews will support continuous product improvement while signalling responsiveness and transparency. In parallel, the business will invest in educational content—blogs, short videos, and workshops—that inform customers about sustainable parenting, traditional craftsmanship, and the developmental benefits of bamboo toys. Over time, these strategies will aim to build not just a customer base, but a community of advocates who support the brand's broader mission of empowering Northeast Indian artisans and promoting eco-friendly living.

- **Personalized Engagement**: Tailored marketing focusing on safety and sustainability.
- **Community Building**: Online forums for parents and educators to share experiences.
- **Feedback Mechanisms**: Gathering customer insights for continuous improvement.
- **Educational Resources**: Providing information on the importance of sustainable toys.

4.5.6.8 Cost Structure

A clear understanding of the cost structure is vital to ensuring both financial sustainability and scalability of the bamboo toy enterprise. Operating within the context of Northeast India, the business faces a unique blend of opportunities and constraints—low-cost artisanal labor and local bamboo availability offer cost advantages, while logistics, quality training, and regulatory compliance introduce notable expenditures. The cost structure is primarily value-driven, emphasizing quality craftsmanship, eco-friendly materials, and ethical production. Core cost components include the procurement of sustainably harvested bamboo, fair compensation for artisans, and investment in safety-compliant, child-friendly finishes.

Further, significant costs arise from training programs to upskill artisans in modern toy design and international standards, in collaboration with institutions like NID Jorhat, IIT Guwahati, etc. Marketing and outreach, particularly consumer education and digital visibility, represent ongoing expenditures. The development and maintenance of a reliable e-commerce infrastructure, along with logistics and export compliance, add to operational costs, especially when targeting foreign markets. By carefully managing these expenses while aligning with its social and environmental mission, the enterprise will aim to remain competitive and impactful in both domestic and global markets.

- **Material Costs**: Investment in sustainably sourced bamboo and non-toxic finishes.
- **Production Costs**: Labor costs associated with skilled artisans and quality craftsmanship.
- **Marketing Expenses**: Budget for campaigns, branding, and educational content.
- **E-commerce Operations**: Costs related to website maintenance, logistics, and shipping.
- **Training Programs**: Funding for artisan training on design and safety standards.
- **Export Compliance**: Expenses for meeting international regulations.

4.5.6.9 Revenue Streams

The revenue model for the bamboo toy enterprise is designed to align with both its social mission and market potential, blending traditional craftsmanship with modern business opportunities. Rooted in the rich artisan culture of Northeast India, the enterprise diversifies its income sources to ensure resilience and scalability. The primary revenue stream will come from direct sales through its dedicated e-commerce platform and retail partnerships, targeting eco-conscious families, educators, and gift buyers. To complement this, the business will also seek bulk orders from educational institutions and Early Childhood Care and Education (ECCE) programs, where demand for safe, skill-enhancing toys is growing.

Innovative models such as subscription boxes, which offer curated collections of themed bamboo toys delivered monthly, create recurring revenue and deepen customer engagement. Additionally, workshops and educational events conducted in collaboration with schools, NGOs, and sustainability forums will generate revenue while promoting environmental awareness. A key long-term growth area lies in export sales, especially in EU and US markets, where demand for sustainable, ethically produced toys is rising in response to stricter plastic

regulations and shifting consumer preferences. By diversifying revenue streams while staying true to its core values, the enterprise will build a financially viable path to preserving traditional skills, supporting rural livelihoods, and promoting eco-conscious play.

- **Direct Sales**: Revenue from e-commerce and retail sales of bamboo toys.
- **Bulk Orders**: Partnerships with schools and ECCE programs for educational supplies.
- **Subscription Boxes**: Monthly services featuring curated bamboo toys.
- **Workshops and Events**: Hosting educational sessions on sustainability and craftsmanship.
- **Export Sales**: Revenue from international markets, contributing to the growing global toy market.

4.5.7 Design Management Model

Design management, in the context of the bamboo toy business, is not limited to aesthetics or product development—it is a holistic, cross-disciplinary framework that aligns the business strategy, stakeholder engagement, and value creation with the principles of sustainable innovation. The integration of the Business Model Canvas (BMC) and Blue Ocean Strategy (BOS) allows for a comprehensive Design Management Model (DMM) that captures value beyond profit—fostering cultural preservation, child-centered education, rural employment, and environmental stewardship.

4.5.7.1 Components of the Design Management Model

This Design Management Model is built on three foundational pillars:

A. Strategic Alignment

- Anchors the business in value innovation, a key Blue Ocean Strategy principle, by creating a new market space for eco-cultural educational toys.
- Embeds the BMC framework to align Key Activities, Resources, Channels, and Customer Segments with sustainable design priorities.

B. Human-Centered, academically relevant and culturally connected Design

- Collaborates with NID Jorhat, IIT Guwahati, and tribal/rural artisans to design toys that are safe, educational, and culturally rooted.

- Uses participatory design to ensure artisans, educators, and parents influence the final product.

C. Ecosystem Thinking

- Combines stakeholder networks (government, NGOs, design schools, e-commerce platforms) to scale impact.
- Integrates social entrepreneurship, design pedagogy, and environmental compliance in production.

4.5.7.2 Value Innovation: The Core of the Model

The enterprise does not compete in the traditional "red ocean" of low-cost plastic toys. Instead, it adopts value innovation by increasing educational and cultural value while reducing harmful and wasteful practices.

4.5.7.3 The four Actions Framework in application

The Four Actions Framework transforms the bamboo toy industry by eliminating toxic materials, reducing reliance on mass production, raising cultural and educational value, and creating a new category of eco-friendly, artisan-crafted educational toys. It redefines the market space by focusing on sustainability, identity, and purposeful play.

Educational Impact

- Curriculum Integration: Bamboo toys tailored to Montessori and ECCE frameworks promote sensory and cognitive development.
- Design as Pedagogy: Children engage with shapes, balance, blocks, and narrative—deepening learning through play.
- Teacher Resource: Toys serve as tools for inclusive education, storytelling, and motor skill development in rural and urban preschools.

Social Impact

- Artisan Empowerment: Rural bamboo artisans who are very skilled craftsman are trained in toy design, safety standards and design thinking, boosting dignity and income
- Cultural Preservation: Tribal/Rural craft craftsmanship, and stories are embedded in toy design, promoting pride and cultural exchange

- Gender Inclusion: Many SHGs led by women are central to the production, enabling financial independence and leadership roles.

Economic Impact

- Rural Employment: The enterprise fosters employment in remote areas through fair-trade supply chains.
- Export Potential: Once the compliance with EU/US safety norms are being incorporated, bamboo toys will tap the international eco-conscious markets
- CSR & Development Channels: Sales via NGOs and government schemes diversify revenue and create community impact

4.6 Conclusion

This thesis explored the integration of bamboo toys into Early Childhood Care and Education (ECCE) through a multidisciplinary lens, addressing policy, pedagogy, design, and enterprise. By examining the curriculum and pedagogical needs of ECCE, evaluating the developmental relevance of existing toys, and mapping the value chain of bamboo as a material, this study highlighted the immense potential of bamboo toys as both educational tools and sustainable economic products.

The research underscores the importance of aligning local craft traditions with early learning objectives, ensuring toys are not only eco-friendly but also developmentally appropriate and culturally resonant. Moreover, through stakeholder engagement and product development, the study demonstrates how design-led innovation can uplift communities while enriching children's learning environments.

The Design Management Model formulated in this study blends the Business Model Canvas and Blue Ocean Strategy to create a strategic roadmap for introducing bamboo toys into ECCE settings. This integrated approach supports innovation, sustainability, and inclusivity, while also identifying new market spaces and educational needs.

4.6.1 Educational Impact

The integration of sustainable bamboo toys into ECCE encourages child-centric, play-based learning aligned with key developmental domains. By replacing synthetic, often non-biodegradable toys with locally crafted, renewable alternatives, the learning environment becomes safer, more culturally resonant, and pedagogically effective. The thesis also emphasized the role of toys in stimulating cognitive, emotional, and motor skills—making them vital tools in achieving quality education (SDG 4). The design management model proposed encourages curriculum-aligned, developmentally appropriate product innovation, which lays the foundation for research-based, child-friendly education resources rooted in sustainability. By embedding educational intent within design, it supports holistic child development and improves classroom engagement using natural, safe materials.

4.6.2 Social Impact

The Design Management Model maps stakeholders across the bamboo toy value chain and promotes inclusive participation—especially of women, tribal, and rural artisans and youth. It activates local craftsmanship by connecting traditional knowledge with modern design and educational needs, fostering social empowerment and cultural revival. Moreover, by utilizing Common Facility Centers (CFCs) for toy development, it strengthens community infrastructure, supports skill development, and boosts rural resilience. Social innovation in this context directly addresses SDGs such as 'No Poverty' (SDG 1), 'Gender Equality' (SDG 5), and 'Partnership for the Goals' (SDG 17).

4.6.3 Economic Impact

Economically, the model opens a new market by introducing a Blue Ocean Strategy—creating demand for sustainable, educational toys where little competition exists. This not only enhances rural livelihoods through entrepreneurship and job creation but also transforms traditional bamboo sectors into engines of local economic growth. Leveraging existing CFCs for manufacturing and design leads to cost-effective scaling and promotes responsible production and consumption (SDG 12). The business model built into the design framework ensures long-term economic viability while minimizing environmental costs, contributing to inclusive and sustainable economic growth (SDG 8). It reduces dependence on imported, plastic-based toys and stimulates rural entrepreneurship through value addition in the bamboo sector. As a result, it builds a circular economy rooted in local resources and creative design thinking.

In summary, the thesis does not merely propose a product but presents a **Design Management Model as a systems-level intervention** that merges early childhood education, design innovation, rural livelihoods, and environmental consciousness. It demonstrates that meaningful impact emerges when educational goals are addressed in parallel with economic opportunity and ecological responsibility. The model encourages further exploration into sustainable education products and policies, creating a foundation for design-led social transformation.

This study thus serves as a call to action for educators, policymakers, designers, and local entrepreneurs to co-create a future where learning, livelihoods, and the environment thrive together.

Chapter 5

Conclusion, Future scope of work & Limitations

Chapter 5
Conclusion, Future scope of work & Limitations

5.1 Introduction

The thesis concludes that successful implementation of a Design Management Model for ECCE through sustainable toys requires a coordinated effort among raw material suppliers, skilled workers, bamboo clusters, designers, educators, packagers, marketers, sales channels, parents, exporters, schools, environmental advocates, and government ministries. By leveraging the strengths and contributions of each stakeholder, it is possible to create toys that not only support child development but also promote environmental sustainability, promote a healthier and more conscious future generation and achieve the sustainable development goal.

This chapter briefly discusses the novelties (key contribution) of the present thesis. This chapter also includes how research objectives have been fulfilled. This chapter ends with limitation, future scopes, and an overall conclusion of the present thesis work.

5.2 Contributions to the Field

5.2.1 Integration of sustainable practices in ECCE

In the present thesis, we conducted an integrative review of literature relevant to the topic of ECCE, various curriculum, pedagogies, developmental domains, management systems, human resource skills, sustainability, community engagement, consumer inclination towards sustainable products and environmental consciousness of present-day adults. Valuable insights drawn from this study shows that the success of ECCE depends on addressing multi-dimensional issues. Integration of the sustainability dimension in ECCE will prioritize environmental responsibility along with education efficacy. This will emphasize on using eco-friendly and renewable material while implementing developmentally appropriate ECCE. It suggests a promising future

research direction to conduct studies on ECCE with sustainability as a parameter, which were unexplored previously.

5.2.2 Role of toys & developing bamboo toys

In this current study, we studied literature and identified the role of toys in various developmental domains. Toys are pivotal in child development and is being used for educations, development, entertainment, etc. However, use of plastics in making has contributed negatively to the environmental factor. Studying the different types of toys and their roles in child development has initiated the idea of developing sustainable toys with environmental stewardship along with addressing the developmental goals. Further research in integrating toys and sustainability can result in fulfilment of various SDGs. Initiated the idea of developing toys with bamboo as a material and left the opportunity for further research on refining and developing more bamboo toys, sustainable packaging, etc.

5.2.3 Design Management model for introducing bamboo toys in ECCE

In the study, design management model for introducing bamboo toys in ECCE has been developed where stakeholders are mapped for design value chain of bamboo toys and initiated opportunity for further research on creating an ecosystem, jobs, entrepreneurship and livelihood generation at local area by innovative bamboo toy production. It has raised the platform for collaboration between various stakeholders and designers to innovate the ecosystem

5.2.4 Strategic integration of SDGs

Strategy aiming various SDG such as ‘1-No Poverty’, ‘3-Good Health and well-being’, ‘4-Quality Education’, ‘5-Gender Equality’, ‘8-Economic Growth’, ‘12-Responsible Consumption & production’, ‘13-Climate Action’, ‘15-Life on Land’, ‘17-Partnership for the Goal’

5.2.5 Utilization of existing CFCs for enhancing sustainability

Utilizing the existing Common Facility Centers (CFC) in Bamboo clusters for another value-added product and increasing the sustainability of such CFCs

5.3 Fulfilment of the Objectives

Obj 1. To study the model for Early-Childhood-Care and Education (ECCE).

- To study the curriculum and pedagogy of ECCE
- To study the management system, human resource skill and challenges for ECCE

In line with Objective 1, the research delved into an extensive exploration of various curriculum, pedagogy, management system, human resources skill and challenges for ECCE. These were studied both in the context of urban and rural settings. ECCE is vital for child's development, well being, lifelong learning, social and cognitive skill. Different curriculum imparts the development training in different manner, so, by leveraging the different approaches of play-based, cultural inclusivity, and child-centric method, these programs can effectively nurture the young minds. Investment in skill development of educators, good management system and community collaboration can ensure that high-quality ECCE is accessible to every child for a brighter future. Further, addressing the challenges of funding, quality assurance and parent angagement is very important for enhancing the impact of ECCE in child life. Section 3.1.1, 3.1.2 & 3.1.3 comprehensively discusses these and asserts that Objective 1 of the research has been effectively fulfilled.

Obj 2. To Study the role of toys for effective implementation of developmentally appropriate Early-Childhood-Care and Education (ECCE)

- To study existing toys in ECCE and their alignment with curriculum and pedagogy
- To study the existing toys in terms of developmentally appropriateness

The section 3.2, it is discussed in details the role of toys for effective implementation of developmentally appropriate ECCE in context of curriculum alignment and developmentally appropriateness. Its been discussed that play and toys and integral part holistic development of a child for enhancing cognitive, social, physical and emotional development skills. Its being noticed that play-based learning enhances creativity, problem-solving, and social interaction which enhances brain development. The toys need tpo be developmentally appropriate as there is specific milestone for each age. When the toys are developed with developmentally appropriateness, these toys can be wonderful educational tools. However, there is an increasing concern for eco-friendly toys that aligns with developmental goals while minimizing environmental impact.

Obj 3. To study the value chain of bamboo toys as a sustainable intervention in ECCE

- To study the present status of bamboo toys in India and abroad
- To explore the possibilities of introduction of bamboo toys in ECCE
- To design and develop a range of bamboo toys for educational purposes
- To study effectiveness and consumer acceptance of the diversified bamboo toys in ECCE

Section 4.1 to section 4.4 discusses the development and testing of bamboo-based toys for ECCE. These sections has successfully described the potential of sustainable material and their uses in ECCE setting can increase children's educational experiences and imbibe the sustainability concept. Toys developed were Tangram puzzle, Fraction puzzle, Spindle Box and Jenga. All these toys have been adapted to be both eco-friendly and engaging for the young leaner. Test result indicates that feedback are very positive when the toys are creative and problem-solving. Minor refinement were done and with that the toys improved their functionality and safety to be used for young children. Further, the introduction of these bamboo toys not only contributes toward developmental learning needs but also contributes to environmental sustainability and generation of livelihood for artisans and thus boosting up the local economy. With this objective 3 has been successfully fulfilled.

Obj 4. To formulate the policy and strategy for effective implementation of bamboo toys in ECCE

Integrating bamboo toys in ECCE in north-east India can foster a unique opportunity to blend traditional craftsmanship of the region with contemporary educational needs, aligning with NEP 2020 which has focus on play-based learning. This can promote livelihood for craftsmen which can create a safe, eco-friendly toys for holistic development of children. The policy emphasises on establishing safety standard, training for artisans, and integrating bamboo toys in ECCE curriculum, thus enhancing the play-based interactive learning.

It will boost up local economy by utilizing the government schemes for financial support, skill development and market access. This initiative will definitely enrich educational quality for ECCE, drive sustainable economic development and position northeast India as a leader in innovative, sustainable educational solution. Objective 4 has been successfully achieved in this section.

Obj 5. To formulate business model for design driven enterprises to introduce and implement bamboo toys in ECCE

The business model which is developed here for sustainable bamboo toys from north-east India leverages local craftsmanship and bamboo resources to produce eco-friendly, non-toxic toys promoting child development. The value proposition include regional and cultural authenticity, safety, and "Vocal for Local" initiative. The target markets are ECCE centers, export to US & EU market, Eco conscious parents and gift buyers. The sales channel includes e-commerce platforms, trade fairs, social media retail outlets and export promotion fairs. Customer relationship will be to provide customised online engagement, community-building and educational workshops. Revenue will come from online sales, bulk orders, B2B sales, workshops, subscription boxes. Key activities include product design, training of craftsman, sourcing sustainable raw material, marketing and export compliance. The key partners include government agencies, design institutions, artisans and e-commerce platforms. Cost includes the raw material cost, labor, salaries, training, and regulatory compliance. This canvas was generated by conducting workshop with various stakeholder and from different regions and perspective of all of them are incorporated in the model. The objective 3 has been fulfilled successfully.

5.4 Limitations of the Study

Sustainable adhesive and polish which can retain the look of a bamboo product and are also safe for children are yet to be identified. The research primarily focused on a few states (Assam, Meghalaya and Maharashtra) and specific stakeholders. The data may not be the complete representation of diverse culture, economy and social dynamic. There is a lack of infrastructure for mass level production of bamboo toys. Quality of bamboo boards developed in China is more suitable than what is produced in north east in terms of size, weight, density required for toy development but import is an issue. Lack of designers specifically working on toy in the geography studied. The research highlights the craftsmanship of bamboo artisans, however, the data on their skills in toy making for ECCE with maintaining safety for national and international market is limited. Market acceptance is uncertain as economic viability of bamboo toys are yet

to be measured in depth. While bamboo is sustainable but scaling up bamboo toy production may require further cultivation & resource management, the implication of which is not known fully. With the limited data based on short term workshop and prototype it is difficult to analyse the long-term impact of bamboo toys on child development, artisan livelihood, and regional economic growth. Presently there are government schemes, however, in case of policy fluctuation, there can be financial risks which are not studied in the research.

5.5 Future scope

The following steps can be considered for future work as an extension of this thesis.

- While the current study focuses on bamboo, future research could explore other locally available sustainable materials—such as cork, jute, or recycled paper—for toy design, especially in other regions of India with different ecological contexts.
- The developed toy prototypes and design management model can be piloted in a larger number of Anganwadi centres, preschools, and government-supported ECCE institutions to evaluate scalability, adaptability, and long-term impact.
- Future research can involve long-term studies to assess how sustainable toys influence children's cognitive, emotional, and social development over time, compared with conventional plastic toys.
- There is scope for integrating interactive or digital elements with sustainable toys, such as augmented reality (AR) for storytelling or learning enhancement, blending tactile and tech-based pedagogy.
- The findings can contribute to the formulation of national design and education policies, especially in advocating for the inclusion of eco-friendly, developmentally appropriate toys in public ECCE procurement schemes.
- Future initiatives may build on the business model proposed in the study by supporting toy-based social enterprises, especially within bamboo clusters under SFURTI or TRIFED schemes, thus strengthening rural livelihoods.

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Appendix 1

Table 0.1 Different toy manufacturer across India

Sl. No.	Company, Head office, Factory location , Founder, website	Material used for toys	Policy for ECCE	Go to market strategy	Revenue	Support from Govt. of India	North east presence
1	Bamboo India, Pune, Maharashtra, Maharashtra, Ashish Sahu, www.bambooindia.com	Bamboo, organic cotton	**Sustainability Education**: Incorporates sustainability concepts into early childhood education by teaching children about eco-friendly materials. **Workshops for Educators:** Conducts training for teachers on the benefits of using sustainable toys. **Collaborative Projects**: Engages with schools to integrate bamboo toys into their curriculums.	**E-commerce:** Direct sales through their website and major online marketplaces. **Community Engagement:** Organizes local workshops to demonstrate the benefits of sustainable toys. **School Partnerships:** Collaborates with educational institutions for direct distribution.	FY 2021: ₹3 crore FY 2022: ₹6 crore FY 2023: ₹12 crore	Received grants for small businesses focused on sustainability and artisan support. Participation in various government initiatives for promoting eco-friendly products.	Limited; primarily available online
2	Gilli Gilli Aaa, New Delhi, Haryana, Nandita Sinha,	Natural wood, organic cotton, non-toxic paints	**Integration of Traditional Toys:** Focus on reviving and integrating traditional Indian toys into educational settings. **Educational Workshops:**	**Social Media Marketing:** Active presence on platforms like Instagram and Facebook to engage parents and educators.	FY 2021: ₹3 crore FY 2022: ₹5 crore FY 2023: ₹10 crore	Grants for promoting local artisans and crafts. Participation in government-backed initiatives for handicrafts.	Limited; primarily online

	www.gilligilli.com		Conducts workshops in schools to train teachers on using these toys for developmental learning. **Research Collaboration:** Partners with educational institutions for research on the impact of traditional toys in ECCE.	**Local Fairs and Exhibitions:** Participates in local handicraft fairs to reach potential customers. **Collaborations with NGOs:** Works with NGOs focused on child development to promote sustainable toys.			
3	Knotty Tots, Noida, Uttar Pradesh, Uttar Pradesh, Surbhi Agarwal, www.knottytots.com	100% organic cotton, eco-friendly dyes	**Focus on Safety and Health:** Advocates for the use of non-toxic, organic materials in toys to ensure child safety. **Awareness Programs:** Conducts programs for parents and educators on the importance of eco-friendly toys. **Collaborative Curriculum:** Works with educational institutions to create modules integrating sustainable toys into learning.	**Direct-to-Consumer Sales:** Primarily sells through their e-commerce platform. **Influencer Partnerships:** Collaborates with parenting influencers to reach a wider audience. **Workshops and Fairs:** Hosts workshops to demonstrate the benefits of organic toys.	FY 2021: ₹2 crore FY 2022: ₹3 crore FY 2023: ₹5 crore	Received grants aimed at promoting eco-friendly products.	Noida, Uttar Pradesh.

4	Toyroom, Bengaluru, Karnataka, Karnataka, Ravi Kiran, www.toyroom.in	Sustainably sourced rubberwood, non-toxic paints	**Quality Standards:** Ensures that toys meet educational standards suitable for preschoolers. **Play-Based Learning Advocacy:** Supports the integration of play-based learning approaches in early education. **Training Programs for Educators:** Offers training to preschool teachers on how to effectively use their toys in classrooms.	**E-commerce and Online Marketing:** Strong online presence with targeted digital marketing campaigns. **Partnerships with Educational Institutions:** Direct sales to schools and educational bodies. **Social Responsibility Programs:** Engages in CSR activities that promote child education and development.	FY 2021: ₹4 crore FY 2022: ₹7 crore FY 2023: ₹15 crore	Participates in government initiatives for promoting sustainable products.	Limited; primarily available online
5	PlanToys, Thailand, No known IIT/IIM alumni, Piyapong Tanjawad (Thai company with operations in India), www.plantoys.com	Sustainably sourced rubberwood, natural rubber	**Educational Value:** Focuses on developing toys that enhance learning through play. **Sustainability Education:** Engages with educators to incorporate sustainability concepts into their teaching. **Research and Development:** Collaborates with institutions to study the impact of their toys on child development.	**Global Presence:** Strong international distribution and partnerships with educational organizations. **Extensive Online Marketing:** Leverages social media and e-commerce for global reach. **Participation in Trade Shows:** Actively participates in international toy fairs and exhibitions.	FY 2021: ₹50 crore (global) FY 2022: ₹70 crore (global) FY 2023: ₹90 crore (global)	Assistance for international trade and eco-friendly certifications	Available through distributors and online platforms

6	Khel Kood, Delhi, Haryana, Ankit Gupta	Bamboo, natural wood, biodegradable materials	**Play-Based Learning**: Advocates for the inclusion of play-based learning methodologies in preschool education. **Educational Workshops**: Offers workshops for educators to demonstrate the educational benefits of their toys.**Collaborative Curriculum Development**: Works with schools to develop educational modules that incorporate their toys.	**Workshops and Educational Events**: Hosts events to promote awareness of the benefits of sustainable toys. **Online Sales**: Primarily sells through their e-commerce site and major online retailers. **Partnerships with Educational Institutions**: Collaborates with preschools for direct distribution.	FY 2021: ₹1 crore FY 2022: ₹2 crore FY 2023: ₹4 crore	Received grants for educational initiatives	Limited; primarily available online

Appendix 2

Different schemes for north east India

1. **Northeast Industrial Development Scheme (NEIDS)**

- **Overview**: Promotes industrialization in the Northeast through financial incentives, including capital investment subsidies and interest subsidy
- **Focus on NER**: Targets the development of industries specifically in the North Eastern Region
- **Support Provided:** Capital investment subsidy, central interest subsidy, reimbursement of insurance premium
- **Website**: Ministry of Development of North Eastern Region

2. **Northeast Entrepreneurship Development Programme (NEEDP)**

- **Overview**: Provides training and support to entrepreneurs to enhance business skills and promote entrepreneurship in the Northeast
- **Focus on NER**: Designed to boost entrepreneurial ventures in the North East
- **Support Provided:** Skill training, business development support, capacity building for startups
- **Website**: Ministry of Micro, Small and Medium Enterprises (MSME)

3. **Prime Minister's Employment Generation Programme (PMEGP)**

- **Overview**: A credit-linked subsidy scheme that promotes self-employment and small businesses
- **Focus on NER**: Prioritizes projects in rural and semi-urban areas, including NER
- **Support Provided:** Subsidized loans for setting up new enterprises
- **Website**: Khadi and Village Industries Commission (KVIC)

4. **Micro Units Development and Refinance Agency (MUDRA)**

- **Overview**: Offers loans to small and micro enterprises for various business activities

- **Focus on NER**: Aims to empower small businesses, including those in the North East
- **Support Provided:** Loans under categories like Shishu (up to ₹50,000), Kishore (₹50,001 to ₹5 lakh), and Tarun (₹5 lakh to ₹10 lakh)
- **Website**: MUDRA

5. **Startup India Initiative**

- **Overview**: A government initiative that provides support to startups through funding, tax exemptions, and mentorship
- **Focus on NER**: Encourages innovation and startup culture in the North East
- **Support Provided:** Funding, tax exemptions, ease of registration, and incubation support
- **Website**: Startup India

6. **Digital India Programme**

- **Overview**: Aims to transform India into a digitally empowered society, enhancing online access and services for businesses
- **Focus on NER**: Enhances digital infrastructure to benefit small businesses in remote regions, including NER
- **Support Provided:** E-commerce platforms, digital literacy, online marketing support
- **Website**: Digital India

7. **Atal Innovation Mission (AIM)**

- **Overview**: Promotes innovation and entrepreneurship through funding support, incubation, and mentorship programs
- **Focus on NER**: Supports startups and innovative projects in the North East
- **Support Provided:** Grants, incubation centers, mentoring, and innovation challenges
- **Website**: NITI Aayog – AIM

8. **Skill India Initiative**

- **Overview**: Focuses on equipping youth with skills for better employment and promoting entrepreneurship
- **Focus on NER**: Provides tailored skill training programs for the youth of the North East
- **Support Provided**: Vocational training, certification, and placement assistance.
- **Website**: Skill India

9. **Handicrafts and Handloom Sector Schemes**

- **Overview**: Promotes traditional crafts and provides financial assistance to artisans
- **Focus on NER**: Encourages bamboo crafts and local handloom products
- **Support Provided:** Grants, design development, marketing assistance, and raw material support
- **Website**: Ministry of Textiles

10. **Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)**

- **Overview**: Provides a legal guarantee for unskilled wage employment for rural households
- **Focus on NER**: Utilized for bamboo plantation and related rural activities in the North East
- **Support Provided:** Guaranteed wage employment, skill development for sustainable livelihoods
- **Website**: MGNREGA

11. **National Bamboo Mission**

- **Overview**: Promotes the holistic development of the bamboo sector by adopting a region-based strategy and increasing bamboo plantation and processing.
- **Focus on NER**: The North East is a priority region under the NBM due to its vast bamboo resources. The mission supports bamboo cultivation, processing units, and artisans involved in bamboo-based crafts, including toys.
- **Support Provided**:
    - Financial assistance for setting up bamboo processing units.

- Training programs for artisans and entrepreneurs.
- Promotion of bamboo-based products, including toys, furniture, and handicrafts.
- Marketing support through exhibitions, trade fairs, and online platforms

12. **Pradhan Mantri Van Dhan Yojana (PMVDY)**

- **Overview**: Empower tribal communities by promoting value addition to Minor Forest Produce (MFP), including bamboo.
- **Focus on NER**: The scheme includes setting up **Van Dhan Vikas Kendras** (VDVKs) in tribal areas, particularly in the North East, to enhance the livelihood of tribal communities.
- **Support Provided**:
  - Training for tribal communities in bamboo craft and toy-making.
  - Funding for setting up processing and manufacturing units.
  - Assistance in marketing bamboo toys and crafts through TRIFED's retail network.

13. **Schemes of Fund for Regeneration of Traditional Industries**

- **Overview**: Promote the cluster-based development of traditional industries, including bamboo crafts, by providing support to enhance productivity, skill, and marketability.
- **Focus on NER**: The scheme has a special focus on bamboo clusters in the North East to promote bamboo crafts and toy-making.
- **Support Provided**:
  - Financial assistance for setting up Common Facility Centers (CFCs) in bamboo clusters.
  - Skill development and training for artisans.
  - Support for branding, packaging, and marketing bamboo toys and products.

14. **North Eastern Region Community Resource Management Project (NERCORMP)**

- **Overview:** To improve the livelihoods of the rural poor in the North East through sustainable management of natural resources, including bamboo.
- **Focus on NER**: The project supports the creation of livelihood opportunities in bamboo-based industries, including toy-making, in rural communities.
- **Support Provided**:
    - Funding for bamboo-based micro-enterprises.
    - Skill development programs for bamboo artisans.
    - Marketing support for bamboo products.

List of Publications

Journal

- Das, Soumen, and Pratul Chandra Kalita. “Integrating Sustainability into Early Childhood Care and Education: The Role of Bamboo Toys”. *Archives of Design Research (communicated).*

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