Design for Motivation to Facilitate the Adoption of Assisted Self-Production in Emerging Economies

(Rural and Semi-Urban Context)

A thesis submitted in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

By

Prarthana Majumdar

Department of Design,
Indian Institute of Technology Guwahati

Assam, India 781039
February 2024

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DECLARATION

It is certified that the work contained in this thesis entitled “Design for Motivation to Facilitate the Adoption of Assisted Self-Production in Emerging Economies (Rural and Semi-Urban Context)”. It has been carried out by me, a student in the Department of Design, Indian Institute of Technology Guwahati under the guidance of Dr. Sharmistha Banerjee for the award of Doctor of Philosophy and that this work has not been submitted elsewhere for a degree.

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CERTIFICATE

The research work presented in this thesis entitled "Design for Motivation to Facilitate the Adoption of Assisted Self-Production in Emerging Economies (Rural and Semi-Urban Context)" has been carried out under my supervision and is a bonafide work of Ms. Prarthana Majumdar. This work submitted for the degree of Doctor of Philosophy is original and has not been submitted for any other degree or diploma to this institute or to any other institute or university. She has also fulfilled all the requirements including mandatory coursework as per the rules and regulations for the award of the degree of Doctor of Philosophy of Indian Institute of Technology Guwahati.

Date: _____

Dr. Sharmistha Banerjee

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Dedication

Close to a billion people in rural and semi-urban India who have a fascinatingly different reality.

My family, grandmother, and late grandfather.

And Lars Hoogewerf.

Acknowledgement

I started my PhD research in 2016 in The Netherlands, a period that presented numerous challenges and uncertainties. To fulfil the aim of my research, I moved to India and joined the PhD program in Indian Institute of Technology Guwahati in 2018.

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Prarthana Majumdar

Abstract

'*Making'* traces its origins to early societies where material needs for survival were produced using simple tools and local materials. In the 18th century, the Industrial Revolution introduced the factory system, alienating most societies from making practices. Today's emerging economies, once colonized by the West, followed a different consumerism trajectory. India, the most populous among them, presents an exemplary case. Before independence, India was deliberately deindustrialized to provide a market for finished goods from England. Societies across India, especially in rural and semi-urban contexts, did not witness a devolution of *Making* practices. In fact, "*Making*" was a cornerstone of Mahatma Gandhi's freedom movement, appealing to all Indians to retain their making practices for self-sufficiency and to boycott British goods. However, in the 1990s, the Indian economy was liberalized, soon becoming a major market for global companies. It allowed such companies to flood the market with cheaper-priced products, leading to the slow dissension from *Making*. It was no longer essential for collective survival. Simultaneously, along with the economic growth, India witnessed an unprecedented rate of labor migration from farms to factories, environmental pollution, loss of culture, and unsustainable urbanization.

A large body of scholarship believes that reviving *Making* practices in such communities can help mitigate these problems. *Making* offers an opportunity to stimulate local-to-local production (in the lines of Distributed Economies), employ environmentally friendly materials and production techniques, and harness creativity and entrepreneurship from the margins. This reasoning parallels the ongoing Maker Movement in the West, originating as an antithetic response to the passivity imposed on consumers by mass-produced industrial goods. Yet there are basal differences between the Maker Movement and the *Making* practices in emerging economies, as we observe during this research. The former is stimulated by self-actualization, but the latter is motivated by resource-constraints, traditions, lack of market products and solutions and gutsy inventiveness. In emerging economies, such practices are usually conducted in the informal sector and can also be destined for purposes other than self-consumption. *Making* itself changed character with the modern-day technology changing the way knowledge is made opensource and skills are shared in networks. Owing to these differences, we bring forward a new definition of such practices in our context and propose a new terminology: "Assisted Self-Production (ASP)" that encompasses the assistance enabled by technology and connotes only self-*Making* to such practices but frees it from self-consumption. Accordingly,

> **Assisted Self-Production:** *"Activities in which individuals or communities engage tools and materials from their surroundings to produce or physically transform material goods destined either for self-consumption or for the market, conducted outside the formal economy. Such activities can be assisted with skills or knowledge share through technology-enabled platforms."*

In this thesis, we investigate how ASP practices can be revived in rural and semi-urban communities in emerging economies. We examine the infusion of ASP practices (either traditional or new) as a two-stage process: adoption by a few community members and then diffusion throughout the community. In the current research project, we focus only on the adoption stage, investigating how lost meaning can be restored for making practices in such communities.

Our literature review revealed that while the Maker Movement has been studied extensively in the context of the West, there is little research that has been conducted to understand the *Making* in the context of emerging economies, except for the forms that is relevant in Business and Innovation studies, such as Grassroots Innovations and *Jugaad.* Hence, when we distilled the societal problem to a research problem, our first research question centered around gaining a foundational understanding of such practices. The other two research questions pertained to how we can aid designers in designing products around ASP for such communities with an aim for adoption, and how effective is such design.

> **Research Question 1**: What are the characteristics of the Making culture in emerging economies?
>
> **Research Question 2**: How can Design facilitate the adoption of Making culture amongst the youth of emerging economies?
>
> **Research Question 3**: How usable and effective is the framework?

At the onset, we reflect on the nature of the societal problem and the research methodology that can provide answers to our research questions. Given that the societal problem is a wicked problem with no definite causal relationships, is undertheorized, requires an in-depth understanding of the socio-cultural constructs and has no one-true solution, we adopt an Interpretivist perspective and scout for methodologies that lay emphasis on ground research and has the ability to assimilate knowledge from multiple domains. We choose the Design Inclusive Research (DIR) Methodology for its capability to integrate research and design and achieve a careful balance between the two.

ASP, with its connotation of how an individual constructively interacts with the environment, can be viewed as a 'practice.' As such, we examine ASP practices through the lens of Practice Theory which state that any practice has three interconnected elements that uphold it: *skills*, *stuff* and *images.* We begin our research with field and literature studies to gain an empathetic understanding of the *skills*, *stuff*, and *images* (meaning) that uphold *Making* practices in these communities. We observed that such communities have a plethora of

Making practices that are either borne out of necessity or have continued as traditions for ages with community underpinnings. Such practices utilize local materials from the environments and simple tools and techniques. Yet, they can have high craftsmanship worth and can assume immense symbolic value. We also study how such practices are socially underpinned and are evolving intergenerationally. We studied the motivations to engage in *Making* through Ryan and Deci's Self-Determination Theory and observed that while the older generation are still motivated to engage in *Making* practices as part of their lifestyle, the younger generation no longer does so due to changing socio-technical landscapes. Yet, the older generation reported learning hands-on making practices in their early adolescent years. Hence, for imparting *Making* in the community, it is logical to consider young adolescents as the target group, who are cognitively more absorptive of new skills and knowledge. The research problem of the adoption of *Making* practices then condenses to a problem of behavior change: from not doing anything to actively engaging in the practice of *Making*.

In the intervention design phase, we examine several behavior change theories and methods, and adopt the COM-B (Capability, Opportunity, Motivation- Behavior Change) model of behavior change and the Behavior Change Wheel (BCW) Method as an appropriate theoretical lens for their emphasis on reflective behavior. Endorsing *Making* is a reflective-level behavior. We especially focus on the motivation component of the COM-B model since, in our case, the capability and opportunity to engage in making either exist or can be imparted. The component leading to the dissolution of such practices is meaning. We also study theories of motivation to explore how the target group can be motivated to readopt making. Ryan and Deci's Self-Determination Theory and Csikszentmihalyi's Flow Theory, used widely in studying Do-It-Yourself (DIY) behaviorism in the West, provide an appropriate lens to understand the motivations of the target group. Finally, we apply a generative tool proposed by Athavankar (2009) to create a mental map of such motivations.

In the second stage of our research, i.e., the Design phase, we propose a framework, underpinned by the theories mentioned above, to aid designers in designing products and product service systems (PSS) that infuse *Making* in such communities. Our goal is to aid designers in embedding *intrinsic motivations* to bring about behavior change. *Extrinsic motivations* rely on external rewards and consequences, and while it can drive behavior, it cannot bring about long-term change. *Intrinsic Motivation* on the other hand, is more effective in sustaining behavior change, as it stems from personal satisfaction, interest, or a genuine desire to engage in an activity. The framework has the following steps:

> **Observe:** Conduct semi-structured interviews to discern *intrinsic motivations* of the target user group for a specific or related activity to understand what they perceive as *Competence, Autonomy,* and *Relatedness Needs* for the activity.

Categorize: Based on insights from Step 1, choose images illustrating the user perceptions of *Competence, Autonomy*, and *Relatedness Needs* for the activity and add captions. Have users rank these images from most motivating (typical) to least motivating (atypical) to create scales.

Build: With the graded scales from step 2, the designer strategically chooses components representing *Competence, Autonomy*, and *Relatedness Needs*. The selection tries to move as close as possible to typicality (most motivating) with due consideration for project goals and design feasibility. The result is a semantic profile, akin to a mood board, outlining the components for *Competence, Autonomy,* and *Relatedness Needs* that the designer will embed in the design.

Ideate: Design the product or PSS to be slightly more challenging than the user's skill level for engagement. Utilize environmental opportunities and incorporate *intrinsic motivations* as semantic devices in operational and socio-linguistic contexts.

We name this framework as "Catalyst: Design for Motivation to Induce Behavior Change" for its potential to catalyze a certain behavior.

In this thesis, the proposed framework is intended for the adoption of making practices, but it can be used in other contexts where the designer needs to induce behavior change by aiming at the reflective level of the target user. Unlike the BCW method, which suggests overt ways of inducing behavior change such as education, penalty, restriction, persuasion, etc., our framework affords the designer more subtle ways of embedding meaning through product semantics. In the final stage of the thesis, we evaluate the Catalyst framework through a multi-stage evaluation process, namely: Pilot tests (semi-structured interviews), Use Cases by two designers, Experts' Review, and an Efficacy-testing workshop. We observed that the designers gave reasonably positive feedback on the understandability, satisfaction, and usefulness of the framework, with qualitative suggestions that certain parts of it can further be developed into a more user-friendly toolkit. The designers also recommended an introduction that explains what kind of behavior can be changed using the framework. In designing the structured questionnaire for experts, we used the psychometric method of data reduction called the Mokken Scale Analysis, which has not been used in the field of Design before, to the best of our knowledge.

We then tested the framework for its efficacy by conducting a workshop with young adolescents in a semi-urban school. One group of participants (control group) were given an ASP kit that was designed by an expert designer without using the framework, and the other group (experimental group) was given a kit designed by the same designer using the framework. We observed a clear divergence in the nature of motivation triggered by both the kits. The control group viewed the activity as goal-oriented school projects and focused more on self-expression rather than learning a new skill. The experimental group, on the other

hand, demonstrated higher craftsmanship, creative imagination, and prototyping. When the workshop concluded, a significantly higher number of participants showed an inclination to try or continue with the experimental kit rather than the former.

In this research project, the Catalyst framework has been tested in the context of adoption of an ASP practice by a target user group, the framework is rooted in basic theory and is generic enough to be useful in other contexts where a designer needs to design for behavior change, especially when motivation is the focal concern. In other words, where reflective-level design is required to bring a new practice or change a behavior. The key research findings are:

Concept of Assisted Self-Production (ASP): We present a new conception of *Making* practices in emerging economies that captures the essential, yet divergent attributes of such practices that make them fall outside of current definitions.

Typology of ASP in Emerging Economies: We developed a typology of ASP practices through the lens of Practice Theory and observed that the primary differentiator for the categorizing (*Jugaad*, Grassroots Innovation, Bricolage, Crafts, and Prosumption) is motivation.

Catalyst Framework: We introduce the "Catalyst" framework, a Design for Motivation to Induce Behavior Change framework, that aids designers in designing at a reflective level and embed *intrinsic motivations* as sematic devices in products and PSSs.

Design for Behavior Change Through Product Semantics: We bridged the domains of Behavior Change theory and Product Semantics, exploring how products can have meaning to motivate behavior change, emphasizing on subtle meaning generation over tangible interventions as proposed by other methods.

The following are the Design contributions from this thesis:

Guidelines for Designers: We adopted Athavankar's (2009) generative method to guide designers in the process of making a tangible map of a concept as abstract as motivational matrix.

Mokken Scale Analysis (MSA) in Design: We applied MSA to refine user research questionnaires, a novel approach in the field of design.

CSS Toolkit: We introduced an Excel-based CSS toolkit called Composite Scale and Subcultures (CSS), designed for analyzing image or object ranking data. It simplifies recording and managing

rankings, assessing agreement among rankers, and visualizing composite scales. It utilizes K-means clustering to identify subgroups within data, enhancing the analysis of image or object perception and ranking behavior.

Though our research concludes with the design of products and PSSs to facilitate the adoption of *Making*, future research can explore how such a designer can design to disseminate knowledge of such practices in the community. Future work can also study how such practices can evolve into an alternate production-consumption system besides the current factory model, making such communities more sustainable in the future. Another research possibility is to address the Achille's heel reported by the experts and investigate how to aid designers in translating the components of the semantic profile to semantic devices in the operational and socio-linguistic contexts.

As the Maker Movement continues to gain momentum, it offers a significant avenue for designers worldwide to influence production and consumption systems towards sustainability. Unlike previous perspectives that primarily focused on assessing the capability and opportunity for engaging in ASP, our framework introduces a psychological dimension, encouraging designers to delve into subtler aspects of design considerations. Many of today's global concerns could be alleviated through changes in behavior rather than the development of new technology or products. Examples include conscious consumerism, promoting healthy living, adopting green transportation, practicing digital ethics, and managing the impact of social media and information consumption. The Catalyst framework can be useful for the Design community in designing for such transformation.

Keywords: Design for Behavior Change, Design for Motivation, Design for Motivation to Induce Behavior Change, Making, Maker Movement, Adoption of a Practice, Design for Intrinsic Motivation.

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List of Abbreviations

ASP	Assisted Self-Production
BCT	Behavior Change Technique
BCW	Behavior Change Wheel
COM-B	Capability, Opportunity, Motivation Behavior
CSS	Composite Scale and Subcultures
DIR	Design Inclusive Research
DIY	Do-It-Yourself
DIWO	Do-It-With-Others
MSA	Mokken Scale Analysis
PSS	Product-Service System
RiDC	Research in Design Context

1. Introduction

This chapter sets the stage for the thesis through the lens of past challenges such as the World Wars, the Great Depression, and the Covid-19 pandemic, and their varied impact on the production-consumption systems in the West and emerging economies. We trace the evolution of societal responses that have shaped the modern production-consumption model. The introduction delineates the impact of these events on innovation, technology, and societal organization, providing a foundation for understanding the (re)emergence and significance of *Making* (explained in detail in 1.8 *Making*, page 10) in contemporary contexts.

Making existed in early societies, where survival depended on using simple tools and local materials to produce essentials. The Industrial Revolution in the 18th century, however, introduced the factory system, distancing many societies from traditional *Making* practices. Emerging economies, especially those previously colonized by the West, followed a different trajectory in consumerism. India, the most populous among them, offers a striking example. Before independence, India was intentionally deindustrialized to serve as a market for British goods. Only rural and semi-urban communities retained their *Making* traditions. Later such *Making* practices became central to Mahatma Gandhi's freedom movement, which emphasized self-sufficiency and boycotting British products as a way to earn economic freedom. However, the liberalization of India's economy in the 1990s opened the market to global companies, leading to a decline in *Making* practices as factory-made goods from global companies became widely available. This shift, coupled with economic growth, triggered the movement of labor from farms to factories, environmental degradation, cultural loss, and unsustainable urbanization.

We argue that with a unique historical background, *Making* has different cultural meanings and connotations in emerging economies as compared to the West and hence needs a different approach to operationalize it amongst the masses in such communities. *Making* as a way of living is disappearing in emerging economies due to the Western production-consumption forces and cannot be rekindled by Western models such as Fablabs and maker workspaces. For designers aiming to rekindle the *Making* culture amongst communities in emerging economies, the challenge lies in fostering the adoption and diffusion of a product or product-service system (PSS) designed to infuse a *Making* practice in a scale and manner similar to how it had happened during Gandhi's Swadeshi Movement. Though counterculture in today's consumeristic world, *Making* still retains traditional and social meaning that can be leveraged by designers.

Our foray into the rural and semi-urban communities in India reveals that although the skills and stuff (Shove et al., 2012, pp. 1–48) for *Making* in emerging economies exist, the meaning for its survival and sustenance is disappearing. Consequently, this thesis aims to understand the *Making* culture in the

emerging economies and use Design to facilitate the (re)adoption of *Making* culture. We envisage the revival of *Making* as a behavior-change problem and propose a two-stage solution to facilitate its adoption and diffusion. Though the framework developed has been centered around adoption of *Making,* it has a strong rooting in fundamental theory and can be applied to other intervention designs for behavior change as well.

1.1. The Trailing Edge of Global Events

Global events have unforeseen trail effects. The early 20th century posed significant challenges, marked by world wars, economic downturns, decolonization, and the Spanish flu pandemic. Despite these hardships, it was also an era of profound innovation, featuring scientific breakthroughs, political ideologies, new national boundaries, and the advent of the atomic bomb. In the face of adversity, human society demonstrated resilience, forging a path toward a new future characterized by evolving values, technology, production-consumption methods, and societal organization. The World Wars were historic shocks, but spurred remarkable investments in science and technology, creating a transformative impact on military capabilities and shaping the trajectory of progress. Scientific research became the new promise of a transformative society and through most innovations tended to be applied in nature (Davies & Stammers, 1975), powerful groups in the society also raised their expectations from the fundamental sciences (Katzir, 2017). We are still ubiquitously surrounded by wartime innovations such as air travel, freeway system, radar, microwave, computer, blood transfusion, skin grafts, trauma treatment, vaccines and unfortunately, also the atom bomb (D. P. Gross & Sampat, 2023). Conversely, the Great Depression prompted the liquidation of businesses and investments linked to inflated prices and interest rates. This not only disciplined investors but also facilitated economic healing by reallocating resources to more productive uses (Meissner, 2024). American investor, Warren Buffet once commented:

> *"In the 20th century, the United States endured two world wars and other traumatic and expensive military conflicts; the Depression; a dozen or so recessions and financial panics; oil shocks; a flu epidemic; and the resignation of a disgraced president. Yet the Dow rose from 66 to 11,497." (Castle Point Funds, 2020)*

It is interesting to note that the during the Great Depression, Americans experienced a notable increase in life expectancy, attributed to reduced work stress, fewer workplace injuries, and decreased after-hours smoking and drinking (Granados & Diez Roux, 2009). Major events such as this often leave lasting impact on society, with support and healing systems becoming institutionalized or ingrained in the collective psyche (Ardolino et al., 2022). For instance, the freeway system developed by Germany during World War I is now widespread, and inventions such as radar and microwaves continue to find applications. The World Wars also shaped a generation of penny pinchers in Europe who endured wartime starvation (Davies & Stammers,

1975). Furthermore, government regulations on financial markets post-Great Depression and surveillance systems post-9/11 remain in force today (Dinev, 2008; Meissner, 2024; Nakhaie & De Lint, 2013).

1.2. A Pandemic and Socio-Economic Reverberations

The world a hundred years later, is still witness to such global events, albeit with different causes, urgencies and remedies. The recent Covid-19 pandemic has disrupted healthcare, transport, manufacturing, and supply chains globally (Karmaker et al., 2021). To curb the virus, workplaces adopted new rules, emphasizing social distancing and remote work (Boland et al., 2020). Before the pandemic, offices were pivotal for productivity and company culture. However, remote work's effectiveness has reshaped this perspective, leading to a reconsideration of workspaces, focusing on immediate changes for social distancing and broader considerations such as exploring suburban campuses and leveraging digital communication (Boland et al., 2020; Sneader & Singhal, 2020).

The pandemic has had another significant consequence: the disruption of long supply chains, especially those supporting offshore production in Southeast Asian countries (Ardolino et al., 2022; Xu et al., 2020). Western countries[1] faced challenges accessing basic medical supplies during the crisis peak due to these disruptions (Capobussi & Moja, 2020; Pearce, 2020). The outsourcing trend, aimed at cutting manufacturing costs post-2008, has faced unprecedented challenges, prompting criticism for neglecting environmental and socio-cultural impacts (Ardolino et al., 2022; Xu et al., 2020). Previously, concerns centered around environmental sustainability and pollution from mass production (Clarke, 2001; Crocker & Lehmann, 2013; Felker, 2003;

[1] The term "Western World" or “Western countries” or simply West encompasses the majority of European Union member states, along with the United Kingdom, Norway, Iceland, Switzerland, the United States, Canada, Australia, and New Zealand. Additionally, there are two specific sub-regions whose inclusion varies. The Orthodox World comprises Eastern European nations like Russia, Greece, and Slovakia, while Latin America encompasses Mexico, Peru, and other Central and South American countries. These areas might be categorized within the Western World or regarded as distinct entities. In this thesis, we exclude these sub-regions.

Kahn & Yardley, 2007). But the pandemic highlighted the challenges faced by the Global South[2] in sustaining the long supply chains of globalized companies by providing labor. It exposed the vulnerabilities and the fragile state of urban migration and migrant laborers (Andrade, 2020; Choudhari, 2020; Sengupta & Jha, 2020) that has resulted from the factory-system being installed in such economies. Governments in these countries now grapple with heightened issues such as unemployment, labor displacement, and acute food shortages (Sengupta & Jha, 2020).

1.3. The Impact of the Pandemic on Production-Consumption Models in the West

While globalization has been widely acknowledged for its developmental benefits (Dunning, 2000; Manolică & Roman, 2012; Mittelman, 2006), the Covid-19 pandemic exposed the severe vulnerabilities in this production-consumption model. It is now faced with new challenges such as decreasing dependence on Southeast Asian countries, addressing uncertainties in long supply chains, and ensuring a sustainable globalized economy (Clarke, 2001; Kahn & Yardley, 2007; Massey, 1996; Stiglitz, 2017). Post-pandemic, companies contemplate strategies to mitigate future shocks, potentially reviving domestic manufacturing using technologies such as Artificial Intelligence (AI) and Internet of Things (IoT) (Ardolino et al., 2022, 2024; Dunford & Qi, 2020). Diversification of supplier bases (e.g. companies such as Apple and Samsung moving part of their operations to India) reflects a trend towards building more resilient supply chains (Amico et al., 2024; Dunford & Qi, 2020). Data emerges as a crucial strategic asset for decision-making, both top-down and bottom-up, with the deployment of technologies such as Industrial IoT and AI (Ardolino et al., 2022, 2024; Wollschlaeger et al., 2017).

Post-pandemic, a global reimagining is essential, encompassing climate change, population growth, urban migration, and contextual matters such as business models, technology in production, and work environments. Western countries focus on addressing unsustainability in their production-consumption systems, seeking to shift the economic center of gravity away from China (Dunford & Qi, 2020; Hayat, 2019; Shih, 2020; Swanson & Tankersley, 2020). Companies recognize that the need to prioritize sustainability in their operations is beyond corporate altruism, acknowledging it as a fundamental element

[2] The United Nations Conference on Trade and Development (UNCTAD) defines the Global South as encompassing the regions of Africa, Latin America, and the Caribbean, along with Asia (with the exception of Israel, Japan, and South Korea), and Oceania, excluding Australia and New Zealand. Countries in these regions often face greater poverty, more pronounced income disparities, and tougher living conditions than the more affluent countries of the Global North.

to their modus operandi (Bond, 2014; Dyllick & Hockerts, 2002). The pandemic highlighted the consequences of neglecting sustainability as the tragedy of the commons, emphasizing the interconnectedness of global systems (Carlsson-Szlezak et al., 2020; Sułkowski, 2020). A holistic approach that addresses both Western and emerging economies'[3] challenges is crucial for solving the larger systemic issues illuminated by the pandemic.

1.4. Ills of Outsourced Manufacturing in the Emerging Economies and Solutions Adopted

The impacts of economic globalization on emerging economies differ significantly from those in the West, with notable consequences such as the shift of labor from agriculture to manufacturing (Garg, 2005). Companies exploit lower labor costs by producing non-essential goods that are channeled through effective marketing strategies (Hilton, 2009), resulting in increased demand and planned obsolescence (Guiltinan, 2009). While consumers are immersed in a culture of excessive consumption and ever-changing designs, workers in emerging economies face harsh conditions in sweatshops (Joy et al., 2012). Economic openness only benefits the rich, widening the income gap and contributing to poverty (Stiglitz, 2017). This growing poverty fosters crime, violence, and urbanization challenges, as the poor migrate to cities for a better life (Kumari, 2014; Massey, 1996; Mathur, 2005).

Addressing poverty, income inequality, illiteracy, and related issues such as crime, family disruption, and urban migration presents a formidable challenge. These challenges are categorized as wicked problems, indicating their intricate nature with constantly evolving interdependencies and a lack of definitive solutions (Coyne, 2005; Webber & Rittel, 1973). Wicked problems defy simple resolutions, often being symptoms of deeper issues. Moreover, each solution has a singular chance for implementation without the opportunity for re-evaluation (Webber & Rittel, 1973).

An examination of the current strategies employed by affluent nations to address these challenges in the Global South reveals the prevalence of the aid approach. Originating in the 1990s, this method involves

[3] Emerging economies in this thesis means an emerging market economy. An emerging market economy is that of a developing nation growing more connected with global markets. Such economies exhibit some, but not all, characteristics of developed markets, which may include robust economic growth, high per capita income, liquid financial markets, foreign investor accessibility, and a reliable regulatory system (Piñeiro-Chousa et al., 2019) .

wealthier nations donating a portion of their GDP to alleviate issues such as hunger and poverty, to enhance healthcare and education, and to stimulate industrialization in poorer nations. However, Nobel laureate Angus Deaton in "The Great Escape," criticizes such efforts as 'hydraulic approaches.' He argues that assuming a linear relationship between effort and outcomes oversimplifies the complex challenges faced by developing nations. Deaton contends that certain international financial aid programs may inadvertently hinder, rather than promote, economic progress in these regions. Kenya experienced a modest growth rate in the 60s and 70s but turned negative in the 80s and 90s. Deaton (2013), argues that developed countries must invest in developmental programs, administrative structures, and infrastructure in poorer nations for sustainable development. The second approach involves the western design community creating products for emerging markets, leading to affordability and effective branding (U. A. Athavankar, 1994; Gopal et al., 2003). However, this often displaces indigenously designed goods (Clarke, 2001). Consider the case of the textile industry that made pantaloons for the Indian market. Within a span of few decades, Indian men almost entirely switched to pantaloons from the traditional cotton dhoti (Figure 1). For the hot Indian climate, a dhoti is a more comfortable attire than the pantaloons, but effective marketing has created new meaning in the Indian mindset that the pantaloons are convenient and modern and a dhoti, unfortunately is not (Athavankar, 2002). Robert Chambers (Chambers, 1997) in “Whose Reality Counts” draws attention to this invasive phenomenon or the design colonization of the western companies and organizations that have imposed prescriptive solutions to the problems of the communities in emerging economies with inadequate reflection on the broader context of the problem, the social norms and aspirations of the consumers. The case of providing safe drinking water to the urban slums in such countries is an apt example here. In addressing the need for safe drinking water in urban slums, bottled water companies aimed to provide affordable options. However, their large packaging quantities remained unaffordable for the urban poor. In India, Piramal Sarvajal implemented a cost-effective hub-and-spoke model, installing centralized water purification units and dispensers in slums. This not only ensured 24/7 access to affordable drinking water but also minimized packaging, showcasing an innovative solution that is sustainable on all the three dimensions - environmental, economic and social. (Sachdeva et al., 2023).

Figure 1. Indian Prime Minister, Jawaharlal Nehru in a Dhoti (Source - (Unknown Author, 1939))

1.5. The Need for a More Holistic Solution

Amidst the pandemic-induced economic slowdown causing widespread unemployment and hunger, traditional financial aid appears superficial. Relying on global companies to reabsorb the displaced workforce without addressing the structural and socio-cultural implications risks exacerbating the problems associated with globalization. This includes loss of culture, quality of life, design colonization, labor displacement, urbanization, and environmental pollution (U. Athavankar, 2002; U. A. Athavankar, 1997a, 1997b; Clarke, 2001; Hay & Rosamond, 2002). The systemic disruption prompted by the pandemic offers an opportunity to reconsider coping strategies for emerging economies, addressing structural, socio-cultural, and environmental issues inherent in the current production-consumption system. Similar to past global events that paved the way for restorative ideas and societal restructuring, the pandemic provides policymakers and designers with a unique chance to design interventions for complex problems that are often challenging to implement during normal circumstances (UNDESA, 2025). In an era of highly optimized operations and supply chains, the current unemployment crisis in emerging economies prompts a critical examination of the pitfalls of globalization and its efficiency.

1.6. The Swadeshi Movement and the Inspiration for Local Self-Production

In history, a parallel situation occurred in one of the world's most populous countries during the early 20th century ((Hans) Bakker, 1990). India faced economic exploitation by the British Imperial Government, leading to widespread issues such as unemployment, hunger, and the decline of craft industries (Nachane, 2007). Recognizing the need for self-reliance, Mahatma Gandhi initiated the Swadeshi Movement in 1905, advocating the boycott of British goods and emphasizing local production (Basu, 2018). Beyond a mere economic resistance, the Swadeshi Movement laid the philosophical foundation for subsequent movements addressing the challenges of an exclusionary economic system (Vezzoli et al., 2017, pp. 76–86). Gandhi's principles in this movement are explored below.

a. **Redefining manufacturing:** The Swadeshi Movement centered on the idea that goods should be locally produced using community resources and human assets. Gandhi advocated for community-level production, challenging the Industrial Revolution's factory-centric approach. He envisioned every community as a manufacturing unit capable of meeting basic needs with local resources, fostering self-reliance, even in impoverished communities (Vezzoli et al., 2017, pp. 76–86).

b. Endogenous innovation and Appropriate Technology: The Swadeshi Movement endorsed unlocking community innovation, emphasizing the deinstitutionalization of creativity for solving local challenges. Coined by Gandhi, "Appropriate Technology" denotes user-driven innovations developed endogenously by communities, optimizing available resources ((Hans) Bakker, 1990; Vezzoli et al., 2017, pp. 76–86).

c. **Redignifying labor:** During the Industrial Revolution, societies experienced new class hierarchies, elevating those involved in invention, design, and manufacturing as the elite. This shift undermined the agricultural sector, prompting Gandhi's vehement opposition to this capitalistic mindset. Gandhi emphasized the essential role of agriculture and advocated for the support of farmers and manual laborers by the entire community, regardless of wealth. He rejected the notion that the lives of those engaged in manual labor should be devalued and argued for the re-dignification of their work, recognizing its integral role in sustaining communities (Nachane, 2007; Vezzoli et al., 2017, pp. 76–86).

d. **Emphasis on Services:** The Swadeshi Movement, unique in its emphasis on sustaining communities economically through services, challenged the prevailing product-oriented consumerism fostered by the Industrial Revolution. The idea that services could drive economic mobilization and optimize human resources was revolutionary. Not everyone had the capacity for agriculture but supporting it through services became a novel proposition. During the movement, the primary focus was on boycotting mill-made clothes from Manchester, utilizing Indian cotton procured at exploitative rates as raw material. The movement advocated that those unable to engage in agriculture could contribute by taking up spinning and weaving to meet basic clothing needs (Vezzoli et al., 2017, pp. 76–86).

e. **Concept of Trusteeship or redistribution of excess wealth:** The community-cantered model of the Movement, rooted in a departure from traditional capitalism, presents an alternative perspective on wealth creation. Emphasizing economic principles for the masses, Gandhi contends that the affluent are custodians rather than sole proprietors of wealth, advocating for its purposeful use to generate community profits. Inequality, according to this view, stems not only from disparate individual wealth but also from the entitlement of the rich to benefit from the services of the poor without contributing labor. This disruptive concept challenges the affluent to embrace a more minimalist lifestyle, engage in some form of labor, and leverage their wealth for enhanced community equity (Vezzoli et al., 2017, pp. 76–86).

1.7. The Philosophical Succession of the Swadeshi Movement

The Swadeshi Movement, while economically supporting calls for political freedom, also spawned progressive ideologies emphasizing wealth equality, community action, philanthropy, co-operative models, services, and sustainability (Chakrabarty, 2015; Chandra & Tirupati, 2002; Renard, 2003; Vezzoli et al., 2017). Gandhi's focus on services influenced the Product Service Systems (PSS) thinking in sustainability, advocating for design strategies that supplement products with services to reduce ecological footprints (Vezzoli et al., 2017, pp. 76–86). The movement for wealth equality contributed to the Fair-Trade Movement, combatting exploitative labor practices globally (Raynolds, 2000; Renard, 2003). The emphasis of Gandhism on agriculture spurred revolutions such as the White and the Green Revolutions in post-independence India (Bellur et al., 1990; Chakravarti, 1973; Chandra & Tirupati, 2002). The trusteeship approach is considered a precursor to Corporate Social Responsibility, where companies use excess profits for social and environmental programs in response to societal challenges (Chakrabarty, 2015; Vezzoli et al., 2017, pp. 76–86).

Recently, Distributed Economies in Industrial Ecology, proposed by Johansson et al. (2005), reflects Gandhi's economic model emphasizing local manufacturing and community innovation. Distributed Economy reintroduces a regional approach to innovation and manufacturing, countering the environmentally unsustainable centralized production model brought by globalization. Distributed Economy promotes collaboration among regional entities for resources, knowledge, and more, fostering local production and market catering. It resembles pre-industrial local economies but with amendments: advocating centralized production when local manufacturing is economically infeasible and emphasizing collaboration among regional players as a key recommendation (Johansson et al., 2005).

In essence, approaches such as Distributed Economy, Fair Trade, and the Cooperative business model advocate for decentralized globalized production systems, empowering individuals and small to medium-scale businesses at the grassroots level (Chandra & Tirupati, 2002; Johansson et al., 2005; Renard, 2003;

Vezzoli et al., 2017). While Distributed Economy addresses sustainability issues in manufacturing and distribution, Fair Trade focuses on empowering marginalized laborers, and the Cooperative model reduces entry barriers for small-scale players (Bellur et al., 1990; Chakravarti, 1973; Raynolds, 2000; Renard, 2003). Scholars emphasize democratizing manufacturing to reduce income inequality, prevent labor dislocation, and foster local innovation (Forbes & Schaefer, 2017; Fox, 2013; Fox & Mubarak, 2017; Gupta et al., 2003; Prahalad & Ramaswamy, 2004). In tandem with these advocacies, the Maker Culture has emerged, emphasizing individual makers' creative capacities and challenging passive consumerism (Fox, 2014). The movement aligns with the growing consumer demand for personalization, identity creation, and meaning construction through commodities, reflecting the spirit of the Maker culture.

1.8. Making

The essence of the Maker Movement is *Making*. The term "*Making*" can have different meanings depending on the context. In a general sense, "*Making*" refers to the act of creating, producing, or forming something. It can involve various activities such as crafting, building, manufacturing, or generating. In a broader and more abstract sense, "*Making*" can also encompass the process of bringing ideas, concepts, or thoughts into existence. It involves transforming raw materials, whether physical or abstract, into a final product or outcome. The specific meaning of "*Making*" can vary in different fields, such as art, manufacturing, technology, and more. It often implies a creative and constructive process where individuals use their skills, knowledge, and resources to produce something new or valuable.

Tim Ingold, a British anthropologist, provides a perspective on *Making* that is deeply intertwined with his broader understanding of anthropology and the study of human societies. According to Ingold, *Making* is not a distinct activity separated from living but is rather a way of dwelling in the world. He emphasizes the idea of "taskscape," suggesting that our engagement with the environment is continuous and involves ongoing tasks that shape both the environment and us. *Making*, for Ingold, is a process that is embedded in life, inseparable from our existence and the landscapes we inhabit (Ingold, 2013, p.1-17).

According to this perspective, a maker is an individual engaged in a continuous process of exploration and learning, intertwining with the materials they work with. A maker, in this context, goes beyond a mere technical role; they embody skilled practice and craftsmanship as integral aspects of human life. The act of *Making* is not isolated but is a dynamic engagement with the world, emphasizing relationships between people, materials, and the environment (Ingold, 2013, p.1-17).

1.9. The Evolution of the Maker Movement in the West

Figure 2. Make Magazine (Dougherty, 2012)

In the West, the Maker Movement traces its origins to Silicon Valley in the 90s when software developers played with technology, resulting in innovations that transformed basements and garages into successful companies. Initially confined to the computer industry, the maker culture focused on hardware efficiency and task automation (Dougherty, 2012). In 2002, entrepreneur Dale Dougherty founded Make magazine (Figure 2) with a vision similar to Popular Mechanics, aiming to democratize manufacturing and Do-it-Yourself/ Do-it-with-Others (DIY/ DIWO) activities (Dougherty, 2012; Sivek, 2011). Maker Faires, initiated in the Bay Area and later organized globally, became catalysts for the modern-day Maker movement. Technological advancements, particularly in communication through platforms such as Pinterest and Etsy, further fueled the movement. The pivotal moment came with Makerbot's affordable 3D printers, democratizing rapid prototyping and fostering a community of tinkerers via Thingiverse (Lopez & Tweel, 2014). Pioneering scholars such as Toffler (1981, pp. 345–365), Breaux (2017), and Louridas (1999) have extensively examined the historical trajectory of the DIY movement. Toffler, in "The Third Wave," forecasted the emergence of DIY as a counter to mass production and passive consumerism. He delineated three waves in human history, highlighting the shift from self-production in the First Wave to industrialization in the Second. Post-World War I, DIY resurfaced as an essential skill due to manpower shortages. Toffler envisioned the Third Wave characterized by demarketization, demassification, and prosumption, with a central theme of individuation knowing and fulfilling one's needs through learning and self-production (Toffler, 1981, pp. 243–300). Notably, the advent of compact 3D printers, particularly stereolithography, played a pivotal role in democratizing fast prototyping and catalyzing the DIY movement (Lopez & Tweel, 2014).

1.10. The Evolution of the Maker Movement in Emerging Economies

The Maker Movement, largely centered in the West, lacks substantial literature on the evolution of *Making* in emerging economies. Focusing on India, a populous emerging economy with a history of colonization and deindustrialization, the craft sector thrived prior to British rule (T. Roy, 1999). During colonization, India's craft industry adapted to European tastes, particularly in textiles (Habib, 1980). The Industrial Revolution in Britain led to India's deindustrialization, reversing its developmental trajectory (T. Roy, 1999). The Swadeshi Movement emerged as an early maker movement during the freedom movement, emphasizing on self-reliance ((Hans) Bakker, 1990). Post-independence, the focus shifted to agricultural productivity and industrial growth (Chakravarty, 1987). Despite economic liberalization in the '90s boosting the craft sector, attracting youth to hands-on skills remains a challenge. Initiatives such as MIT's FabLabs aim to stimulate a maker culture, yet understanding the socio-cultural perception of *Making* in India is crucial for such interventions to be effective.

However, the biggest weakness of the sector in India is how people perceive an artisan: a skilled laborer who uses inferior manufacturing techniques (Frater, 2019). The handicraft sector is unorganized, with artisans facing constraints such as lack of education, low capital, poor exposure to new technologies, and absence of market intelligence. These factors contribute to their dependence on intermediaries and reinforce the perception of inferiority. (Datta & Bhattacharyya, 2016; Kasturi, 2005). Introducing designers into the profession as creators and the artisans as executioners has fueled image degradation and opportunities for creative expression and recognition for the artisans (Frater, 2019). In our field research, we observed a loss of meaning in *Making, which* is seen as providing less competence than studying and excelling academically to gain urban jobs. Not just the younger generations' loss of meaning in *Making*, but the older generations currently engaged in *Making* in the craft sector are also seen to dissuade their children from joining the profession (Kasturi, 2005).

The wane in the craft sector can have a significant impact on the informal sector and the remaining labor force whose livelihood derives from it. We highlight a few statistics to elucidate this impact. The Development Commissioner (Handicrafts) is the nodal agency in India for craft and artisan-based activities. According to the agency, over 7 million people in India are engaged in this sector, of which 56.13% are women, and 80.7% belong to the weaker sections of society (as per 2007 census data) (Development Commissioner (Handicrafts), Ministry of Textiles, Government of India, 2024). It is the second highest employment generator in the country after agriculture and is practiced both as a full-time and part-time activity. The handicraft sector is a significant contributor to India's export economy. In the fiscal year 2022-2023, the export value of Indian handicrafts (excluding handmade carpets) stood at approximately USD 1.68 billion. This sector has shown steady growth over the years, with the total exports of handicrafts, including handmade carpets, reaching USD 4.35 billion in 2021-2022, marking a 25.7% increase from the previous year.(Export Promotion Council for Handicrafts, 2024). The sector's contribution to the national GDP is 6% (Sahu et al., 2024). Although there are no official statistics on how many people are leaving the craft sector

annually, several researchers (example – (Datta & Bhattacharyya, 2016; Kasturi, 2005)) and news agencies point out the dire situation in the industry, plagued by low wages, lack of innovation, and financial and infrastructural support systems.

1.11. Sustainability

Introducing sustainability into the current production-consumption model requires as much focus on emerging economies as in the West. In the following sections, we examine how the ongoing Maker Movement can provide a way to rethink this model in the context of emerging economies. At the onset, we begin by understanding the concept of sustainability.

Sustainability is a multifaceted concept encompassing various dimensions and interpretations. It involves maintaining or enduring systems and processes over time while considering environmental, social, and economic factors. Sustainability has been defined differently in different contexts. One widely cited definition of sustainability is from the Brundtland report of 1987. That defines sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). This definition emphasizes the intergenerational equity aspect of sustainability. Definitions of sustainability need to look at the world as a system that connects the world over time (intergenerational) and space and quality of life as a system (B. J. Brown et al., 1987).

In this thesis, we look at sustainability through the lens of democratization by distributing the power of creation and, thereby, in the future distribution of economic power in the hands of individuals and communities, in line with the concept of Distributed Economy. The idea of equitable distribution of wealth, dignity of labor, services and appropriate technology stem from Gandhi's core philosophy of self-reliance and a welfare community as is discussed in 1.6 (page 7).

1.12. Sustainability and the Third Wave

While we posit the ongoing Maker Movement as a possible means to introduce sustainability in communities in emerging economies, we observe that such possibilities are akin to the nature of *Making* itself: non-uniform and non-conformist. A big body of scholarship in design, engineering, marketing and socio-cultural studies also views the Maker movement as a possible means to introduce environmental and socio-cultural sustainability in the production consumption systems (Diehl et al., 2018; Fox, 2014, 2015; Gupta et al., 2003; Rognoli et al., 2015). In this section, we examine a few ways in which the Third Wave or *Making* has introduced sustainabilities into the production-consumption system.

1.12.1. New Materials and Techniques

In line with the philosophies that advocate a local-to-local mode of production, fostering creativity at the grassroots and building sustainable production-consumption models for communities such as the Self-Determination Movement, Fair Trade, Distributed Economies and Sustainable Product Service Systems, *Making* affords the opportunity to stimulate sustainable production methods with local materials and means (Rognoli et al., 2015). With the democratization of fabrication technologies and open-source knowledge, several designers have demonstrated how eco-materials from the surroundings can be used in non-standard ways in products or new materials can be made from locally available resources. They have also demonstrated how self-invented techniques can be employed for *Making* activities with local materials (Rognoli et al., 2015). Thousand Years by Tomas Libertiny (Figure 3) is a series of Honeycomb vases that is exemplary for the unconventionality of its manufacturing technique (Libertiny, 2014). The designer erected a vase shaped metal scaffold on which bees deposited their wax over a period of one week. However, DIY new materials can be made through conventional manufacturing methods as well (Rognoli et al., 2015). Indian scientist Narayana Peesapati makes Edible Cutlery (Figure 4) from rice, wheat flour, sorghum, vegetable pulp and flavoring agents. The spoons and chopsticks are shaped and consequently baked and hardened at high temperatures (Namratha & Gaonkar, 2024). In the West particularly, a growing movement in Design views *Making* as an opportunity to replace environmentally damaging materials such as plastics with more eco-friendly ones or to recycle them into usable products (Diehl et al., 2018).

Figure 3. Thousand Years by Thomas Libertiny (Libertiny, 2014)

Figure 4. Edible Cutlery by Peesapati (Reddy, 2016)

1.12.2. Crowdsourcing Innovation

Besides promoting the use of local eco-materials, *Making* is also viewed as a fertile ground to stimulate community collaboration in creative projects (Fields et al., 2014; Freeman, 2015; Gupta et al., 2003; Lakhani & Wolf, 2005). The feeling of connectedness and belongingness to a group with a similar culture can largely influence *Making* behavior by either encouraging people to make things open source, work collaboratively with peers through crowdsourcing or simply by valuing the recognition that one receives within peer groups. Freeman (2015) investigates how a community of Finnish makers that engaged in internet-enabled DIWO for sharing of their own innovative solutions for wood palette technology, later began to feel a sense of comradeship with the others in the forum and enjoyed the recognition that they received for their innovativeness. Fields et. al. (2014) analyze how creative communities are assisting amateur writers, programmers and media content creators to collaborate with each other, critique each other's work and be inspired by the struggles and creative feats of others. Lakhani and Wolf (2005) argue that such hackers not only act as part of a group driven by the goal to make all software openware, but they also operate under the normative expectations (what others believe one should do) that their own work should be open source. The community level collaborative manufacturing and grassroots level creativity has frequently been discussed in sustainable manufacturing approaches (Fox & Mubarak, 2017; Gupta et al., 2003; Smith et al., 2016). While the fragmented and informal level at which community *Making* practices are conducted, is not robust enough to sustain manufacturing at an economically viable level (Gupta, 2006; Johansson et al., 2005), *Making* nevertheless, lays the understructure of a production model that is situated outside the centralized factory system. In several cases, *Making* conducted in an informal way has evolved into formalized manufacturing units employing community members and operating in a commercial scale, as observed from

the case studies on Grassroots Innovations and *Jugaad* from India (Gupta, 2006; Ustyuzhantseva, 2015). For instance, Edible Cutlery discussed above, has grown into a company that only employs women from the local community (Namratha & Gaonkar, 2024). Similarly, Mitticool, a company that makes zero-energy refrigerators using cooling from clay, was started by a single innovator who wished to cater to the food storage needs of the local economically backward population but has an extensive line of products today (Prajapati, 2009).

1.12.3. Appropriate Technology

In the context of the Emerging countries, the community structures, the social dynamics within communities and the consumption needs arising out of lack of access to markets or market availability of goods, has led to the evolution of distinct forms of *Making* that cater to unfulfilled material needs and rely on social norms for collective survival. In the West, the Maker Movement was primarily driven by the need for self-actualization and the need for higher personalization and communiqué in products (Wolf and McQuitty, 2011). But *Making* in emerging countries is chiefly for self-consumption, either at a personal level or at a community level (Majumdar et. al., 2019). *Jugaad* practices for instance, are devised by individuals to cut costs and cut corners (Radjou et. al., 2012). The jury-rigged vehicle (Figure 15, Page 65) used in the agricultural sector in most emerging countries, is an exemplar of this form of *Making*, with customization and hacking of technology to cater to needs in an affordable manner (Krishnan, 2010). Grassroots Innovations, on the other hand, focus on local community level problems and finding contextualized solutions where market doesn't provide a solution (Gupta, 2006; Ustyuzhantseva, 2015). Grassroots Innovations bears semblance to the "Appropriate Technology" concept from the Self-Determination Movement and also adopts the local approach that it advocated for by Gupta et al. (2003). Besides *Jugaad* and Grassroots Innovations, emerging countries have also preserved a plethora of prosumption (production for one's own consumption) (Toffler, 1981) practices that utilizes local materials and tools and embedded knowledge in the community that has been passed on from generation to generation such as making of granaries, baskets, furniture, storage vessels, woven artifacts, etc. (Majumdar et al., 2019b). It is common for such communities to have a tradition of crafts, preserved with locally mastered techniques and using materials that are usually available in the local milieu (Majumdar et al., 2019b, 2019a).

1.13. The Third Wave in Emerging economies - Challenges and Opportunities

In fostering the Maker Culture globally, MIT Center of Bits and Atoms established FabLabs worldwide (N. Gershenfeld, 2012; N. A. Gershenfeld, 2005; Kulkarni, 2013). The modern Maker Movement aims to reconnect individuals with labor, revive craftsmanship, and promote self-actualization through *Making.* However, *Making* practices amongst communities in emerging economies present unique prospects and

challenges. Before delving into their unrealized potential and significance for the design community, we first explore the challenges these practices encounter.

- **Loss of meaning for survival:** Unlike the West, where *Making* embodies self-actualization, its significance in emerging economies is survival oriented (Majumdar et al., 2019b). The influx of cheap mass-produced goods, designed for cost-effectiveness in these markets (Karnani, 2011; Prahalad, 2005), diminishes the meaning of *Making* practices (Majumdar et al., 2019b). Purchasing a plastic container is often more convenient and economical than weaving a storage basket.

- **Movement of Labor into Factories:** As companies outsourced manufacturing to emerging economies, labor shifted from agriculture and crafts to factories (Garg, 2005; Kumari, 2014; Mathur, 2005). The socio-economic impact and cultural unsustainability of centralized manufacturing led to the decline of *Making* and crafts practices in these communities (Ghouse, 2012; Majumdar et al., 2019b). This repercussions of the movement of labor into factories was felt during the pandemic (Section 1.4, page 5). Rural populations now perceive urban migration and employment in global companies as more promising for economic well-being (Majumdar et al., 2019b).

- **Unsustainabilities of some *Making* Practices:** Numerous *Making* practices in emerging economies addressing unmet product needs are often unsustainable due to material choices and a lack of human-centered design (Birtchnell, 2012). For instance, the iconic jury-rigged vehicle (Figure 15, Page 65) in these countries is fuel-inefficient and poses safety risks to commuters (Krishnan, 2010). Additionally, the traditional practice of crafting cow dung cakes for fuel is both energy-inefficient and environmentally polluting.

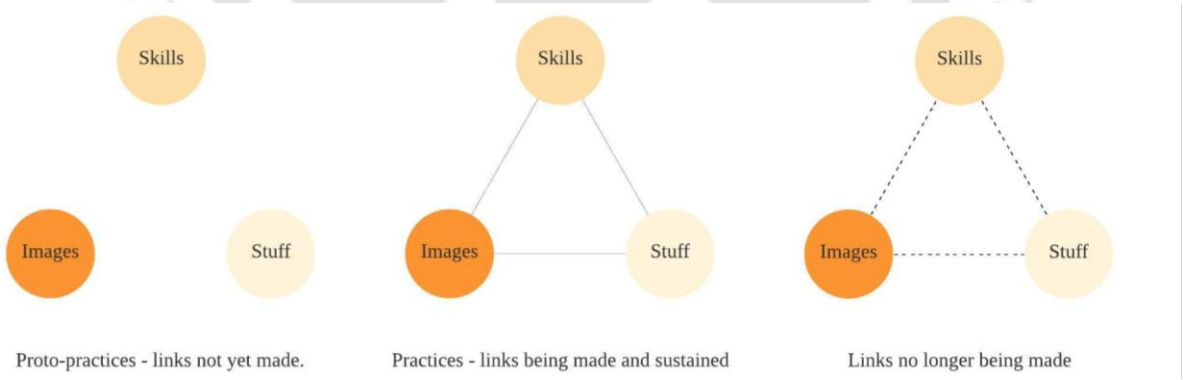


Figure 5. A practice with its components: Skills, Images and Stuffs, and the sustenance or mutation of linkages (Shove et. al., 2012, 1-48).

- **Superficiality of current models:** Shove et al. (2012, pp. 1–48) argue that a practice consists of three key elements: *skills*, *images*, and *stuff (*Figure 5*). Skills* encompass learned routines, know-how, and ways of doing and feeling. *Images* provide socially shared meanings that justify engagement in the practice, while stuff represents the physical components—objects, tools, and the maker's body. These elements interact and evolve over time to shape the practice. Initiatives such as FabLabs and maker workspaces (Diehl et al., 2018; Soomro et al., 2022) offer the necessary material resources but often neglect the unique skills, knowledge, and meanings associated with *Making* in these communities. Models aiming to strengthen communities economically by commercializing crafts or teaching new *Making* practices (Khaire & Kothandaraman, 2007; Luckman, 2013; Majumdar & Banerjee, 2017) rely on external motivations, overlooking the intrinsic drivers behind community adoption of *Making.* Programs such as Skill India, focusing on youth skills for employment, fail to comprehend the aspirations of young individuals in these communities who are exposed to a broader world today through technology (Majumdar et al., 2019b; Skill India, n.d.).

As much as *Making* in such communities are faced with challenges today, the nature of *Making* practices that they retain and nurture also present unique opportunities, especially in the post-pandemic world, where the need to explore alternate models of production-consumption will be of paramount importance. We examine these opportunities through the lens of the sustainability approaches that have been discussed in section 1.12 (page 13).

a. **Use of local materials and indigenous *Making* techniques:** Most *Making* practices, rooted in First Wave societies, like prosumption and craft practices, have sustained through embedded knowledge (Gupta, 2006; Majumdar et al., 2019a, 2019b). These practices utilize eco-materials and environmentally friendly *Making* techniques, driven by self-sufficiency needs. Examples include weaving clothes, constructing houses, and making everyday items with basic tools and manual machines such as looms. These practices hold significant symbolic value for the communities (Majumdar et al., 2019b).

b. **Creativity from the Margins:** Grassroots Innovations provide contextualized solutions for local issues, showcasing the creativity of under-represented communities (Gupta, 2006; Gupta et al., 2003; Ustyuzhantseva, 2015). Anil Gupta emphasized the significance of these marginalized minds, stating, "*The minds on the margins are not marginal minds*" (Gupta, 2016). These solutions address self-sufficiency in consumption, agriculture, transport, energy, and other domains, countering design colonization and superficial interventions by external bodies. While the West relies on technology-intensive solutions due to labor shortages, emerging economies face resource scarcity, necessitating solutions that utilize available resources. (Gupta, 2006; Gupta et al., 2003; Ustyuzhantseva, 2015).

c. **Community Underpinnings:** Communities in emerging economies exhibit strong social structures, engaging in grassroots innovations collectively (Gupta et al., 2003; Smith et al., 2016). *Making* activities within these communities involve diverse motives, with individuals influenced socially by network dynamics, authority figures, or competition among artisans (Majumdar et al., 2019a). Majumdar et al. delve into the one-to-one influence motives shaping *Making* behavior in these communities, shedding light on the intricate interplay of social dynamics in emerging economies.

1.14. Assisted Self-Production (ASP)

In chapters 4, 5 and 0, we present our study on the *Making* practices in rural and semi-urban communities in India with a systematic literature review and field studies. We introduce a new term Assisted Self-Production (ASP) for *Making* in our context to include aspects of such practices that current terminologies and definitions do not adequately capture. As such, hereafter, we refer to *Making* practices in our context as ASP or ASP practices. We define ASP (on page 82) as:

> *"Activities in which individuals or communities engage tools and materials from their surroundings to produce or physically transform material goods, destined either for self-consumption or for the market, conducted outside the formal economy. Such activities can be assisted with skills or knowledge share through technology-enabled platforms."*

1.15. *Making* through Assisted Self-Production as a model of Distributed Economy

Making holds several possibilities to shape production-consumption in the lines of Distributed Economy. Of all the forms of *Making* (Grassroot Innovation, Prosumption, Bricolage and Jugaad, as explained in Figure 22 (page 82)) observed in India, craft is the most formally researched one. Hence, we first discuss *Making* through ASP in the context of craft as a model of Distributed Economy. Then we draw parallels with the other forms of *Making* as ASP as models of Distributed Economy.

The craft sector is decentralized, unorganized, labor-intensive and follows the traditional cottage industry format (Yadav et al., 2020). The craft sector symbolizes cultural heritage and community fulfilment for the country (Banik, 2017). The craft sector in India follows a community-centered production process. Despite this, an individual within the community can pursue their own goals. (Venkatesan, 2006).

The craft sector in India is an example of a Distributed Economy (Dos Santos et al., 2021) as the production mostly happens in cottage and small-scale industries, using local resources and skills. Craft production usually depends on local sources and partnerships, spreading economic advantages among community members. It is a paradigm shift from traditional centralized economic models. It can adapt to different needs

and markets (Pathak & Mukherjee, 2021), resist domination and oppression, keep or create traditions, and offer income and poverty relief. It produces various values, from cultural expression to economic to environmental. This is the key sustainability aspect of this sector. The key strength of the Indian craft sector's distributed-ness can be attributed to the following aspects:

1. **Distributed Design and Distributed Design Networks –** Individuals and communities conceive different design solutions independent of each other and through influence from each other (example – (Parveen Shaieka, 2023; Pathak & Mukherjee, 2021)) The influences range from local culture and traditions, religious belief systems, political patronage, market demands, the nature of training the craftspeople receive and so on. The independence in design creation allows for a rich diversity of products and simultaneously brings democratization in creating innovations. Thus, the distributed design and distributed design networks formed in the craft sector promote social sustainability in terms of cultural preservation, maintain and celebrate a region's unique crafts and foster a sense of identity and community pride. This empowers the individuals involved through not only income generation opportunities but also provides them a platform to express their creativity. Crafting activities often involve community collaboration, strengthening social bonds and fostering a supportive environment.

2. **Distributed Manufacturing and Distributed Manufacturing Networks –** Crafts in India involve the localization of production processes across various small-scale units, primarily utilizing physical technologies and sometimes digital technologies as well. Employing local artisans brings avenues for economic development of the locality and avoids migration of people from rural areas to urban localities. In all those craft clusters, where the manufacturing units are small, the distribution of economic power between the manufacturer and the artisans is more balanced (example - (Banerjee et al., 2019; Datta & Bhattacharyya, 2016)). The nature of the economic power distribution results in a more symbiotic relationship between multiple stakeholders. Craft cluster formation is encouraged in India by various governmental and non-governmental agencies (Ministry of Textiles, Government of India, 2022) These are geographical concentrations of interconnected artisans, craftspeople, and small enterprises engaged in the production of traditional crafts. These clusters play a crucial role in enhancing the resilience of distributed production networks by promoting resource sharing, fostering innovation, and enabling collective problem-solving (like bargaining power with raw material providers, wholesalers, surety of order fulfilment), financial and institutional supports, access to government support and micro-credit (example - (Das, 2020; Jagatramka & Prasad, 2021)). This resilience is vital for the sustainability and competitiveness of the craft sector in the face of economic, social, and environmental challenges.

3. **Distributed Innovation and Distributed Innovation Networks -** Distributed Innovation can be viewed as bringing sustainability and resilience to the craft ecosystem in multiple ways. For example, several innovative artisans are trying to blend tradition with modernization in terms of design elements and language (example – (Jagatramka & Prasad, 2021)), bringing in cost reduction and efficiency improvement through technological innovation while still maintaining the critical essence of being hand-crafted (example - (Mahato & Das, 2021)), and network innovation to build an entrepreneurial ecosystem and social entrepreneurship (example – (Pathak & Mukherjee, 2021)). Several artisans, having realized that eco-conscious consumers are an emerging craft buyer group, are adopting natural dyes and sustainable weaving practices to reduce environmental impact and use that as their product's unique selling proposition (example - (Greeshma et al., 2023)). New product development with traditional materials for tapping new markets is also being explored. For instance, Muga silk from Assam, originally used for making indigenous outfits, is used for making high-end umbrellas and kimonos for the Japanese market. The innovations come from both the formal and the informal sector. The informal sector has engaged in distributed innovation as grassroot innovators, *Jugaad* or Bricolage. Institutions such as the Honeybee Network (Gupta, 2006) have documented several of these innovations from the informal sector, aiding innovators in further developing their products and putting them on the market. Thus, the craft sector is a well-documented case of distributed innovation wherein innovations come from both the formal and informal sectors. Several attempts have been made to provide formal help to the informal sector to bring their innovations to fruition. Together, they have formulated a distributed innovation network, such as the Honeybee Network's case or the context of crafts from Kutch (Pathak & Mukherjee, 2021).

4. **Distributed Entrepreneurship and Distributed Entrepreneurship Networks –** The Distributed Design, Manufacturing and Innovation resulting out of the very nature of the craft sector in the country results into creating Distributed Entrepreneurship wherein the various small entrepreneurs work as a network to deliver the value in terms of the crafted product, the meaning associated with it, its cultural identity and resilience to the local economy.

Like the craft sector, the other forms of *Making*, cater to a similar ethos of sustainability potential through Distributed Economy features. For example, in rural areas, artisans have developed solar-powered looms using discarded bicycle parts (Huang, 2023). This grassroots innovation democratizes access to renewable energy and reduces dependency on electricity. It is an example of Distributed Design, Innovation and Entrepreneurship. Similarly, the pomegranate deseeder (Bharali, 2009) made by Mr. Udhav Bharali, an example of bricolage, exemplifies Distributed Innovation. Prosumption practices such as making a scarf or towel, primarily for self-consumption, exemplify Distributed Design and Manufacturing.

The other forms of *Making* (Grassroot Innovation, Prosumption, Bricolage and Jugaad) appear more sporadically and are less formally connected to economics the way craft is. These have the possibility of appearing only when the people are habitual makers. The National Education Policy 2020 (Ministry of Human Resource Development, 2020) of India also recognizes this issue and advocates for experiential learning, where students engage in hands-on projects, experiments, and activities that involve making things. This approach is intended to move away from rote learning and toward a more application-based understanding of concepts. The policy suggests integrating crafts, arts, and other practical activities into the curriculum from an early stage. It places a strong emphasis on vocational education starting from Grade 6. Students are encouraged to learn practical skills, including traditional crafts and modern technologies, which directly involve *Making* and creating things. This focus is aimed at bridging the gap between education and employment, making students more job ready. In summary, the recognition of loss in *Making* as a practice is evident from government policies of the country as well.

Consequently, the sustainable development stance in this thesis we have taken is to re-inculcate the culture of *Making* through design for *intrinsic* motivation wherein the younger generations will find new meaning in the practice, adopt and diffuse it. This can give us a chance to sustain all forms of ASP and the sustainability advantages of the Distributed Economy that it brings.

1.16. The Role of Designers

The Maker Movement provides a plethora of opportunities to the design community to redesign and recast several aspects in the society that have directly or indirectly been influenced by the factory system that has alienated humans from labor. One such important area is the current education system which disproportionately stresses on theoretical learnings without exploring how *doing* can be an active agent in learning (Martin, 2015). When the Maker Movement commenced with the first edition of the *Make* magazine, the goal was to democratize *Making* and support a learn-as-you-do model (Dougherty, 2012; N. Gershenfeld, 2012; N. A. Gershenfeld, 2005; Kulkarni, 2013; Sivek, 2011). This model is extensively used today in assistive learning through software applications, games and DIY kits. Figure 6 shows a woodworking kit for children, that besides woodwork aims at promoting constructional ideation and tinkering amongst children (Hsu, 2018). Besides, designers have also taken the opportunity to demonstrate how, through *Making*, consumers can play a more active role in their material culture. Consumers no longer need to remain as passive end-users of the mass-production system, but can participate in building their own living environments, customizing their own consumables and reflect their needs of social communication through their products (Designboom, n.d.; Diehl et al., 2018; Fields et al., 2014; Freeman, 2015; *Precious Plastic*, n.d.). It is this sense of empowerment that designers utilize in demonstrating how the new production model can be pushed towards a more sustainable direction through the use of clean materials and environmentally friendly *Making* techniques.

However, we believe that it is in the context of the emerging economies, where the unsustainabilities of the globalized production system are more sombre, that the design community has a bigger role to play. While the Maker Movement devolved the factory model to the self-production model, we contemplate whether it also has the potential to mitigate the socio-economic problems that has arisen out of the factory model in emerging economies. The erosion of meaning of a self-sufficient lifestyle caused by the centralized production system and migration of laborers to urban areas has barely conferred them any *autonomy* over their own circumstances. The current interventions to promote a ASP culture in such communities such as the Fablabs, Skill India, DIY workspaces and entrepreneurship programs (Khaire & Kothandaraman, 2007; Kulkarni, 2013; Luckman, 2013; Majumdar & Banerjee, 2017), have not been designed with either an understanding of what meaning *Making* holds for such communities or the challenges that it faces in the current global scenario. Moreover, such interventions also do not explore and utilize the unique opportunities that the organic maker culture of these communities present to push production into a more sustainable direction. In a similar manner as the West, *Making* can be spawning ground for a new education model that converges with hands-on activities. It can also be the precursor to a future production system that is more democratic and confers higher *autonomy* to such communities. In essence, the Maker Movement can be the proto-stage for a more distributed model of production with higher order collaboration and knowledge-sharing facilitated by technology that can lead such communities to be more self-sufficient and less at the mercy of centralized manufacturing systems. All significant models of sustainable production reach confluence at this point: local production ((Hans) Bakker, 1990; Johansson et al., 2005; Vezzoli et al., 2017, pp. 76–86).

Figure 6. Woodworking kit for Children (Hsu, 2018)

1.17. Outlook towards Product Service System

The framework designed in this thesis: "Catalyst: Design for Motivation to Induce Behavior Change," aids designers in designing products and PSS that infuse *Making*. In the thesis, we have used the term PSS to refer to an integrated combination of products and services designed to deliver value in use rather than just functionalities (R. Roy & Baxter, 2009) (example, a kit teaching origami along with a workshop plan for infusing the making practice amongst school children using the kit).

Several researchers have used multiple lenses to deliver typology for PSS. The typology is diverse and still emerging. The traditional classifications include product-oriented, use-oriented, and result-oriented PSS, based on the nature of the product-service relationship and their intended outcomes (Tukker & Tischner, 2006). Chiu et al. (2019) introduces the concept of platform-oriented PSS to this traditional classification where the product-form is intangible and the provider operates as an intermediary between manufacturers, service providers and customers. On the other hand, Ostaeyen et al. (2013), uses the dominant revenue mechanism to derive the typology for PSS. Roy (2000) defines sustainable PSS as "alternative socio-technical systems" which can offer the desired satisfaction that the end-user needs. The researcher suggested four typologies: result services, shared utilization services, product-life extension services, and demand-side management; each aiming to reduce environmental impacts significantly while maintaining service quality and offering the desired end-satisfaction to the customers. Mathieu (2001) provides a service-oriented typology for PSS where-in the distinction is presented based on the nature of service provided (such as services that support the supplier's product (e.g., after-sale services) and services that support the client's action in relation to the supplier's product (e.g., training services)). All these typologies have focused on the formal industrialized context only.

The aim of the thesis is not to delve into the intricacies of PSS typology and neither does the Catalyst framework aid the designer in thinking about of PSSs in term of types. There are several reasons for this position that we have taken. First, we argue that the current PSS typologies are inadequate to typify the different PSS offerings that we typically observe in the context where our research is located. For example, we argue that neighbors helping each other to build a granary in rural settings in India is a PSS. The granary is the physical product being constructed. The neighbors helping each other with their labor and knowledge is the service component. The community network, or the social ties and relationships among the neighbors, forms the backbone of this PSS. It enables the sharing of labor, resources, and knowledge. While traditional PSS models from industrialized contexts often involve formalized services offered by companies (example, car-sharing services), the rural Indian context here gives an example of an informal, community-driven PSS. The principle remains similar, that is the integration of products and services to create value and satisfy needs, but the contracts are informal and not commoditized. Secondly, there are several guidelines available for designing PSS. The focus of our research in this thesis has been to aid in design for motivation to induce

behavior change. Thirdly, we want to encourage designers in thinking about contextually appropriate products or PSS. We intend to leave it to designers to produce interesting combinations of products and services connected through unique formal or informal contracts rather than bind them with certain existing typologies. For example, in section 9.2.1 (page 134), we present the work of a novice designer who used the framework to design an ASP kit for printing (an example of a half-way product). The kit is a standalone product, which the designer intended to be integrated with locally available materials and components so that practice can be continued and built upon. The outcome of the printing (such as printed bags or t-shirts) could be shared as gifts amongst kids. Now, half-way products such as DIY kits are customization-oriented PSS where-in provider can offer added supports to complete the product such as training, assembly or installation services, display your customization to the world and so on. The expert designers on the other hand, in 9.2.2 (page 151) designed a workshop for school children to motivate them to adopt *Making* with a toolkit which had an origami tutorial so as to aid the process. It is an education-oriented PSS where providing the service of education is the main motive and the product is the tool in the process. The results with the designers reveal that the Catalyst framework did help designers design a combination of products and services that together aimed to create the desired value: motivation to change behavior for adoption of *Making*.

We also assume that the principles of semiotics of product design can be applied to PSS as well. The reason for this over-simplification is the lack of adequate literature which deals with theory of meaning making and semiotics in particular to PSS. Very few researchers (example - (Candi & Saemundsson, 2011; Ceschin et al., 2014)) have dealt with only the need for and importance of aesthetics in PSS but there is no explicit theoretical development which we can bank upon.

The manner in which the pandemic has highlighted the importance of distributed manufacturing and *Making* practices and how it presents an opportunity to designers in infusing sustainability in emerging economies, is presented diagrammatically in Figure 7.

1.18. Thesis Problem Definition

For designers aiming to rekindle the *Making* culture amongst communities in emerging economies, the challenge lies in fostering the adoption and diffusion of a product or PSS designed to infuse a *Making* practice. The design process involves a two-stage problem: Adoption and Diffusion (Figure 8). To facilitate adoption, designers must empathetically grasp the community's perception of *Making* and integrate motivational meaning into the PSS. For diffusion, understanding the unique social dynamics is crucial. Designers need insight into existing *Making* practices, their characteristics, the surrounding materialities, and the skills involved, forming the foundation for contextual understanding.

In this thesis, we focus on the adoption phase (as discussed in 1.22, page 28), and investigate how a designer can gain contextual understanding of the motivational meaning of the target user to adopt *Making* and design a product or a PSS that facilitates the adoption of such a practice. The research problem in this thesis circumvents around how we can design a framework that aids designers in the following:

a. Studying the motivations of the user group to engage in *Making*.
b. Constructing a mental map of the abstract motivational matrix.
c. Choosing the components of the matrix to embed in the design.
d. Designing a product or PSS with such meaning.

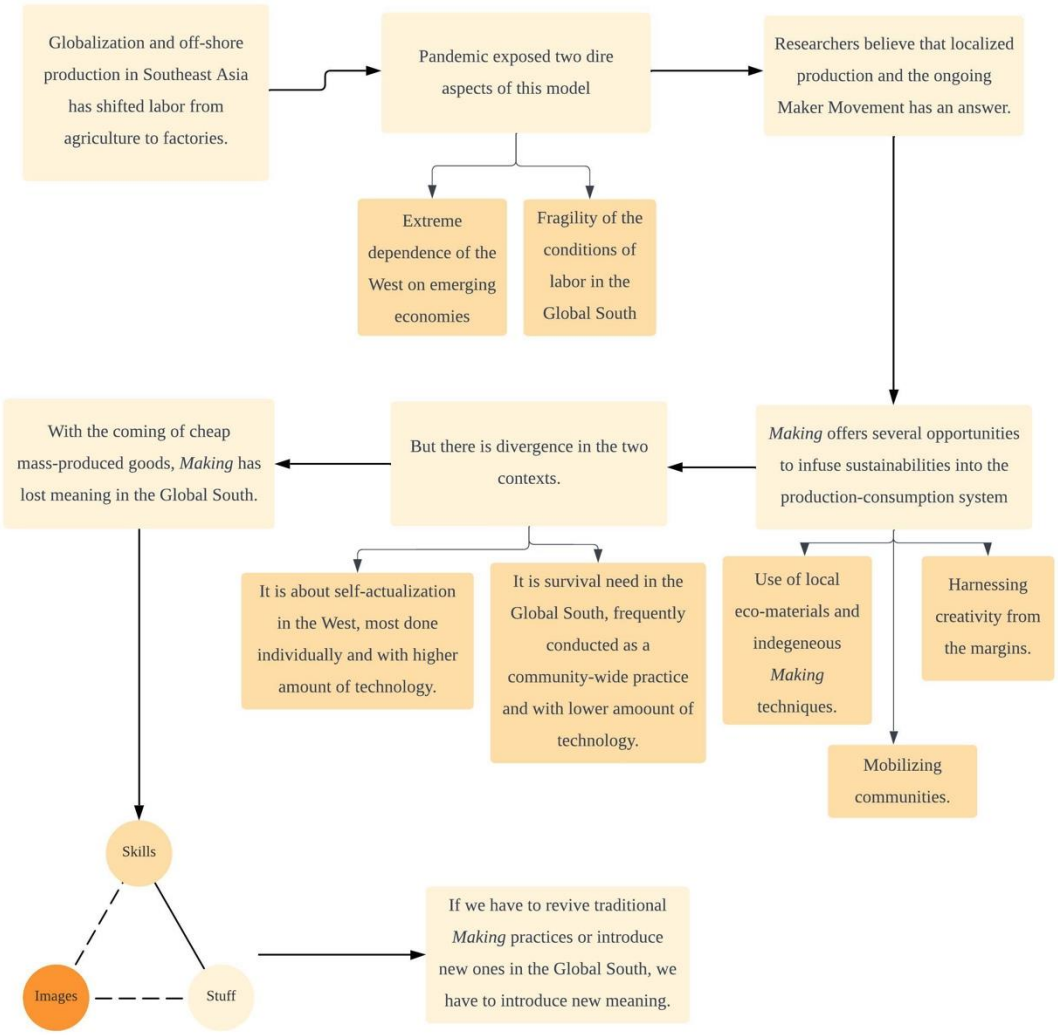


Figure 7. Schematic showing how the pandemic can shape the Maker culture to induce Sustainability.

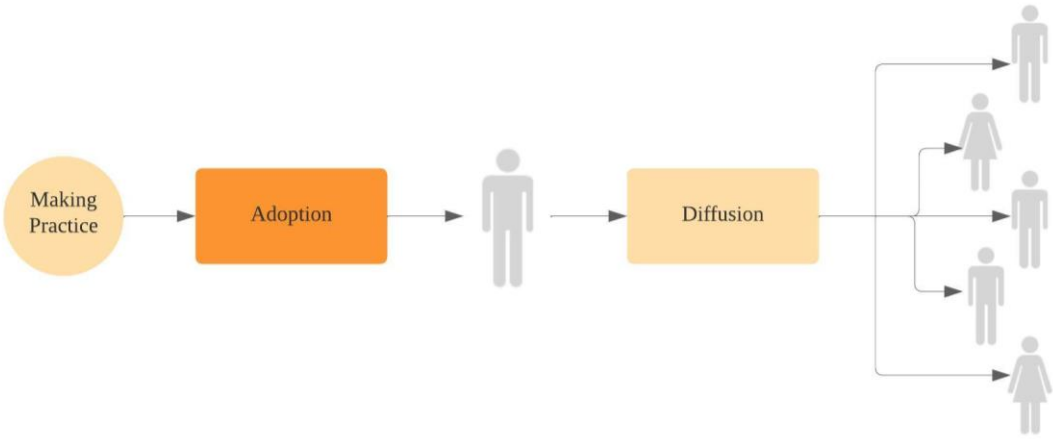


Figure 8. Two stages: Adoption and Diffusion of a DIY practice in a community.

1.19. Aim of the Thesis

Consequently, this thesis aims to understand the *Making* culture in the emerging economies and use Design to facilitate the adoption of *Making* culture.

1.20. Research Objectives

Thus, the research objectives of this thesis are:

1. Gain an empathetic understanding of *Making* practices in rural and semi-urban communities from emerging economies, including the stuff, images, and skills surrounding them.
2. Explore existing and relevant theories, frameworks, and conceptual models that can potentially aid in designing artefacts and activities for motivation for *Making*, ensuring the adoption of *Making* practices at a behavioral level by the members in such communities.
3. If relevant theories, frameworks, and conceptual models are inadequate for the design process, then formulate a framework that can aid designers in achieving the research aim.
4. Test the framework for its usability and efficacy.

1.21. Research Questions

Research Question 1: What are the characteristics of the *Making* culture in emerging economies?

A. What are the different classes of *Making* practices?

B. What are the characteristic features that distinguish the different *Making* practices in emerging economies?
C. How is the *Making* culture evolving inter-generationally in such contexts?

Research Question 2: How can Design facilitate the adoption of *Making* culture amongst the youth of emerging economies?

A. What are the existing and relevant theories, frameworks and conceptual models that attempt to or can potentially explain how to facilitate adoption of *Making* culture?
B. If the existing design frameworks, guidelines, or tools are not sufficient for facilitating design for adoption of *Making* culture, what can be an appropriate framework for the same?

Research Question 3: How usable and effective is the framework?

A. How usable and effective is the developed design framework in helping expert designers in designing products or product-service systems that facilitate the adoption of *Making* culture amongst today's youth living in emerging economies?
B. How effective is the designed product or product-service system in facilitating adoption of *Making* culture amongst today's youth living in emerging economies?

1.22. Scope of the Thesis

In this research project, we explore how Design can facilitate the adoption of *Making* practices by young adolescents in the communities in our context. During our foundational field studies, presented in chapter 4 (page 60), we observed in the self-reports of makers, that they learned such practices in their early adolescent years, either at home or from other members of the community. Earning a livelihood or doing household chores came to the fore once they entered late teenage years. During the young adolescent phase, it is easier to learn a new skill and adopt a behavior changing practice. With age and education, as our knowledge grows, we become less open to new ideas. Secondly, younger minds are inherently more flexible and exploratory, making them more suitable to unlearn old habits and learn new skills (Gopnik et al., 2015).

Our field studies also demonstrated how loss of meaning led the young generation to feel demotivated in continuing *Making* practices. Hence, we focused on motivations of the younger generation and studied how such motivational tendencies can be embedded in products and PSSs designed to infuse such practices in the community.

Ryan and Deci (2000a) states that for an individual to engage in an activity in a continued manner, the individual must be intrinsically motivated for it. *Extrinsic motivation* cannot drive a certain behavior in a sustained manner. As our aim is to make the communities in our context adopt *Making* practices at a behavioral level, with the long-term vision that such practices might be able to embody an alternate production-consumption system in future, we primarily focus on *intrinsic motivations* of young adolescents in this thesis. Figure 9 shows how our field studies shape the course of this thesis in solving the research problem.

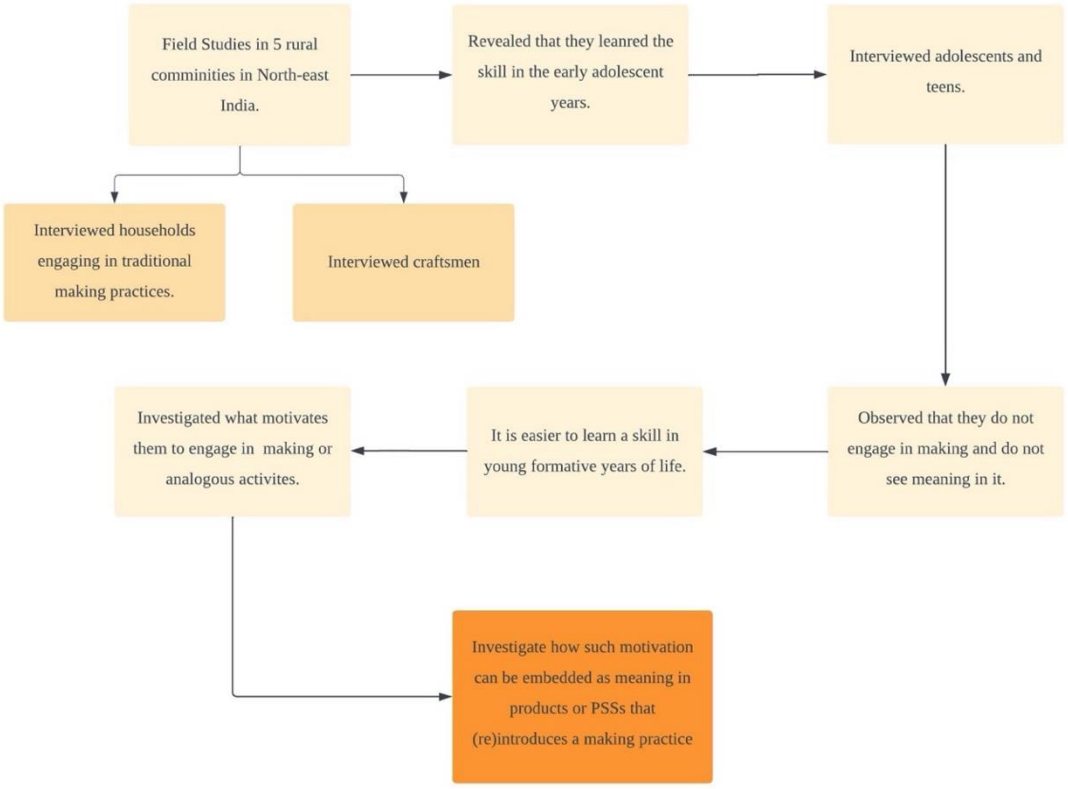


Figure 9. The sequential stages in solving the research problems beginning with field studies.

In conclusion, the ongoing Maker Movement presents new opportunities to designers to push production and consumption towards higher sustainability by enabling local-to-local and distributed manufacturing. This is especially crucial for the Global South where the environmental and socio-cultural impact of outsourced production is grievous. But with the coming of cheap mass-produced goods, *Making* practices have lost meaning in the communities of the Global South. This loss of meaning in *Making* practices is higher for the younger generation than the older generation. If designers aim to design products and PSSs

that aim to infuse sustainable *Making* practices in a community, they must understand what new meaning can motivate adoption.

In this thesis, understanding how to infuse motivational meaning in products and PSSs designed around *Making*, will form the core of the research investigation. How such knowledge or skills of such practices can be disseminated and diffused in the community will be a matter of future research.

The framework developed in this thesis is derived from elementary theories in the fields of Motivational Psychology, Behavior Change and Product Semantics. Hence, our framework can be used for designing any product or PSS that requires infusion of motivational tendencies of the target user group to bring about behavior change. Since the societal problem in this thesis revolves around revival of *Making* practices in emerging economies, we use the developed framework to design such a product or PSS and test it on a sample of the target population, i.e. adolescents in rural and semi-urban communities in emerging economies. But the generic roots of the frameworks ensures that it is equally applicable in any other context and any other target population where behavior change through motivation is involved.

1.23. Target Audience of this Research

This research aims to bring out a framework to aid designers in designing for behavior change (discussed in 7.2.1, page 113). Though the societal problem that the thesis attempts to solve pertains to the revival of ASP practices in emerging economies, the framework is rooted in foundational theories from different fields and can be applied to other behavior change applications. As such, our framework can be used by designers in various fields such as User Experience (UX) Design, Sustainable Design, Health and Wellness Design, Transportation Design, Financial Design, Workplace Design, Social Impact Design and Public Health Design where designers intend to change current behavior to a more responsible, aware, engaged, positive, healthier, or collaborative state. Our framework is especially useful for designers who intend to design at a reflective level where motivation is required to trigger behavior change.

In this thesis, we targeted the young generation in emerging economies and developed artifacts that we assumed, could drive them to adopt *Making* at a behavioral level. During the final testing, we observed that using our framework led to higher adoption for a workshop-based *Making* practice. Our experimentation affirms that our framework is also ideally suited in the field of Education Design. If motivation can be integrated in the design of upskilling programs, educational workshops and the design of maker labs, we believe that designers can effectively impart a hands-on practice into the target user group.

1.24. Our Position as a Researcher

Our research is aimed at emerging economies, but the communities that have been studied during this research project are in the state of Assam in North-East India. These communities have various ethnicities, are low-income, and are in rural or semi-urban areas. We, as researchers, do not belong to such communities. Our Interpretivist approach leads us to study these communities subjectively, observing how people make sense of the world. At the same time, our constructivist approach during the design phase, helped us to integrate new information gathered from fieldwork with existing knowledge frameworks to build the Catalyst framework (discussed in chapter 8, page 121 and chapter 9, page 130). The framework straddles both the design-led and design-driven approaches. It begins with a designer-led approach: the designer gaining an understanding of the skills, materialities, and motivations of the target user in a specific context. Such understanding is aimed at fostering higher adoption of *Making* at a behavioral level. The process involves empathizing with the user, defining the behavior change area, ideating solutions and semantic devices of the products or PSS. For expert level designers, the framework, however, evolves into a design driven approach. The focus extends beyond solving the specific problem of embedding behavior change at the target user level. The framework has the potential to supersede the level of individual interventions and to shape the overall direction, which in our case is to introduce sustainability in the lines of Distributed Economy.

1.25. Outline of the Thesis

The chapters in this thesis have the following structure with content. Chapter 1 (page 1) introduces the concept of ASP and its potential to reshape the production-consumption patterns towards higher sustainability. In emerging economies, where the environmental degradation and socio-cultural disruption is a severe threat, ASP can introduce new materialities and distributed modes of production, that mitigates the problem.

Chapter 2 (page 33) outlines the methodology (Design Inclusive Research (DIR)) adopted in this research project and explains the tools and techniques employed in the various stages.

Chapter 3 (page 51) presents the various theoretical lenses used in the thesis and examine how they are ontologically connected.

Chapters 4 (page 60), 5 (page 66) and 0 (page 88) form the pre-study phase of the DIR methodology that we have adopted in this thesis. Chapter 4 delves into the concept of ASP with a systematic literature review. Chapter 5 describes the field studies that we conducted to understand ASP in greater depth. The results and observations are presented here, along with a compendious definition of ASP in the context of emerging economies and its typology. In chapter 0, we expound on the meanings that ASP has for such communities: both motivational as well as social.

In the next part of the thesis, we design the framework and evaluate it.

Chapter 7 (page 109) delineates the theoretical lenses from the fields of Motivational Psychology and Product Semantics, that we explored for constructing the framework. In chapter 8 (page 121), we explain how we built the framework stagewise. Chapter 9 (page 130) lays out the evaluation plan and presents the results of the quantitative and qualitative evaluation of the framework.

In chapter 10 (page 179), we discuss the key research and design contributions in this thesis. Thereafter, chapter 11 (page 191) presents our conclusion, chapter 12 (page 196) puts forward possible research areas in future that can extend this work in a more comprehensive direction, and chapter 13 (page 199) enlists the publications and planned publications from this research project.

2. Methodology

This chapter delves into the methodological foundations and design strategies underpinning this thesis. Situating the inquiry within a philosophical framework that emphasizes the interpretative nature of research, the methodology chapter lays the groundwork for a comprehensive exploration of the socio-cultural dynamics and individual motivations driving ASP practices. By adopting the Design Inclusive Research (DIR) methodology, the study aims to bridge the gap between theoretical knowledge and practical design interventions, ensuring that the research outcomes are deeply rooted in the lived realities of the communities under study. Through a meticulous process that encompasses a pre-study phase of extensive literature review and field studies, a creative design phase, and a post-study evaluation, the research navigates the complex landscape of *Making* culture in emerging economies.

2.1. Philosophical Position and theoretical perspective

Research, as a systematic process of critical and self-critical enquiry (Bassey, 1990) and knowledge creation, begins with the researcher's understanding of the nature of the phenomenon under study as outlined by the research questions (Landry & Banville, 1992). Three questions, at this stage, form the backbone of the research enquiry henceforth:

a. **The ontological question:** What can be known about the nature and form of reality?

b. **The epistemological question:** What is the relationship between the researcher and that which can be known about the reality?

c. **The methodological question:** How can the researcher systematically enquire into what can be known about the reality? (Makombe, 2017)

These structural questions are the key elements of the researcher's paradigm which is broadly defined by Guba and Lincoln (1994) as "a basic system or worldview that guides the investigator." These questions are however, interrelated, in the sense that once an answer is provided to one of them, it restricts the possible answers to the other two Guba and Lincoln (1994). For instance, assuming a real reality ontologically, the researcher assumes objective detachment as the epistemological stance, quantitative as the method and positivism as the overall paradigm. On the other hand, if the researcher locates the research in an interpretivist paradigm, then the ontology cannot be real reality and objective detachment cannot be the epistemology (Guba & Lincoln, 1994; Makombe, 2017). Identifying the interrelatedness of the ontological and epistemological stances, Crotty (1998) proposes a hierarchal decision making schema (Figure 10). The

author suggests that epistemological stance of the researcher is the beginning point of the research design process which governs the theoretical perspective, choice of research methodology and methods.

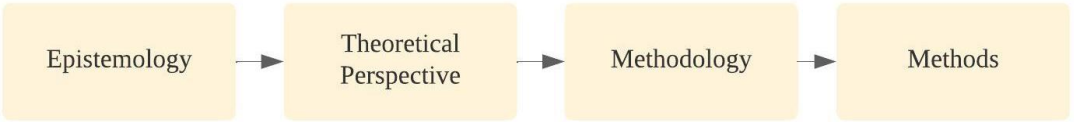


Figure 10. Crotty's (1998) Schema for Research Design.

In this research design, we adopt Crotty (1998)'s schema. The social complexity of the research problem with no determinable causal agents and no one-true solution, implies that the standards of the proposed solution are those that are intellectually defensible by the researcher (Foley, 1987) and meets the standards of recognized experts in the researcher's community (Stich, 1985). The research, thus, assumes an epistemologically subjective stance which entails relativism as the ontology, qualitative and/or mixed as the method and Interpretivism as the paradigm.

Interpretivism is concerned with subjective meanings as it recognizes an individual's understanding and interpretation of a social phenomenon (Schwandt, 1994) and argues that the researchers cannot distance themselves from the social matter being studied and the research methods being adopted (Hussain et al., 2013). This paradigm is considered constructivist, naturalist and humanist (Shah & Al-Bargi, 2013) that looks for "culturally derived and historically situated interpretations of the social life-world" (Crotty, 1998). Since, this research is guided by the urge to understand and address a social-reality, more than the cause-and-effect relationships underpinning it, the aim is to explore individuals' perceptions and meanings (Bryman, 2016) and ultimately how such subjective interpretations shape the objective features of the community (Shah & Al-Bargi, 2013). The ontology of Interpretivism is relativism which holds that there is no absolute truth, but multiple forms of intangible mental constructions that are framed by an individual or a group's belief, justification or rationality (Shah & Al-Bargi, 2013). The truth, therefore, is always with respect to a reference frame such as an individual's standards, moral values, norms of a culture or a language (Baghramian & Carter, 2022). In our research, we have adopted the idea of multiple realities emerging from individual and social mental constructs to understand the social reality of the community under study and in conducting qualitative research on the individuals.

The Interpretivist paradigm is based on a subjective and transactional epistemology where the observer and the observed are fused into a single entity and observations actualize through their interactions (Shah & Al-Bargi, 2013). Subjective interactions are the only means to access the realities constructed in the respondents' minds and the interpretivist researcher is guided by the belief that the interpretations of the individuals and their participations influence the observed phenomenon (Alwan, 2007). In order to understand a social

phenomenon from an individual's perspective, studying the interactions among individuals and the cultural and historical contexts in which the individual dwells (Creswell, 2013), interpretivists use hermeneutical research methods (Guba & Lincoln, 1994). Interpretivists also do not believe that quantitative methods are adequate to understand the richness of social phenomenon. For this, Interpretivism uses primary research techniques that place humans as the primary research instrument such as Grounded Theory, Case study and Ethnography.

While Interpretivism emerged as a contradistinction of positivism and the one-reality that it posits, it lacks in generalizability (Samdahl, 1999) and reproducibility (Shah & Al-Bargi, 2013) for the contextual nature of its research findings. Moreover, carrying out in-depth qualitative research can be time consuming and might also be prolonged by idiosyncratic interactions. Furthermore, due to the open-ended nature of the qualitative research, personal subjectivity of the researcher tends to reflect on the findings and compromise the participant's perspective (Howe et al., 1999). The participant's lack of *autonomy* over the findings might result in a theorized account of the respondent's sociological understanding (Danby & Farrell, 2004). Despite the shortcomings, qualitative research is widely used in fields such as social sciences, psychology, business, and design for its ability to generate deep insights into individual constructs and make sense from a large mass of unstructured data through the inductive approach. Positivist criteria such as *internal* and *external validity*, *reliability*, and *objectivity* are replaced with *credibility*, *transferability*, *dependability*, and *confirmability* in Interpretivist research (Denzin & Lincoln, 1998). Furthermore, Creswell (2013) suggests that qualitative research is an appropriate method when the research problem is complex and a detailed understanding of the issue is required. The natural setting is important in qualitative research as it is an inseparable part of the context in which the respondents tell stories of their lives and works. Creswell (2013) further suggests, that qualitative research is a suitable approach when existing theories are inadequate to explain the complexity or the whole picture of the problems being studied. The issue being investigated in this research presents all the above difficulties: (a) It is a wicked problem with no definite causal relationships (discussed in Section 1.4, page 5) (b) It is undertheorized as it has not been studied before from a design intervention point of view to the best of the researchers' knowledge (discussed in Chapter 4, page 60) (c) It requires in-depth understanding of the socio-cultural constructs of the target population for meaningful intervention design (discussed in Chapter 5, page 66). Moreover, qualitative research allows the researcher to have a holistic account of the multiple perspectives and have an emergent design that can be changed during the process of data collection (Yen, 2012). It has a repertoire of tools and techniques that supports the data collection on the field and inductive data analysis (Yen, 2012). All of this is in line with our research problem and essential for the framing methodology, namely: Design Inclusive Research (DIR) that we have adopted.

2.2. Design Inclusive Research Methodology

The framing methodology is the holistic process that facilitates the thinking process (Horvath, 2008). The chosen methodology should be concordant with the interpretivist theoretical perspective in this thesis. It should guide the researcher in investigating the social issue, which is of a complex nature, design interventions, test their efficacy in the real-world context in an evolving manner and generate new knowledge. The DIR methodology which integrates the two domains: research and design, in an unscrupulous way provides a methodology that is rigorous enough for proper scientific framing (Horvath, 2006, 2008). While there is no definition of DIR, it is best described as a methodology that "embeds design as research means" in which "design" might be an "artifact, process, entity, phenomenon and knowledge" (Horvath, 2006, 2008). The "artifact" here is the result of prototyping designed with mindfulness of the internal research goals as well as the external societal problem, the social content of designing and the assumptions regarding the nature, utility and the experience with the product (Horvath, 2006). This methodology has been adopted in several PhD research projects earlier (Gribnau, 1999; Keller, 2005; Rusák, 2003).

The primary reason for choosing DIR, which is relatively a new methodology in design research over traditionalist methodologies[4] such as Research in Design Context (RiDC), Participatory Design, Research through Design, and Design Science Research, in this thesis, is the careful balance that is achieves between research and design (Horvath, 2008). The current research problem requires an in-depth understanding of the social context and the possible ways to design an intervention which takes into account the latent dynamics within the community while fulfilling the societal need. At the same time, it requires the design of an "artifact" (tangible or intangible output, such as framework, prototype, digital model, sketch, or narration) which becomes the scientific tool for the inside research question and the process of knowledge creation which should simultaneously have some utilitarian and functional value (Horvath, 2008) for the community. DIR carefully intertwines these three key needs of our research problem: the object and the context, design knowledge and research knowledge (Horvath, 2008).

[4] RiDC supports analytical disciplinary research, focusing on building theories and using methods from background disciplines (Horvath, 2007, 2008) and is discussed further in detail in 2.4 (page 40). Practice-based Design Research extracts knowledge from practical design processes and environments (Horváth, 2007). Design Science Research (DSR) is an approach with multiple methodologies, and researchers can choose an appropriate methodology based on situational contingencies (Venable et al., 2017). Action Design Research (ADR) is considered a particular case of DSR, although they can assume different epistemological positions (Maccani et al., 2015).

The second reason for choosing DIR is its structural suitability in research problems where current theory is not convergent enough to explain the societal problem cohesively and exploratory research is required to frame it as a research problem (Horvath, 2006). DIR begins with a phase of explorative research action which includes aggregation of existing knowledge about a specific phenomenon, critique of the current understanding and the synthesis of new knowledge that is relevant for solving the research problem though induction and deduction (Horvath, 2008). Since the societal problem in this thesis is of a complex nature and relies on multi-disciplinary knowledge, besides observations on the field, coalescing both the forms of exploratory insights to synthesize the research questions as well as informing the design process, is an important stage in this research.

DIR proposes an iterative design process and evaluation, but more than the iterative refinement of research artifact (Horvath, 2006), it is the simultaneous creation of knowledge that appeals to this research. A central feature of DIR is information flow, both external as well as internal, and stage-wise information coupling. The external flow informs the design process of the market's needs, technological opportunities and user preferences whereas the internal flow informs the design process of the aggregated and synthesized research findings. (Horvath, 2008). The latter is implicit in all design research methodologies such as Design Science Research (Iivari & Venable, 2009), Research in Design Context (Desmet, 2002; Horvath, 2008), Research through Design (Stappers & Giaccardi, 2017; Zimmerman et al., 2007) and Action Research (Cole et al., 2005; Iivari & Venable, 2009), but it is the external information flow that has the potential to make the design process more open, explorative, technologically relevant and socially-situated.

Though DIR has many epistemological, methodological and pragmatic issues, it enables an active involvement in design activities conducted either in real-life or laboratory settings with tangible research means such as hardware, software, knowledge or a hybrid. It also enables research to be contextualized by different aspects of design and vice versa in an evolving manner. (Horvath, 2008). This holistic design process is one of the important reasons for adopting this methodology.

2.3. Design Inclusive Research Process

The chief characteristics of the DIR methodology are: (a) Inclusion of design in the research process to create opportunities for knowledge generation. Theory building takes place concurrently with the constructive design and evaluation process (b) Besides exploration in multiple disciplines, the DIR process involves manipulation of relevant knowledge to create conceptual models, frameworks or guidelines that are usable in the design context. (c) The artifacts used for research are designed with the societal context in mind with the aim of delivering utility through it. (d) The output of the research is better understanding of the concepts, models, and prototypes (Horvath, 2008). Figure 11 shows the general process of DIR. It can be divided into three broad stages:

- An explorative or a pre-study phase.
- A creative design phase.
- An evaluative or post-study phase.

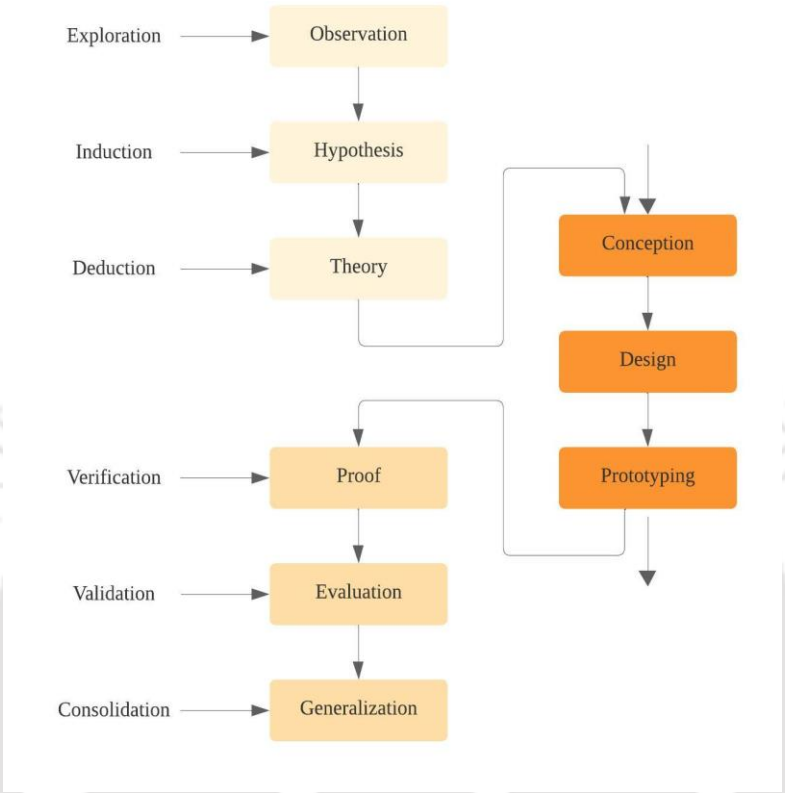


Figure 11. The Design Inclusive Research Process (DIR) (Horvath, 2006)

The pre-study phase is for aggregation of existing knowledge on the societal problem or phenomenon and critiquing the current understanding. It also involves formulation of the research questions and the design problem, and development of relevant theories to solve the research problem (Horváth, 2007). This is followed by the iterative design process wherein the research artifact is conceptualized, designed, and prototyped. The role of the embedded design process with research artifacts is for the formulation of concepts, models, and methodologies, to test the validity and feasibility of the ideas and to contribute to theory building in an evolving manner. The final stage is the post-study or the evaluation phase where the hypotheses and the constructed theory is verified, research and design methods are internally validated, the research findings are externally validated and the results are generalized towards other applications (Horvath, 2006, 2008) .

There are some loose ends in the DIR methodology, on the integration of the internal and external knowledge flows. The two sets of information are expected to complement each other, but further studies seem necessary on how to achieve meaningful integration of the two. Furthermore, it is also not defined how to embed design in the research project which might compromise the rigor in the experiment design and knowledge creation process. (Horvath, 2008). Despite these operational limitations, DIR has the structural capacity to interweave context related knowledge, research process or methodological knowledge and design process or methodological knowledge (Horvath, 2008; Horváth, 2007).

2.4. Design Inclusive Research versus Research in Design Context

In choosing an appropriate methodology for the research problem in this thesis, the primary criteria were: (a) it should enable the researcher to stay close to fundamental research in synthesizing knowledge related to the sociological phenomenon. In other words, it should allow the researcher the space for curiosity, interest and hunch without the outright imposition of practical boundaries from the design feasibility point of view, (b) it guides the researcher in assimilating multi-disciplinary knowledge for generating a more holistic knowledge construct that can lead to higher innovativeness in the intervention design, and finally, (c) moves the researcher closer to applied research in designing and empirically testing the research artifact (ASP PSS in our case). Two design research methodologies, with varying amounts of fundamental and applied research were considered for framing our research, namely: Research in Design Context (RiDC) and Design Inclusive Research (DIR).

RiDC is closer to fundamental research than DIR. RiDC proposes that all kinds of observation, descriptive and explorative research methods used in fundamental sciences can, in principle, also be applied to design research (Horváth, 2007). Studies conducted according to the RiDC framework are mono-disciplinary, similar to basic sciences, yet, unlike basic sciences where scientific enquiry is decontextualized, it is not without a context or purpose (Desmet, 2002; Hummels, 2000; Snelders, 1995). In fact, empirical and experimental studies are purposefully conducted to gain a deeper understanding of a context. The context is defined by the (i) people who are involved and influenced by the design, (ii) the artifacts created by the design process and (iii) the interaction of people with the artifacts. Research in RiDC often tries to investigate the interrelationships between the three contextual elements. (Horváth, 2007). The six-stage scheme in the RiDC process is shown in Figure 12 (Horvath, 2008; Horváth, 2007).

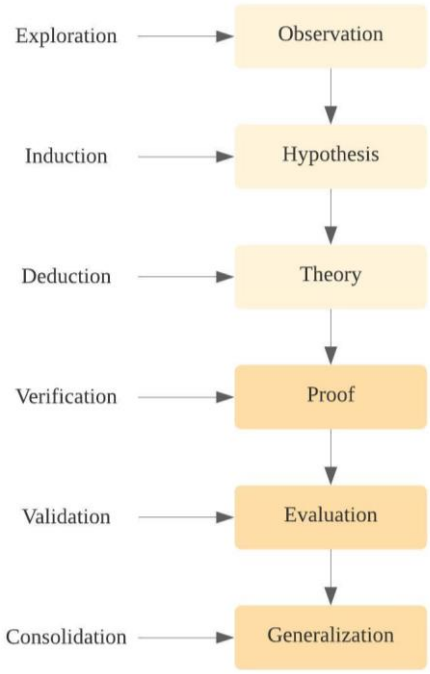


Figure 12. The Research in Design Context (RiDC) Process (Horvarth, 2008).

RiDC, as a methodology is not domain specific and can be applied to a vast range of research problems for generating better insights into a phenomenon and building theory (Horváth, 2007). But research conducted through RiDC is analytical and not constructive (Desmet, 2002; Hummels, 2000; Snelders, 1995). Moreover, RiDC with its mono-disciplinary nature, shows weak capacities to integrate multi-disciplinary knowledge (Horvath, 2008; Horváth, 2007). Table 1 shows a comparison of the RiDC and DIR methodologies in some important respects.

Table 1 Comparison between RiDC and DIR Methodologies (Horvath, 2007, Horvath, 2008)

Aspect	**RiDC**	**DIR**
Research Perspective	Exploration, description, explanation	Exploration, description, explanation, manipulation
Epistemological Basis	Knowledge from specific background sciences or design contexts.	Knowledge from multiple related background sciences and design contexts.
Context of Research	One or limited number of aspects of design.	Large number of design aspects.
Design of Research means	According to research goals	According to research goals as well as external requirements.
Status of Research Means	Unchanged in the experimental process	Evolving with the experimental process.

Style of Research	Mono-disciplinary and analytical	Multi-disciplinary and constructivist
Methodological Basis	General research methods and methods of background sciences	General research methods and dedicated methods of design research
Location	Mainly laboratory settings	In real life or in research and design laboratory settings
Involvement in design activities	Passive	Active
Output	Better insights into a phenomenon	Better understanding of concepts, prototypes, models, and methodologies.

As the nature of the research problems is such that it requires a multi-disciplinary assimilation of knowledge and a constructivist approach and high contextual-situatedness for designing and effective intervention, we believe that DIR is a more suitable framing methodology for the current research. Its evolving nature and higher proximity towards applied sciences, also makes it more suitable for a research problem that requires active design involvement and tangible research output in the form of models and prototypes. DIR also allows research to be conducted with practical constraints from the societal problem whereas in RiDC, research is not constrained by the design context. Due to the above reasons, DIR is more a suitable methodology for this research.

2.5. Actualizing the Research Design

The DIR methodology has three distinct stages: the pre-study, the design phase and the post-study, and at the onset, the researcher chooses the context of design. The pre-study phase entails open-ended exploration and in-depth understanding of the social context through literature review and/or field studies, formulation of the research questions and generation of theory based on the exploratory studies that guides the design process. Our societal problem concerns emerging economies, and, in this research, we choose the state of Assam in the eastern part of India as our context for design. There are several reasons for this choice:

a. The primary reason is the operational ease for the research team. It is the state in which the base institution is located. Fieldwork requires a base in the geographical area where the researcher or the team is conducting exploratory studies or field tests (Chipchase, 2017). In our case, the base institution serves as our field base.

b. The second reason is that with a large land area (78,438 km²) and a great diversity in ethnicity and lifestyles of people, the state provides several uses cases for our fieldwork study. We will shortly discuss, how open-exploratory studies require multiple use cases to generate meaningful, convergent qualitative insights.

c. A fieldwork researcher ideally adopts triangulation of data with multiple data collection techniques for studying the same phenomenon in qualitative research. This is to compensate for the lack of verification techniques in such research. While triangulation increases confirmability of qualitative data, it is a time-consuming process and requires the researcher to be in an immersive mode on field. When the target population is located near the base institution, time constraints on the fieldwork researcher are less demanding.

d. The diversity in use cases also increases the *transferability* of our qualitative research findings which forms an important part in the third phase of DIR or the post-study.

Figure 13 summarizes the various stages in this research based on the DIR methodology.

2.5.1. Pre-study

The pre-study phase of the DIR methodology serves as a foundational phase, designed to establish a comprehensive understanding of the problem context, research goals, and the sociocultural intricacies of the problem context, in this case ASP within emerging economies. This phase is characterized by a multifaceted approach that includes a detailed problem statement, an exhaustive review of background material, field studies employing various data collection techniques, and the operationalization of research findings. Through the application of methods such as the Double Diamond Model of fieldwork (Chipchase, 2017) and the Opportunity Detection Toolkit (Mink, 2016), alongside traditional fieldwork techniques like semi-structured interviews and focus group discussions, the pre-study aims to gather both broad and in-depth insights into ASP practices, motivations, and the social dynamics at play. The culmination of this stage is the development of a framework informed by a review of literature across multiple disciplines, including motivational psychology and product semantics, refined through iterative feedback from experts in design. The output of the pre-study stage not only offers a detailed literature review and a nuanced understanding of ASP practices but also establishes a theoretical foundation for facilitating the adoption of ASP at a behavioral level, setting the stage for subsequent design and evaluation phases. The various stages, methods and output of the pre-study phase are elaborated in the following sub-sections.

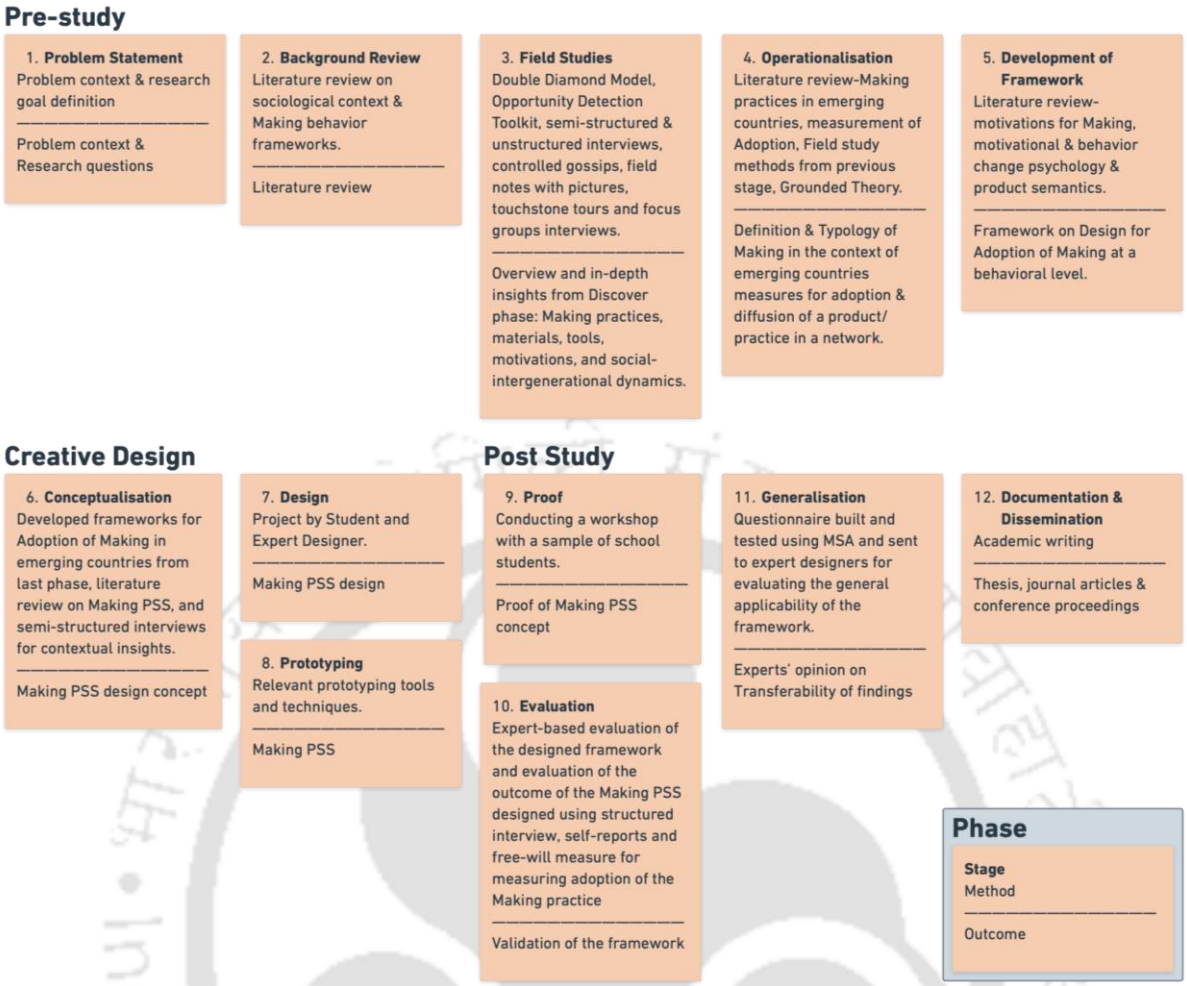


Figure 13. The various stages in this research based on the DIR methodology

2.5.1.1. Problem Statement

The research begins with a clarification of (a) the problem context, (b) the research goals and (c) the research questions. The problem context, discussed in chapter 1, delineates the sociological and labor related problems arising in the Global South during and expectedly, after the Covid-19 pandemic. It also discusses the need to focus on the problems in the Global South post pandemic and the various production-consumption and labor related solutions that have been adopted in practice or presented in theory in the last century. We also discuss the need for a design approach that can bridge the tenets of ASP mass movements, the theories advocating local production and the sociological and environmental context of the target community. We conceive the potency of Design research in assimilating multi-disciplinary knowledge, conducting in-depth inquiry into the sociological context of the target population and designing with a systems view, as key in presenting a holistic solution to the problem in hand.

Our research goals are thereafter defined as:

1. Gain an empathetic understanding of *Making* practices in rural and semi-urban communities from emerging economies, including the stuff, images, and skills surrounding them (Shove et al., 2012).
2. Explore existing and relevant theories, frameworks, and conceptual models that can potentially aid in designing artefacts and activities for motivation for *Making*, ensuring the adoption of *Making* practices at a behavioral level by the members in such communities.
3. If relevant theories, frameworks, and conceptual models are inadequate for the design process, then formulate a framework that can aid designers in achieving the research aim.
4. Test the framework for its usability and effectiveness.

2.5.1.2. Review of Background Material

The first step in addressing the research problem, outlined through the research objectives and research questions, is the compilation and analysis of relevant background material. To set the stage for developing the necessary framework for design, the researcher conducted a review of literature on design for economically backward consumer bases, design approaches and production-consumption models from the domain of sustainability, the Maker Movement, psychological analysis of ASP communities and ASP practices in emerging economies. For this, we not only looked at academic databases such as Web of Science, ScienceDirect, Scopus, Sage Journals, Springer, Elsevier and JSTOR but also at national databases such as National Innovation Foundation ((National Innovation Foundation & Department of Science and Technology, n.d.), Honeybee Network (HoneyBee Network, n.d.) and Handmade in India (Ranjan & Ranjan, 2009). To state that the research objectives and research questions lead to this literature review, would not be entirely correct. The research objectives and questions and the literature review were iteratively conducted, one influencing and qualifying the other.

The research questions, thereafter, directed us to specific disciplinary research in the fields of Motivational Psychology, Product Semantics, and Behavior Change Theory that we believed would be a wellspring of scientifically backed conceptual models and frameworks for our intervention design. Here, the literature review gained a more directional nature than the open-ended review phase described above. Besides research articles, domain-specific books and relevant doctoral theses were reviewed.

2.5.1.3. Field Studies

The following research questions are answered in this phase:

Research Question 1: What are the characteristics of the *Making* culture in emerging economies?

A. What are the different classes of *Making* practices?
B. What are the characteristic features that distinguish the different *Making* practices in emerging economies?
C. How is the *Making* culture evolving inter-generationally in such contexts?

Research Question 2: How can Design facilitate the adoption of *Making* culture amongst the youth of emerging economies?

A. What are the existing and relevant theories, frameworks and conceptual models that attempt to or can potentially explain how to facilitate adoption of *Making* culture?

We adopted the Double Diamond model of fieldwork (Chipchase, 2017) (Figure 14) for the initial observational field study which consists of the four phases: *Discover*, *Define*, *Develop* and *Deliver*. The *Discover* phase is the 'phase of divergent thought' where the researcher conducts an overview study of a broad number of cases to have a general understanding of the sociological context: people, surroundings, and objects. The *Define* phase is a review phase where the insights from the *Discover* phase are analyzed, the primary research question is drafted and the variables or aspects to study in the next convergent phase are decided. In the *Develop* stage, the researchers focus on one field-study case and studies the dynamics of the community in-depth along the lines of the *Define* phase. In the *Deliver* phase, the final research questions are formulated based on the findings of the *Develop* phase, theory is developed through the processes of induction and deduction to lead the researcher into the subsequent Design stage in the DIR methodology (Chipchase, 2017; Horvath, 2008). It is to be noted that the Double Diamond model employs terminology that is frequently used in practice-based design projects, the reason being its adoption into fieldwork research from the in-house design processes of companies such as Alessi, Lego, Sony, Microsoft and Starbucks (Design Council, 2005).

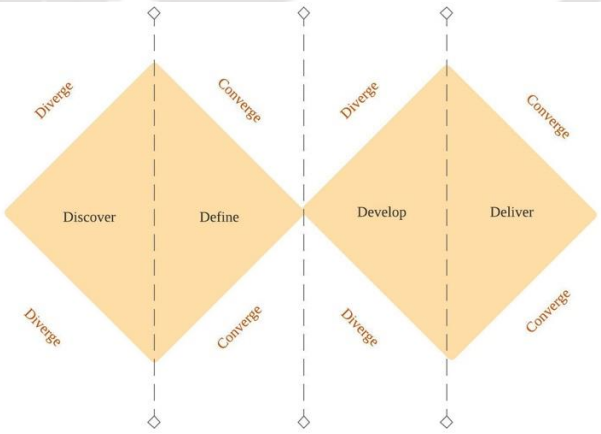


Figure 14. The Double Diamond Model of Fieldwork Research (Chipchase, 2017)

The open exploratory or the *Discover* phase was conducted in four villages in Assam namely: Joypur, Gopalpur, Paator Kusi and Sarthebari. Though our focus was on observing ASP practices, materials and tools used and social dynamics in the community, we embraced an openness of mindset to be receptive of "hidden gems" in the community that could open unforeseen directions for intervention design. Several fieldwork techniques were adopted to gather data such as semi-structured interviews, controlled gossips, field notes with pictures, touchstone tours and focus groups interviews (Chipchase, 2017; Handwerker, 2001). The purpose of employing multiple techniques is twofold:

a. Different observable variables required different techniques for comprehensive data collection. While field notes with pictures and semi-structured interviews were sufficiently resourceful for collecting data on most variables, some variables needed supplementary techniques for gaining either hidden information or insights. For instance, to observe ASP practices, the researcher considered it essential to enter into homes and backyards of the subjects and conduct an artefact analysis and touchstone tours. The researcher also conducted focus group interviews with 3-5 members, besides one-to-one semi-structured interviews to gain deeper understanding of the social dynamics behind ASP practices in such communities.

b. Adopting more than one technique helped in achieving data triangulation and increased the reliability of the data collection process (Handwerker, 2001)

Thereafter, we focused on one site, namely Naumati in Assam and studied the same variables in-depth. The research questions and observational techniques for the in-depth phase had been refined based on our observations from the open observation phase. As an overarching guideline to the in-depth phase, we adopted the 4-stage field study method suggested by the Opportunity Detection Toolkit in the "Capability Driven Design" process developed by Mink (2016). The four stages include: *Preparation, Informal Insights, Deep Insights* and *Verification.* The overview findings from the *Informal Insights* stage helped us formulate the questionnaires for the subsequent interviews for gaining deep insight, the findings of which were confirmed in the verification stage through focus group interviews. The results of the in-depth phase along with details of the observational techniques employed and analysis conducted are included in Chapter 0 (page 88). The end results of the pre-study phase of DIR are conceptual models and frameworks developed through the process of induction (data from fieldwork) and deduction (related conceptual models and frameworks from literature) that operationalizes our research and aids in the next stage of the DIR process, namely: the creative design phase.

2.5.1.4. Operationalization

The following research question is answered in this phase:

Research Question 1: What are the characteristics of the *Making* culture in emerging economies?

A. What are the different classes of *Making* practices?
B. What are the characteristic features that distinguish the different *Making* practices in emerging economies?

We formulate a working definition of ASP (on page 82) in the context of emerging economies and develop a typology of such practices. We also identify the key factor which differentiates the different types of ASP practices and renders the categories orthogonal. We use grounded theory (Glaser & Strauss, 2017) built on the original Grounded Theory proposed by Strauss and Corbin (1990) with the coding scheme proposed by (Charmaz & Belgrave, 2007) on cases of ASP practices obtained from field studies and literature. We accessed academic databases such as Google Scholar, Scopus and SAGE Journals using combinations and variations for keywords such as- 'Do-It-Yourself, types of Do-It-Yourself, Making, India, Maker Culture, Maker Movement, Base of the Pyramid, Fablab, *Jugaad*, Grassroots Innovations, Craft, Prosumption, Do-It-Yourself Practice', etc. We also looked at other databases that catalogue ASP and craft practices from India such as the National Innovation Foundation ((National Innovation Foundation & Department of Science and Technology, n.d.), Honeybee Network (HoneyBee Network, n.d.) and Handmade in India (Ranjan & Ranjan, 2009). The field studies which supplied another set of cases has been discussed in the preceding section 2.5.1.3 (page 44).

2.5.1.5. Development of Frameworks

The following research question is answered in this phase:

Research Question 2: How can Design facilitate the adoption of *Making* culture amongst the youth of emerging economies?

A. What are the existing and relevant theories, frameworks and conceptual models that attempt to or can potentially explain how to facilitate adoption of *Making* culture?
B. If the existing design frameworks, guidelines, or tools are not sufficient for facilitating design for adoption of *Making* culture, what can be an appropriate framework for the same?

The guiding frameworks for the Creative Design phase were developed in this stage taking root in theory from multiple disciplines such as motivational psychology, product semantics and behavior change design. The development of the framework for the adoption of the ASP PSS is discussed in Chapter 8 (page 121). In Chapter 9 (page 131), we discuss how the framework is subjected to iterative design by conducting semi-structured interviews with PhD scholars in Design.

2.5.2. Creative Design Phase

The second phase of the DIR methodology is the Creative Design Phase. The Creative Design phase of the research methodology focuses on the translation of theoretical insights and frameworks developed during the pre-study phase into tangible design concepts and prototypes for ASP PSS in emerging economies. This phase is structured around three key stages: conceptualization, design, and prototyping.

During conceptualization, the framework for adopting ASP in emerging economies, informed by phase one findings, and enriched with external data on existing ASP product service systems, guides the creation of ASP PSS design concepts. Semi-structured interviews are conducted to deepen the understanding of the target population's motivations to engage in ASP practices, ensuring that the design concepts are grounded in the users' real-world context and needs.

The design stage sees these concepts being brought to life through projects undertaken by both student and expert designers. This collaborative effort ensures a diverse range of perspectives and expertise are applied to the ASP PSS designs, aiming for innovative and feasible solutions tailored to the identified needs and motivations of the target communities.

Prototyping then materializes these designs into physical or digital prototypes, employing various relevant tools and techniques to create functional representations of the ASP PSS. These prototypes serve as a bridge between the theoretical frameworks and practical applications, enabling further evaluation and refinement based on real-world interactions and feedback.

The Creative Design phase culminated in the development of ASP PSS designs that are both conceptually grounded and practically viable, ready for testing and evaluation in the subsequent phase of the research.

2.5.3. Post Study

The post-study phase is the final phase in the DIR methodology, dedicated to the validation, evaluation, and dissemination of the findings from the Creative Design phase. It encompasses four stages: proof, evaluation, generalization, and documentation and dissemination.

In the proof stage, the viability of the ASP PSS concept is tested through workshops conducted with a sample of school students. This hands-on interaction provides tangible evidence of the concept's effectiveness and its potential impact on the target audience, offering initial proof of concept.

The evaluation stage involves a rigorous assessment of the framework developed in earlier phases. This is achieved through a combination of questionnaires refined using Mokken Scale Analysis (MSA) and sent for expert evaluation, alongside structured interviews, self-reports, and measures of free will designed to gauge the adoption of the ASP practice. This multifaceted approach ensures a comprehensive validation of the framework, confirming its effectiveness and applicability.

Generalization focuses on extending the research findings beyond the immediate study context. Questionnaires, again refined using MSA, are distributed to experts to gather their opinions on the broader applicability and transferability of the findings. This stage aims to determine whether the insights and solutions developed can be applied to similar contexts, thereby increasing the research's impact.

Finally, the documentation and dissemination stage are where the research findings are compiled and shared with the wider academic and professional community. This includes the preparation of a detailed research thesis and the publication of findings in conference papers and journal articles. This stage is crucial for sharing the knowledge gained with others in the field, contributing to the academic discourse, and potentially inspiring further research and development around ASP PSS.

Through these stages, the post-study phase closed the loop on the research process, providing evidence of the research's validity, applicability, and contribution to the field, while ensuring the findings are accessible for further academic inquiry and practical application.

The following research question is answered in this phase:

Research Question 3: How usable and effective is the framework?

A. How usable and effective is the developed design framework in helping expert designers in designing products or product-service systems that facilitate the adoption of *Making* culture amongst today's youth living in emerging economies?
B. How effective is the designed product or product-service system in facilitating adoption of *Making* culture amongst today's youth living in emerging economies?

2.6. Conclusion

We embark on this research project with a clear understanding of the nature of the societal problem, and the researcher's paradigm in relation to the research problem. As the research problem is a wicked problem, whose solution relies on the shared reality perceived by the researcher and subjects, we assume an interpretivist stance and adopt qualitative and semi-qualitative research methods. The research problem also requires an active assimilation of fundamental knowledge from multiple disciplines and knowledge generated through Design. Hence, we adopt the DIR methodology and follow its steps, recognizing its suitability for our research problem. In the next chapter, we discuss how we ontologically bridge the various theoretical lenses used in synthesizing our framework and examine how we add to the richness of the research methods by taking a pluralistic approach.

3. Methodology: Ontological Bridging and Methodological Pluralism

In this chapter, we study the various theoretical lenses used in this thesis and examine how they are ontologically connected. We also examine how theories that are rationalistic or have a constructivist grounding are commensurate with the Interpretivist paradigm of the researcher. Furthermore, we discuss how theories with differing units of observation, analysis and design have been ontologically connected in the synthesis of the intervention that aims to solve the societal problem in this thesis. We also describe how a positivist experimental setup befits as an appropriate evaluation of the designed intervention in the final stage of DIR.

3.1. The Two-Stage Model and the Theoretical Lenses

While consumerism is on the rise in emerging economies, *Making* practices are losing their meaning for survival. During our fieldwork in rural communities in India, we observed that while the older generation engaged in *Making* practices to fulfill their material needs, such meaning saw intergenerational decay as the younger generation did not view *Making* as a necessity (discussed in chapter 0, page 88). During this phase we conducted both open-ended observations as well as subsequent in-depth observations. Given that as researchers, we do not belong to that demography, to have a holistic understanding of *Making* in such communities, we viewed it as a 'practice.' Adopting Practice Theory enabled us to study *Making* in the context of the materialities, the skills involved, and the social and symbolic significance. Moreso, it enabled us to examine how *Making* practices are embedded within social contexts and are often influenced by cultural norms, values, and shared understandings, which further solidify their subsistence in the community.

Among other findings, we observed the decaying intergenerational trend for *Making* practices in the communities where fieldwork was conducted (discussed in chapter 0, page 88). As such, we posit that for *Making* to emerge as an alternate production-consumption system in emerging economies, it must be readopted and diffused in such communities. Hence, we envision the readoption of *Making* as a two-stage process: adoption, and the subsequent diffusion (discussed in 1.18, page 25 and Figure 8, page 27).

The adoption of a practice, within the context of Practice Theory, refers to the process by which an individual or group begins to engage in a particular practice, integrating it into their daily lives. During this process, the three key elements of a practice are integrated successfully so that the individual can reproduce it and sustain it over time (Shove et al., 2012). Adoption of a practice within a community often begins with a small group of individuals or early adopters who introduce and normalize the practice. This group plays a critical role in influencing others within the community to adopt the practice. Over time, as more members of the community observe and interact with the early adopters, the practice spreads and becomes more widely

accepted. (Haider & Kreps, 2004; Kaur Kapoor et al., 2014; Mandl, 2019; Valente, 2010). Social networks play a crucial role in the spread (diffusion) of the practice. They are the channels through which information about new practices flows. When a member of a network adopts a new practice, they often share their experiences with their peers, giving them an opportunity to consider adopting the practice themselves ("In Memory of Everett M. Rogers," 2005; Melkote, 2006; Singhal, 2012). In the scope of the thesis, we only focus on facilitating the adoption of *Making* practices and consider the diffusion stage as future research.

In emerging economies, people are increasingly disengaging from *Making* practices, though it formed a core of their traditional material culture, owing to a combination of social, economic, and environmental factors. As economies modernize, traditional *Making* practices often become undervalued. Younger generations perceive these practices as less prestigious or financially rewarding compared to other professions (Majumdar et al., 2019b; *UNESCO - Traditional Craftsmanship*, n.d.). Added to it, Globalization drives consumer preference towards modern, global brands, decreasing demand for locally made traditional items. Cheap, mass-produced goods make it hard for traditional makers to compete on price (Ghouse, 2012; Petrick & Simpson, 2013). Factory made products are in fact, designed with the overarching paradigm that products should relieve users of physical and mental activity, rather than engaging them in thought and *Making* (Norman, 2013). Such products are so ubiquitous that engaging in *Making* today is tantamount to change in the usual behavior of being a passive user. Hence, the research problem of (re)adoption of *Making* can be viewed through the lens of behavior change theories. In this thesis, we study several behaviors change theories (discussed in 3.2, page 54 and 3.3, page 56) in an effort to find an appropriate lens. The end goal is to design at a reflective level and induce behavior change from not doing to doing. In the comparative analysis, we determined that the COM-B model (discussed in 3.3, page 56 and 3.4, page 57) which posits capability, opportunity and motivation as the three ingredients for reflective behavior change, as the appropriate lens for our intervention design.

Our fieldwork also revealed that most of the *Making* practices in rural communities have sustained as tradition for generations and utilize simple tools and locally available eco-materials. The skills needed to perform such practices are embedded in such communities as traditional knowledge and techniques that are passed down through generations and are often difficult to replicate outside the cultural context. As such, when we analyze *Making* as a practice in such communities, we observe that it is meanings associated with *Making* that is morphing over time (discussed in chapter 0, page 88). If such practices are to be readopted, new meanings must be associated with them that motivate the younger generation to engage in them. Parallel to the Practice Theory, the COM-B model also posits motivation as one of the key elements of behavior change. The other two: capability (skills and knowledge) and opportunity (resources, social context) are existent in such communities for traditional *Making* practices. Hence, we focus on the motivational meanings and through Ryan and Deci's Self-Determination Theory (discussed in 7.2.1, page 113), we study the

motivation matrix of the younger generation in components. Furthermore, we explore how such meaning can be infused into the *Making* practices as subtle cues.

Behavior Change interventions usually focus on intangible designs such as awareness campaigns, policies, laws, persuasion, and enablement (discussed in 7.2.1, page 113). In our extensive literature review, we did not come across frameworks that lay emphasis on motivation and guided the designer on how to embed them, less so as cues in the products that signal 'motivation' to the target user. As such, we explored the field of Product Semantics to give us insights on how motivation can be embedded as meanings (or cues). Product Semantics looks at how design elements reflect and influence social and cultural meanings. It emphasizes the role of materiality in shaping perceptions, offering insights into how products convey and influence meanings. Though in the scope of this research, we do not delve deep into methods of translating observed motivational parameters into meanings (cues) in products or PSSs, the final step of our designed framework informs the designer of the various contexts in which meaning can be feasibly generated.

The manner in which theories with differing units of observation, analysis, and design are combined in framing the solution, is discussed in the subsequent chapters. Table 2 summarizes the assumptions, units and orientations of the various theoretical lenses used in constructing the solution. Furthermore, how constructs from different theories commensurate with each other is also elaborated in the subsequent sections.

Table 2 Theoretical underpinnings of the various lenses used in this research.

Theory	**Assumptions**	**Units of Observation**	**Units of Analysis**	**Units of Design**	**Individual vs. Collective Orientations**
Practice Theory (Shove et al., 2012)	Practices are routinized behaviors shaped by social contexts, materials, and meanings.	Practices, routines, and activities	Practices as ensembles of materials, competences, and meanings	Practices (i.e., the context in which behaviors occur)	Collective
COM-B Model (Michie et al., 2011)	Behavior results from the interplay of capability, opportunity, and motivation.	Behaviors and associated factors	Capability, opportunity, motivation, and behavior	Interventions targeting capability, opportunity, and motivation	Individual
Self-Determination Theory (R. M.	Motivation is driven by needs for autonomy,	Individual motivation and behavior	Needs for autonomy, competence, relatedness, and	Interventions to support autonomy,	Individual

Ryan & Deci, 2000b)	competence, and relatedness.		their impact on behavior	competence, and relatedness	
Product Semantics (Krippendorff, 2006)	Products communicate meaning through their design and aesthetics.	Products and their designs	Meanings and symbols conveyed by product design	Product design elements (e.g., aesthetics, functionality)	Individual

3.2. Our Approach in Comparison to Other Social Change Theories

Prior to adopting Practice theory, understanding the nuances of the evolution of *Making* practices, and entering the psychological world of intervention design, we studied several important theories of social change. Table 3 presents a comparative analysis of these theories in the field of social change categorizing them as structural (emphasize the overarching systems, structures, and institutions that shape society) or agency (focus on the capacity of individuals and groups to act independently and make choices).

Table 3 Sociological Theories of Behavior Change Examined in this Thesis.

Name of the Theory	**Structural or Agency**	**Proposed by**	**Theory in a Gist**
Functionalism (Mishra, 1981; Van Den Berghe, 1963)	Structural	Émile Durkheim, Talcott Parsons	Views society as a complex system whose parts work together to promote stability and social order.
Conflict Theory (Coser, 1957; Prayogi, 2023)	Structural	Karl Marx	Suggests that social change is driven by conflicts between different groups, primarily over power and resources.
Modernization Theory (Bernstein, 1971; Inglehart & Baker, 2000)	Structural	Walt Rostow, Talcott Parsons	Argues that societies develop in stages toward modernization, typically through industrialization and urbanization.
World-Systems Theory (Goldfrank, 2000)	Structural	Immanuel Wallerstein	Examines global inequalities and how economic dominance by core nations shapes the development of peripheral nations.
Evolutionary Theory (Dietz et al., 1990)	Structural	Herbert Spencer	Proposes that societies evolve progressively, becoming more complex over time.
Symbolic Interactionism (Bruce & Blumer, 1988; Snow, 2001)	Agency	George Herbert Mead, Herbert Blumer	Focuses on how individuals interact based on the meanings they ascribe to things, shaping social reality.

Rational Choice (Quackenbush, 2004; Sato, 2013)	Agency	Gary Becker, James Coleman	Suggests that social behavior results from individuals making rational decisions to maximize benefits and minimize costs.
Post-Structuralism (Harris, 2001; Schulz et al., 2023)	Agency/Structural	Michel Foucault	Challenges fixed structures, emphasizing the role of discourse and individual agency in shaping social norms and power relations.
Practice Theory (Shove et al., 2012)	Integrative (Structure & Agency)	Pierre Bourdieu, Anthony Giddens	Focuses on routine social practices, integrating both structural influences and individual agency in understanding social change.

During our fieldwork, we observed that though there was a societal drift away from *Making*, it emanated from individual minds that failed to see meaning in such practices anymore. As much as broad social and environmental factors affect such a drift, an important tangible factor is how products today encourage not *doing* more than *doing*. Most structural social change theories consider society as the unit and postulates how change trickles down from the network level to the individual level, they fail to capture the individual motivations and decision making. They also fail to capture how inanimate products and PSS's might influence behavior at an individual level (Shove et al., 2012). When it comes to adoption, it is always early adopters who adopt a practice at an individual level at the onset. Structural theories provide an appropriate lens to investigate how the practice can diffuse into the community from the early adopters. But they fail to investigate how adoption can be facilitated at an early stage by individuals (Bernstein, 1971; Coser, 1957; Dietz et al., 1990; Goldfrank, 2000; Inglehart & Baker, 2000; Mishra, 1981; Prayogi, 2023; Van Den Berghe, 1963). The agency theories, on the other hand, investigate how individual interactions and judgements translate to societal change, but fail to shed light on materialities, social meanings of behaviors, or how everyday activities and routines can shape social behavior at large (Bruce & Blumer, 1988; Harris, 2001; Quackenbush, 2004; Sato, 2013; Schulz et al., 2023; Snow, 2001)

We adopted Practice Theory as it bridges the gap between structure and agency by analyzing how social practices both shape and are shaped by broader social structures. It considers a 'practice' as the fundamental unit and seeks to explain how change happens through the evolution, adoption and abandonment of practices (Shove et al., 2012). In the two-stage solution that we proposed in Figure 8, page 27, we have both agency: individual decision-making to adopt *Making*, and structure: diffusion in the network. As such, Practice Theory which juxtaposes 'agency' in the conduction of a practice with the social meaning that sustains it, is a suitable lens for our solution. Furthermore, Practice Theory emphasizes the role of material objects, bodily habits, and the environment in shaping practices unlike other sociological theories that focus primarily on cognitive or ideational aspects of (Bernstein, 1971; Bruce & Blumer, 1988; Coser, 1957; Dietz et al., 1990; Goldfrank, 2000; Harris, 2001; Inglehart & Baker, 2000; Mishra, 1981; Prayogi, 2023; Quackenbush, 2004; Sato, 2013; Schulz et al., 2023; Shove et al., 2012; Snow, 2001; Van Den Berghe, 1963). This, especially,

aids in achieving theoretical triangulation in our approach. The 'capability' and 'opportunity' aspects in the COM-B model of behavior change correspond to '*skills'* and '*stuffs'* in Practice Theory. 'Capability' or '*skills'* refer to the physical and mental ability of a person to engage in a behavior or practice. Whereas '*stuffs'* or 'opportunity' refer to the resources in the environment that facilitates the practice. The slight divergence here being, '*stuffs'* also include the body of the practice-doer, whereas 'opportunity' also includes intangible aspects such as social or institutional facilitators (Michie et al., 2011; Shove et al., 2012). In essence, both theories emphasize the role of materiality in shaping behavior or a practice. As we advance in this thesis, we observe that materiality plays a crucial role in the conduction of *Making* practices in rural and semi-urban communities (discussed in chapter 5, page 66). Embedded skills and shared knowledge form the backbone of most of these practices that revolve around materials available in the immediate environment. If *Making* must enhance sustainability through Distributed Economies, designers have to be mindful of these material cultures and opportunities. As such, Practice Theory in conjugation with the COM-B model provides a suitable framework to analyze the problem in hand.

3.3. The Psychological World of Behavior Change

In section 3.2 (page 54), we discussed how Practice Theory and the COM-B model offer a suitable perspective for inducing *Making* in emerging economies which have witnessed a surge in consumerism and alienation from *Making.* But in our designed intervention, we focus significantly on the *motivation* aspect of the COM-B model. Most models centered around enhancing *Making* in emerging economies either focus on upskilling or on providing material and intangible opportunities. Yet, our fieldwork studies revealed that, it is usually motivation and meaning that is missing in the current generation to engage in *Making* (Majumdar et al., 2019b). Acknowledging that capability and opportunity play a crucial role in effecting behavior change, it is usually observed that most current models focus exclusively on them, and rarely on the minds of the makers (Antaran, 2020; Dastkar, 2021; Dutta, 2023; Ministry of Skill Development and Entrepreneurship, 2015; Soomro et al., 2022). We argue that the psychological factors such as motivation play as vital a role in facilitating behavior change as opportunity and capability. If not, traditional practices which are supported by embedded skills and local materials would continue to sustain in such communities. But with the advent of cheap mass-produced goods in emerging economies, such practices have begun to perish (Grimes & Milgram, 2001; Tung, 2012). Also, the resurgence of *Making* cannot stay confined to the space of crafts. Most models working in this space, focus exclusively on crafts (Antaran, 2020; Dastkar, 2021; Ministry of Skill Development and Entrepreneurship, 2015; Soomro et al., 2022). But, for *Making* to emerge as an alternate production-consumption system, it must become routinized behavior for communities with easily available tools and materials. To incorporate *Making* at the behavioral level, we must understand what can motivate such behavior in a sustained manner, besides enabling skill and material acquisition. If we examine sociological theories at the Agency level, such as Symbolic Interactionism, Rational Choice Theory, and Post-Structuralism, there are limitations when it comes to understanding how people think and

feel. Often, they fail to capture the impact of emotions, biases, and unconscious behavior (Burkitt, 2016; Kiser, 1999; Shilling, 1999; Turner, 2009). These shortcomings of sociological theories, and our observations related to missing motivational meaning, led us to search for more appropriate theories that capture internal psychological drives of people. Hence, we consider Self-Determination Theory as it is highly effective in understanding human motivation and behavior (R. M. Ryan & Deci, 2000b). Unlike agency theories such as Rational Choice Theory, which assumes people act purely out of logical self-interest (Bryant, 2004), Self-Determination Theory recognizes that people are motivated by more than just rational calculations. For a counterculture behavior such as *Making,* rationality can hardly favor its adoption, given that current systems are designed for a factory-made world. On the other hand, a practice that is on the wane, cannot be engendered through social influence, though it can be diffused through it (Rogers, 2003). To facilitate its adoption by certain members of a community, the design has to embed hidden motivational drives to endorse motivational tendences for a counterculture practice.

3.4. COM-B Model and Practice Theory

The COM-B model and Practice Theory offer complementary perspectives on human behavior. The COM-B model focuses on how specific behaviors result from the interplay between an individual's capability, available opportunities, and motivation. This framework is useful for designing behavior change interventions. Conversely, Practice Theory examines broader social practices, emphasizing the role of norms, materials, competences, and meanings in shaping routinized behaviors (Michie et al., 2011).

In the COM-B model, *capability* corresponds to an individual's psychological and physical capacity, similar to the *skills* in Practice Theory, which involves the skills and knowledge needed for practices. The *opportunity* in COM-B aligns with Practice Theory's focus on the material (*stuffs*) and social contexts that influence behaviors. *Motivation* in the COM-B model includes both reflective and automatic processes, which resonates with Practice Theory's emphasis on the meaning (*images*) and cultural significance of practices (Michie et al., 2011; Shove et al., 2012).

Both frameworks recognize that behaviors or practices result from multiple interacting factors. The COM-B model is useful for designing interventions that improve capability, create opportunities, or increase motivation, while Practice Theory focuses on transforming entire practices by altering materials, competences, or meanings. The emphasis on routinization in Practice Theory complements the COM-B model's understanding of habitual behaviors, where motivation becomes more automatic over time (Michie et al., 2011; Shove et al., 2012). Together, these frameworks offer a comprehensive understanding of behavior, providing insights into specific behaviors through the COM-B model and a broader perspective on how these behaviors fit into wider social practices through Practice Theory.

3.5. Meaning and Motivation

In this thesis, we have referred to ‘meaning’ and ‘motivation’ interchangeably. While the two terms come from two different theories, there is a semantic relationship between the two. In practice theory, the concept of "meaning" encompasses the shared understandings, symbols, and cultural significance associated with a practice, shaping how individuals perceive and engage in it. This meaning provides the context for why individuals participate in certain practices and how these practices persist or evolve over time (Shove et al., 2012). Motivation, on the other hand, refers to the drive or reasons behind why people take action or pursue goals. While motivation itself is not typically represented through images in practice theory, it is embedded within the broader practice (R. M. Ryan & Deci, 2000a). Meaning that catalyzes performance of a practice is motivation. The motivation for engaging in a certain activity can be one or more of the following: (a) perception of growth in competence, (b) the perception of being in control of one’s own actions and decision, (c) the perception of being connected to one’s peers (meaning in social context).

3.6. Behavior and Practice

We have used the terms ‘behavior’ and ‘practice’ interchangeably in the initial chapters of the thesis and later to refer to *Making*. The semantic relationship between "behavior" and "practice" lies in their connection through routine actions and the context in which these actions occur. Behavior can be seen as the specific actions or reactions that make up an individual’s or group’s conduct in various situations. It is often more immediate and context-dependent (Bowers, 1973; Molteni, 2010; Rose et al., 1975). Practice is broader and encompasses repeated patterns of behavior that are shaped by and embedded in social and cultural contexts. Practices involve a set of behaviors that are influenced by norms, values, and meanings, and they often persist over time as part of routine life (Shove et al., 2012). In essence, while behavior refers to individual actions or reactions, a practice refers to a more structured and contextually influenced set of behaviors (Molteni, 2010). Though we frequently use the term, “behavior change” in this thesis, we refer to the individual actions pertaining to *Making* and *not Making* as ‘behavior.’ However, such actions when conferred with meaning and performed in a routine manner, constitutes a ‘practice.’ As such, even if the terms ‘behavior’ and ‘practice’ are frequently used to refer to *Making*, there is a subtle distinction, though eventually a behavior pattern can emerge as a practice.

3.7. Combing Paradigms and Methodological Pluralism

In our approach, we have combined several theoretical lenses and research methods. We adopt an Interpretivist/ Constructivist paradigm in this thesis, yet in constructing the two-stage solution, we integrate several theoretical lenses that are grounded in different ontological frameworks. For instance, the COM-B model of behavior change is a rationalistic theory. An interpretivist might use such rationalistic theories to

provide an alternative lens through which to interpret qualitative data, enriching the analysis (Follesdal, 1982; Grafstein, 1997; Knappik, 2015). In our case, the COM-B model provided a structure to analyze the fieldwork data as components that can induce behavior change. The combination of different theoretical perspectives can be especially helpful in addressing complex research questions in a more holistic manner. As the research problem in this thesis is a wicked problem (discussed in 1.4, page 5), the combination of different theoretical perspectives aided in achieving theoretical triangulation and in proposing a solution that can effectively address it. For instance, the components of behavior change in the COM-B model are commensurate with the three elements of a practice in Practice Theory as decided in section 3.2 (page 54). In exploring how *Making* can be incorporated into the behavioral level as a routinized practice, both theories together help to achieve triangulation in the proposed solution.

As interpretivist and constructivist researchers, we prioritize subjective meanings, but we also acknowledge that individuals often operate within frameworks of rationality (Bierstedt, 1965; Knappik, 2015). Understanding these frameworks can help interpretivists comprehend the logic behind certain behaviors or decisions, even when the ultimate goal is to understand the subjective experience rationality (Bierstedt, 1965; Knappik, 2015). Rationalistic theories can be applied contextually. In our case, the use of the COM-B model helps to explore the possibility of behavior change within a particular social or cultural context, recognizing that rationality is shaped by subjective meanings and social interactions.

In the final phase of our research, where we test the designed framework, we adopt a positivist methodology by conducting a true experiment with both control and experimental groups to test the efficacy of the framework. We also conduct a quasi-experiment to test the usability of the framework. This approach enables triangulation in our research, combining empirical data from controlled experiments with qualitative insights from interpretivist fieldwork and literature studies or the overarching constructivist methodology. By integrating these methods, we gain a more comprehensive understanding of the phenomena, as the quasi-experiment and the controlled experiment allowed us to test our null hypotheses within defined contexts while considering broader social and cultural factors of the communities. Additionally, positivist testing can validate qualitative findings, adding rigor and helping to identify patterns that may be applicable across different contexts (Lin, 1998; Modell, 2005). This pragmatic, mixed-methods approach blends controlled experimentation with interpretivist frameworks, offering a balanced perspective that enhances both depth and rigor, leading to a more nuanced understanding of complex social phenomena (Lin, 1998; Modell, 2005).

We also apply statistical analysis to the data that we collected through the positivist experiments at the end. The statistical analysis strengthens our process by identifying patterns and correlations that might not be immediately visible through the qualitative methods that we have employed. It helps to add rigor to our

research and validate our findings by providing empirical evidence that supports or refines our interpretations (Schmidt & Steindorf, 2006; White et al., 2016). By integrating these methods, we achieve a balance between the detailed, context-rich insights of our qualitative research and the reliability and objectivity of quantitative analysis, leading to a more nuanced and comprehensive understanding of complex social phenomena being examined in this thesis.

3.8. Conclusion

As the societal problem in this thesis is a complex one, and the research problem is a wicked problem with no one-true solution or a possibility to retest, we carefully developed our theoretical solution taking root to multiple theories from various domains. In the process, we evaluated several other theoretical frameworks and did a comparative analysis to find the most pertinent theoretical lenses. Our aim has been to develop an effective solution that is humanistic and seeks to integrate basic human instincts for the performances of *Making*. It is the human-centeredness of our approach that differentiates it from other models that have centered around upskilling and facilitation. In this theoretical amalgamation, we had to assume different paradigms and integrate different methodologies. This helps us to in two ways: (a) To craft a solution that takes roots in multi-disciplinary theory and has the potential to facilitate the adoption of a practice in a community (b) Combine the richness of qualitative observations with the rigor of positivistic testing to validate our designed intervention. In all the pluralistic approach with the backbone of the DIR methodology, is of vital essence in this research that begins with a societal problem of a very open-ended nature and translated to research questions that demand in-depth foray into multidisciplinary theory.

4. Understanding *Making* in Emerging Economies: Perspectives from Literature

At the onset of the research project, we reflected on what *Making* is in the context of emerging economies, what *skills, stuff* and *images* support such practices, and how are they morphing over time. We conducted a thorough literature review to find such cases and supplemented it with fieldwork in five rural communities in eastern India, to gain a comprehensive understanding of such practices. The cases from the field and literature not only gave us a detailed typology of such practices, but also a working definition and a new terminology for *Making* in our context. In this chapter, we present the first part of our foray: a systematic literature review, which forms an important pillar of the pre-study phase of DIR as described in Section 2.2 (page 35).

4.1. Research Question(s) Answered

Research Question 1: What are the characteristics of the *Making* culture in emerging economies?

a. What are the different classifications of "*Making*" practices?

4.2. Review and Synthesis from Literature

The growth in consumer behavior seeking uniqueness, personalization and identity creation, provided impetus to the modern day Maker Movement in the West (Fox, 2013). Though *Making* had emerged earlier after World War I due to shortage of manpower (Tsai, 2014), but it only remained as a good-to-have essential life skill. Today's Maker Movement can be traced back to Silicon Valley where software developers in the 90's, came up with innovations that increased hardware efficiency or automated tasks (Tsai, 2014). In 2002, American entrepreneur, Dale Dougherty, started Make magazine to disseminate know-how of *Making* activities. Subsequently Maker Fairs were organized in several cities around the world (Sivek, 2011; Tsai, 2014). It has, in a great way, also been facilitated by how technology changed communication methods. The coming of stereolithography in a compact 3D printer form that made fast prototyping affordable to the masses, was also an important precursor for this movement (Birkhofer & Kundinger, 2014).

Much of the existing literature on the *Maker* movement today focus on the minds of the individual makers and how they operate in social nexuses through knowledge and skill sharing (Wolf & McQuitty, 2011; Alper, 2013; Stinchfield et al., 2013; Gurtoo et al., 2010; Tanenbaum et al., 2012; Williams, 2008; Culton & Holtzman, 2010; Peppler & Bender, 2013; Polynczuk, 2013; Fuchs et al., 2015; Kuznetsov & Paulos, 2010; Fox, 2014; Salvia, 2015). As the concept of *Making* has close relation with the concept of DIY, we examine definitions of DIY in literature. Wolf and McQuitty (2011) applied Grounded Theory on interviews with DIYers in southern USA and defined DIY as- *"Activities in which individuals engage raw and semi-raw materials and component parts to produce, transform, or reconstruct material possessions including those drawn from the natural environment."*

The concept of traditional DIY can also be extended beyond the confounds of physical goods to include areas such as punk scene, citizen science, multimedia creation, open source software and 3D printing (Ratto & Boler, 2014). In this definition, a "DIY citizen" is a broad continuum of people from writers, makers, creators: in essence anybody who employs creativity in everyday life. It elevates DIY from making and fabricating to any activity that engages the creative competencies of the mind. A recent conceptualization expounds on the collaborative aspect of DIY where networked individuals work together to develop and refine solutions in an internet mediated environment- called as DIWO- Do-It-With-Others (Garrett, 2014).

In the context of emerging economies however, *Making* exists in other forms, underpinned by different meanings and motivations, supported by different material objects and facilitated by distinct modes of social collaboration (Keersmaecker et al., 2012; Smith et al., 2016; Ross et al., 2012; Leach et al., 2012; Seyfang & Smith, 2007; Ustyuzhantseva, 2015; Gupta, 2013; Domenico et al., 2010; Hilmi, 2012; (Hans) Bakker, 1990; Gupta, 2006). *Making*, traditionally, has been seen as a practice of making products or constructing solutions for one's own consumption (Kiggundu & Ji, 2008; Levi-Strauss, 1966; Wolf & McQuitty, 2011). The local term for this concept from various countries are "Jugaad (India), Guanxi (China), Blatmir (Russia), Quan he (Vietnam), Ubuntu (South Africa) and Gambiarra (Brazil)". These practices revolve around innovative make-do products, and sometimes systems around it, born out of poverty to economically solve basic problems with resources in the immediate surroundings.

A vast body of scholarship has studied the different forms of *Making* individually, with Grassroots Innovations, *Jugaad*, and Crafts being the most extensively studied forms (Bhaduri & Kumar, 2011; Birtchnell, 2011, 2012; Domenico et al., 2010; Garrett, 2014; Gaur et al., 2014; Gupta, 2006, 2013; (Hans) Bakker, 1990; Hilmi, 2012; Keersmaecker et al., 2012; Krishnan, 2010; Leach et al., 2012; Prabhu & Jain, 2015; Radjou, Prabhu, Ahuja, et al., 2012; Rangaswamy & Densmore, 2013; Rangaswamy & Sambasivan, 2011; Reddy, 2016; Ross et al., 2012; Seyfang & Smith, 2007; M. Singh & Singh, 2012; R. Singh et al., 2012; S. Singh et al., 2011; Smith et al., 2016; Ustyuzhantseva, 2015; Zeschky et al., 2011). Grassroots Innovation have a unique importance in such contexts for its local rootedness and production methods outside of formal institutions (Domenico et al., 2010; Gupta, 2006, 2013; (Hans) Bakker, 1990; Keersmaecker et al., 2012; Leach et al., 2012; Ross et al., 2012; Seyfang & Smith, 2007; Smith et al., 2016; Ustyuzhantseva, 2015). Hilmi (2012) defines Grassroots Innovation as an 'innovative product or process created at the bottom of the pyramid usually due to necessity, hardship and challenges.' Bhaduri & Kumar (2011) define grassroots innovators as *"...individual innovators, who often undertake innovative efforts to solve localized problems, and generally work outside the realm of formal organizations like business firms."* Grassroots Innovation stem from the absence of appropriate products or unaffordability of the available products in the market. For instance, Edible Cutlery (Figure 4) was developed in the absence of an eco-friendly alternative for plastic cutlery (Reddy, 2016). Grassroots Innovation is often undertaken at a community level in response to community wide problems (Ross et al., 2012; Seyfang & Smith, 2007; Ustyuzhantseva, 2015).

Another prominent form of *Making* from emerging economies that has been studied extensively is *Jugaad* which, in colloquial terms, mean *"an innovative fix; an improvised solution born from ingenuity and cleverness"* (Birtchnell, 2011, 2012; Gaur et al., 2014; Krishnan, 2010; Prabhu & Jain, 2015; Radjou, Prabhu, Ahuja, et al., 2012; Rangaswamy & Densmore, 2013; Rangaswamy & Sambasivan, 2011; M. Singh & Singh, 2012; R. Singh et al., 2012; S. Singh et al., 2011; Zeschky et al., 2011). Radjou et al. (2012, p.4) define *Jugaad* as "*A unique way of thinking and acting in response to challenges; it is the gutsy art of spotting*

opportunities in the most adverse circumstances and resourcefully improvising solutions using simple means. Jugaad is about doing more with less." It is usually borne out of poverty as quick-fix solutions to problems with the sole aim of cutting edges and cutting corners (Birtchnell, 2011, 2012). However, *Jugaad* does not remain confined to physical products alone, it can also be in areas of business, transportation, payment systems, supply chain management, etc. (Rangaswamy & Sambasivan, 2011). Several scholars laud *Jugaad* for innovatively combining frugality with flexibility (Birtchnell, 2012; Radjou, Prabhu, Ahuja, et al., 2012; M. Singh & Singh, 2012; R. Singh et al., 2012). But as it is a product of poverty it is usually underpinned by dilapidated infrastructure, resource constraints and systemic risks due to unsafe use of technology (Zeschky et al., 2011). Many of these makeshift technologies like the *Jugaad* vehicle in India (Figure 15) can also be unsafe and environmentally quite unsustainable.

Besides *Jugaad* and Grassroots Innovations, emerging economies have a range of craft and prosumption (*"production for one's own consumption"* (Toffler, 1981, pp. 345–365)) practices that they sustain for survival and livelihood. These practices usually use local eco-materials and embedded knowledge of the community. Weaving, for instance, has been done for centuries, both as a craft and for self-consumption. The patterns are handed down from generation to generation and have drawn inspiration from the objects and artifacts in the local milieu. Some activities have continued only for the satisfaction of their personal, household or community needs such as making of granaries, cow dung cakes for fuel, building their own houses, making their own ovens, etc. (Majumdar et al., 2019b, 2019a). Though segment wise, we examined a significant body of literature that studies each kind of making activity, we could not find a comprehensive definition of *Making* in the context of the emerging economies. The definitions put forward by scholars in the West were felt to be non-inclusive of all the dimensions of *Making* activities from such communities. For instance, these definitions do not specify whether such activities can be carried out for commercial purposes or solely for cost reduction. They also do not specify whether such activities can be conducted at a community level, as is done in the case of Grassroots Innovation in India, or at an individual level. They also do not acknowledge the vast grayness called the *"informal sector"* in emerging economies.

Figure 15. Jugaad vehicle used in India (Kattimani, 2006).

Researchers have also studied *Making* movements in the West from a psychological point of view to understand what motivational meaning they have for makers. They differentiated motivational factors for *Making* into intrinsic and extrinsic based on Ryan and Deci's Self-Determination Theory (Fields et al., 2014; Freeman, 2015; Lakhani & Wolf, 2005; R. M. Ryan & Deci, 2000a, 2000b; Wolf & McQuitty, 2011). The former refers to a behavioral drive resulting from something being inherently interesting or enjoyable and the latter refers to doing something that leads to separable outcome such as economic returns, recognition, and feedback. Ryan and Deci (2000b) state that every individual has the psychological need for *competence*, *autonomy* and *relatedness*. Lakhani and Wolf (2005) further divide intrinsic motivation into a) enjoyment based and b) obligation/ community based. They argue that Makers such as hackers, not only act as part of a group driven by common goals, but they also operate under social norms that all work should be open source. However, such studies have largely remained focused on movements in the West. The author could not find significant literature on the meanings and motivations for *Making* in emerging economies. The way *Making* evolved and the meaning that it assumed is also significantly different than that of the West (discussed in detail in Chapter 1). All societies were agrarian, engaged in crafts and self-produced extensively for their own needs in the preindustrial era. But after the Industrial Revolution, the global North and the global South had significantly different production-consumption paths. Colonization widened the rift further (Habib, 1980; Morris, 1963; T. Roy, 1999).

4.3. Conclusion

Communities in emerging economies engage in different forms of *Making* that are motivated by the desire or need to solve local problems or lack of an appropriate product/ technology in the market. These *Making*

practices utilize locally available tools and materials, and indigenous inventiveness to construct resource-constrained products that solve their contextual problems. Usually, such forms of *Making* are underpinned by dilapidated use of technology. The literature review highlighted the characteristics of Grassroots Innovation and *Jugaad*, forms of *Making* that gain attention due to their relevance in business. We conducted field studies, post this literature review, to investigate if there are other forms that our literature review did not capture, and which can expand our understanding of such practices. In the following chapter, we present a few other forms of *Making* that we observed during our field studies.

5. Assisted Self-Production (ASP) in Emerging Economies: Conceptualization and Categorization

The societal problem in this thesis, with its open-ended nature, required field research to allow the researchers to observe, interact, and collect data in real-world settings instead of relying solely on existing data. Hence, our literature survey was followed by extensive field research in five rural communities in east India, during which we observed more tradition and community-based forms of *Making*. In this chapter we describe how the fieldwork was staged, the tools and methods that were employed, and the findings. The field and literature research together aided us in defining *Making* in the context of rural and semi-urban communities. Examining the cases through the lens of Practice Theory (Shove et al., 2012, pp. 1–48) also led us to the factor that differentiates the practices in an orthogonal way.

5.1. Research Question(s) Answered

Research Question 1: What are the characteristics of the *Making* culture in emerging economies?

a. What are the different classifications of *Making* practices?
b. What are the characteristic features that distinguish the different *Making* practices in emerging economies?
c. How is the Making culture evolving inter-generationally in such contexts? (Partially answered)

5.2. The Necessity for Primary Research

The revival of *Making* signifies an implicit shift in production-consumption systems. But the movement has chiefly remained in the West and has grown as a technology-enabled and technology-intensive culture as discussed in 4.2 (page 61). In the context of emerging economies, the forms of *Making* that exist and has been studied by scholars, are underpinned by different meanings and motivations. However, when we study *Making* in such communities with an aim to propose a compendious definition for it and understand its characteristics and meanings, we need to ensure that all forms of *Making* in such contexts have been accounted for. This necessitates that we look beyond our literature review and attempt to study *Making* practices of such communities to gather firsthand data through direct observational methods. In the following sections, we explain the tools and methods we used to gather primary data and, how we analyzed the consolidated data to arrive at a compendious definition of *Making* in such communities and its characterization.

5.3. Methodology

We developed the working definition and classification of *Making* practices in emerging economies from an amalgamation of cases from field studies and academic literature. While Grounded Theory provides an appropriate lens to build insights from the cumulative data from the primary and secondary research, we felt the need for a sub-structure to guide the process of data collection during the primary research. It is to note that the need for primary research was felt after the conclusion of the secondary research as described in section 5.2 (page 66). The reasons were two-fold: (a.) We, as researchers, hail from urban India and lacked knowledge of the environmental factors as well as the socio-cultural dynamics in rural and semi-urban India. As such, without a guiding method, there was a possibility that crucial insights could have been missed. The divergent-convergent stages of the Double Diamond Model of fieldwork method ensured that an exploratory phase was possible before in-depth insights were gathered. In the exploratory phase, the researcher could touch upon different aspects before analyzing and understanding which aspects might be relevant for the societal problem (section 1.5, page 7). (b.) The two-stage approach aided the streamlining of the data collection process. The first stage ensured that only relevant data was validated in the second (convergent) phase. This significantly reduced time and effort for the research team and helped us in synthesizing insights and moving on to the intervention design stage of DIR (section 2.3, page 37).

Given the open-ended nature of knowledge (from primary and secondary research), Grounded Theory provides an appropriate methodology for data familiarization, coding, theme development and exploration of relationships. It can identify the situated nature of the knowledge and provide thick descriptions of the emerging themes (Glaser & Strauss, 2017). Glaser and Strauss's original Grounded Theory ((Glaser & Strauss, 2017) recommended approaching data without preconceived theoretical notions. However, Strauss and Corbin's approach (Strauss & Corbin, 1990) allows researchers to review existing literature before beginning the study. We adopted the Straussian approach and studied existing classifications before analyzing our data. Example of a similar analysis is by Bocken et al. (2014) who use Grounded Theory with coding scheme suggested by Strauss and Corbin (1990) to develop sustainable business model archetypes and find the factors that differentiate them. Figure 16 summarizes the iterative steps that were followed in arriving at the classification, namely: 1. Theoretical sampling of data, 2. Data Collection, 3. Coding of data (*Initial, Focused* and *Theoretical* (Charmaz & Belgrave, 2007; Mills et al., 2014)), 4. Constant Comparison, 5. Identification of categories (Charmaz & Belgrave, 2007). We utilized Initial, Focused and Theoretical coding for the following benefits: (a) It allows personal insights to develop theoretical insights. (b) Focused coding aids in identifying variations and connections between sub-themes. (c) Theoretical codes connect the subcategories to the core category in the last phase (Charmaz & Belgrave, 2007). We repeated these steps until each category reached saturation and no new categories were identified. We strategically selected cases that would enhance the diversity of the previous set and potentially generate new codes (Bryman, 2016). Figure 17 presents a Venn diagram representation of the literature review and field studies conducted by the researcher.

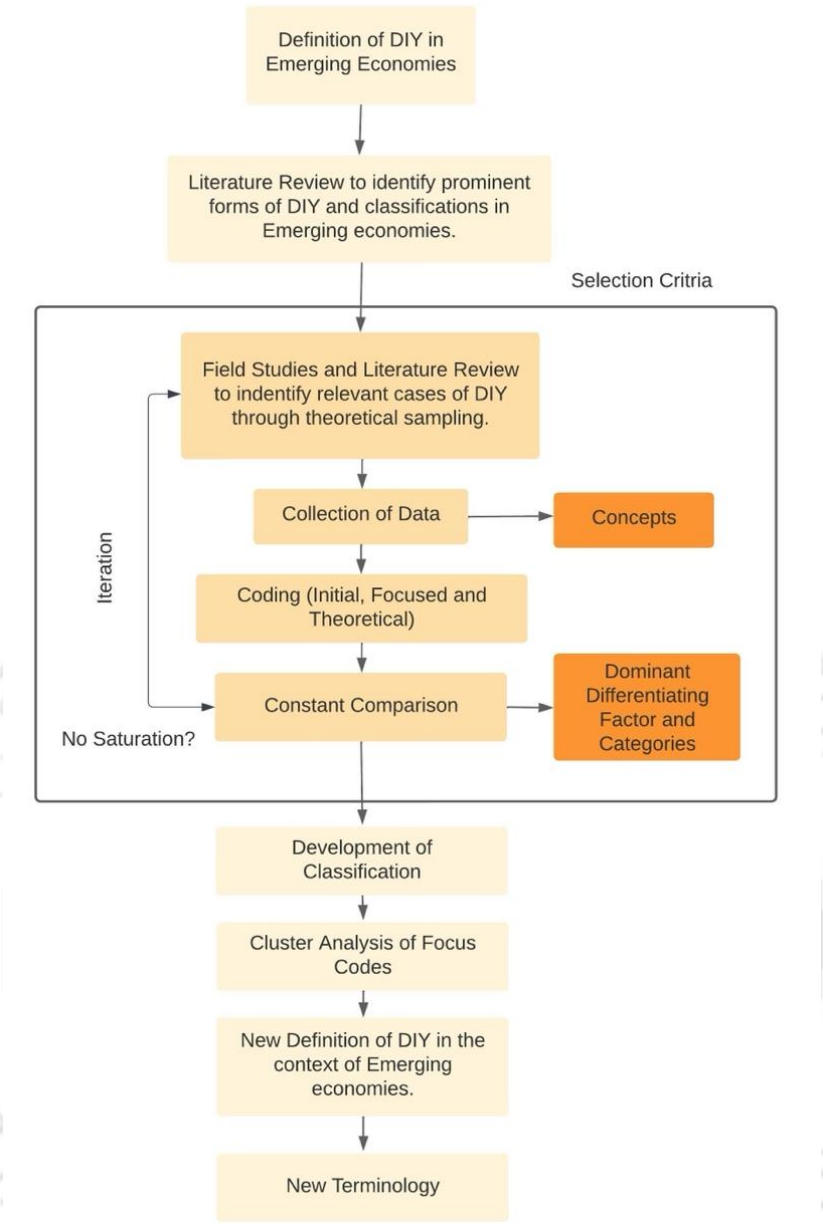


Figure 16. Methodology for literature review and field study.

We have earlier discussed in section 2.5.1.2 (page 44) how we have utilized the structure of the Double Diamond method for collecting data from the field studies.

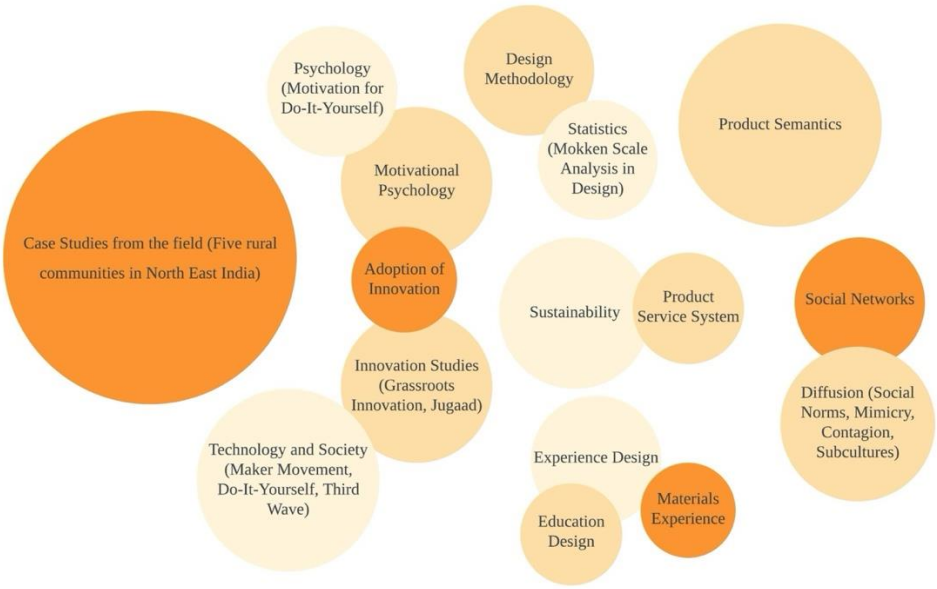


Figure 17. Venn Diagram Representation of the Literature Review and Field Studies Conducted by the Researcher.

5.3.1. Criteria for selecting Making practices from literature and researcher's field study

Criteria are set to facilitate the process of data collection from literature and field study. These cases need to reflect our aim to provide:

a. A mechanism to distinguish between *Making* practices and arrive at a distinguishing factor.
b. An in-depth understanding of each class of *Making*.
c. Thick descriptions of each class of *Making*.

The categories need to be clearly distinguished based on a dominant theme emerging from the coding process, be mutually exclusive, descriptive in terms of boundaries but not overly prescriptive. We selected practices that revolve around self-production and consumption of goods and services. During the coding process, careful analysis was done to find at least one factor, especially through the lens of Practice Theory (Shove et al., 2012), that could achieve mutual exclusivity amongst the categories.

5.3.2. Methodology for Literature Review and Field Study

We relied on both primary and secondary data for this study. We accessed the academic databases: Google Scholar, ResearchGate, JSTOR, Scopus and SAGE Journals using combinations and variations of keywords

- 'Making, types of Making, Making India, Maker Culture, Maker Movement, Base of the Pyramid, Fablab, Jugaad, Grassroots Innovation, Craft, Prosumption, Practice'. We also looked at three other databases that catalogue *Making* and craft practices from India namely, the National Innovation Foundation- India (National Innovation Foundation & Department of Science and Technology, n.d.), Honeybee Network (HoneyBee Network, n.d.) and Handmade in India (Ranjan & Ranjan, 2009). In shortlisting the papers that we studied in-depth, we ensured that it:

a. Brings a unique kind of *Making* practice in terms of materialities[5], skills or meaning.
b. Analyzes primary data from fieldwork.
c. Provides a thick description of the practice.

To ensure a thorough search for cases, we conducted observational field studies in five rural communities in India, given the potential lack of research on certain practices.

5.3.2.1. Research Subjects during Field Studies

Our field studies were conducted in five villages located in the eastern part of India, namely: Joypur, Gopalpur, Paator Kusi, Sarthebari, and Naumati (Figure 18). The selection process for these villages was based on two considerations:

a. They are located within 100 km of our base institution in India, allowing us to revisit the field if necessary.
b. They should be inhabited by different ethnic communities to enrich and diversify our data.

Sarthebari and Naumati shared ethnicities but differed in lifestyles: Sarthebari's economy was based on crafts, while Naumati's was primarily agricultural.

[5] Materialities is defined as "the physical form of tangible interactions in terms of their quality, value, and situation within a user's life, giving materials a dual role as a mediator and active participant in the experience of interaction."(S. Gross, 2015)

Figure 18. The sites where fieldwork was conducted.

We spent an average of five days in each village during the autumn season, working with families to study their household *Making* practices from morning till evening. We used purposive sampling in selecting our subjects with the following criteria: (a.) The subjects can be any gender (b.) They should have a rural or rural or semi-urban lifestyle (c.) They should be medium to low income. We interviewed one member from each of the nineteen households visited, resulting in thirty-one adults (17 male and 14 female) aged 25-70 years. All families relied on agriculture or livestock rearing for their sustenance, and women also contributed to the family income by working as seasonal laborers in agricultural fields or growing crops in their backyards. To sample subjects, the snowballing technique was adopted. Interviews with households highlighted the importance of interviewing expert craftsmen, and eight were subsequently interviewed in Sarthebari and Naumati, known for their cane and bamboo works, brass and bell metal artifacts. Additionally, fifteen young respondents (eight male and seven female) aged 12-20 years who attended school, or a community college were interviewed. The craftsmen indicated that their learning stage was in the early to late teens and hence the choice of the young respondents. We again used purposive sampling in selecting the young subjects with the following criteria: (a.) The subjects can be any gender (b.) They should have a rural or rural or semi-urban lifestyle (c.) They should come from a medium to low-income household. The reason for choosing low to medium-income households in both the sampling is that most households in rural and semi-urban India are low-income in terms of monthly income (Chandha, 2023; Ministry of Statistics & Programme Implementation, 2023). However, some rural communities have a commercial craft conducted community wide. To accommodate such communities, we also include medium-income households in our sampling.

5.3.2.2. Research Approach

We used touchstone tours, field notes, and pictures (Chipchase, 2017) for observational studies inside homes, followed by semi-structured interviews to investigate *Making* practices. However, it is recommended to cross-validate self-reports of social influences, especially norms (Bicchieri, 2016). Therefore, we held focus group interviews with 4-5 participants in each village. Craftsmen and young respondents were interviewed similarly, and craftsmen were shadowed for an hour before the interview. Interviews were transcribed, and findings were supplemented with field notes and pictures.

5.3.3. Selection of Making practices

The literature search and observational field studies showed complementary cases of *Making* practices. While the existing literature focused on *Jugaad* (Birtchnell, 2011, 2012; Gaur et al., 2014; Krishnan, 2010; Prabhu & Jain, 2015; Radjou, Prabhu, Ahuja, et al., 2012; Rangaswamy & Densmore, 2013; Rangaswamy & Sambasivan, 2011; M. Singh & Singh, 2012; R. Singh et al., 2012, 2012; Zeschky et al., 2011) and Grassroots Innovation (Bhaduri & Kumar, 2011; Domenico et al., 2010; Gupta, 2006, 2013; (Hans) Bakker, 1990; Hilmi, 2012; Keersmaecker et al., 2012; Leach et al., 2012; Reddy, 2016; Ross et al., 2012; Seyfang & Smith, 2007; Smith et al., 2016; Ustyuzhantseva, 2015), our field studies uncovered numerous traditional Making practices. These practices lack innovation in manufacturing and design and are not part of the education-centered Maker Culture. They persist due to the need of communities with limited purchasing power for basic necessities.

The cases from practice led to a deeper literature search for self-production of goods in communities from emerging economies. New keywords included: 'Prosumption Practice, Craft, Self-production, Local production, Craft consumption, Traditional *Making* practice, local materials.' However, we could find only a few such cases in existing literature (Majumdar et al., 2019a, 2019b). Therefore, the cases on *Jugaad* and Grassroots Innovation were sampled from literature and reliable databases such as National Innovation Foundation- India (National Innovation Foundation & Department of Science and Technology, n.d.) and the Honeybee Network (HoneyBee Network, n.d.). The cases on prosumption practices and crafts were drawn from field studies. Additionally, the database, 'Handmade in India' (Ranjan & Ranjan, 2009) was reviewed for crafts during theoretical sampling.

5.3.4. Development of Classification based on Literature and Field Study

Using the Grounded Theory approach, we coded our samples in three rounds: Initial, Focused, and Theoretical, as suggested by Charmaz and Belgrave (2007). The raw data and the coding is presented in Annexure 1 (page 230) and 2 (page 248). In the Initial coding phase, we identified lower-level codes from literature cases, field notes, pictures, and interviews. Focused coding involved constructing higher level codes from the most significant initial codes. Theoretical coding stage involved exploring possible relationships between categories and integrating focus codes for theoretical direction. Throughout each phase, we compared lower-level codes with higher-level codes. Our inductive methodology produced a detailed list of codes in Table 4, which led to the emergence of distinct *Making* practice categories and the dominant differentiating factor. The emerging focus codes helped us construct the definition of *Making* for these communities.

Table 4 The different types of Making practices with examples and focused and initial codes that emerged during the application of Grounded Theory on the data.

Type of Making practice	**The primary motivation for the Maker**	**Examples from practice/ literature**	**Other characteristics (*focused codes)***	**Snippets of *initial codes***
Jugaad	Economic Savings	Coffee Cooker (Rozadeen, 2009) Washing Machine Lassi Maker (Rajni et al., 2019) Shed made of empty tins of ghee (S. Singh et al., 2011) Juice/ Seed oil Extractor on Scooter (Patel, 2019) Jury-rigged vehicle. (Birtchnell, 2012; Kattimani, 2006)	Hacking existing technology Using available material resources, Ingenuity High functionality Low aesthetic value A solution to highly contextualized problems	Questionable sustainability of practice A dilapidated assemblage of parts Local problems in the backdrop Diffusion of highly utilitarian *Jugaad* products
Grassroots Innovations	Urge to solve local problems (Birtchnell, 2011; Gupta, 2006; Keersmaecker et al., 2012; Ross et al., 2012; Seyfang & Smith, 2007; Smith et al., 2016).	Mitticool (Prajapati, 2009) Edible Cutlery (Figure 4) (Reddy, 2016) Bicycle Hoe (Bhise, 2014) Living Root Bridges (Middleton et al., 2020)	The local rootedness of the solution Locally available Material resources Community-wide diffusion of the practice High functionality,	Poly-centric functioning of such innovators Questionable sustainability of practice Like *Jugaad*

		Bicycle Pesticide Sprayer (Jagani, 2005)	Hacking of Existing Technologies Making new products Use of "appropriate technology" Commercialization	Tested and modified iteratively
Bricolage	The propensity to tinker and invent (Domenico et al., 2010; Louridas, 1999; Stinchfield et al., 2013).	Regenerative Braking (Das, 2002) Multi-Processing Machine for Juices and Oils (Kamboj, 2009) Reversible reduction gear for marine diesel engines and Z- drive (Lal, 2009)	The invention of new technology and solutions Repurposing of material possessions Reluctance to commercialize innovations. Working individually Enjoyment in the state of flow[6] Spotting intervention possibilities Thinking from First Principles Interest in taking up new projects. Engineering problems	High functionality Low aesthetic value Iterative refinement Transport, Farming Food processing
Prosumption	Increased *Autonomy* (Majumdar et al., 2019b; Toffler, 1981, pp. 243–300)	Constructional DIY (Majumdar et al., 2019b) The weaving of own clothes (Majumdar et al., 2019b). Making furniture for home (Majumdar et al., 2019b).	Heritage Usually done socially. Use of local eco-materials Perception of better quality Learned early during teenage. Social norms associated.	Manual skills Multi-usage of material High functionality

[6] Csikszentmihalyi explains flow as “a state in which people are so involved in an activity that nothing else seems to matter; the experience is so enjoyable that people will continue to do it even at great cost, for the sheer sake of doing it.” (Csikszentmihalyi, 1988)

		Making Clay Stoves and Cow Dung Fuel Rods (Majumdar et al., 2019a) Making public granaries (Majumdar et al., 2019a, 2019b).	Inter-generational flow Embedded knowledge in the community	High aesthetic value[7] High cultural value
Crafts	The need to earn a livelihood (Majumdar et al., 2019b).	Date Palm Craft (Ranjan & Ranjan, 2009, p. 167) Brass and Bell Metal Industry (Majumdar et al., 2019b) Terracotta (Ranjan & Ranjan, 2009, p. 248) Naga Woodcarving (Ranjan & Ranjan, 2009, p. 517) Kuhila (Indian cork) crafts (Majumdar & Banerjee, 2017)	Locally available eco-materials Part of community traditions It holds meaning as a cultural artifact. Aesthetic Done in craftsmen lineages. Simple manual tools Low innovation in product or technique Propensity to commercialize	Multi-usage of a single material High functionality High aesthetic value High symbolic value

[7] We have defined high aesthetic value as –

Fulfils one or more of the following criteria:

1. The use of lines and shapes that are well-organized and arranged.
2. Objects are placed in symmetry and have repeating elements.
3. Colors that complement each other and create a cohesive look.
4. Have visually appealing designs.

The list of initial, focus and theoretical codes are provided in Annexure 1 (page 206)and Annexure 2 (page 248).

5.4. Results

This section describes the dominant forms of *Making* that emerged from the application of Grounded Theory. This built on the classifications that have been proposed before (Levi-Strauss, 1966; Stinchfield et al., 2013) and literature on *Making* from the emerging economies. Five types of *Making* practices were identified namely: *Jugaad,* Grassroots Innovation, Bricolage, Crafts and Prosumption. Iterative case analysis showed that primary motivation (*images*) for *Making* was the main factor differentiating between categories, making them mutually exclusive.

5.4.1. Jugaad

Definition: *Jugaad* refers to the art of *"developing alternatives, improvisations and make-do's"* (Radjou, Prabhu, Ahuja, et al., 2012). It is a way of designing product systems to cut costs and cut corners (Radjou, Prabhu, Ahuja, et al., 2012).

Characteristics: *Jugaad* is often done in resource constrained situations where an intervention is required to solve a problem arising due to lack of affordable product. The hallmark of such *Making* is the jury-rigged vehicle (Figure 15, page 64), which fulfills transport needs in villages where trucks are unaffordable, by adding a seating extension to a commercial vehicle. *Jugaad* involves reconfiguring materialities and hacking existing technologies for problems for which either market solutions do not exist or are not price competitive. A shed made from inverted empty aluminum tins in deserts to capture rising hot air so that the undercurrent below is cooler, serves as an example of the former situation (S. Singh et al., 2011). On the other hand, a coffee maker furbished from a pressure cooker is an example of the latter (Rozadeen, 2009). This practice is supported by tools and materials available from the immediate surroundings. The maker inventively reconfigures them to device a hack for a contextual problem.

Though several scholars have pointed out that adversity and resource constraints are motivators for *Jugaad* (Birtchnell, 2012; Prabhu & Jain, 2015; Rangaswamy & Sambasivan, 2011; M. Singh & Singh, 2012; S. Singh et al., 2011), making economic savings (*extrinsic motivation*) surfaced as the common motivator for such practices in our analysis. Usually, such products have high functionality but low aesthetic value. They are often built to address local issues, such as the bicycle hoe for ploughing fields (Bhise, 2014) and the motorbike pesticide sprayer for cost-effective pest control among farmers (Dodiya, 2005).

5.4.2. Grassroots Innovations

What is it: We adopt the definition put forward by (Bhaduri & Kumar, 2011) that define Grassroots Innovation as *"Innovative efforts to solve localized problems that are generally undertaken outside the realm of formal organizations like business firms."*

Figure 19. Living Roots bridge in Meghalaya (India).

Characteristics: Grassroots innovators are motivated by locally rooted problems. They are driven by a sense of purpose to serve their community. Mitticool, a clay refrigerator running on zero energy, depicts a community-oriented purpose (Prajapati, 2009). The condition of the poor after a catastrophic earthquake in Western India, moved the innovator. In the post-calamity stage, he wanted to cater to their food storage needs in an affordable and economical manner. Though Bhaduri & Kumar (2010) state that grassroots innovators are *"individual innovators,"* there are several instances where communities undertake such efforts. The Living Root Bridges of Meghalaya (Figure 19) present such a case where a community grows bridges with roots of nearby trees over the years to establish transport over fast-flowing streams (Middleton et al., 2020). Grassroots Innovation can be technological solutions (e.g., Vatsal Tong (Gajjar, 2007; Mashelkar et al., 2007)) or simply constructed solutions (e.g., Mitticool). Such innovations frequently entail entrepreneurship (e.g., Edible Cutlery (Reddy, 2016) and Mitticool) or naturally diffuse in a region for their local-rootedness (Living Roots Bridge). Hence, in most cases, an undertone of frugality is observed. Such *Making* is usually underpinned by basic tools and local materials due to limited resources, resulting in a non-industrial tone.

5.4.3. Bricolage

Definition: Bricolage is defined as *"Making-do with resources at hand"* (Louridas, 1999; Stinchfield et al., 2013). Bricoleurs appear to *"reject the face value of traditional definitions of resource acquisition in favor of radical experimentation"* (Stinchfield et al., 2013). They engage in construction of non-standard solutions through tinkering and inventive experimentation by conversing with their own universe of tools (Louridas, 1999).

Characteristics: Bricolage is driven by an individual's desire to play and experiment with tools and materials in their immediate surroundings. Bricoleurs find joy in being in a state of flow with their tools, exploring alternative meanings of materials, and developing new solutions. Through experimentation and invention, they seek to improve their skills and competencies. Our research has identified several instances of bricolage (National Innovation Foundation & Department of Science and Technology, n.d.), where individuals demonstrated enterprise by identifying community problems or potential areas for intervention. However, these bricoleurs lacked the motivation to commercialize their innovations. One such example is the regenerative braking system for bicycles, which was developed with the creative imagination that the kinetic energy lost during braking on bumpy rural Indian roads can be stored as electrical energy (Das, 2002). A seasoned innovator created a pomegranate deseeder to enhance fruit processing in a region where pomegranate cultivation is not prevalent (Bharali, 2009). While these inventors did not take their inventions directly to the market, they found intrinsic motivation in the process of exploring, experimenting, and inventing a working prototype to solve a problem. This process often involved hacking existing technologies or inventing new ones, all while experiencing a state of flow through play, tinkering, and imaginative experimentation.

5.4.4. Prosumption

Definition: (Toffler, 1981, pp. 243–300) defines prosumption as *"production for one's own consumption."*

Characteristics: Self-production of goods in emerging economies is driven by a desire for greater *competence* and *autonomy*. Ryan and Deci (2000a) state that an individual's motivation for an activity is linked to their need for *competence* and *autonomy*. Self-production practices are typically driven by the need for essential Making skills, customization, higher-quality goods, and the opportunity to skillfully use locally available materials. A man helping an old woman in Making a granary. Figure 20 shows two neighbors constructing a granary using bamboo, mud, and cow-dung while Figure 21 depicts a man crafting basic furniture with bamboo. Cheap plastic furniture has made eco-friendly materials from the local environment unnecessary, but traditional practices persist. The prevalence of self-weaving in Indian villages, despite its lack of cost-effectiveness, inspired further exploration. Weaving was reintroduced to India after Mahatma Gandhi's Swadeshi Movement, which promoted making one's own clothes to boycott British-made goods ((Hans) Bakker, 1990; McGowan, 2009). Our field interviews revealed that prosumption practices are passed

down through generations and become a cultural heritage in many communities. *Making* products are often considered superior in function, such as cow dung and mud walls that resist fungi and heat, or hand-woven cotton clothes. However, some *Making* is only for basic needs, like cow dung cakes for cooking fuel in Indian villages. Gender roles influence *Making* practices like women primarily doing weaving or knitting, and men doing constructional *Making* or furniture *Making*, which vary based on seasonal availability, agrarian calendars, and work routines. Makers often follow social norms by helping and sharing knowledge with each other. Some form self-help groups to aid in material acquisition, collaboration, and idea and financial resource sharing.

Figure 20. A man helping an old woman in Making a granary.

Figure 21. A man crafting basic furniture with bamboo.

5.4.5. Crafts

Definition: The term "craft" denotes a skill in the *Making* of a decorative artifact (e.g., pottery) or in an associated practice (making laces). It is a form of creative self-expression and craftsmanship. In certain cases, it can be aided by the use of machines but the larger component of it is hand-on skills (Brantlinger, 1996).

Characteristics: Crafts embody creativity in the Maker culture, but in emerging economies, they serve as a means of earning a livelihood. Despite this, crafts hold significant symbolic and cultural value for communities. However, crafting purely for such value is not commonly observed. The Dongaria community's handwoven scarf is a rare example of a craft laden with symbolic meaning conducted only for cultural value. A man presents the scarf, handwoven by his sisters, to the woman he wishes to marry. (Ranjan & Ranjan, 2009, p. 230). The prevalence of subsistence as the primary motivator in all other instances led us to categorize crafts as a hands-on artistic activity pursued for livelihood. Crafts that are made purely for self-consumption, either for aesthetic or for symbolic value (e.g., Dhokra crafts from Odisha (Ranjan & Ranjan, 2009, pp. 218–219), can be more meaningfully categorized as prosumption. Highly functional crafts can have usage as mainstream as factory-made goods, even within the craft community itself, due to their suitability for contextual needs (such as Lucknow Chikan work on pieces of cotton worn in summer (Wilkinson-Weber, 1997) and their ease of creation using locally available materials (such as Terracotta pottery used for cooking (Ranjan & Ranjan, 2009, pp. 116, 152). Entrepreneurship is a vital component of crafts in such communities. In the case of highly commercial crafts, such as Lucknow Chikan work, craft communities have reorganized into value chains and redesigned the original craft to meet market needs

(Wilkinson-Weber, 1997). Craft lineages typically pass down their skills from one generation to the next. Family lines closely refine and preserve their techniques in the case of less commercialized crafts, as seen in the Kuhila crafts of Indian cork (Majumdar & Banerjee, 2017).

5.4.6. Shared characteristics

We observed that *Making* categories were distinct based on their motivators, but there were overlaps in other traits. Characteristics such as hacking existing tech, saving money, using local materials, and solving contextual issues were shared across multiple types of *Making*. Other shared traits included practicing at a community level, diffusion, and cultural significance.

5.4.7. Definition of Making in the context of emerging economies

We conducted a cluster analysis of the most frequent focus codes for the different categories to visualize what *Making* means as the sum-total of its components. Based on the existing definitions and our observations, we define *Making* for emerging economies as:

> *"Activities in which individuals or communities engage tools and materials from their surroundings to produce or physically transform material goods destined either for self-consumption or for the market, conducted outside the formal economy."*

Here, the term 'goods' has the precise meaning as used by classical economists: *"a material object capable of appropriation and therefore capable of being exchanged between economic units"* (Hill, 1979). *Making*, as such, refers to a service such as making, cleaning, redecorating or repurposing, done in an informal way, that brings a physical change to an economic good. This definition includes several important aspects of modern-*day*[8] *Making*:

1. Individual or community level engagement.
2. Production of finished goods or repair and repurpose of existing goods.

[8] Modern-day *Making* is an expansion of the traditional *Making* practices which involves physically transforming goods mostly working alone. The new conceptualization includes any *Making* activity, with a physical or a digital end product, conducted alone or in a community, and conduced with individual skills alone or with knowledge share (Ratto & Boler, 2014).

3. The end purpose of either self-consumption or selling.

Making used to mean self-use products, but now technology enables artisans to sell handmade products on larger marketplaces, challenging the traditional ethos of self-production. While the idea of creating something for personal use still exists, the commercial value of handmade products often surpasses that of factory-made ones. This blurs the line between creating for personal needs and creating for market demands. The traditional meaning of *Making* overlooks another crucial aspect: the changing methods of acquiring knowledge and skills. Traditional *Making* focused on learning from one's social circle, but now the internet provides open-access learning for *Making* enthusiasts. *Making* now involves more assistance and is less about inherent skills and knowledge. It also serves as a self-production process outside of the formal economy rather than fulfilling material needs. Thus, we propose a term that better encompasses the dynamic aspects of *Making*, called "Assisted Self-Production" that makes the definition we put forward earlier, richer, by including:

1. The technology-enabled assistance that modern day Makers receive outside of their immediate peer networks.
2. A production process that is not just for personal use, but rather performed by a non-formal manufacturer.

Assisted Self-Production and its classification, including the motivations for each category are graphically represented in Figure 22.

We have not introduced a new terminology for the various classes of *Making*. But the differentiating factor (motivation to conduct *Making*) clearly defines what class a certain practice should fall under. For example, the handmade cotton *gamochas* used as towels in India were previously classified as a craft, but since they're made for personal use, they now fall under prosumption in our classification.

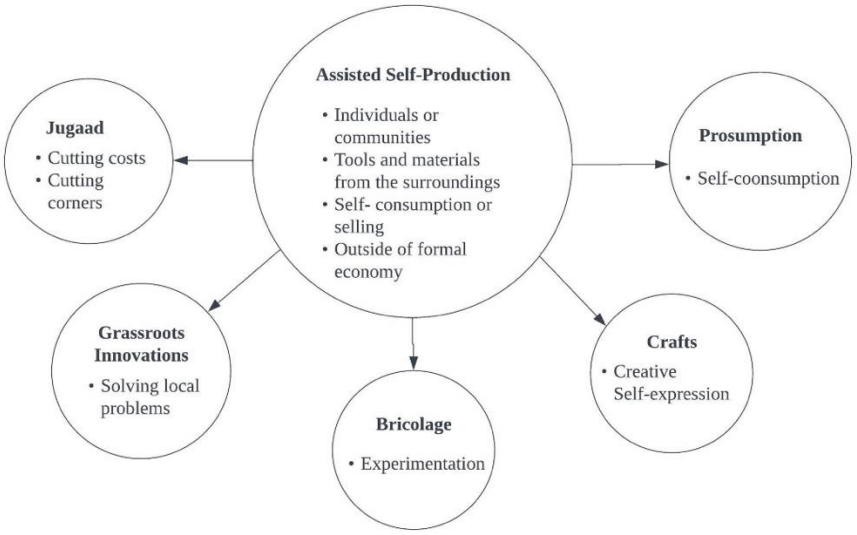


Figure 22. Graphical representation of the concept of Assisted Self-Production and it's classification along with their chief motivators.

Thus, we redefine *Making* for emerging economies as Assisted Self-Production (ASP). We define ASP as:

"Activities in which individuals or communities engage tools and materials from their surroundings to produce or physically transform material goods, destined either for self-consumption or for the market, conducted outside the formal economy. Such activities can be assisted with skills or knowledge share through technology-enabled platforms."

5.5. Discussion

The discussion presented in this, and the next section answers the following research questions:

Research Question 1: What are the characteristics of the *Making* culture in emerging economies?

a. What are the different classifications of *Making* practices?
b. What are the characteristic features that distinguish the different *Making* practices in emerging economies?
c. How is the *Making* culture evolving inter-generationally in such contexts? (Partially answered)

The Maker Culture has redefined production-consumption patterns in the post-industrial era. It has also offered a lens to rethink education, shifting from pure theoretical ways to a more hands-on approach. (Alper,

2013; Dougherty, 2012; Gilbert et al., 2013; Tanenbaum et al., 2012). With this vision, MIT Center for Bits and Atoms, started Fablabs to provide universal opportunities to imagine, tinker and fabricate personalized goods (N. A. Gershenfeld, 2005). But the question that remains is: Can a Western-originated Movement be adapted for emerging economies, where *Making* developed differently with distinct reasons for its persistence? Figure 23 presents a qualitative comparison between some of the *Making* movements from the West and ASP from the emerging economies using Polarity Diagrams (Manzini, 2015, p.40). We observe that the movements in the West are motivated by the need for self-actualization rather than material needs for survival. They are also conducted more at an individual level rather than at the community level. There is also difference in the level of technology involved in both contexts. Most *Making* practices in the emerging economies use primitive tools. Several factors contribute to such differences: per capita income, societal structures, norms of community living and level of development.

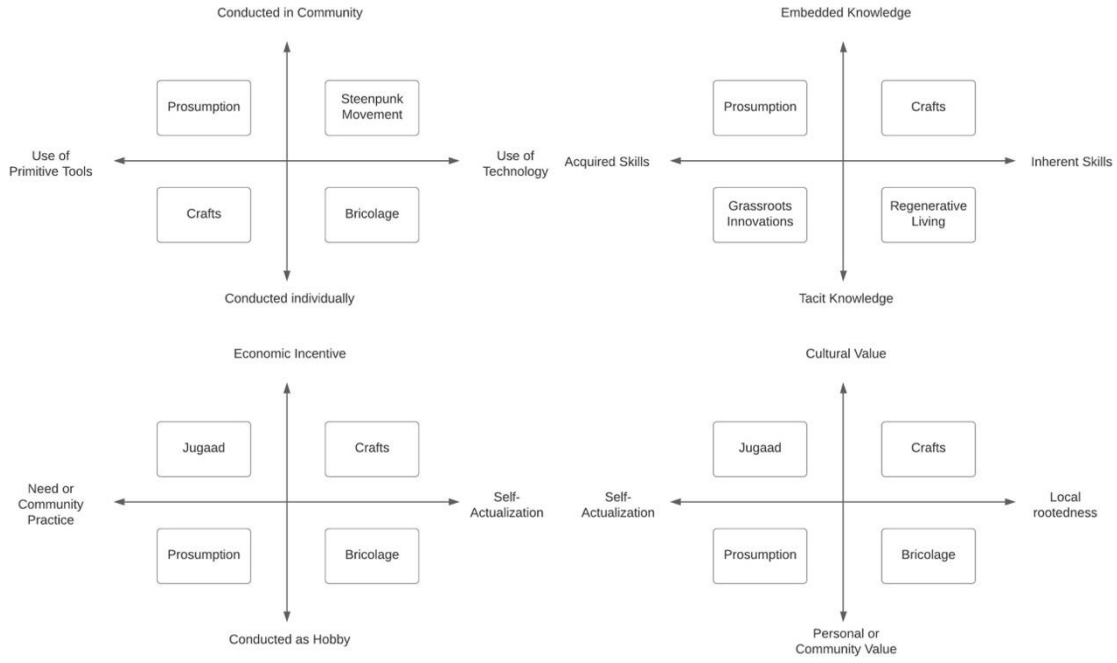


Figure 23. A qualitative comparison of different ASP movements in the West and in emerging economies through Polarity Diagrams.

In Design, an empathetic understanding of the context is key. It is crucial to grasp the motivators of ASP, the reasons for its sustenance, surrounding materialities, and skill levels to design successful ASP products and PSS. (Majumdar et al., 2019b) studied ASP (termed as DIY in the publication) behaviorism in the rural communities and found that while the older generations continued doing ASP as a way of life, the younger generation failed to see *meaning* in it. They expressed skepticism about the potential of the existing ASP

practices to confer them with either higher *competence* or *autonomy*. We have discussed these issues in greater detail in the next chapter where we fully answer research question 1.c.

The West is seeing a change in production and consumption through fast prototyping, maker communities, and open sharing, with a vision beyond consumerism. However, emerging economies face resource constraints, making ASP a survival skill rather than self-actualization. This creates a distinct difference in the meaning of ASP in both contexts. Promoting ASP practices in emerging economies have the potential to reduce pressure on global resources caused by the current rise in consumeristic culture in the emerging economies. Handmade products are more emotionally durable, employ sustainable production techniques, and valorize local eco-materials, offering an opportunity for designers to integrate them and stimulate local-to-local production-consumption. ASP practices that have the potential to provide livelihoods, can diffuse throughout the community and exist in a realm between the formal and the informal sector. In Sarthebari village, we observed that brass and bell metal works were done collectively. Experienced craftsmen trained and employed younger individuals, allowing the techniques to spread within the community. It is observed that on a small scale, community members collaborate and support each other under social norms, demonstrating entrepreneurship by financing their business and reaching the market. For instance, SHG's of women collaborated in rearing of silkworms, spinning thread, weaving, and selling their products in the market. Designers, businesses, government, and non-government bodies have explored this social model in several ways to formalize the practice(s) in the desired direction. Some examples of the same are listed below:

1. Shared maker spaces such as FabLabs and plastic recycling units (Diehl et al., 2018; *Precious Plastic*, n.d.).
2. Businesses adopting an aggregator model with polycentric manufacturing of products in an informal setting (Khaire & Kothandaraman, 2007; Luckman, 2013).
3. Educating community members about *Making* techniques to empower them to earn livelihoods (*Auroville - Learning.Net. A Network to Experience Auroville. Auroville*, n.d.).
4. Educating prominent members (opinion leaders) from the community about *Making* techniques and handing sharable material to him/ her to disseminate know-how of the practice throughout the community (Majumdar et al., 2019b).

Figure 24. A rural woman weaving at home.

While critiquing each model is beyond the scope of the current research, the undertone of formalizing the practice or the search for a hybrid model that either makes a practice sustainable or attempts at the adoption-diffusion of a new practice is perceptible. Some of these models have demonstrated success in sustaining an existing practice or inseminating a new one (Khaire & Kothandaraman, 2007; Luckman, 2013; *Precious Plastic*, n.d.). However, institutionalization can neglect the organically evolved communication channels and the community's propensity to function in informal environments. In rural India, textile weaving has been a long-standing tradition for women, providing them with a relaxing respite from their household chores (Figure 24). Although the introduction of automated Jacob machines made handmade textiles less cost-effective, the practice has persisted as an important part of rural lifestyle. For these women, weaving offers a therapeutic outlet to express their creativity and socialize with nearby women, sharing patterns and handmade gifts. For some communities, the weaving practice has assumed immense symbolic meaning. For example, the handmade scarves from the Dongaria (Ranjan & Ranjan, 2009, p. 230) and Assamese communities (Pradhan et al., 2020) are gifted as a token of respect. Owing to its significance in rural economy, the government dispenses several programs from area Block offices that train rural women in other crafts such as embroidery, knitting and weaving (Welfare Directorate of Social & Department of Women & Child Development and Social Welfare, 2005). However, these were designed to give young rural women a skill that could earn them a livelihood, in other words, a strong extrinsic motivation. These new practices did not diffuse enough to become a mainstream rural activity as weaving. Corporate models which leverage on extrinsic motivations while sourcing handwoven textiles, also could not give enough *meaning* to the practice for the next generation to adopt it (Khaire & Kothandaraman, 2007; Luckman, 2013).

On the other hand, the Swadeshi Movement initiated by Mahatma Gandhi a century ago, succeeded in bringing back weaving which was decimated by the British rulers in favor of the textile mills in Manchester. The Swadeshi Movement was a mass call for self-reliance. ((Hans) Bakker, 1990). Its success can be attributed to the motivational *meaning* that Gandhi could infuse in his social design. It did not employ new tools or materials and it did not entail the possibility to earn a livelihood. But he touched the right nerve by giving it *meaning* in several layers: (a) self-producing textiles could enhance the community's economic *competence*, (b) it could give people higher control of their own consumption needs, (c) it could be informally conducted from home, (d) it gave the maker a sense of purpose to move the country towards independence.

The Swadeshi Movement is a classic example of how motivational meaning can be as crucial as the materialities surrounding a practice in facilitating its adoption and diffusion. It did not seek institutionalization of a practice and occurs in naturally formed networks. Taking this successful precedence as our inspiration, we investigate in this thesis how we can formalize the design of an ASP PSS for emerging economies taking into account their contextual understanding of ASP, ways to motivate adoption, and designing the PSS to naturally diffuse through relevant communication networks. The emergence of distributed manufacturing, post pandemic, also offers fresh opportunities and the need for the design community to push production in emerging economies in a sustainable direction.

5.6. Conclusion

Upon in-depth investigation of the concept of *Making* in emerging economies, we redefine it as Assisted-Self Production and provide a classification of the associated practices. The literature on these practices is limited, with a disproportionate emphasis on Jugaad and Grassroots Innovation, necessitating additional field research. Observational studies were used to gather data on the other categories - Bricolage, crafts, and prosumption - employing various fieldwork techniques. Utilizing the Grounded Theory methodology proposed by Glaser and Strauss, we established a comprehensive classification of ASP practices, culminating in a cohesive definition for emerging economies. The different categories that emerged from the 40 cases are as follows:

a. Jugaad
b. Grassroots Innovation
c. Prosumption
d. Crafts
e. Bricolage

We delve into the definition of each practice type and its distinctive traits before performing a cluster analysis. Our findings highlighted two key points: (a) the significant characteristics of each category and (b) their commonalities. The overlapping traits helped redefine ASP for emerging economies and introduce a new, more inclusive term for it. As ASP practices evolve, the term no longer fully encompasses how skills are learned, or end-products are used. With open-source knowledge and technology, ASP is no longer a solitary exercise and can extend beyond self-consumption.

Nonetheless, it remains a form of self-production outside the formal sector. Therefore, we suggest "Assisted Self-Production" as a more accurate term to describe these processes and practices. We define Assisted-Self Production (ASP) as:

> *"Activities in which individuals or communities engage tools and materials from their surroundings to produce or physically transform material goods, destined either for self-consumption or for the market, conducted outside the formal economy. Such activities can be assisted with skills or knowledge share through technology-enabled platforms."*

6. The *Images* of ASP: Motivational Meaning and Social Dynamics Behind ASP in emerging Economies

Making is a creative experience of imagination and tinkering through which one finds resourcefulness in surrounding objects and materials. In chapter 4 (page 60), we have presented the various characteristics of *Making* practices in emerging economies, in relation to the *skills* and *tools* surrounding them. In chapter 5 (page 66), We observed that motivational meaning was the primary differentiating factor between the different categories and an important factor that elicited Making behavior in such communities. In this chapter, we discuss our field studies in rural India and present our findings of the *images* that sustain ASP in such communities. Furthermore, we observe how such meaning is evolving between generations, especially in relation to the youth in such communities. We also study how meaning is socially shared in such communities.

6.1. Research Question(s) Answered

Research Question 1: What are the characteristics of the *Making* culture in emerging economies?

c. How is the *Making* culture evolving inter-generationally in such contexts?

In Practice Theory put forward by (Shove et al., 2012), *images* are defined as *"socially shared meaning related to a practice that give reasons for engaging in it." Images* or *meaning* has significance both at an individual and at a social level. At an individual level, a person's values, beliefs and motivations strongly influence behavior (Ajzen, 1991; Bandura, 2001; R. M. Ryan & Deci, 2000b). On the other hand, at a social level, norms tacitly shape behavior in networks (Bicchieri, 2016; Contractor & DeChurch, 2014; Katz & Lazarsfeld, 1955; Van den Bulte & Lilien, 2001). (Bicchieri, 2017) defines *norms* as a rule of behavior such that individuals prefer to conform to it on condition that they believe that (a) most people in their reference network conform to it (empirical expectation), and (b) that most people in their reference network believe they ought to conform to it (normative expectation). Collectively, both individual and social determinants, provide meaning that motivates individuals to engage in a practice and sustain it. In our quest to understand ASP practices, we had forayed further than literature review, to study such practices in five communities as described in 5.3.2.

Several researchers have studied the propensity to *make* from a psychological point of view and differentiated motivational factors into intrinsic and extrinsic based on Ryan and Deci's Self-Determination Theory (Fields et al., 2014; Freeman, 2015; Lakhani & Wolf, 2005; R. M. Ryan & Deci, 2000b). The propensity to enhance skills is highly visible among ASP communities. Each is in a pursuit for greater self-

expression, inventive epiphanies or finer craftsmanship (Freeman, 2015; Tanenbaum et al., 2012; Williams, 2008; Wolf & McQuitty, 2011). The identity-seeking ASPer is also seeking higher participation in the material world by trying to establish coherence between himself and his surroundings (Freeman, 2015; Lakhani & Wolf, 2005; Williams, 2008). The final component is the feeling of connectedness to a group with a similar culture or goals. It encourages ASPers to work collaboratively and seek recognition from peers (Fields et al., 2014; Freeman, 2015; Lakhani & Wolf, 2005; Tanenbaum et al., 2012). Such connectedness can also engender a sense of obligation towards the group. Hackers, for instance, not only act as part of a group with the goal to make all software openware, but also operate under the *norm* that their own work should be open source (R. M. Ryan & Deci, 2000a). Just as the rise in consumerism led to an alienation of people from labor in Western societies, communities from emerging economies are also witnessing a gradual drift away from ASP practices despite their significance as heritage and their local rootedness (Breaux, 2017; Majumdar & Banerjee, 2017).

Social influence has also long been known to be a powerful determinant of individuals' behavior. In collectivist societies such as rural and semi-urban India, social influence can play an active role in the performances of need-based ASP practices for survival (Majumdar et al., 2019a). Being collectivist societies, these practices are socially underpinned by shared beliefs, shared knowledge, and norms to help and support each other. We posit ASPers in rural and semi-urban societies in emerging economies as a network and investigate into the distinct social motives that influence ASP in such communities.

6.2. Theoretical Lenses

This section delves into the foundational theories underpinning motivations and social influences used in the study. We begin by exploring Self-Determination Theory to dissect the intrinsic and extrinsic motivations driving individuals towards ASP, highlighting the crucial roles of *competence*, *autonomy*, and relatedness. Subsequently, we examine ASP through the lens of Practice Theory, which provides a comprehensive framework for understanding the amalgamation of skills, images, and physical tools that define ASP as a practice and influence its evolution and sustainability. Lastly, we investigate the social motives behind peer-to-peer behavioral influence, utilizing the Structured Influence Process to analyze how social interactions foster behavioral and attitudinal changes within networks. Through these theoretical perspectives, we aim to unravel the complex interplay of motivations and social dynamics shaping ASP in emerging economies.

6.2.1. Understanding Motivations: Self- Determination Theory

In this research, we use Self-Determination theory (R. M. Ryan & Deci, 2000a, 2000b) to analyze the motivations for ASP in communities from emerging economies. Self-Determination theory (R. M. Ryan & Deci, 2000a, 2000b) categorizes motivation as two distinct categories: *Intrinsic motivation* and *Extrinsic motivation. Intrinsic* motivation is the behavioral drive that results from something being inherently interesting or enjoyable. *Extrinsic* motivation, on the other hand, is the drive resulting from separable outcome such as economic returns, recognition, feedback, etc. *Intrinsic* motivation has three components: *competence*, *autonomy*, and *relatedness*. Ryan and Deci (R. M. Ryan & Deci, 2000a) states that every individual has the psychological need for *competence*, *autonomy*, and *relatedness* and despite what is obvious, all humans are endowed with inherent motivational tendencies that are expressed only under specific conditions. External agents can catalyze, rather than cause, such internal drives to be expressed. *Competence* is the perception of growth in skills and knowledge. Ryan and Deci (R. M. Ryan & Deci, 2000a) claim that the feeling of *competence* alone cannot enhance intrinsic motivation, unless it is accompanied by a sense of *autonomy*, or the sense of free will that one is doing something out of one's own interests and values. The final component of *intrinsic* motivation is *relatedness*. A primary reason why people often engage in a certain kind of behavior is that they are valued by significant others to whom they feel connected either as family, peers, social circles, or a wider network based on common goals and values.

6.2.2. Understanding ASP as a Practice: Practice Theory

In order to understand how ASP subsists in these communities, we consider ASP as a practice: *"an active integration of materials, meanings and forms of competence"*. A practice embodies three loosely structured groups of elements: *skills, images, and stuff* (Figure 25). *Skills* embody learned routines, know-how and ways of doing and feeling. *Images* are socially shared meaning related to the practice that give reasons for engaging in it. *Stuff* embodies the physical aspects: the objects and tools along with the body of the maker (Shove et al., 2012). These elements are interlinked and interact with each other to transform the practice over time. For example, the coming of 3D printing (*stuff*) transformed the practice of prototyping and changed its *image* from a slow hands-on process to a fast automated process. It also implies a change in *skill* requirement, from skills in hand modelling to 3D modelling software. Establishing a practice, often involves establishing these linkages to connect the *materiality* with the skills to execute and the *images* (reasons) to engage in it. Similarly, the mutation of the linkages can deform the practice over time and eventually lead to its extinction through breakage of links (Figure 26) (Shove et al., 2012). Practice theory has been used to analyze emergence, evolution and extinction of practices (Österlund-Pötzsch, 2013; Shove et al., 2012) and to design products with higher embeddedness in daily routines or to have higher sustainability (Kuijer, 2014; Shove et al., 2012). It provides us with a useful lens to examine ASP as a practice, the motivations that give it meaning and how such meanings are evolving over time.

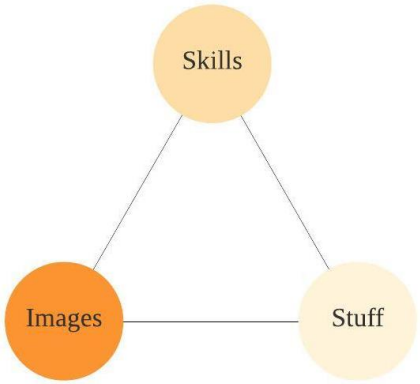


Figure 25. The three interlinked elements of a practice.

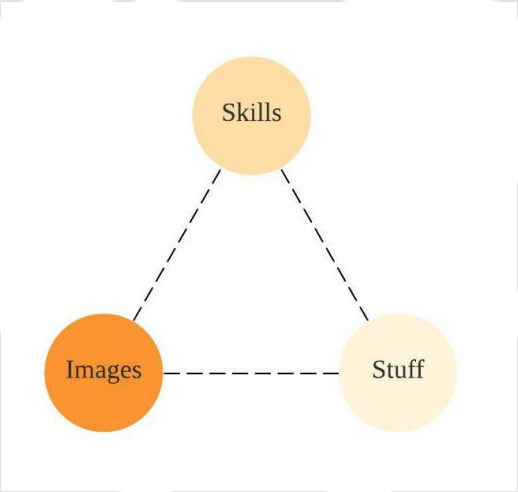


Figure 26. Linkages breaking and practice mutating.

6.2.3. Understanding Social Influence: Social Motives Behind Peer-to-Peer Behavioral Influence

The study of social influence in networks has frequently had a structural approach that looks at diffusion of a practice in a network as a two-step process: adoption by highly influential individuals or '*opinion leaders'* and the subsequent adoption by others as a result of the influence of the *opinion leaders* (Katz & Lazarsfeld, 1955; Kim et al., 2007; Lazarsfeld et al., 1944; Troldahl, 1966). Others have studied the downstream effect of how a change in behavior or attitude contagiously spreads in a network (Burt, 1987; R. M. Ryan & Deci, 2000b; Van den Bulte & Lilien, 2001). While these studies identify the *who (pivotal elements)* of the process, we analyze the *how (social motives)* of the process by specifically focusing on the subset of social motives that result in peer-based behavioral and attitudinal change from social interactions. Such motives have earlier

been explored in the development of the Structured Influence Process that shows an array of ways in which *opinion leaders* can be influenced by peer influences (Contractor & DeChurch, 2014).

Humans have two basic categories of needs that prompt them to look at others in a network (Contractor & DeChurch, 2014):

1. **Need for Accuracy**: The Need for Accuracy prompts people to look at others in their network to determine the correct way to act through two types of social interactions: (a) information about what others are doing (*social proof*) and (b) information about what others with influence or expertise are doing (*authority*) (Cartwright, 1965; Eagly & Chaiken, 1993; Festinger, 1954; Sherif, 1936).

2. **Need for Affiliation**: The Affiliation motive stimulates people to act in ways that enhances their belongingness to a group or builds good interpersonal relations with others. This motive gives rise to four kinds of interactions: people acting (a) similar to people they like *(liking),* (b) in consistence with their prior beliefs and behaviors *(consistency,)* (c) returning obligations *(reciprocity),* (d) conforming with social norms in their network *(accountability)* (Baumeister, 1982; Baumeister & Leary, 1995; Byrne, 1961; Contractor & DeChurch, 2014).

The theory on social motives gives us a useful lens to inquire about the possible reasons why people in emerging economies are influenced by others in their network. It also provides us with a suitable way to have a diffuse observation of social influence in the network without largely focusing on *opinion leaders.* We assume that such insights can be especially pertinent when an ASP practice is not new, and its survival is not known to be dependent on *opinion leaders.*

6.3. Methodology

6.3.1. Research Subjects

For our fieldwork in India, we adopted the subsequently divergent and convergent, Double Diamond model of fieldwork (Chipchase, 2017) to gather insights. The first part of the Double Diamond Model of fieldwork pertains to observatory studies. The researcher approaches the target group with an open exploratory mindset and makes observations about aspects that are relevant or has the potential to influence the design process. During this stage, the number of subjects observed is large, corresponding to the divergence in the first diamond. The insights from the first phase are then analyzed to identify dominant themes and factors that will influence the design process. In the second phase of the Double Diamond Model of fieldwork, the researcher focuses on the key aspects that are likely to be the biggest determinants in the design process.

This corresponds to the converging part of the first diamond. Here certain aspects are studied with rigor in a smaller group of subjects, to generate deeper insights into the phenomenon being studied.

In accordance, our study was conducted in five rural communities, namely: Joypur, Gopalpur, Paator Kusi, Sarthebari and Naumati in rural Assam in India (Figure 18). The first four villages constituted the first group of subjects being studied in an open exploratory manner under the Double Diamond Model of fieldwork. The last village, namely: Naumati, constituted the group of subjects who were studied in more depth. It is to be noted that not all observations made in the first phase, were studied in greater rigor in the second phase. Only the observations that we perceived to have the highest influence on the evolution of the ASP culture, were studied more thoroughly in the second phase.

The communities that were studied, each had a different ethnic background except for Sarthebari and Naumati. We visited nineteen low-income households in total and used purposive sampling to select subjects as described in 5.3.2.1. On an average, we spent five days in each village. Nineteen households were visited in total and one member from each household was interviewed. We spent the working day from morning till evening during the season of autumn, with families to study their household prosumption practices. All the households sustained on agriculture. The women worked in the fields as seasonal labor. At times they grew other crops such as beetle nut, rubber, bananas, etc. in their backyards and reared livestock. There were 31 respondents in this group (17 male and 14 female) from the age of 25 years to 70 years. We also interviewed fifteen young respondents (8 male and 7 female) from the age of 12-20 years. All of them either attended school or a community college. Purposive sampling was used in the process of subject selection as described in 5.3.2.1.

For selecting our research subjects, we had adopted the snowballing technique for fieldwork, in which interviews with households pointed towards the importance of interviewing expert craftsmen who in turn indicated that their learning stage was in their early to late teens. We, therefore, interviewed eight craftsmen in Sarthebari and Naumati which have burgeoning craft industries of cane and bamboo works, brass and bell metal artefacts. Subsequently, we interviewed fifteen young respondents, eight male and seven female (aged 12-20 years). All respondents either attended a school or a community college. Furthermore, to confirm certain findings (elaborated below), we held focus group interviews with 4-5 respondents in each village.

6.3.2. Research Approach

We conducted a contextual enquiry in the aforementioned communities. We used field work techniques such as touchstone tours in homes, field notes, pictures and shadowing rural ASPers along with semi-structured interviews. Our foci during these observations were the kinds of materials and tools used and the *skills* involved in the practice. The semi-structured interviews focused on the *images* (motivations) of the ASP

practice to the community and the individual and the motives for social influence around ASP practices. The craftsmen and the young respondents were interviewed in a similar manner (without cross-validation). The craftsmen were also shadowed for about an hour each prior to the interview.

The interviews were transcribed and subjected to the three-stage coding process described in 5.3.2.2. The raw data and the coding is presented in Annexure 1 (page 230) and 2 (page 248). The field notes and pictures were thoroughly gleaned to corroborate our findings. In order to understand the *motivations* and *purposes* for engaging in ASP, we conducted a qualitative cause-effect analysis using the reference model construct from Design Research Methodology (Blessing & Chakrabarti, 2009). The field notes and pictures were arranged under the themes (concepts) to aid in the development of the associated concepts. We also interviewed the young respondents with the same questionnaire to understand the *meaning* that they assigned to ASP so that we could identify if there was a variance or continuity in meaning. If we encountered a respondent who did not engage in ASP, we restructured the interview to study the kinds of activities that s/he was most *intrinsically* motivated for and what their major sense of purpose was. We, however, did not interview craftsmen as they were majorly driven by *extrinsic* motivation to do ASP.

In studying social motives for behavioral influence, it is recommended to cross-validate self-reports of social influences (especially in the case of norms (Bicchieri, 2016)). Hence, in addition, a focus group interview was also held in each village with 4-5 participants.

6.4. Observations and Results

In our research enquiry, we observed several prosumption practices in the households that support a self-sustaining lifestyle. The touchstone tours around the houses revealed that these communities engage in some form of *Making* practice to be self-sufficient either in the form of weaving their own clothes, constructional ASP for making houses, sheds and granaries or making quotidian products for transporting goods, storage of food or for catching fish. Figure 27, Figure 28 and Figure 29 show a woman making a granary, a woven basket to transport fish and a weaver working at her manual loom. They use basic tools such as knives, sickles, hammers, shovels, etc. (Figure 30) to more complex manually operated machines like looms (Figure 29). They also extensively use local materials such as cane, bamboo, various palms, coconut leaves and coir, woods (teak, sal, gambare), water hyacinth, husk, hay, sand, cow dung and silk cocoons (Eri and muga) (Figure 31). Most of the ASP practices have evolved as heritage for such communities, a means of fulfilling their material needs using local resources. The patterns of weaving, the designs of the products and the techniques of making houses and granaries using mud, cow-dung, straws, and bamboo were passed on from generation to generation. The respondents who engaged in ASP reported picking up such skills during the early years of their life. Fifteen out of the nineteen households also reported helping each other in heavy ASP activities such as construction or setting up of looms. Being part of a collectivist culture, the members

valued co-operation and coordination to support each other in their survival needs. The women demonstrated a high sense of collectivism in their practice of weaving wherein they shared ideas and designs with each other continuously.

In our efforts to understand the *motivations* and *purposes* to engage in ASP, we conducted a cause-effect analysis for each of the interviewees. Figure 32 presents the analyses of four representative subjects engaging in three widely conducted ASP activities. Being primarily a survival strategy, ASP in these communities, is at times strongly driven by *extrinsic motivations* such as economic profit, lack of product availability and need for customization of products. Recognition of work by peers and others in the community was also a strong motivator for ASP. The interviews, however, manifested several other intangible needs. They sought higher *competence* through creative expression and refinement of craftsmanship, higher *autonomy* by self-production of goods and higher *relatedness* through sharing of ideas. The subjects also felt a sense of purpose in doing ASP. For some it meant preserving traditions, for others it was a way of bringing welfare to the community.

Figure 27. A woman Making a granary.

Figure 28. A woven basket to transport.

Figure 29. A woman weaving on a loom.


Figure 30. ASPers using simple tools.



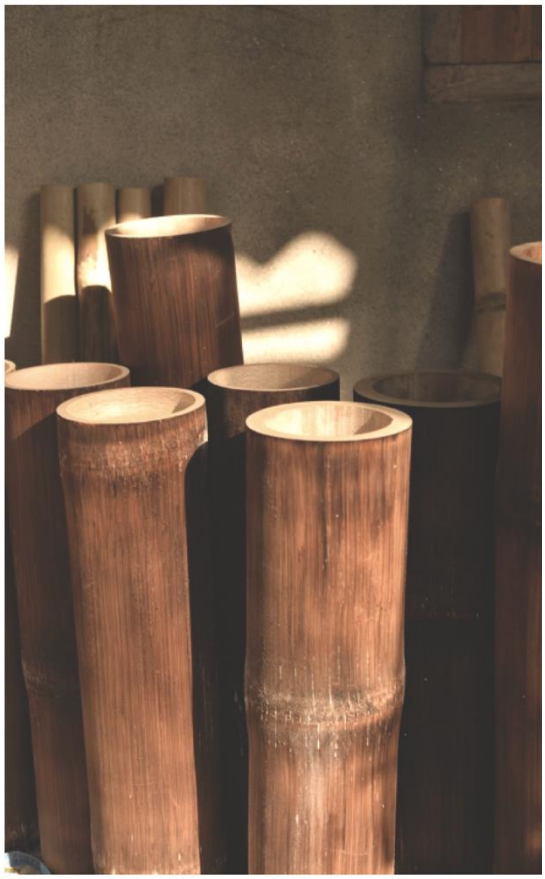


Figure 31. Some local eco-materials that are used for ASP activities.

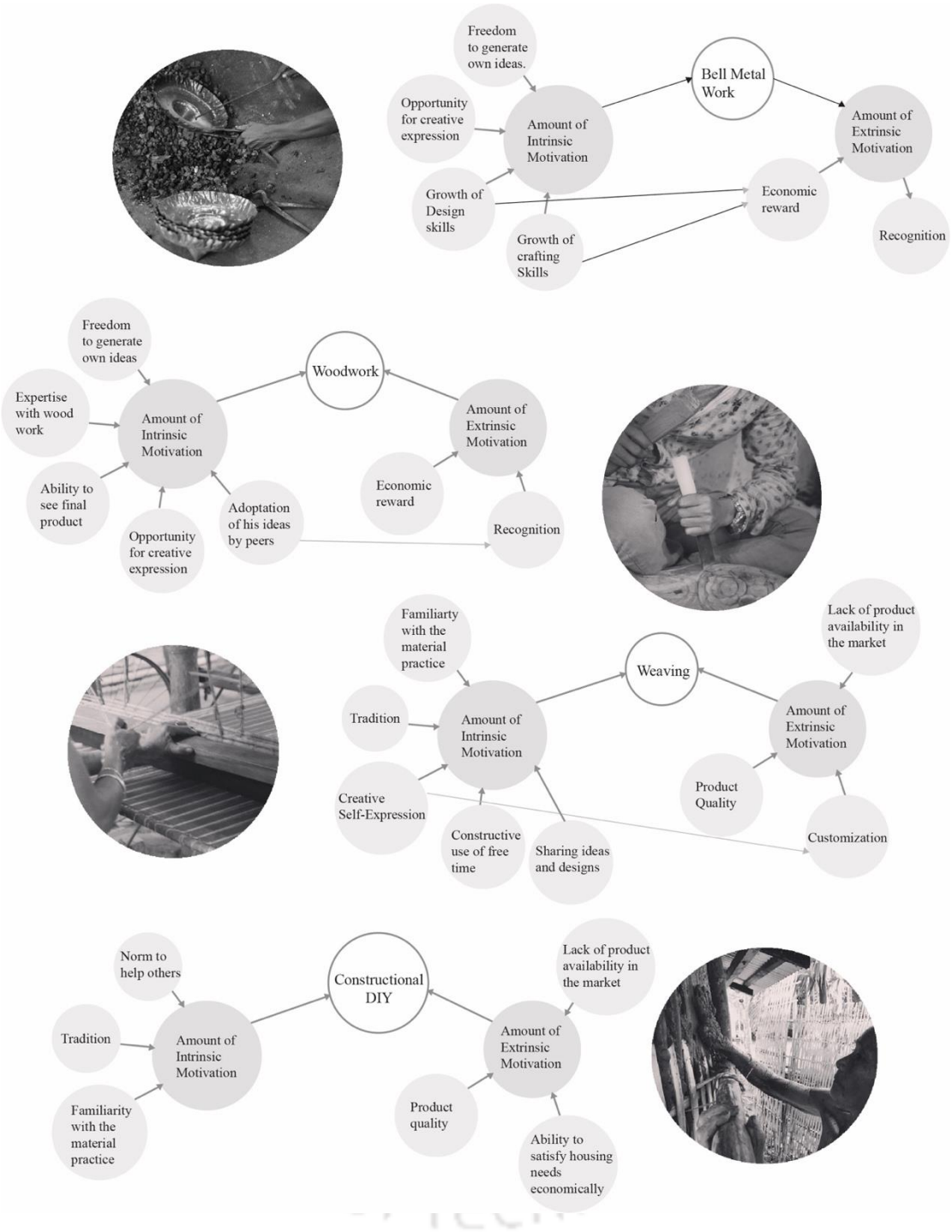


Figure 32. Cause-effect analysis to study motivations of four ASPers engaging in different Making practices.

Table 5 shows the major reasons and motivational factors which give meaning for the people to engage in ASP and the associated concepts that the interviews generated.

Table 5 *The concepts and associated concepts derived from the interviews with opinions of subjects to exemplify.*

Concepts/ Associated Concepts/ Exemplary Opinion from a Subject		
		
Competence	***Relatedness Needs***	***Autonomy***
Creative self-expression, Ability to see final product, Growth in expertise.	Sharing ideas and designs, Adoption of ideas by peers.	Freedom to generate own ideas, Ability to satisfy one's needs.
"I like to work on challenging projects, where I can be creative in new ways."	*"If I have a new pattern, I show it my neighbor and if she has one, she shows it to me."*	*"I make all small things that we use at home. We do not buy them from the market."*
		
Social norms	**Extrinsic Motivations**	**Purpose**
Helping others in the community.	Economic profit, Recognition, Product quality. Customization, Lack of product availability in the market.	Preserving tradition, Community welfare.
"There is a norm in villages to help each other. If I run out of something, I can borrow it from the neighbor."	*"The government gave me a certificate for being a model farmer. They call me train others on farming techniques."*	*"I try to be of help to others. Being able to do community service is a privilege."*

The younger group of respondents, however, did not demonstrate a strong inclination towards doing ASP. Only one out of the eight male respondents reported doing technological ASP in the form of making small toys by repurposing parts from other gadgets. Three out of the seven female respondents expressed that they occasionally engaged in creative ASP projects such as making craft items or doing clay-work. These young ASP'ers were at times, driven by a clear sense of purpose of achieving a goal through their work and at times, solely for the opportunity to dwell in their creative side. The respondents who did not engage in ASP, did not perceive *Making* as having the potential to make them feel higher *competence* and *autonomy* or even affording them the opportunity to fulfill their *relatedness needs*. In Figure 33, we present a mind map depicting what the young respondents perceive as *competence*, *autonomy*, *relatedness,* and *purpose*: the meanings that were assigned to the ASP practice by the older respondents.

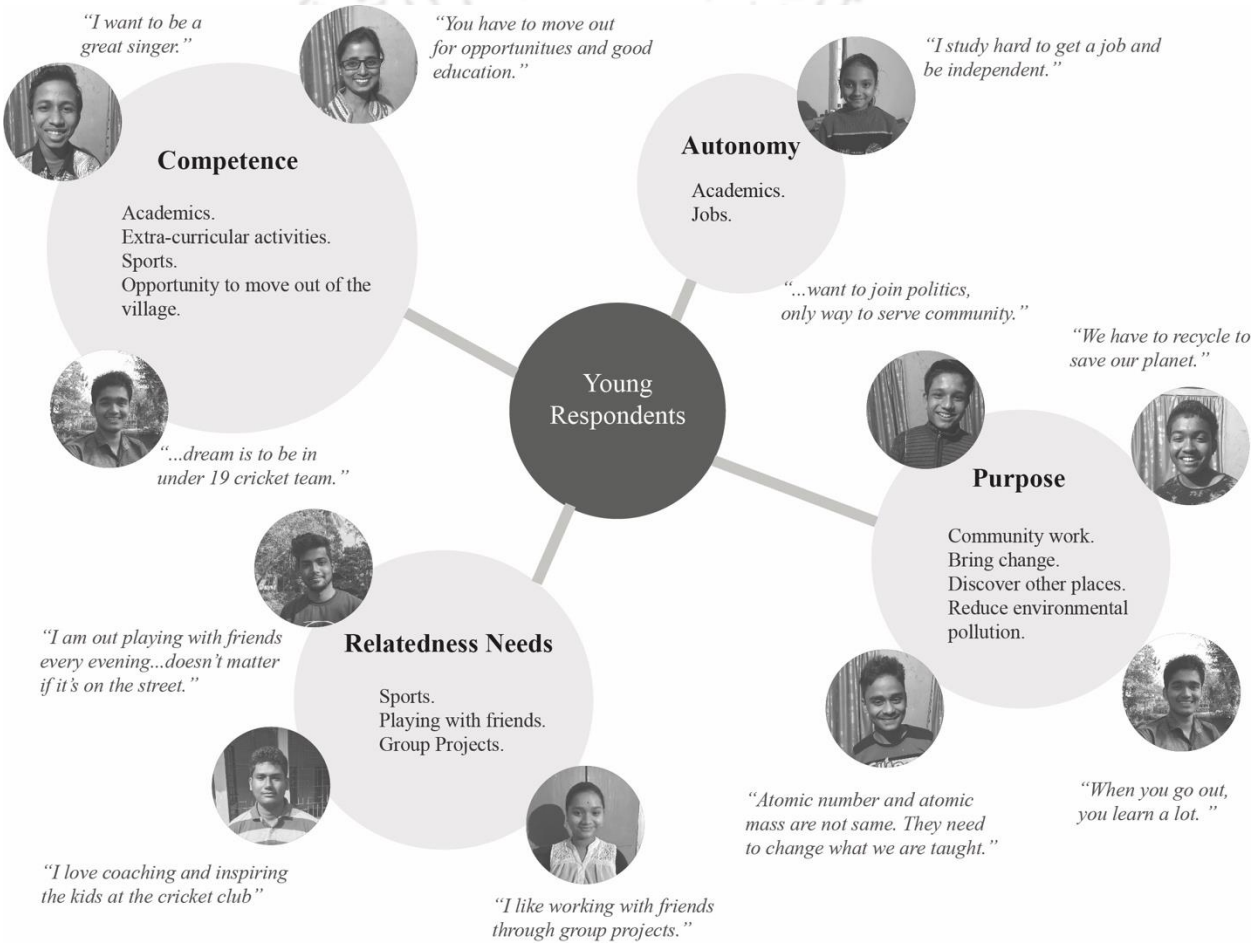


Figure 33. Mindmap showing what Competence, Autonomy, Relatedness and Purpose means to the young respondents.

Four out of the nine young male respondents actively engaged in sports to hone their athletic skills. It also gave them an opportunity to fraternize with friends and club members. The young female respondents

viewed group activities in schools as their opportunity to connect with their peers and work collaboratively with them. Though all the respondents were from similar familial backgrounds and received similar education, the male respondents demonstrated a sense of purpose that was inspired by the problems that they witnessed in their community either in traditions, environmental problems, deficiencies in education or political and socio-cultural failings. The female respondents however, expressed a greater proclivity for creative expression. They experienced such activities as an immersion into a world of playing, tinkering and creative imagining. We observed that while the older respondents viewed self-reliance and being connected to the community as their major source of motivation, the younger respondents opined, without exception, that only education and extra-curricular activities can give them higher *competence* and *autonomy* for a stable future. The young respondents also demonstrated a clear divergence from their older generation in their sense of *purpose*. They had a higher awareness of global problems and how change was required in several fronts to uplift their community.

We also carefully considered the behavioral patterns and self-reports of the subjects that manifested social influences. The analysis of the data reveals how the attitudes and behavior of the subjects are affected by those of others in their social network either through the *need for accuracy* or the *need for affiliation*. We discuss each kind of social motive separately below:

Need for Accuracy: The village communities demonstrated a high degree of social influence from members in the network with expertise in a certain ASP activity when such an activity was primarily driven by *extrinsic* motivations such as economic rewards and/ or had ambiguity in economic viability or technique used, surrounding it. The "correct way to act" is in some way defined by the fear of losing out on competitive advantage because of failure of adopting new techniques of *doing* or *Making.* Craftsmen often emulated the designs of expert craftsmen (*authority)* in the locality who made innovative products and had bigger businesses (Figure 34). Young men from a community were more drawn towards a craft profession, if there was a skilled craftsman in the community who made a good livelihood from it. The need for accuracy could also be observed in the field of agriculture which provided subsistence for a majority in these rural communities. Information about what an expert is doing flowed through the network and reoriented the practices of others to be more aligned with the expert's way of doing (Figure 35). At times, however, the interactions were in the form of *social proof* when the practice is novel to the community and the long-term success of it is yet to be proven (Figure 36). Growing of new crops, use of non-local materials for crafts, *Making* of new products with a seemingly essential functionality are instances when information about what others are doing can echo in the practices of others in the community. A perceived sense of increase in *competence* stimulates people to mimic practices whose long-term value is not known yet.

Figure 34. Authority: "The themes and designs I have, will slowly be made by other brass craftsmen in the area. But my quality is higher. " - A recognized brass craftsman.

Figure 35. Authority: I try new things like beekeeping and others become interested to learn it from me. The government trains me and I bring in new farming techniques to the village." - A model farmer.

Figure 36. Social Proof: "I saw the other craftsmen were Making beer mugs from bamboo. I started Making too. There is no local market for it. But they are shipped by suppliers." - A cane and bamboo craftsman.

Need for Affiliation: The rural communities had a close-knit structure. Members frequently engaged in community activities in their need to belong, to connect, and to sustain relationships with others. Such a behavioral pattern seeking affiliation was also observed in ASP practices that had socially shared meaning

(significance or reasons for engagement) in the community. Women conformed with social norms and learnt weaving from an early stage in their life *(accountability)*. It is a usual practice in Indian villages for women to weave their own clothes stemming from the Gandhian philosophy of self-sufficiency in living (Figure 37) ((Hans) Bakker, 1990). People in such communities also shared the normative expectation that they should help each other in essential ASP for their collective survival. They frequently helped each other in the construction of granaries and houses (Figure 38). But besides being triggered by existing norms, people in such communities also demonstrated a strong proclivity to act similar to someone they like *(liking)*. Women often visited their friends and shared their weaving designs with their friends who in turn, would share their own designs and ideas (Figure 40). Children were influenced by others in their network, whom they either bonded with or looked up to (Figure 39). Finally, the researcher also observed a sense of reciprocity in their interactions. Children often helped others who helped them in *Making* projects. Similarly, gifting or hospitality shown with hand-made or home-made products to others also entailed a similar gift or hospitality in return (Figure 42 and Figure 41).

Figure 37. Accountability: "I learnt weaving when I was 12 or 13. All girls in the village do."

Figure 38. Accountability: A young man helping an old woman build a granary in her house.

Figure 40. Liking: A woman spinning thread with her neighbor.

Figure 39. Liking: "My sisters make dolls with clay. I love playing with clay with them."- A young girl.

Figure 41. Reciprocity: "We have a tradition of gifting other women hand-woven clothes." - A weaver.

Figure 42. Reciprocity: "We serve only home-brewed alcohol when guests come. It's customary."- A housewife.

During our field study, we also observed that the social integration events over ASP practices propelled by social motives, often provided the young subjects with the opportunity to experience *Making*. The process of playing, tinkering, and transforming creative imagination to materiality, made the subjects experience a self-transformation into someone more resourceful. Through self-reports, they expressed enthusiasm to revisit such practices on their own.

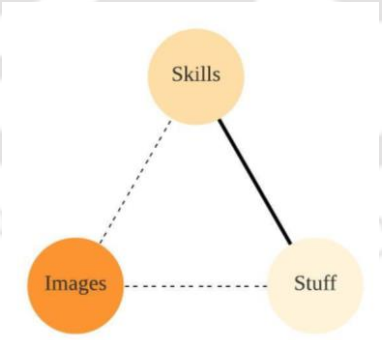


Figure 43. Linkages with Images breaking from stuffs and skills.

Table 6 A comparison of what motivations and purpose are for the younger and older generations.

	Competence	***Autonomy***	***Relatedness Needs***	**Purpose**
Older Generation	Creative self-expression, Ability to see final product, Growth in expertise.	Freedom to generate own ideas, Ability to satisfy one's needs.	Sharing ideas and designs, Adoption of ideas by peers.	Preserving tradition, Community welfare.
Younger Generation	Academics, Extra-curricular activities, Moving out of the village.	Academics, Jobs.	Sports, Playing with friends, Group projects.	Community work, Bring change, Discover other places, Reduce environmental pollution.

6.5. Discussion

ASP practices in rural and semi-urban communities in emerging economies, have subsisted as a powerful medium of harnessing local materials and resources to fulfill the material needs of such communities. In the pre-consumeristic era, they have played a vital role in the sustenance of these communities and in establishing a collaborative society for collective survival (Toffler, 1981). Besides fulfilling material needs, people often engage in ASP with abstract goals such as preserving traditions and ensuring community welfare. These motivational factors, reasons and goals together constitute an intangible whole that gives a socially shared meaning to ASP practices for these communities. Our field work revealed that prosumption practices have subsisted in such communities being supported by *skills* (know-how and expertise), *stuff* (tools and raw materials from the environment) and *images* (motivations, goals and purpose). However, we also observed the links between the two elements: *skills* and *stuffs* with *images* are decaying as depicted in Figure 43. The *images* associated with ASP are either morphing in a manner that introduces a disconnect with the current *skills* and *stuffs* or the *images* associated with ASP are simply disintegrating along with the linkages (Shove et al., 2012). The new generation does not perceive ASP as a means of collective survival. They do not view ASP as capable of affording them with either *competence* or *autonomy* to sustain themselves in the real context. The exposure to the world outside the vicinity of their villages, either through television or smart phones, have further given them a "vision of a good life" that is no longer aligned with the rustic lifestyle where self or social production of goods is a norm for survival. Table 6 shows a comparison between the older generation and the younger generation on their perceptions of growing *competence, autonomy* and *relatedness* and their sense of purpose.

Universal free and compulsory education in India has contributed to the movement of youth in rural and semi-urban contexts, from hands-on activities to more academic pursuits in the hope of a better future (Fox, 2014). To compound on it, the Indian education system is *"generic, utility-driven and structural"* that somehow relegated vocational and skill-based activities to the level of outmoded, heritage practices (Bhatia et al., 2023). (Somanath et al., 2017) studied the unique challenges that the youth in an Indian school face with breaking the barrier between a passive recipient and an active, experimental maker. Their findings

showed that the monetary and psychological costs of experimenting, limited resources for independent learning and difficulty finding the intellectual courage to tinker, also hindered the adoption of ASP by the youth. Another prominent factor that contributes towards the gradual move away from ASP practices is the abundance of labor available in emerging economies which obliterates the necessity to take up need-based *Making* practices (Gurtoo et al., 2010).

Our study also researched into the social motives behind ASP practices in rural and semi-urban communities in emerging economies. The potency of such social influence events have long been observed in rural communities (Kim et al., 2007; B. Ryan & Gross, 1943; Spark Energy, n.d.). They are a known determinant in the successful adoption and diffusion of products in such collectivist societies. The classic study by Ryan & Gross (1943) on the diffusion of new hybrid corn seeds in two farming communities in Iowa was one of the pioneering works in this direction. The adoption of the seeds within a short span of four years in the post-Depression era was intriguing at first but the study revealed that the rural farmers in the mid-west were strongly affected by social influence. The early adopters began to operate as *opinion leaders* for the larger community and the sight of their lush green fields validated their adoption as the "right way to act". Other farmers started emulating them, partly for the ambiguity of the new situation and partly for the fear of falling behind in competition. Several companies, social campaigns, and marketing campaigns today, tap into the social networks of the rural communities in emerging economies for diffusion of their innovations. The Dutch startup, Rural Spark (Spark Energy, n.d.), utilizes the network structure in villages to make expensive solar charging devices affordable to the masses. Rural people rent charging equipment from the company and serve as micro-retailers for others in their network by letting them charge their devices by paying a fee. Another such corporate initiative is the e-Choupal system (Kim et al., 2007). Select farmers are trained and given a computer with internet access. Other farmers in his social network can use this infrastructure to gain information about real time prices of crops and conduct online transactions.

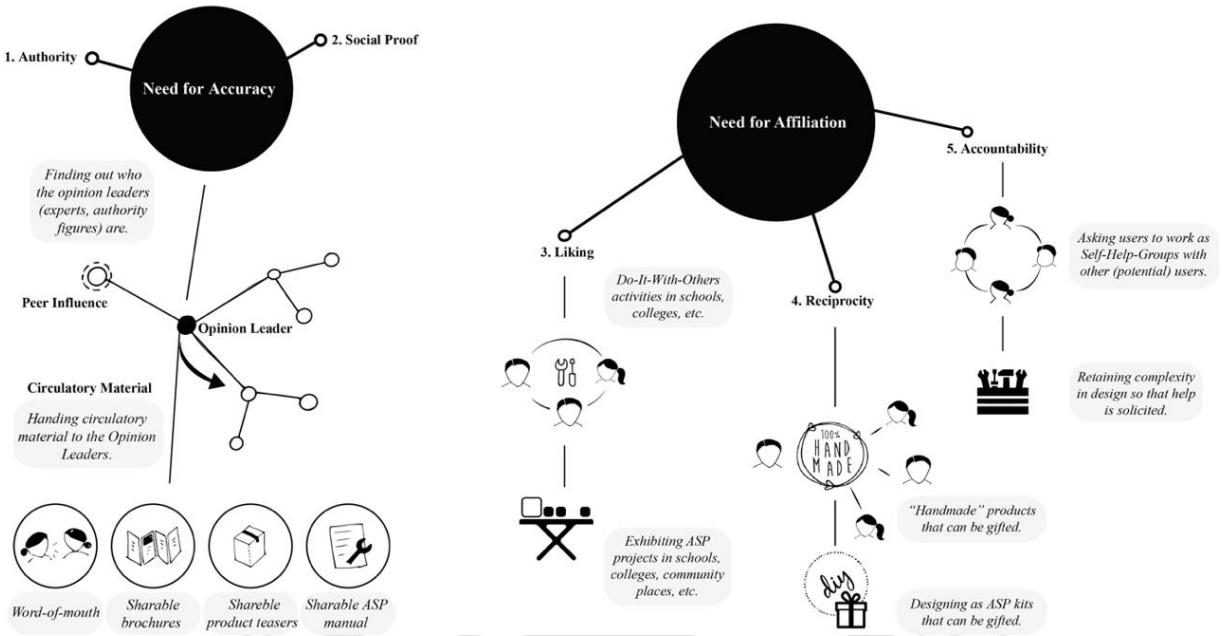


Figure 44. Possible ways in which ASP products can be designed and/ or diffused in the communities in our context through systematic exploration of social motives to be influenced by others for ASP.

We observed that the diffusion was distinctly a two-step process when there was ambiguity around a new ASP practice either in the viability of it or in the know-how of doing it. A new agricultural method or a new craft technique was more readily adopted if an *opinion leader* had already adopted it. However, when it came to existing ASP practices that are traditions for the community, the social interactions at a micro level between members of the community were key to sustaining such practices. For instance, a teenage girl who has grown up watching her mother in the loom, is influenced to learn it herself and continue with the tradition. Similarly, a neighbor who receives help from others in the network in constructional ASP, is also likely to help someone else to adhere to the social norm of mutual support. A child was more likely to pick up a *Making* practice as a leisure activity if he/she could do it with a playmate in the neighborhood, rather than being demonstrated by an *opinion leader* in the classroom. Understanding the nature of the ASP practice, new or existing, and the social motives behind their adoption can be key to designing ASP products and product systems or product communication strategies for such communities. Figure 44 summarizes the different kinds of ASP practices we observed in the communities, the social motives that influence behavior in such networks and exemplary ways in which products and product communication strategies can be designed to systematically incorporate such motives.

6.6. Conclusion

Our exploratory field studies revealed that *Making* practices in communities from emerging economies are gradually morphing over time, losing meaning for sustenance. While *skills* and *stuff* to conduct such practices still exist in such communities, the *images* are changing due to globalization and socio-technological changes. The linkages from *skills* and *stuff* to *images* are broken, especially for the younger generation (Figure 45). If such practices are to be revived or new *Making* practices ingrained in such societies, new images have to be created such that the broken linkages are reestablished (Figure 46). Such images have to motivate the younger generation to adopt *Making* and change their behavior from being a passive consumer to an active maker. In order to facilitate adoption of such practices in the community, we believe that it will be more effective to target the young adolescent population. The reasons are twofold: (a) Most ASPers in such communities learned the skill early in the adolescent phase of their lives. As they grew older, their lives became encumbered with the burden of earning a livelihood and other familial duties (b) The human mind learns skills faster at a younger age (Gopnik et al., 2015). In the scope of this thesis, we will only focus on how to facilitate the adoption process. Though our fieldwork studied the peer-to-peer social influence that exists in maker networks in emerging economies, we will leave the research on diffusion of the practices in such networks as future work. In the following chapter, we explore various theoretical lenses from the fields of behavior change theory, Motivational Psychology and Product Semantics and investigate how designers can design products and PSSs around ASP practices so that they are adopted by the adolescents in such communities.

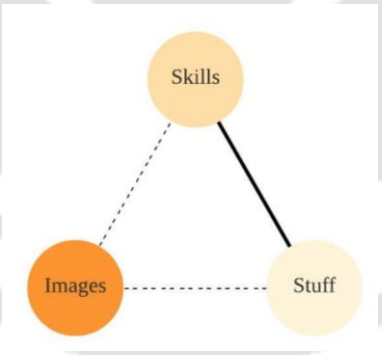


Figure 45. Linkages with Images breaking in case of Making practices.

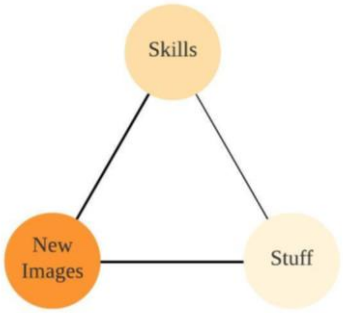


Figure 46. New images to restore a practice with new linkages.

7. Readoption of Assisted Self-Production: A Case of Behavior Change

Almost two-thirds of the Indian populace lives in villages, that in the decades after Independence, have witnessed a consistent loss in meaning of age-old making practices. The rise in consumerism since the economic liberation in the 90's, have made not doing more behaviorally ingrained than doing was prior to its advent. In this chapter, we research into how such practices can be revived, how we can facilitate their readoption in rural and semi-urban communities, and what is an appropriate lens to design interventions to affect the same. We seek to answer the research question:

Research Question 2: How can Design facilitate the adoption of *Making* culture amongst the youth of emerging economies?

a. What are the existing and relevant theories, frameworks and conceptual models that attempt to or can potentially explain how to facilitate adoption of *Making* culture?

We also present the process of development of the framework that guides designers on how to design for adoption of ASP practices. And in the next chapter, we present the Design for Motivation to Induce Behavior Change framework, which we name as the Catalyst framework for its prospective ability to actuate an intended behavior.

7.1. Introduction

Making has a beautiful story. The Maker Culture could gradually permeate into a consumeristic society as it reminded us of that story, that humans are essentially creative and making is a natural instinct. In a pre-industrial era, our material culture revolved around handmade objects. Crafts and artifacts abound as household objects. Yet, is the post-industrial society, well-designed factory-made products became so abundant in our daily lives, that for a product to grab our attention, it now must make doing easier than not doing. Most designed objects have reduced the threshold of behavior change so drastically by enabling a more comfortable life, especially with the use of AI in the modern day, that it is hard to imagine human society espousing *Making* as a viable alternate production-consumption system.

Ever since the rise of the Maker Movement that reassociated humans with labor, *Making* has evolved as a self-actualization activity for consumers who have been reduced to passive users of mass-produced goods by the industrial system. But such meaning does not translate to the context of emerging economies. Majumdar et al. (2019b) investigated the motivational factors behind different classes of ASP practices in the context of India, one of the largest emerging economies, and observed that such drives emanated more

from either *Making* traditions or the incapacity to fulfill their material needs, rather than self-actualization. With focus on five different communities in rural India, (Majumdar et al., 2019b, 2019a) also observed that even for traditional Making practices, there was an inter-generational loss of meaning for ASP due to various socio-economic factors and the percolation of technology into such communities.

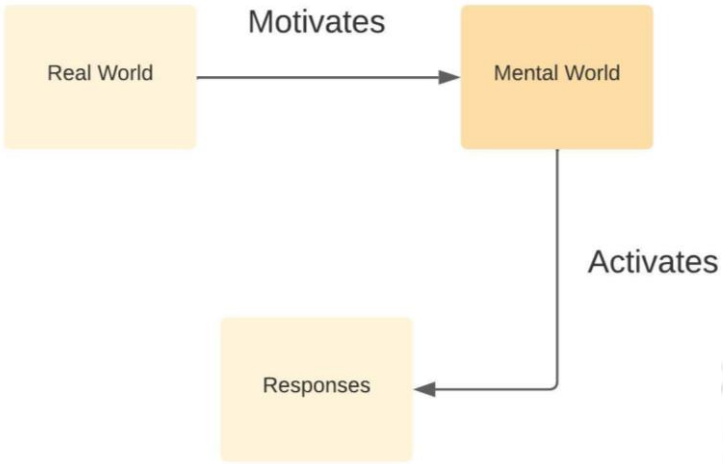


Figure 47. Schematic showing how the mental world intercepts between the real world and the user (Athavankar, 1990).

It is interesting to note that most prominent ASP movements in the past have been pushed by socio-cultural or economic events that assigned new meaning to the practice. For instance, in the period after World War I, due to dearth of labor in Europe, ASP assumed the meaning of an essential life skill from a good-to-have skill (Breaux, 2017). The biggest ASP movement started in India in its fight for freedom when people started spinning their own thread and weaving their own clothes to boycott the exploitative cotton textile industry in Manchester ((Hans) Bakker, 1990). In this case, ASP meant *autonomy*. In the context of emerging economies today, if ASP must assume such a scale, so as to become an alternate production-consumption system, it will have to gain new meaning. While designers have traditionally focused on imparting skills and providing the materialities for ASP in such communities (Diehl et al., 2018; Soomro et al., 2022), what ASP means to them and what new meaning can motivate them to readopt ASP, has often been blatantly overlooked. It is common to assume that what the designer intends through a product is perfectly mirrored in the mental world and actions of the user. But to expect such passive alignment is an underestimation of the intellectual processes and cultural precepts that shape the mental world of the user. The mental world is motivated by the real world, but it does not truly represent it Athavankar (1990). Figure 47 depicts how the real world influences the mental word, which in turn activates responses.

The end goal of designers with ASP products and PSS is usually to stimulate the user to adopt the ASP practice. As such, the design of such products and PSSs requires a second order understanding of what meaning can potentially motivate the mental world of the user to adopt the practice. Such meaning is likely to be influenced by social factors as much as the individual's thought processes (U. A. Athavankar, 1990). Assigning new meaning that can motivate a specific behavior is as crucial to the adoption of a practice as the skills and materialities around it (Shove & Pantzar, 2005). However, the skill level of a user is measurable and the materialities (tools) of a practice are tangible. The bigger challenge in designing an ASP PSS is in understanding how to embed something as abstract as motivational meaning into the PSS. Fortunately, the field of Product Semantics presents a range of contexts in which meaning can be embedded in products and PSSs. Meaning can, in fact, be embedded in several layers. How the product is operated, what conversations can ensue from it, how it interrelates with other products in the environment, how it was produced and what lifecycle it will go through are some of the important ways in which meaning can be infused into a product.

Recognizing how new meaning can reestablish a practice, it is however, imprudent to understate the importance of supporting skills and materialities in inducing behavior change and sustaining a practice (Shove et al., 2012). Since the Industrial Revolution, product design has evolved with the goal to reduce effort in operating a product. The usual goal often is to design habit forming products and make life as easy for the consumer as possible rather than to stimulate activity in the users (Eyal & Hoover, 2019). Reverting people to *Making* will involve changing human behavior from a state of passive consumerism of well-designed goods to understanding one's needs and inventing ways to fulfill them. Hence, when ASP products and PSSs are developed, the enabling skills and the surrounding materialities that can support and sustain the behavior change need to be kept in mind. Figure 48 shows the systematic pathway that a designer can follow in designing for an ASP practice that especially needs renewed meaning to be adopted at a behavioral level. In the sub-sequent sections, we present our in-depth study of relevant theories from Behavior Change Design, Motivational Psychology and Product Semantics. Our aim is to develop a framework for designers that can support them in designing ASP PSS. We also explore how the tenets of behavior change can be semantically embedded in an ASP PSS.

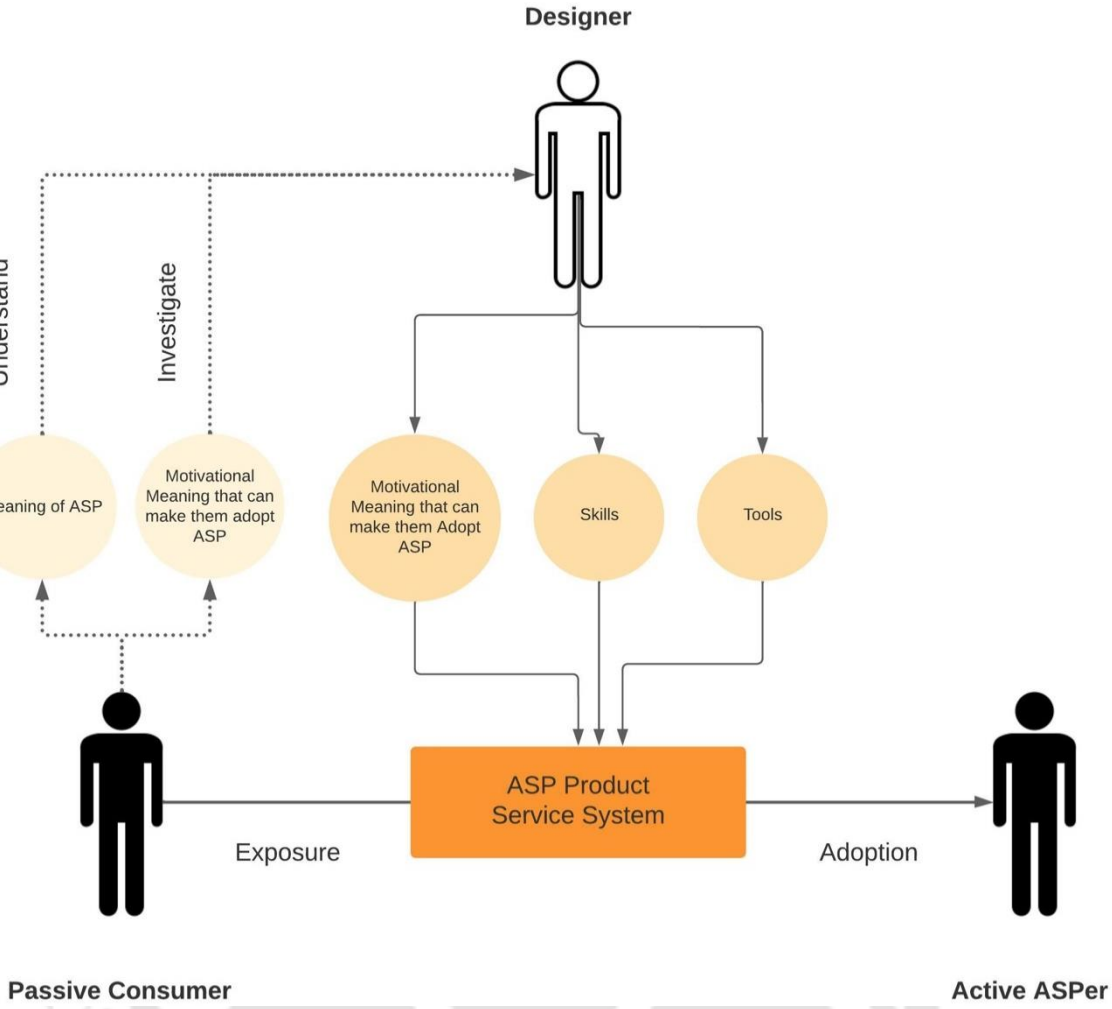


Figure 48. Schematic showing the pathway of behavior change induced by providing new meaning to an ASP practice and considering the skills and materialities of the practice.

7.2. Theoretical Background

In this section we present our study on the intricacies of behavior change through a lens of intrapersonal, interpersonal, and community levels, addressing how individual beliefs, social influences, and organizational settings shape human actions. It contrasts traditional guidelines with the Taxonomy of Behavior Change Techniques (BCTs) and introduces the Behavior Change Wheel (BCW) method, grounded in the COM-B model (Capability, Motivation, Opportunity), to offer a comprehensive framework for designing interventions. The addition of Self-Determination Theory and Flow Theory enriches our understanding of motivation, emphasizing the role of intrinsic and extrinsic factors in engaging activities. This theoretical backdrop underscores the importance of contextual understanding and the use of semantic devices in product design to influence user motivation and behavior. Ultimately, it presents a nuanced approach to embedding

motivational meaning within the operational and socio-linguistic contexts of product interaction, facilitating targeted behavior change.

7.2.1. How is Behavior Change induced?

Transforming or modifying human behavior has been a consistent end goal in many large-scale design projects pertaining to public health, public safety, community hygiene, environmental protection, disease and injury prevention (Abraham & Michie, 2008; Bicchieri & Dimant, 2022; T. Brown et al., 2019; Coleman, 2010; West et al., 2010) Based on the level at which influence happens, behavior change theories have been divided in three categories: intrapersonal, interpersonal and community (Gielen & Sleet, 2003). The intrapersonal level refers to the influence of a person's beliefs, knowledge and attitude in his or her behavior. Examples include theories relating to self-perception (Bem, 1972) and motivation (Kelman, 1958; R. M. Ryan & Deci, 2000b). The interpersonal level refers to how family, peers, friends and co-workers influence behavior. Examples are theories on social influence (Kelman, 1958) and social norms (Bicchieri et al., 2023). Finally, the community level considers how organizational level settings influence behavior. Examples are theories on community mobilization (Campbell, 2014) and organizational change (Levasseur, 2001). Intervention design in the public domain have applied different behavioral models based on the perceived efficacy of a model in a given context. Theory of reasoned action which proposes that behavior is a function of intention, norms and attitudes, was used as a framework to understand the attitude of parents towards car seat use for children and to develop educational material (Gielen et al., 1984). Similarly, the Stages of Change model which predicts five stages of behavior change: inaction, awareness, preparation, action and maintenance was used by researchers to study how abusive men can change their behavior and how abused women can end abuse (Walker Daniels & Murphy, 1997).

In order to simplify the application of these theories without taking recourse to the theoretical implications of them and bearing the burden of picking an appropriate theoretical lens form a vast spectrum, two approaches have been adopted (Abraham & Michie, 2008):

A. Guidelines or Checklists such as MINDSPACE intended for policymakers in UK and EPOC group's extensive taxonomy of public health interventions (*Institute for Government: MINDSPACE; Influencing Behaviour through Public Policy*, 2010)
B. BCT's such as goals and planning, feedback and monitoring, social support, reward and threat, etc.

These are selected as they can be quickly selected from and efficiently used in developing interventions (Abraham & Michie, 2008).

The first approach has been frequently used in the public health domain for programs such as tobacco control and healthy diet. Yet, it fails to be coherent in its structure and often loses sight of the drives that result in behavior. As a result, we see instances of public programs that fail miserably in creating the intended behavioral change (Michie et al., 2011). The second approach has been, however developed into more usable frameworks for designers that connects to overarching theory and also considers the pragmatics of application. The Intervention Mapping method is an iterative process of user need assessment, selection of appropriate BCT's and then implementing the BCT's in strategies and programs (Bartholomew Eldredge et al., 2016). The BCW Method (Michie et al., 2011), on the other hand, builds on the COM-B model of behavior which proposes that the behavioral system is influenced by three factors: Capability, Motivation and Opportunity. Capability is an individual's psychological and physiological capability to engage in a behavior, motivation involves all brain process that trigger behavior consciously and finally, opportunity refers to all external factors that facilitate behavior. **Error! Reference source not found.** shows a schematic of the COM-B model (Michie et al., 2011). The COM-B model has several limitations. It may oversimplify complex behaviors by reducing them to capability, opportunity, and motivation, potentially overlooking more nuanced factors (Whittal et al., 2021). Additionally, the model may not fully account for the varying contexts and cultural influences that shape behavior (Timlin et al., 2021). It tends to focus primarily on individual behavior change, sometimes neglecting broader systemic or environmental factors (Michie et al., 2011). Furthermore, the model does not deeply explore the dynamic interactions between its components over time (Marks, 2020). But for the purpose of this research, we adopt the COM-B model for its conceptual alignment with Practice Theory (discussed in 3.4, page 57). It also considers a broad range of factors influencing behavior, including physical and psychological capabilities, social and environmental opportunities, and motivations, and provides actionable insights by identifying which component(s) need to be addressed, thereby facilitating the design of the intervention.

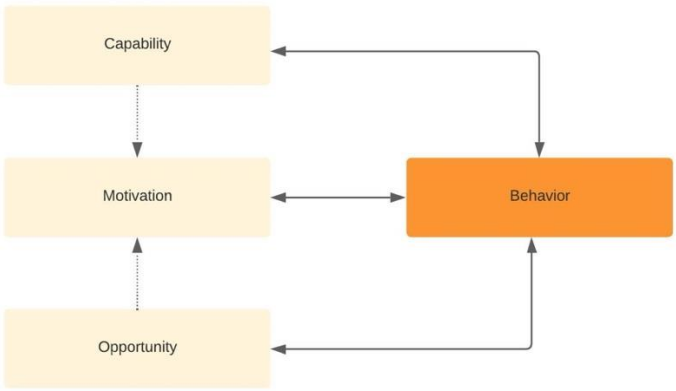


Figure 49. COM-B Model of Behavior Change (Michie et al., 2011).

The BCW method presents an exhaustive taxonomy of available interventions that can influence one or more behavior molding components in the COM-B model. Here, policy level measures are placed as an enveloping tier over the intervention functions as most policies are based on designed interventions and made to implement them (Michie et al., 2011).

The Intervention Mapping method investigates the fine-grained behavioral parameters that can be modified with BCT's (Bartholomew Eldredge et al., 2016). The Behavior Change Wheel (BCW) method on the other hand, states if the capability and opportunity exist, then behavior can be directed towards a target. The interventions that it enlists also include "enablement" interventions that support the intended behavior and reduces barriers to create opportunity, and interventions such as training, education and modeling that enhances capability of an individual (Michie et al., 2011). With a broad view of the system that facilitates, supports, and motivates behavior, the BCW method appeals to us as a well-fitting method for application is our context. The reason being twofold:

1. The design problem in hand, i.e. incorporating ASP at a behavioral level in emerging economies, is a complex one impacted by more severe problems such as poverty, urban migration, natural calamities that impact agriculture and low level of education. For such populations, to readopt a practice, it would also entail creating opportunities and capabilities for them.

2. Young people in emerging economies no longer view ASP as a practice that can confer them higher *competence* in the modern world. Education and urban migration are viewed as more potent in doing so (Majumdar et al., 2019b; Majumdar & Banerjee, 2017). Hence, our designed intervention has to address their motivation to engage in ASP which is immense goal to be tweaked by BCT's.

Though the BCW represented in Figure 50 is a comprehensive and a coherent method, the interventions compiled lays inadequate stress on motivation (Marks, 2020). Motivation is catalyzed by external factors (R. M. Ryan & Deci, 2000b) and these external agents need to carry meaning that signals 'motivation' to the subject. These signs and meanings are context dependent where factors such as a person's cultural background, thoughts and beliefs, education, exposure to media and technology, socio-economic conditions, etc. play a determining role (Iyengar & DeVoe, 2003; Majumdar et al., 2019b; Stetsenko, 2005).

In the following section, we study Ryan and Deci's Self Determination theory (R. M. Ryan & Deci, 2000b) and Csikszentmihalyi's theory of flow (Csikszentmihalyi, 1988) to augment the BCW method further in the motivation component. These two theories have been extensively used to study DIY behaviorism (Fields et al., 2014; Freeman, 2015; Lakhani & Wolf, 2005; Majumdar et al., 2019b; Wolf & McQuitty, 2011). While Self Determination theory provides an understanding of the different components of motivation, Flow theory shows what level of challenge is required by an activity to be engaging for the doer.

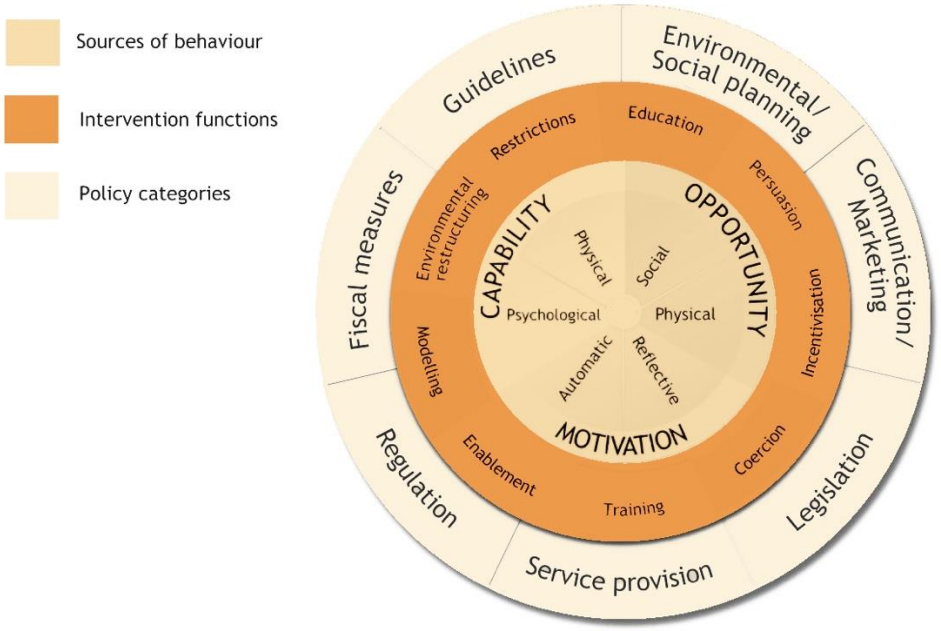


Figure 50. The Behavior Change Wheel (BCW) showing various interventions and intervention areas.

7.2.2. What is Motivation?

7.2.2.1. Self-Determination Theory

Ryan and Deci's Self-Determination theory divides motivation into two classes: *intrinsic* and *extrinsic* motivation. The former refers to a behavioral drive resulting from something being inherently interesting or enjoyable and the latter refers to doing something that leads to separable outcome such as economic returns, recognition, feedback, etc. (R. M. Ryan & Deci, 2000a, 2000b). Ryan and Deci (2000a) states that every individual has the psychological need for *competence*, *autonomy* and *relatedness needs* and that all humans are endowed with inherent motivational tendencies that are expressed when catalyzed by external agents (R. M. Ryan & Deci, 2000a). *Competence* refers to skills and knowledge, but *competence* alone cannot enhance *intrinsic motivation*, unless it is accompanied by a sense of *autonomy*, or the sense of free will that one is doing something out of one's own interests and values. The final component is *relatedness needs*. A primary reason why people often engage in a certain kind of behavior is that they are valued by significant others to whom they feel connected either as family, peers, social circles or a wider network based on common goals and values (R. M. Ryan & Deci, 2000a, 2000b). Kaptelinin (2005) identifies such activities as a poly-motivated activities: activities that have several motives simultaneously and might sometimes entail a

tradeoff between the various factors in case of conflict of interests. Stetsenko (2005) notes that in poly-motivated activities, the subjective moment can dominate with a strong contextual and social rooting.

7.2.2.2. Csikszentmihalyi's theory of flow

Csikszentmihalyi (1988) analyzed a variety of leisure activities that appeared to be highly enjoyable and internally motivated such as composing music, dance, chess, rock climbing etc. and concluded that the enjoyment derived from an activity arose from experiencing an intense state of absorption or '*flow'*. A state of optimal *flow* is when an individual's perceived sense of challenge in the activity is balanced by his or her own skills and capabilities. For a task to be mentally captivating, the perceived level of challenge must exceed the threshold value when skill and challenge are both at par (Csikszentmihalyi, 1988).

7.2.3. How do designers understand motivation for a given population?

Motivation is a part of the reflective system that determines behavior and as such is dependent on a person's thoughts, ideas and background (Iyengar & DeVoe, 2003; Majumdar et al., 2019b; Stetsenko, 2005). Though it is unreasonable to expect all the members of a population to have the same motivation matrix. Subjects from a similar backgrounds, education, media and technology exposure, lifestyle and environmental settings will have reasonable confluence on what motivates them for a practice such as ASP (Majumdar et al., 2019b). It is then a matter of contextual understanding for the designer to study what motivates a certain population for ASP. Among, external agents that motivates a certain behavior, some might have a stronger drive than others. Consider a child in a rural Indian school who has to choose between doing an ASP project and academically performing well. Most of the children will opt to academically perform better as that signals higher *competence* for them.

According to a categorization framework from Cognitive Science, the human brain categorizes information in containers by coding, structuring and labeling them with a common lexical term (Rosch, 2002). The categories were earlier believed to be formed based on shared characteristics and specific clues, usually visual, which are termed as semantic devices, can trigger the mental search for a class of similar examples (Rosch, 2002). Later, however, Lakoff (1990) proposed that categories were defined by a central member, one that is considered salient or exemplary for the particular category. For instance, retainers with handles, a hollow cavity on top and a certain height to width ratio might be termed as a 'cup'. The handle, cavity on top and height to width ration might be the visual clues that mentally activates the category called 'cups.' The members of the same category have shared features with a typical or 'good example' (e.g., certain height to width ratio for cups). Some members might resemble the exemplar more closely than others hence being more typical than the others. The class of objects, therefore, forms a category with graded membership where

some cups are more 'cuppy' than others. The boundaries of categories are, however, fuzzy with no clear definition of where a certain class of objects ends.

In the case, motivation embedded in an ASP product is also compound concept whose semantic devices signal a varying degree of *competence, relatedness needs* and *autonomy* for the user. These semantic devices might be strong motivators (typical of what the user considers to be *competence, relatedness needs* and *autonomy*) or weak motivators (atypical cases). With passing time, the mental categories of *competence, relatedness needs,* and *autonomy* of the target user might shift with exposure to newer value systems. But, in order to facilitate adoption of an ASP practice, the designer must understand what motivates them for *Making* in the first place. Misplaced motivations might result in a product that the user sees no reason to engage in. We use a generative tool proposed by Athavankar (2009), that aids designers in designing products with compound concepts. The method proceeds in the following steps: (a.) Deciding on the characteristics that the designer wants to embed in a product. (b.) Through user interviews, understanding what the user considers typical and what s/he considers atypical in the case of each characteristic. (c.) For each characteristic, arranging the results in a graded membership scale from typical to atypical. (d.) Based on what is feasible in the design project and the deliberate departures that the designer intends to do from the typical along each characteristic, developing a trajectory along the graded memberships. (e.) Incorporating semantic devices in the product based on the trajectory.

7.2.4. The contexts in which motivational meaning can be embedded

In this final section, we study the various contexts in which the meaning can be embedded through semantic devices. In the field of product semantics, the contexts in which meaning can be generated have been extensively studied by Klaus Krippendorff in his seminal book, "The Semantic Turn" (Krippendorff, 2006). It not only studies how meaning is generated from the form and function of an artifact, but its interrelatedness in a situated whole and how such meaning evolves over time. Krippendorff identifies four contexts in which meaning is constructed (Krippendorff, 1989, 2006, pp. 36–165):

a. **Operational Context:** The functioning of products and the way people interact with them.
b. **Sociolinguistic context:** The manner in which people communicate to each other about an artifact, its use and users (verbally or non-verbally) and how meaning if co-constructed in communication.
c. **Context of Genesis:** The context in which a product is designed, manufactured, distributed and used attaining meaning through its lifecycle and through stakeholder networks.
d. **Ecological Context:** The manner in which a product interacts with other products in a population of artifacts and competes with them, complements them and forms cultural complexes.

Considering the practicality of implementation, we consider the first two contexts in which the designer can embed the semantic devices namely, operational, and socio-linguistic context. We succinctly describe different ways of generating meaning in both contexts below:

7.2.4.1. Operational Context

The operational context in Krippendorff 's theory delineates how form constrains the sense that users make of artifacts in the environment (Krippendorff, 1989, 2006, pp. 36–165). A user hypothesizes relationships and distinctions upon the first encounter with an artifact, and both are either confirmed or dismissed after the user interacts with the artifact. This process of acquiring meaning continues to evolve with time depending on the affordances of the product, the inventiveness of the user and the cultural context in which meaning is developing. (Krippendorff, 1989, 2006, pp. 36–165) identifies ten dimensions in which such meaning can be generated. But in the context of an ASP product that has a physical form, we select six ways in which such meaning can be embedded.

a. **Identity**: Shapes, patterns of organization of the components, identifying features and characteristic behavior (how the product interacts with the user) are some of the vehicles through which the designer can arouse associations and convey what to expect from the product (Krippendorff, 1989).
b. **Qualities**: The attributes of the product that aids the user in categorizing it. e.g. a "toylike" device, a "futuristic" project, etc. Dimensions, features and characters (symbolic analogues such as a "fragile" looking component) are ways in which the qualities of a product can be expressed (Krippendorff, 1989, 2006, pp. 36–165).
c. **Orientations**: Geometry and movement of the components in relation to the user's body are not only matters of usability but also of communication between the product and the user (Krippendorff, 1989, 2006, pp. 36–165).
d. **Locations**: Where the product is located also signifies different meaning (Krippendorff, 1989, 2006, pp. 36–165). A craft product placed in the living room might serve as decor and the same product placed on the countertop, might signify memorabilia.
e. **Affordances**: All possibilities that the user can expect from the ASP product can provide room for exploration (Krippendorff, 1989, 2006, pp. 36–165).
f. **Motivations**: The possibility to explore can spark inventiveness and play and lead to a state of flow for the user (Krippendorff, 1989, 2006, pp. 36–165).

7.2.4.2. Socio-Linguistic Context

An interaction with an object is rarely ever a solitary issue. Users perpetually contemplate how their interactions would be interpreted, judged, critiqued, or admired by their peers, by-standers, critics or other parties of interest. Such a discourse might be entirely hypothetical and in the user's mind. Yet it might match the level of importance of facts. Actual discussions of objects also take place in language and in the process, they acquire socially engendered meaning and provide material for human communication, in turn (Krippendorff, 1989, 2006, pp. 36–165).The author identifies four semantic dimensions in which such meaning can be generated.

a. **User Identities:** When it comes to creating and showing one's identity, people assign a subordinate role to the functionality of a product. ASP, provides a fertile ground to engage users and enable them to create or reinforce their identity through their own creation.
b. **Social Differentiation and Integration:** The degree of individuation or the degree of integration are matters of personal liking. ASP, with its possibility to involve users in different levels of collaboration or bring out end-products that signal non-conformism, offers an opportunity for both.
c. **Content of Communication:** Products provide content for communication and in doing so, acquired new meaning through conversations. A designer cannot plan entirely the conversations that will ensue but can provide a general direction to the exchange.
d. **Social Relationships:** Products play an important role in establishing, maintaining and changing social relationships. When objects change ownership, they acquire new meaning and can form influence the nature the relationship.

7.3. Conclusion

Engaging in *Making* is a reflective level behavior and designing products and PSSs around such practices would entail understanding how to motivate such behavior. We analyzed how the societal problem of loss of meaning of ASP practices can be formulated as a research problem pertaining to behavior change. We also studied various theoretical lenses in Behavior Change Theory, Motivational Psychology and Product Semantics, that can aid in designing a suitable intervention (design framework in our case). The intervention should aid in the readoption of such ASP practices by rural and semi-urban communities. In the next chapter we discuss the development of the Design for Motivation to Induce Behavior Change framework's design, development and testing.

8. Catalyst: Design for Motivation to Induce Behavior Change - Development of the Framework

The readoption of ASP practices is a matter of behavior change from being a passive consumer to being an active doer. In chapter 7 (page 109), we studied various theoretical lenses that can aid in the development of an intervention. In our case, the intervention is a framework that guides designers on how to design a product or a PSS to induce behavior change focusing on the *intrinsic motivations* of the target user. We name this framework as Catalyst for its prospective ability to actuate a certain behavior. In this chapter, we seek to answer the following:

Research question 2:

How can Design facilitate the adoption of *Making* culture amongst the youth of emerging economies?

b. If the existing design frameworks, guidelines, or tools are not sufficient for facilitating design for adoption of *Making* culture, what can be an appropriate framework for the same?

We present the step-by-step process of development of the Catalyst framework.

8.1. Introduction

Our framework is intended for changing behavior that stems from reflective aspects of the target user, namely: *intrinsic motivation*. It is not an appropriate framework for behavior that emanates from habits and impulses. In addition, the diverse theoretical lenses used to construct a wholesome approach towards inducing behavior change, makes this framework appropriate for expert designers. We develop the framework with the following objectives:

a. The framework should be easily comprehensible to an expert designer and should explain the COM-B model lucidly.
b. It should guide the designer in the process starting from understanding the motivational drives for ASP to semantically embedding such motivations into the PSS in a step-by-step manner.
c. The designed PSS should lead to higher motivation in the user to adopt the ASP practice.

We begin with a logical sequence of steps for the development of the framework that will embody the above objectives, will take root in the theory of behavioral change, and encourage a contextual understanding of the motivational tendencies of the target population. In all, the designed PSS should:

a. Be optimally challenging: i.e., required skill level should slightly exceed the skill level of the target user (Csikszentmihalyi, 1988).
b. Be *intrinsically* motivating.
c. Create capabilities and utilize opportunities.

Figure 51 shows the various stages of the framework.

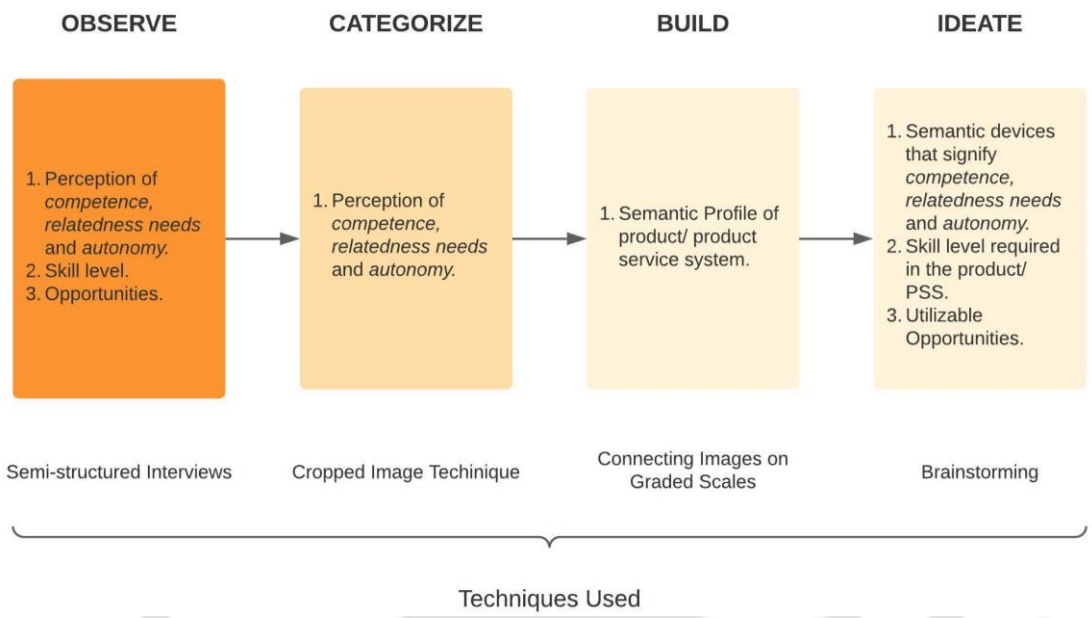


Figure 51. The steps of the framework that aids designers in understanding motivations and embedding them in products/ PSS.

The framework (Figure 51) consists of four steps as elaborated below:

STEP 1: OBSERVE The designer begins by studying the target user population (or a sample of it) and studies their *intrinsic motivations* for engaging in ASP and their skill level in *Making.* In the absence of direct involvement of the user in *Making* activities, the designer can probe into similar activities. Based on the amount of time available, various techniques can be used to study the above parameters: such as interviews and quick ethnography. Athvankar (2009) suggests an interview method using cropped images to understand the user's perceived sense of typicality. Cropped Image is a technique in which the designer uses cropped portions of images and asks the user to organize them on a scale of "Surely", "Maybe" and "Not". In the self-arrangement of cropped images by the subject, the graded membership scale, which is in step 2, is built by the subject in a participatory manner. In the proposed method of Athavankar (2009), the designer also attempts to pick verbal clues from the conversations with the subjects such as "very", "likely", "don't like", etc.

STEP 2: CATEGORIZE The designer now analyses the data from step 1 and categorizes it to construct the graded membership scales for the following components: perceived *competence*, *relatedness needs*, and *autonomy*. In the case of use of cropped images, the scale is built by the subjects themselves. Figure 52 shows how the graded membership scale can be constructed for the different components of motivation.

Figure 52. Graded Membership Scales of Motivational Components from typical to atypical.

STEP 3: BUILD With the graded membership scales in hand, the designer now builds the semantic profile of the compound concept. The level of expression for each component can be controlled by choosing clues along the gradients as shown in the Figure 53. The chosen clues are connected by linkages to build the semantic profile. AA' and BB' are two semantic profiles of the numerous possibilities. The designer picks the cues for the semantic profile along the gradients considering the following:

a. An overall move towards typicality to be more *intrinsically* motivating and to arouse a higher perception of "fun."

b. Deliberate departures or move towards atypicality to induce a certain behavior. For instance, subjects might perceive *Making* activities with friends as more typical than participating in online groups for *relatedness needs.* Yet, the designer might intend the user to collaborate with peers on an online platform remotely.

c. Overall goals of the project such as fostering entrepreneurship, promoting experimentation, education via doing, use of sustainable materials and processes, etc.

d. The feasibility in the design project.

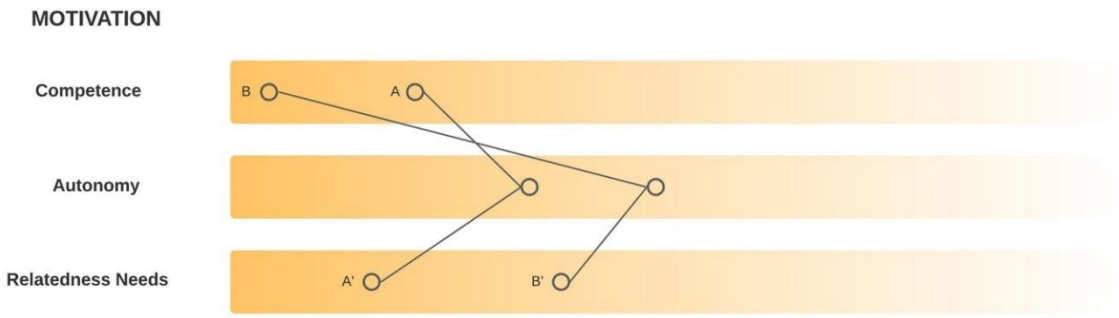


Figure 53. Two semantic profiles constructed along the graded membership scales of motivation of the target group.

STEP 4: IDEATE In the final step, the designer ideates on how to embed the semantic profile as semantic devices in the product and other interventions that might be needed to create capacity and opportunity for the users. A big body of scholarship on Product Semantics focus on incorporating meaning as visual cues in a product and justly so, as a visual encounter is the first encounter a person has with a product (U. A. Athavankar, 1990; Feijs et al., 2007; Hekkert & Cila, 2015; Petiot & Yannou, 2004). But, meaning has deeper roots. It evolves with time as the user interacts with it, talks about it, displays it, shares it and preserves it. In fact, the process of meaning acquisition is a lifelong affair in the life of a product (Krippendorff, 1989, 2006, pp. 36–165). As such, the designer should not restrict to visual semantics, but also explore other dimensions in which meaning can be generated.

As discussed in section 7.2.1 (page 113), for behavioral change to occur, the designed PSS should create capabilities and utilize opportunities, to be used or to be engaged with it in a sustained manner. ASP, as a practice, essentially hinges on the skill of learning new things as and when needed. As such, the designer not only has to impart the skills for doing the ASP activity, but also show how to learn what to learn. The schematic shown in Figure 50 (page 116) shows several other possible interventions that can aid in inducing ASP behavioral change. The list of interventions presented in our framework does not include all interventions from the BCW method. We chose interventions that can be easily and pragmatically implemented by a designer. Also, we do not include policies in our framework as designers hardly ever get an opportunity to participate in policy making. We, however, include the contexts in which meaning can be generated and interventions can be implemented. It is not necessary that one intervention can be incorporated in a single context only. The intervention called “Educate”, for instance can be designed as a detailed brochure, or a narrative from the designer to the user in the socio-linguistic context or as a learn-as-you-do product in the operational context. Not only are there multiple alternate ways to implement the same intervention, but an intervention can be simultaneously implemented in various contexts, strengthening each other.

Figure 54 shows the steps of the proposed method in detail. The segment on top outlines the theoretical basics of the framework to refresh the designer about the building blocks of this framework. It also briefly elaborates on the core concepts of the COM-B model of behavior change and the components of Intrinsic Motivation. The segment at the bottom represents the flow of the steps in the framework. The different components of Intrinsic Motivation are coded in different colors to enhance usability.

8.2. Limitations of the Catalyst Framework

The Catalyst framework guides the designer to map the motivational matrix of the target user, grade it from most motivating to least motivating, build a semantic profile, and finally to embed the motivations from the semantic profile as meaning in various contexts. However, a limitation of this process is that it does not ontologically connect the mental map of motivations to the contexts in which meaning can be generated and as such, might be difficult to use for novice designers who have limited experience of designing semantic devices. We leave it as future research to design a systematic method by which designers can seek inspiration, gain understanding of the social and cultural meanings, add nudges, delights and surprises, explore alternate routes such as gamification, and design semantic devices accordingly. Another limitation of the Catalyst framework is that it does not guide the designer on how to select images for the cropped image technique used in Step 2. We again leave it as future research work to explore how a designer can judiciously select images that are representative of the observed motivations.

Figure 54. Schematic of the framework Catalyst: Design for Motivation to Induce Behavior Change explaining the various steps in detail.

8.3. Discussion

The field of behavioral design started with the somber admittance that it is difficult to change behavior. Much as it is difficult to design interventions that induce behavioral change, it is equally confounding to understand *why people behave in the way they behave*, especially so when the context is remote to the natural milieu of the designer. The framework we propose encourages a deep contextual understanding of the factors that trigger the behavior that the designer wishes to transform, taking cognizance of the fact that the same behavior can have different triggers across cultures, age groups, professions, income groups, etc. In essence, the target population is a key determinant in the design process. In our use case of ASP, what is *intrinsic* motivation, capability and opportunity for a child in the western education system will vary greatly from that of a child in an emerging economy. What the child encounters in school, the family settings at home, the exposure through media and technology, the social milieu will all contribute towards this differential motivation.

In planning behavior change, there has frequently been a tension between active behavioral strategies and passive structural design strategies. Yet, several scholars agree that for an intervention to be successful, it needs careful integration of behavior elements with the structural design (Michie et al., 2011). For instance, the success of a public safety program for bicyclists depends as much on cyclists wearing their helmets and using night lights as much as it depends on having dedicated cyclist lanes and fines for not taking the precautionary measures. Our framework adds richness to design for behavior change by emphasizing on the motivational aspect. It goes beyond the overtness of most behavioral change designs and judiciously employs the silent non-verbal cues hidden in products. In other words, it is able to forge a liaison between the predominantly sign world of product semantics and the psychological world of intervention design for behavior change. That signs can illicit behavior, in fact, has also been described in other theories. The field of Materials Experience describes how materials can have visual clues that illicit performances (Giaccardi & Karana, 2015). Examples are a visual clue of a rough surface inviting the user to touch and scratch or a bubble wrap eliciting playful bursting of the bubbles are instances of such performances. Similarly, in the field of Developmental Psychology (Winnicott, 2016) describes how objects that signify safety and warmth to a child, such as a teddy bear, can continue to do so even in adult life. In fact, toys sometimes retain the potential to trigger explorative play even in adults. In embedding *intrinsic motivations* into the ASP PSS, the ultimate aim of the designer should be to trigger such a state of playful exploration and inventiveness in the user.

Though, the use case in our research is the adoption of ASP in emerging economies, we believe that this framework will be useful in a multitude of problems that involves behavior change at a reflective level. *How do we appeal to people to consume less when companies design and incrementally innovate to hook people to products? How do designers promote higher use of bicycles when the freeway and roadway systems are*

mostly designed for cars? How do we design packaging for healthy foods that will attract a consumer in a departmental store more than the unhealthy food in the next aisle? For such design cases, the COM-B model, that serves as the backbone of our framework, is especially useful in considering piecewise, the performances that the user is capable of, the facilitating opportunities that exist in the environment and the motivations at the reflective level that will aid in the adoption of a new practice.

It is to be noted that our framework focuses on the reflective processes rather than instinctive behavior or emotion-driven behavior. Design for Emotions and Experiential Design might be more resourceful lenses when we consider emotions is design. The Intervention Mapping method is expectedly, a more useful framework when we consider behavior emanating from impulses and habits (Michie et al., 2011). Also, the framework requires understanding of several theories and the open-endedness of the process of embedding semantic devices. Experienced designers are expected to find the framework more usable.

8.4. Conclusion

The present-day Maker Culture threatens the current model of the centralized factory system. With its potential to foster distributed production-consumption of goods, it presents a unique opportunity to introduce sustainabilities such as valorizing local eco-materials and indigenous Making techniques, stimulating creativity in the fringes and strengthening community dynamics. In emerging economies, where the environmental degradation problem is more severe and outsourced production of western economies is making it worse, such distributed production of goods can greatly assuage the situation. However, since the rising consumerism of mass-produced goods has moved people away from ASP activities, reviving *Making* would involve a behavior change from being a passive user to being an active maker. Thus, we investigate into behavior change theories to find an appropriate theoretical lens for the development of our framework. We observe that the BCW framework which takes recourse to the COM-B model of behavior change to be most befitting for the problem in hand. While our framework makes room for the designer to understand the skill level (capacity) and the opportunities available, there is special emphasis on the reflective determinant, i.e., motivation. From our prior field studies with five rural communities in India, we had observed that one of the biggest challenges for ASP in such communities in their loss of meaning due to cheap mass production of goods. Hence, such communities no longer have motivation to engage in ASP practices. Our framework describes how the designer can, in a set-by-step manner, investigate what the motivations for ASP are of a target group of users and embed them as semantic devices in the designed ASP PSS. For understanding the different components of motivation (*Competence, Relatedness Needs* and *Autonomy*), the designer uses a categorization framework proposed by (Rosch, 2002). In collaboration which the target user, the designer builds scales of what is most typical to what is least typical of each component in the mental world of the user. The framework also enlists the possible contexts in which such semantic devices can be embedded elaborating on the operational and sociolinguistic contexts. Though, limitations exist in the form of an

ontological gap between the graded scales of motivation and the semantic devices and the absence of a systematic method in which images can be selected for the cropped image technique, we envisage it as a future research project to bridge this gap. In the next chapter we show how a designer can design an ASP PSS to induce such behavior change using the Catalyst framework.

9. Evaluating the Framework

The DIR methodology as discussed in Section 2.2 (page 35) recommends an iterative design process in which the designed framework or artifact is subject to evaluation and progressive improvement. In accordance with the final step in the methodology, we subjected the designed framework to four rounds of testing to answer the following:

Research Question:

Research Question 3: How usable and effective is the framework?

A. How usable and effective is the developed design framework in helping expert designers in designing products or product-service systems that facilitate the adoption of *Making* culture amongst today's youth living in emerging economies?
B. How effective is the designed product or product-service system in facilitating adoption of *Making* culture amongst today's youth living in emerging economies?

The four stages of testing, represented in Figure 55, are: pilot user testing of the framework with designers, use cases by two designers, experts' review of the framework and testing for the efficacy of the framework though a workshop. The first three tests are designed to answer the first research question and the final test answers the second research question.

1. **Pilot tests**: We conducted the pilot tests with five PhD candidates in the Department of Design, IITG, seeking their feedback on the framework through semi-structured interviews. The interviews were recorded on video and several observations made during the post-analysis of the interviews were utilized in refining the framework.

2. **Use Cases by Two Designers:** Two design groups: an undergraduate level Designer and a group of two expert designers with over 10 years of professional experience, were given the framework and a design assignment. Their design journeys and the final products were analysed to understand how the framework can be made more comprehensible and usable by designers.

3. **Experts' Review:** In this stage of testing, the framework was shared with expert designers, who were asked to review it by answering a set of questions in a structured questionnaire. Some of the

suggestions we received in this stage has been incorporated in the framework, and the others remain as part of our future work.

4. **Efficacy Testing Workshop:** In the final stage of testing, we check for the efficacy of the Catalyst framework, meaning how effective it is in embedding *intrinsic motivations* and bringing behavior change. The workshop is designed around an ASP practice, in line with the central aim of this thesis.

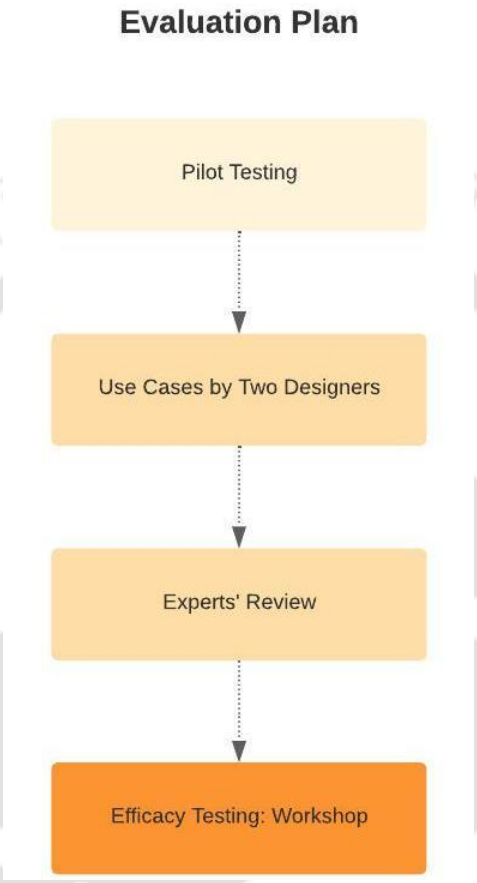


Figure 55. The four stages of the Evaluation Plan.

In the following sections, we describe each of the stages of testing and the outcome.

9.1. Pilot Tests

Our evaluation phase commenced with pilot tests wherein five PhD candidates were handed our framework and asked to review it with an aim to identify issues in the comprehensibility and usability of the framework. The aim was to generate an improved version to be sent to experts and designers. The semi-structured video interviews were analyzed, and the following observations were made:

9.1.1. Observations

We cluster the observations from the pilot tests based on the level of design experience of the subjects. This was done due to the observed similarity in the feedback from the designers from each level.

a. **Novice Designers:** The two PhD candidates who were novice designers needed further explanation on the core concepts such as Behavior Change and Product Semantics. For instance, one subject needed clarity on how "Capability" in Behavior Change was different than "Competence" of Intrinsic Motivation. Another subject posed questions on what was meant by "Semantic Profile" and "Contexts for Meaning Generation." The number of questions they posed on the concepts superseded the number of issues that they pointed out to in the usability of the framework. Another question that the novice designers posed pertained to the logic behind the sequence of the steps. There was difficulty in understanding why the method opened with semi-structured interviews with subjects from the target audience. The novice designers also had difficulty envisaging how in the final step, a designer would ideate on ways in which the motivations observed in the preceding steps, can be embedded in the design in the operational and socio-linguistic contexts. They asked for an exemplary design case to understand how this step could be conducted. Besides, the issues with comprehensibility, one novice designer found the graphics and arrangement in text, slightly cluttered.

b. **Intermediate Designer:** Of the five PhD candidates who were interviewed, one was an intermediary designer. He did not have difficulty in understanding concepts such as Behavior Change, Product Semantics and Semantic Profile. He however, had difficulty in visualizing how he would embed motivational meaning into a design. Like the novice designers, the intermediate designer, also asked for an example of an application of the framework to understand how this can be achieved. The intermediate designer was satisfied with the framework and expressed enthusiasm to use it in one of his design projects. He expressed particular interest in how a mental map of motivations for an activity can be constructed using our framework and how a visual method is employed in categorizing the motivations from the most typical to the least typical.

c. **Expert Designers:** The two expert designers who were interviewed at the end, expressed enthusiasm about the utility of the framework in mapping a vague mental construct such as motivation and embedding it in a design. They did not need any assistance in understanding the sequence of steps and how the outcome of each step facilitated the next step. They also did not require any assistance in understanding the core concepts in the framework, including the contexts of meaning generation (which the two novices and the intermediate designer did not find easily

understandable). They were also able to draw parallels with other design methodologies and contemplated on how this framework can be used for other assignments.

The expert designers, however, found the framework too detailed for pro designers. In their opinion, the steps in the framework are not unknown to pro designers. And instead of detailed guidelines on how to execute each step, a "slight nudge" to remind a pro-designer where s/he is at in the roadmap is enough. They also did not believe that pro designers are likely to follow the instructions verbatim. They anticipated that such designers would adopt the framework to their particular needs and work intuitively with it. All they needed to know was what information was flowing from one step to the next. Accordingly, they stressed on the visual elements in the framework and suggested that the guidelines and the flow of information from one step to the other should be depicted in a more visually readable manner. The emphasis, during both the interviews, was on the flow of information.

9.1.2. Modifications and Actionable Plan

After the pilot tests were concluded, the feedback was carefully analyzed, the suggestions were evaluated for feasibility, scope of the PhD research and relevance. Accordingly, some suggestions were incorporated in the current framework and some formed part of our actionable plan. The framework was modified in the following ways:

a. The core concepts were explained in greater detail so that the framework is usable by designers at all levels. We have retained the domain-specificity of the terms and endeavored to avoid jargon at the same time.
b. In each step, the information flow (output) that would facilitate the following step, was described textually. This was in conjugation with the experimental methods employed in each step.
c. We appended an example of an application by a designer with the framework in line with the philosophy that example is better than precept.
d. The example also delineates how the semi-structured interviews in step 1 can be conducted and how the output is used in selecting images depicting motivation in step 2.

The Catalyst framework presented in the last chapter (Figure 54, page 126) is the revised version of the framework, developed post this test. We, however, did not foray into guiding the designers on how to brainstorm for embedding motivational meaning in step 4 to stay withing the scope of the research project. The example case gives an idea of how a designer did so in another project. Moreover, the expert designers did not express difficulty in visualizing how meaning can be embedded in the two contexts, namely: operational and socio linguistic. Furthermore, we decided on developing the framework as a visual toolkit,

clearly depicting the methods employed and the flow of information as a roadmap for a designer, as future work.

9.2. Use Cases by Designers

In this testing phase, we handed the framework to two designers: one undergraduate level and a group of two expert designers and asked them to use it to design for two different assignments. The final year undergraduate student used it for his thesis project. We hand-held the process for him and the project ran for a duration of 6 months. He created an ASP kit (Tha-Paak: The DIY print-making kit) for 11–13-year-old of semi-urban India. The other two designers were expert designers, comprising a PhD candidate in Design with 10 years of industry experience and an academician with 16 years of industry and academic experience. They designed an origami-based kit called MUNKI and the way to conduct the workshop for 11–14-year-old of semi-urban India. We study their design journeys and present a critique of these two design cases in the next sections.

9.2.1. THA-PAAK: The ASP Print-making Kit

The Designer: The designer is a final year undergraduate student in Design with intermediate level experience. The designer was assisted in data collection and data-analysis. During the design process, his progress was also monitored, and feedback was provided.

The Assignment: Design an ASP kit for semi-urban children in India for the age group of 11-13 years. The duration of the assignment was 6 months.

The Design Journey: The designer began his journey with a contextual understanding of what ASP is, its historical roots and how it has come to evolve into the present-day Maker Movement. Figure 56 shows a snippet of the contextual research conducted by the designer at the onset of the project. His initial research also included a market benchmarking of ASP kits.

STEP 1: Observe

In the next stage, the designer starts with step 1 of the framework, namely: OBSERVE. Fifteen young subjects, aged 12-20 years, 8 male and 7 female, were interviewed using semi-structured interviews enquiring whether they engage in any form of ASP. Most of the respondents did not engage in any form of ASP. Thereafter, the designer enquired about their motivations for similar practices that involved an activity such as sports, group projects and hobbies. The subjects associated various concepts to *competence*,

autonomy and *relatedness needs* when it came to such activities. Figure 57 shows a mind map of the various motivational concepts that the respondents associated with such activities.

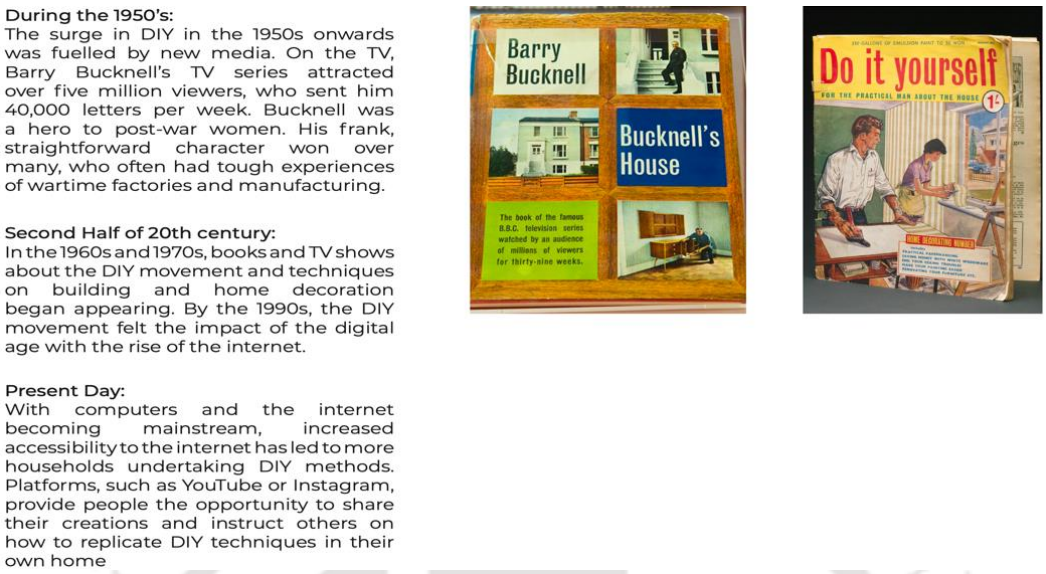


Figure 56. Contextual Understanding of ASP by Designer.

STEP 2: Categorize

The designer then selected images from the internet corresponding to each of the concepts in Figure 57. The images in the *relatedness needs* section were carefully selected to align with a child's need for the love and affection of parents, approval of teachers, the propensity to engage in activities with peers, or the recognition of achievements (Figure 58). The images corresponding to *competence* pertains to behaviors that make individuals feel most skilled and proficient in performing those activities (Figure 59). The images selected for *autonomy* explore the elements that empower children to feel a sense of control. Three sets of pictures depicting potential future career paths were presented, providing the designer with valuable insights into the child's aspirations and revealing what would grant them the greatest sense of *autonomy* (Figure 60). The images were provided with appropriate captions that were translated to the local language for better understanding by the subjects and then printed as stickers.

Figure 57. Mind Map showing the various concepts associated with Competence, Autonomy and Relatedness Needs by the subjects.

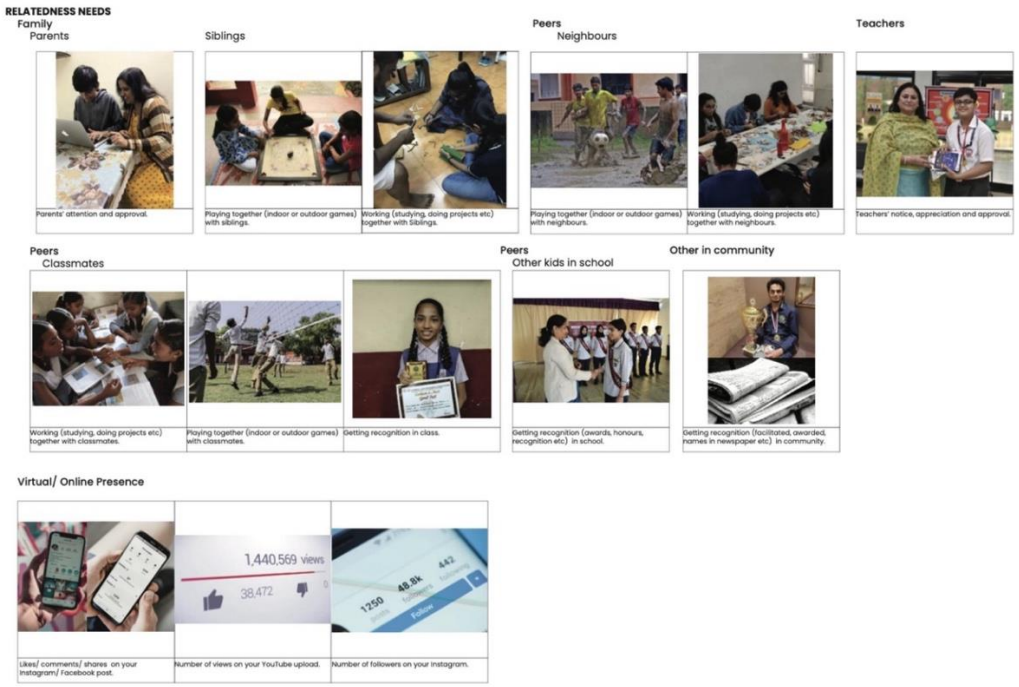


Figure 58. Cropped images and captions representing Relatedness Needs.

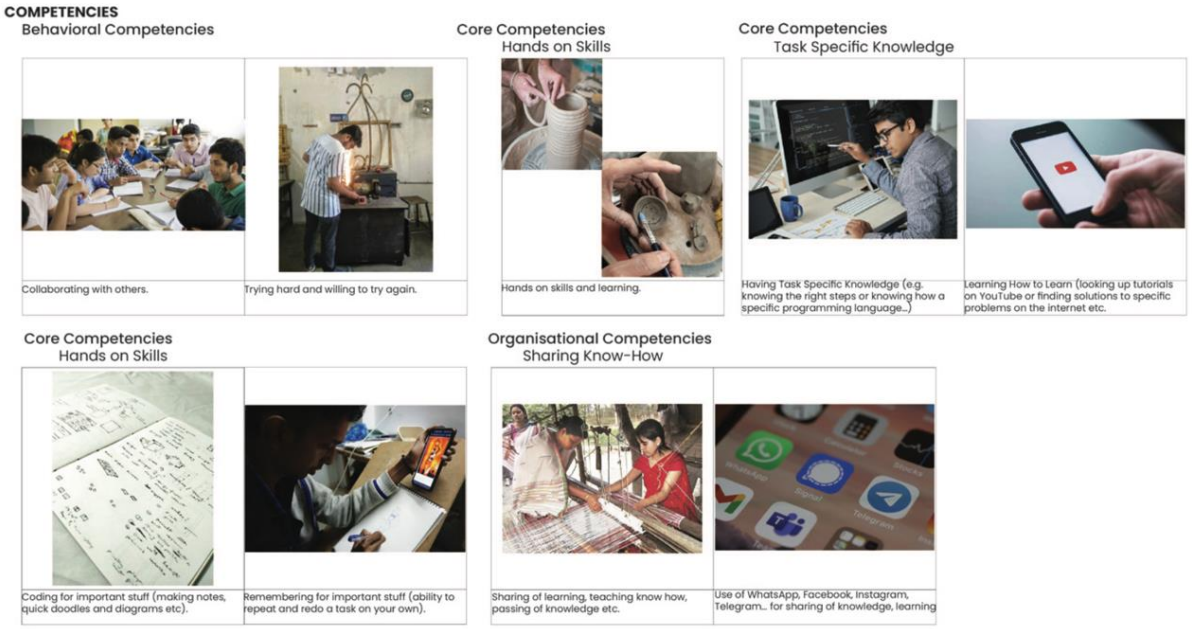


Figure 59. Cropped images and captions representing Competence.

Figure 60. Cropped images and captions representing Autonomy.

We then assisted the designer in interviewing 40 school children in a vernacular school in a semi-urban locality near Indian Institute of Technology Guwahati. Nineteen of the respondents were females and twenty-one were males, aged 12-14 years (Figure 61).

Figure 61. The 40 respondents interviewed to observe intrinsic motivations.

Each candidate was handed three sets of stickers, one each for the three motivational aspects: *competence, autonomy*, and *relatedness needs*. For each aspect, they were asked to arrange the images from the most motivating to the least motivating and to stick the images on the corresponding scale on the response sheet (Figure 62) provided.

Step 3: Build

The data was then analyzed to create a composite scale. The data was initially separated into categories for males and females. Then, the designer tabulated the frequencies of images in different positions for all the images. In other words, he assessed how many times each of the 14 images in the *relatedness needs* section was rated in positions one, two, three, and so on. Next, he identified the images with the highest frequencies in each of the 14 positions. Similarly, he also recorded the peak frequencies of images in the *competence* and *autonomy* sections. Pictures with higher ranks can be considered as more motivating, while those with lower ranks can be viewed as less motivating (Figure 63, Figure 64 and Figure 65).

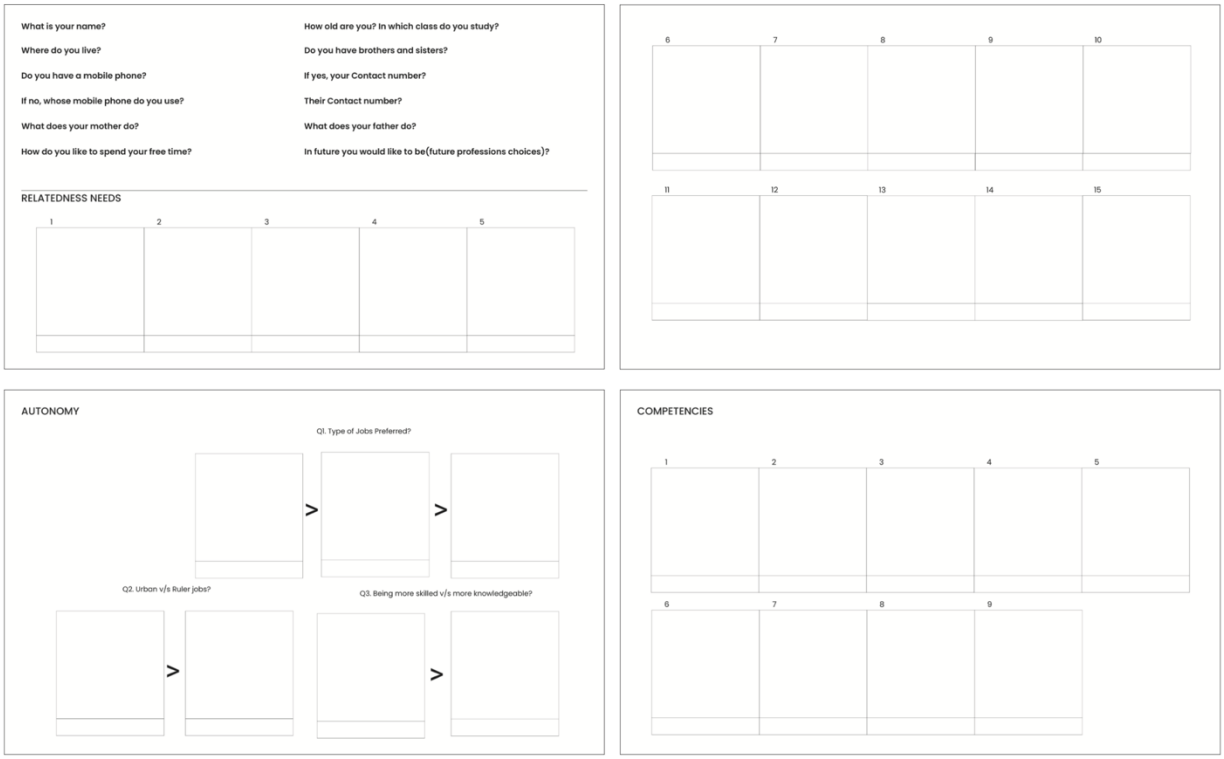


Figure 62. Response sheets handed out to the subjects to paste the image stickers on.

Figure 63. Graded Scales of Competence.

Figure 64. Graded Scales for Autonomy.

Figure 65. Graded Scales of Relatedness Needs.

Inferences

***Relatedness Needs*:** The top-ranking images, especially three out of the top five, emphasized play and interaction with classmates, neighbors, and friends, highlighting the significance of friends and peers as a primary source of *relatedness needs*. Additionally, school life emerged as another significant source of connection, with at least seven out of the top ten images related to school activities such as working with classmates, receiving recognition from teachers, and being honored at school. Surprisingly, social media and internet presence did not rank high, possibly because many families cannot afford separate mobile phones for their children due to economic constraints.

Autonomy: Most participants in the study expressed a preference for urban jobs over rural ones, indicating a desire to settle in urban areas. A similar trend was observed in the choice of job types, with most participants favoring white-collar positions over technical or traditional ones. Additionally, when comparing technical and traditional jobs, the majority showed a preference for technical roles. Overall, the participants appeared to believe that possessing skills rather than knowledge would be more advantageous for being more independent in life.

Competence: Among the top 5 images, collaborating with others (working in groups) appeared to be the most preferred activity, indicating a high level of comfort with group work. Following closely, the ability to repeat a learned task was considered the next most competent activity. Additionally, the children demonstrated a considerable level of tech-savviness as looking up online tutorials ranks third among their preferences. Surprisingly, despite the pandemic, the use of social media groups for studies did not rank high among their choices as expected.

Semantic Profile:

The designer then built the semantic profile of the kit from the three scales: *competence*, *autonomy* and *relatedness needs* (Figure 66). He selected the following components in each scale for the semantic profile of the kit:

Competence*:* Learning through group projects.

Autonomy*:* White-collared jobs, Urban Jobs.

Relatedness Needs*:* Working with friends, being applauded by friends.

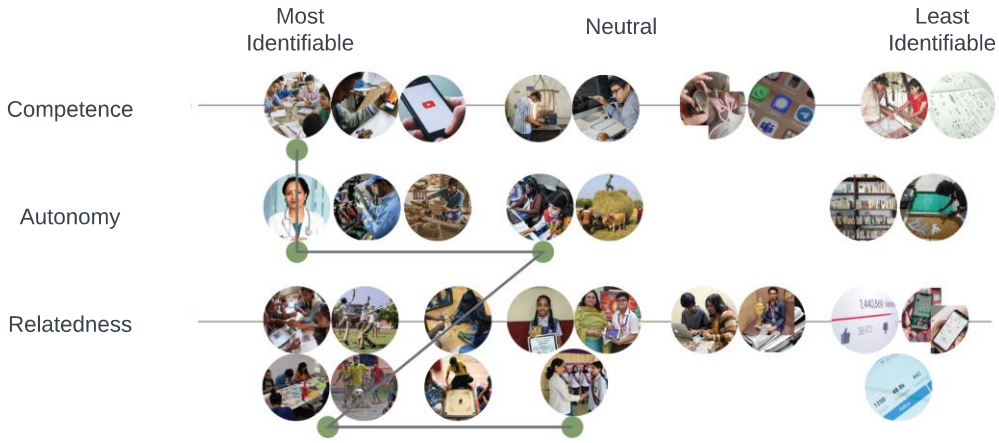


Figure 66. Semantic profile constructed by the designer.

STEP 4: IDEATE

The designer begins this phase by conducting secondary research on the kinds of ASP practices that can be designed as a kit for children of his target group. Figure 67 shows a snippet of the research he conducted on the kinds of ASP practices that can be incorporated in available kit. Figure 68 shows various *Making* trends amongst school children. Figure 69 shows a snippet of the research he conducted on the activities that are included in the school curriculum of the children.

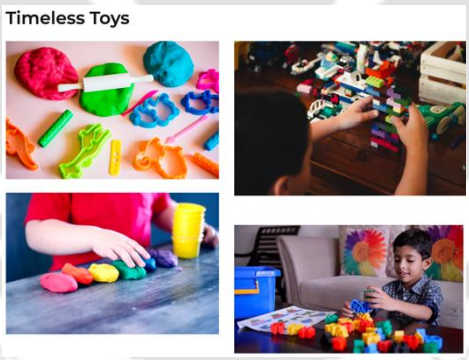


Figure 67. Making practices in kit form for children.

Figure 68. Making trends amongst school children.

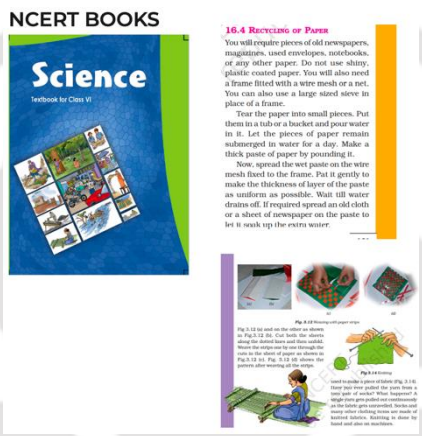


Figure 69. Research on activities in school curriculum.

To shortlist the practice that will be incorporated in the kit, the designer made a list of parameters that considered several important factors such as safety of the kit, opportunities (local materials and available components), capability of the target group, repeatability of the practice, etc. Figure 70 shows all the parameters that the designer enlisted.

After running all the ideas through the parameter list, the designer shortlisted block printing as the practice that he would develop into a kit. He tested with several commonly available materials such as newspaper, cardboard, corrugated sheets, wool yarn, wires, straws, etc. Figure 71 shows all the initial experiments that the designers conducted to test the viability of each material.

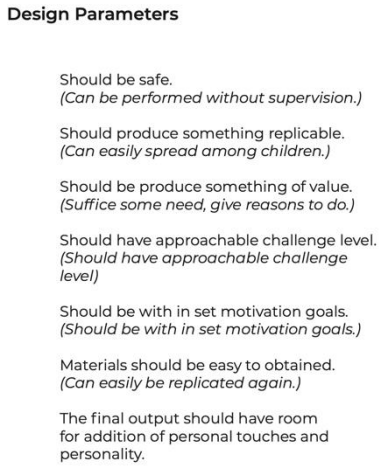


Figure 70. List of design parameters compiled by the designer.

Next, he conducted pilot tests with three children aged 10-13 years to test if the practice generated enough engagement and enjoyment in the children. Figure 72 shows the children using the different materials to make prints on sheets of paper. The children were intrigued and excited when the prints were revealed. They selected materials they found easy or interesting based on provided samples. Some guidance was required due to their younger age. Additionally, the need for vertical height in the blocks for ease of use was highlighted, suggesting the need for a grip or handle.

The designer, then experimented with the form of the block handle (Figure 73) to design the most ergonomically comfortable grip. He also made mockups of the handle to test for usability (Figure 74). Next, the designer brainstormed on various ways to attach the pattern on the printing surface of the block (Figure 75 and Figure 76) Finally, the designer selected the form of the block that had the most ergonomic grip and a weak adhesive to attach the patterns underneath it. This ensured that the patterns could easily be replaced by other patterns without having to change the whole block. He made some prototypes using MDF sheets (Figure 77).

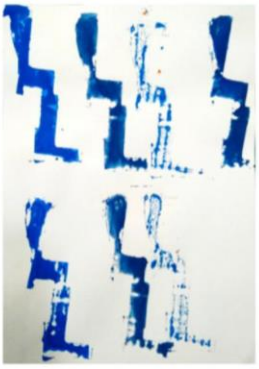
In the final form, the kit contained all the basic ingredients needed to initiate the subject into the practice of block printing (Figure 78) with the possibility to do three levels of printing, graded in difficulty.

Critique

In the Tha-paak block printing kit, the designer aims to facilitate the adoption of the ASP practice by being mindful of the capabilities of the target user group and the opportunities that are offered by the environment. But more significantly, the designer follows the framework in a methodical manner to understand the latent

2 Ply Corrugated Cardboard Sheet Cut-out:

- The *block* absorbed the ink.
- The thick 2 ply sheet could be difficult to cut and shape.
- The texture of Corrugation came through and created interesting pattern.

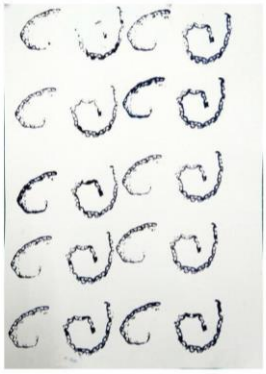


Cardboard with Glossy Paper Backing:

- The side taking the ink had smooth paper on it, that prevent it from absorbing the ink.
- Decent prints
- The texture of Corrugation came through.

Curled Up Newspaper:

- The material is easy to shape and manipulate.
- The Newspaper didn't absorb much ink.
- The impressions were decent with minimum gaps due absorption of ink by the paper.
- Only the spots where newspaper had warped while making the block missed the ink.



Cardboard Sheet:

- The presence of vertical-height made for a comfortable grips.
- Easiest to make.
- Created crisp prints with even pressure distribution.
- The pattern of corrugation came through, which can be easily remedied by placing a paper strip along the edge.

Wool Yarn:

- The yarn was covered in glue it firm it up.
- Easy to handle and shape.
- The prints had the twisting pattern of the threads.
- The glue in yarn prevented the yarn from absorbing the ink and warping.

Insulated Wires:

- The hard wires are can be tricky to shape.
- The wires were very close block surface, hence not the best resulting prints.
- Possibly the ink also slipped off the insulated wire surface.

Figure 71. Block-printing experiment conducted by the designer with various materials.

Figure 72. Pilot tests with children

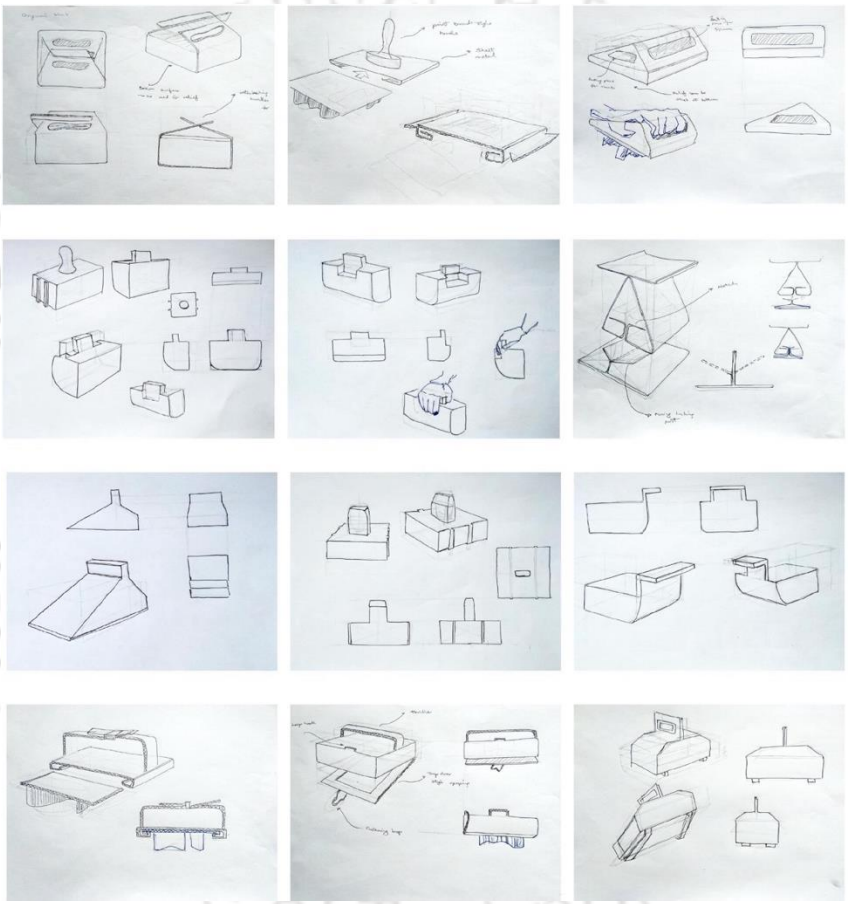


Figure 73. Experiments with the form of the handle.

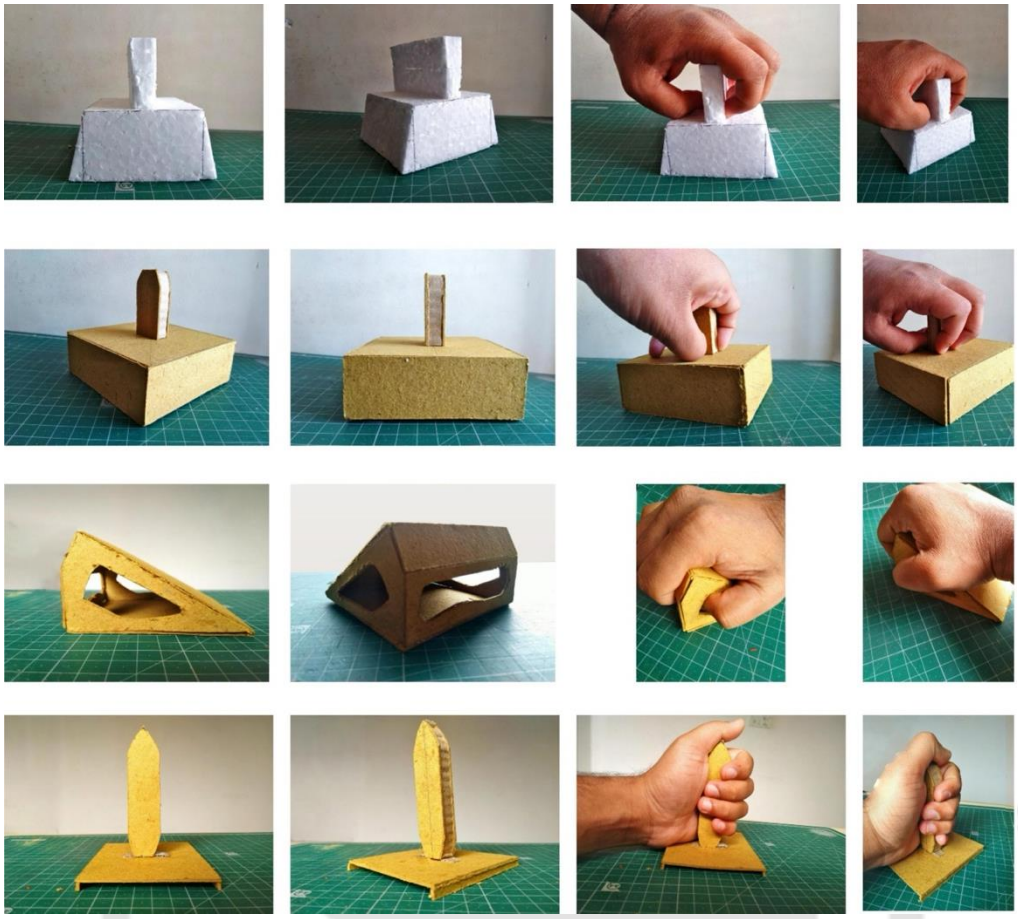


Figure 74. Cardboard mockups of the handle.

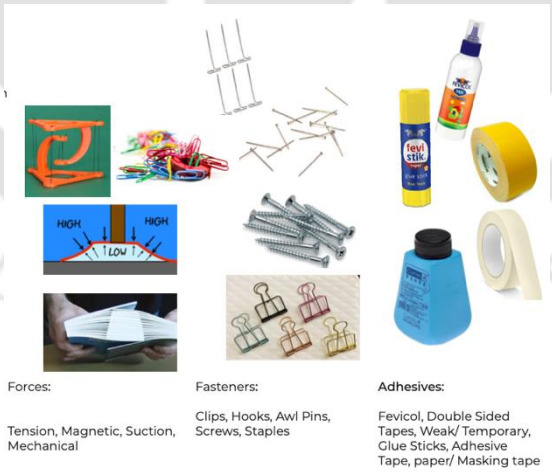


Figure 75. Attachment techniques of the print with the block.

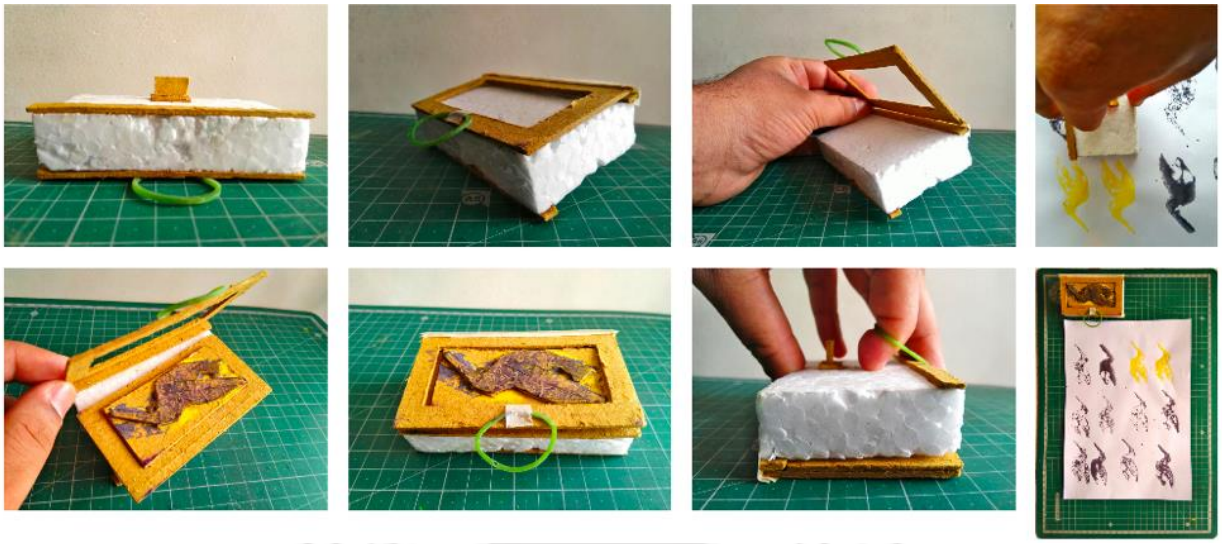


Figure 76. Different ways of attaching the print to the block.

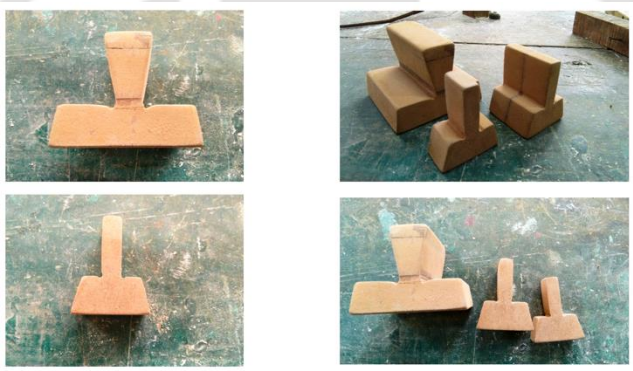


Figure 77. Blocks made from MDF sheets.

Figure 78. Basic ingredients of the Tha-paak kit.

motivations of the target user group, categorize them from most motivating to least motivating, build a composite scale from the individual responses, build the semantic profile of the kit, and then embed the motivations from the semantic profile into the kit. The designer not just aims at the adoption of the practice, but also designs the kit so that the performance of the practice can be easily repeated with local materials and components. For higher contextual understanding, he conducted considerable secondary research to understand what the children are being taught in school, what skills they already have and what kind of ASP practices they might have exposure to. He also conducts market benchmarking to explore how other kits have been designed.

We observe that in parallel to the Catalyst framework, the designer followed first principles of Design by brainstorming several ideas, pilot testing different materials, and prototyping and user testing different forms. Being a novice designer, he required guidance and explanations in several stages but was able to follow each step as the framework states. He also did not modify the steps according to his own needs or way of doing things, as the pro-designers in the pilot phase suggested.

The designer designed the packaging of the kit to be modular and stackable such that each module would represent one step in the printing process (Figure 79) The graphics on the packaging were made colorful to induce a sense of playfulness in the children (Figure 80). Figure 81 shows the final kit with all its components.

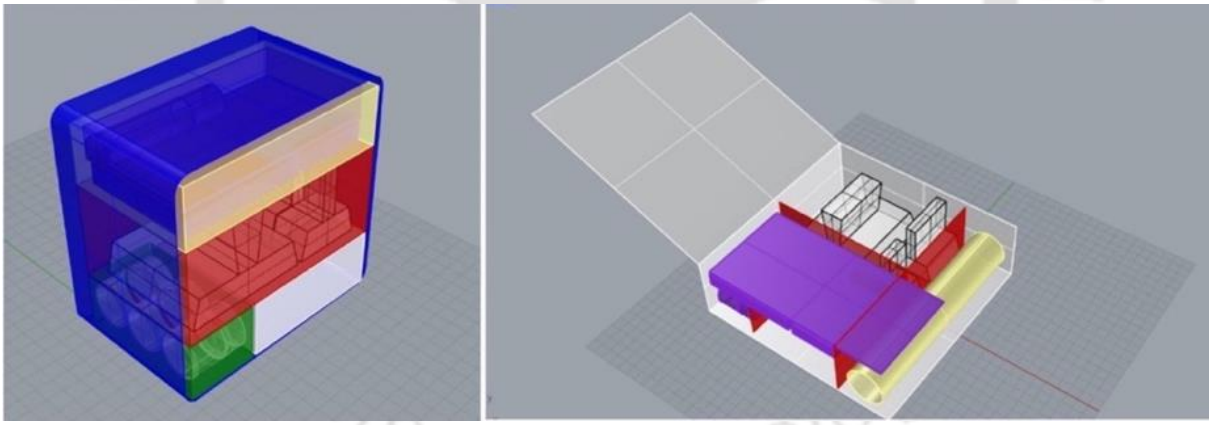


Figure 79. Modular packaging of the Tha-paak kit.

Figure 80. Colorful packaging of the Tha-paak kit.

Figure 81. Final form of the Tha-paak kit.

The centerpiece of this design was how the designer embedded the motivational factors from the semantic profile into the kit. We now examine each one of them in a piecewise manner:

Competence: The designer adds a collaborative dimension to the kit by designing the blocks and patterns in such a way that the patterns can be easily made using local materials and weakly attached to the block using adhesives. This ensures that the patterns can be easily detached and shared amongst peers. The practice can also be conducted in groups with shared motifs, suggestive of the group projects being conducted in school (element picked in the semantic profile). While the designer aims at adoption and continued engagement in

the practice, he designs the whole kit around blocks. He expects only the blocks and the patterns to provide the materiality for the continuing practice.

The designer also uses a playful name, “Tha-paak” which mimics the splashing sound of slippers made by kids in puddles. He also uses colorful, high-contrast graphics on the packaging to evoke a sense of frolic to the kit.

Autonomy: The designer uses a clean modular structure for the packaging to evoke a chic urban feel. Each module contains the ingredients needed for a step in the block printing process. The instructions are minimally printed on the top surface of each module. The designer also demonstrated how the printing process can be done in an incremental way to add to the sophistication of the prints: patterns, repeat patterns and lastly, layering. This adds to the perception of a growth in skills for the children.

Relatedness Needs: Though the kit has been designed for individuals, the designer adds a collaborative aspect in the pattern making process by making the patterns shareable. The prints can be made on objects such as school bags, key chains, notebooks, etc. which can become an expression for the user identities and content for social conversations. But most importantly, they can lead the user into experiencing a sense of being appreciated by friends and teachers at school (elements picked in the semantic profile).

Stumbling Blocks

The designer followed each step of the framework in a methodical manner. He received guidance and help for the data collection in step 1: Observe, and the data analysis in step 2: Categorize. But we observed that he experienced difficulty in analyzing the data we collected from forty children in step 2. The designer manually counted the frequencies of how many times each image appeared on a particular spot of the scale. But the process was tedious and time-consuming. Considering it as important feedback on our framework, we developed an Excel-based toolkit called CSS, which stands for "Composite Scale and Subcultures" which can aid designers in constructing composite scales from rating data of multiple participants. The toolkit also guides the designers on how to decipher the level of agreement between the participants and the presence of subcultures.

9.2.2. MUNKI: The ASP Origami Kit

The Designer: The designers in this case were two experts: a PhD candidate in Design with an extensive industry experience, and an Assistant Professor in the Department of Design, IIT Guwahati. The designers were provided with data for steps 1 and 2 of the framework. Thereafter, the designers conducted steps 3 and 4 without external help.

The Assignment: Design a DIY kit for semi-urban children in India for the age group of 11-13 years. The duration of the assignment was 1 week.

The Design Journey: The design team began the assignment from the data that we had collected from the field in 9.2.1. They were also provided with the scales of *competence, autonomy* and *relatedness needs* that the designer constructed during the design of the Tha-Paak kit, using manual frequency counting methods. The designers began the project by first understanding what the skill level of the target audience was, and whether it would be better to focus on training them for a practice or on giving them an engaging exposure to it. We planned to conduct a workshop with their designed kit. As the duration of a workshop is limited, they decided to focus on the latter, i.e., giving an exposure to facilitate adoption of the practice.

Step 1: Observe, Step 2: Categorize

These steps were conducted by us as described in 9.2.1. The design team received the scales of *competence, autonomy* and *relatedness needs* rated from most motivating to least motivating by 40 members of the target group as described in 9.2.1.

Step 3: Build

The designers decided on using the same semantic profile as depicted in Figure 66 (page 142). selecting the following components in each scale for the semantic profile of the kit:

Competence*:* Learning through group projects.

Autonomy*:* White-collared jobs, Urban Jobs.

Relatedness Needs*:* Working with friends, being applauded by friends.

Step 4: Ideate

The designers started the ideation process with four considerations in mind:

a. The kit will be used in a workshop whose elements will also be designed by them.
b. What is feasible to learn in the short duration of the workshop.
c. The skill level of the target group.
d. Materials that are easily available.

The designers quicky selected the practice of Origami with paper as it fulfills all the above conditions. Instead of teaching the target audience how to make different folds in Origami, they decided to teach how to make one building block that can be used to construct three-dimensional solids. Figure 82 shows the instruction sheet of the kit which teaches the user step-by-step how to build the “Phizz unit.”

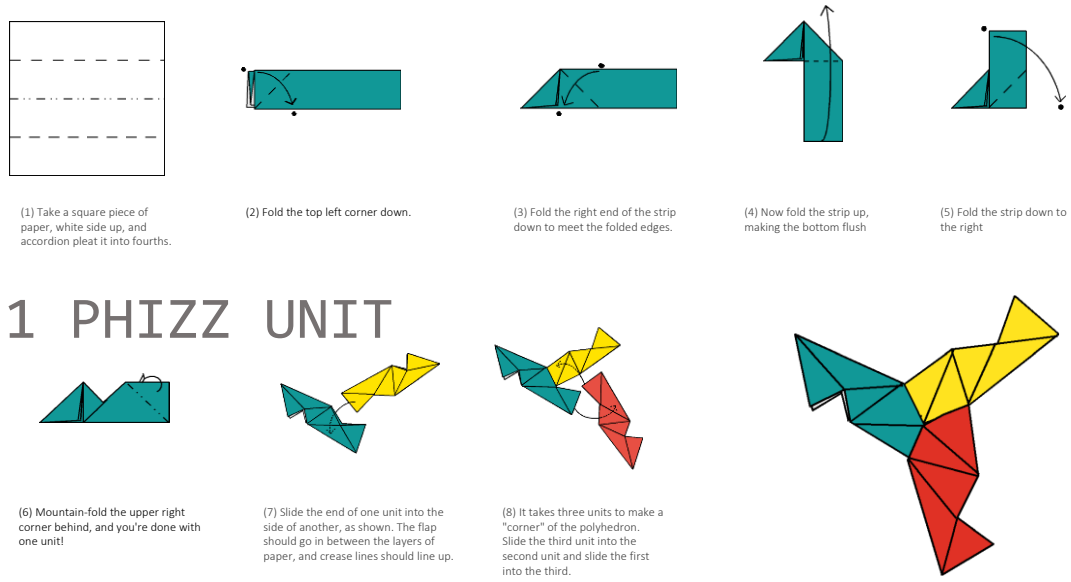


Figure 82. The MUNKI kit instruction sheet.

The designers also included examples of products made by undergraduate Design students in the workshop to demonstrate what the possibilities are with a simple “Phizz unit.” Figure 83 shows the various exemplars that were made for demonstration.

Figure 83. Exemplars shown in the kit.

The designers were mindful of the fact that designing for this practice was not merely designing a physical kit but rather, designing a workshop in which the physical kit will be used. They took the opportunity to embed the various elements from the semantic profile as affordances of the workshop. They are as described below:

a. Conducting the practice as a group project. The designers allow for the self-organization of the students into groups so as not to prescribe a friend circle, but rather to show empathetic consideration of their own circles.
b. Sharing of tools to enhance participant interactions.
c. Friendly interactions with the conductors of the workshop to elicit fun and playfulness.
d. Limited help in making the Phizz units and imagining the products that can be built with them. The conductors are to give them enough help to get them started but leave enough room for their creative imagination and experimentation.
e. Display of the products in the school hallway for the viewing and appreciation of the teachers and students in the school and elicit *relatedness needs*. The designers were careful not to pick the best projects as that would imply competition amongst peers and *extrinsic motivation*.

Critique

The designers of the MUNKI Origami kit showed significant divergence from the designer of the Tha-paak kit in the use of the framework and the ideation process. It is to be noted the former designers are experienced designers and the latter is a novice designer. As such, the designers of the MUNKI kit took significantly less time in designing it. They also had a more systemic view of the design and extrapolated the design elements to include non-physical aspects, i.e., the elements of the workshop. The designers also demonstrated a very intuitive understanding of the motivations from the three scales and which elements would be embedded in the design. Also, their ideation process was much quicker. They took less recourse to the framework and showed more adoption of the same for their project in hand. In short, the framework did not provide them with a step-by-step guide on how to design with human motivation as the central theme. Rather, it helped them adopt their own way of doing things to take in human motivation as an important factor.

The designers were mindful of how to make the elements of the workshop provide mental cues to the elements of the sematic profile. But even in the physical aspects of the design, they incorporated several elements from the sematic profile. The design was minimalist with succinct pictorial instructions, giving the kit an urban feel. Following the concise instructions in making a Phizz unit and then scaling it up to build products also gives a sense of growth in skills. This was especially facilitated by the presentation that the conductors of the workshop gave in which they introduced the field of Design to the participants. They showed various examples of how origami is used by product designers in various utilitarian products to

enhance their functionality and aesthetics. The subtle essence here if the introduction to Product Design and the motivation of the target user to seek white-collared knowledge-based jobs (from the semantic profile).

In order to generate engagement and flow in the first exposure itself, the designers also do not bog down the participants with the task of making Phizz units endlessly. Rather, after making two to three units, each participant is provided with at least ten units so that they can quickly move on to creating products and experiencing flow in the short duration of the workshop. The designers were also careful not to incorporate *extrinsic motivations* in the design. For instance, instead of selecting and showcasing the best student projects, they display all the projects for others in the school to appreciate and to trigger *relatedness needs* (from semantic profile). The designers also added a few instruction sheets for similar building blocks and products as shown in Figure 84 and Figure 85. The intention is to retain their interest in the practice after the workshop is over and to strengthen the adoption process.

The MUNKI toolkit was tested in a workshop where half the students were given the origami toolkit and the other half, were given another toolkit that taught Design Thinking in a step-by-step manner without taking recourse to *intrinsic motivations*. The latter was designed by one of the designers of the MUNKI kit before he was familiar with the Catalyst framework. At the end of the workshop the difference in the level of motivations were compared between both the groups. The results have been discussed in 9.4 (page 169).

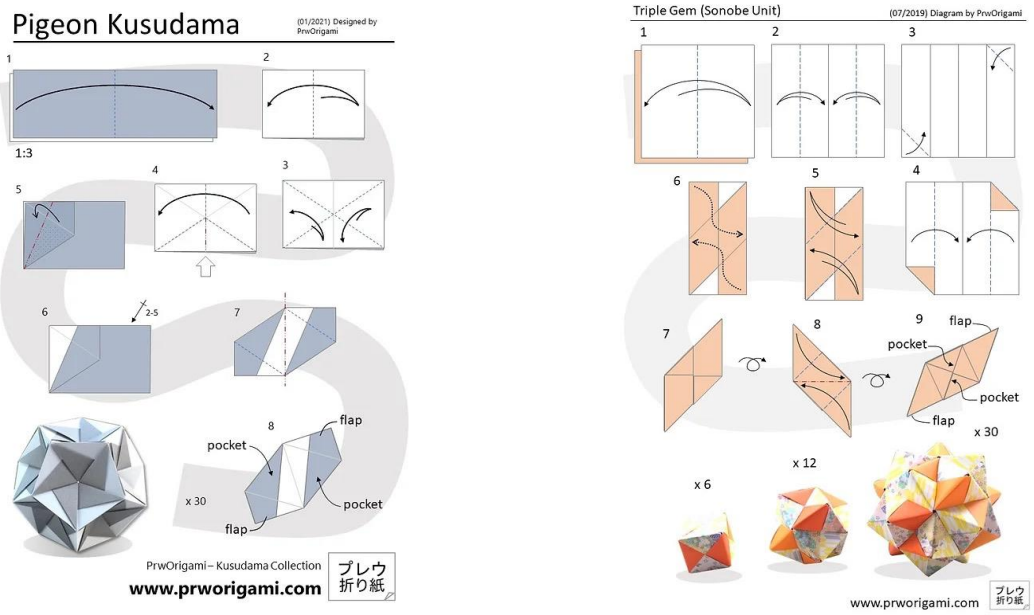


Figure 84. An auxiliary Origami instruction sheet supplied in the kit.

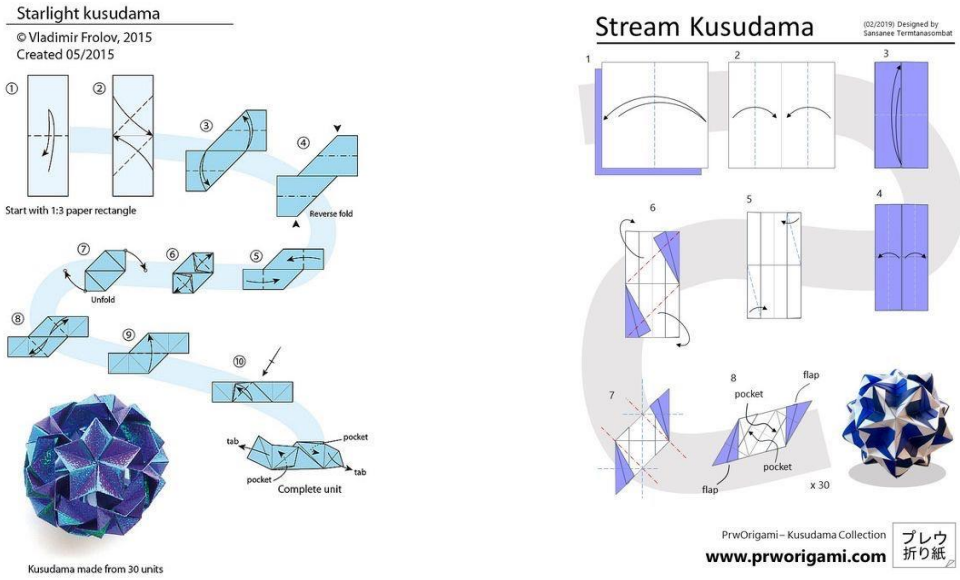


Figure 85. An auxiliary Origami instruction sheet supplied in the kit.

9.3. Expert's Evaluation

In order to refine the designed framework with the specialized insights and knowledge from individuals with experience in Design, in this phase of evaluation, we conducted structured interviews with expert designers. With the inputs from the pilot test, we iterated on the design of the framework and created the second version of Catalyst framework (as presented in the previous chapter). We sent a structured questionnaire with 7-point Likert scales measuring usefulness, understandability, satisfaction, and validity and sent it to expert designers. 22 expert designers (3 – US, 1 – Netherlands, 1 – Peru, 1 – Kenya, 14 – India, 1 – Brazil 1, 1 – UK) working in the industry (7) or academia (15) with several years (lowest being 3 years and maximum being 22 years) of design experience responded. The questionnaires sent to the experts has been attached in Annexure 3 (page 250) and Annexure 4 (page 251). Some experts also chose to give a follow-up qualitative review of the framework, the insights of which are presented in 9.3.4 (page 167). Annexure 5 (page 257) presents the raw data from expert evaluation. Subsequent development on the framework can take into consideration the suggestions put forward by some of the experts.

9.3.1. Methodology for Data Analysis

We used the following statistical analysis methods to analyze the data received through expert evaluation of the Catalyst Framework.

9.3.1.1. Mokken Scale Analysis

Mokken scale analysis (MSA) is a statistical method that has been used for over 30 years in various fields such as testing, survey research, educational research, and psychology (Schuur, 2003). It is a nonparametric approach to item response theory and uses a probabilistic approach (Kuijpers et al., 2013; Lee et al., 2002) MSA is used to determine whether a set of items forms a scale, which means that the items measure the same underlying construct. The analysis involves calculating scalability coefficients, which assess the extent to which items in a scale are ordered in terms of difficulty or severity. There are three types of scalability coefficients: pairwise scalability coefficients, item scalability coefficients, and scale scalability coefficients. Pairwise scalability coefficients assess the extent to which one item is more difficult or severe than another item. Item scalability coefficients assess the extent to which each item is ordered in terms of difficulty or severity. Scale scalability coefficients assess the extent to which the entire scale is ordered in terms of difficulty or severity. MSA has several advantages. It does not require any assumptions about the distribution of the data and can be used with both dichotomous and polytomous items. It also provides information about the ordering of items, which can be useful for item selection and test development (Lee et al., 2002). Additionally, MSA can be used to assess the internal consistency and structural validity of scales (Perng & Watson, 2013).

We used MSA to determine whether a set of Likert Type questions formed a scale to measure the underlying construct of usefulness of the designed framework, its understandability and if the experts were satisfied with it or not. We also had five questions, with increasing complexity level, which measure if the experts really understood the framework. MSA helped in validating the construct of this set and calculating scalability coefficients, which assess the extent to which items in a scale are ordered in terms of difficulty or severity.

9.3.1.2. Cronbach's Alpha

Cronbach's alpha is a widely used measure of reliability in the social and organizational sciences. It is a statistic that assesses the internal consistency of a scale or questionnaire by measuring the extent to which the items in the scale are correlated with each other. Cronbach's alpha ranges from 0 to 1, with higher values indicating greater internal consistency (Bonett & Wright, 2014).

After conducting MSA, Cronbach's alpha can provide additional information about the reliability of the scale. While MSA assesses the scalability of items and the internal structure of the scale, Cronbach's alpha focuses on the internal consistency of the scale. Cronbach's alpha can be used to evaluate the reliability of the scale by measuring the extent to which the items in the scale are correlated with each other. It provides a single coefficient that represents the average correlation among all possible pairs of items in the scale. In the context of MSA, Cronbach's alpha can be particularly useful in identifying problematic items that may need to be revised or eliminated from the scale. If the alpha value increases significantly when an item is

removed, it suggests that the item is not consistent with the other items in the scale. This information can guide researchers in refining the scale and improving its psychometric properties (Hanson et al., 2000).

Thus, after using MSA, we analysed the questionnaire data received through expert evaluation of the Catalyst Framework, using Cronbach's alpha to eliminate problematic items from the scale.

9.3.1.3. Spearman Correlation Coefficient

Spearman's correlation coefficient is a nonparametric rank statistic that measures the strength and direction of the monotonic association between two variables. It assesses the monotonic relationship, which can be increasing or decreasing. By using this, researchers can gain insights into the relationships between variables, even when the data does not meet the assumptions of linear correlation. It can be used to assess the relationship between ordinal data variables, which may not meet the assumptions of parametric tests such as Pearson's correlation coefficient. A value of +1 for the coefficient, indicates a perfect positive monotonic relationship, -1 indicates a perfect negative monotonic relationship, and 0 indicates no monotonic relationship (Hauke & Kossowski, 2011).

We used Spearman's correlation coefficient to measure the strength and direction of the monotonic association between the different items of the usefulness, satisfaction and understandability as well as that between the composite measures of usefulness, satisfaction and understandability.

9.3.1.4. Point-Biserial Correlation Coefficient

The point-biserial correlation coefficient is a statistical measure that quantifies the relationship between a continuous variable and a dichotomous variable. It is specifically used to assess the association between a continuous variable and a binary variable, where the binary variable represents the presence or absence of a certain characteristic or attribute. The coefficient ranges from -1 to 1, where a value of -1 indicates a perfect negative relationship, 1 indicates a perfect positive relationship, and 0 indicates no relationship (Bonett, 2019).

If point biserial correlation is used for ordinal data, it will treat the data as though it were continuous. However, ordinal data consists of discrete categories, and the intervals between adjacent ranks are not equal. This violation of the continuity assumption can lead to misleading results. Also, the calculation assumes a normal distribution of the continuous or ordinal variable within each category of the binary variable. If this assumption is not met, the correlation coefficient may not accurately reflect the strength of the relationship.

Ordinal data represents ordered categories but doesn't necessarily imply equal intervals between categories. Therefore, while the Point-Biserial Correlation Coefficient can provide an estimate of the relationship, it may not fully capture the nuances of ordinal data. However, due to the simplicity of the test and difficulties involved in considering other kinds of tests, we used this test to find if there is a correlation between perceived understandability of the framework versus actual understanding, measured using the four validity questions that passed the MSA and Cronbach's alpha test.

9.3.2. Results and Discussion

9.3.2.1. Usefulness of the Catalyst Framework

The analysis presented elucidates a substantial consensus among the evaluated experts regarding the efficacy and usefulness of the proposed framework, as reflected through the various Likert items utilized in the assessment. MSA affirmatively demonstrated that these items coherently measure the same underlying construct of usefulness (Table *7*), a finding further bolstered by the high level of internal consistency revealed through the Cronbach's alpha test (0.914). The endorsement of the framework's utility in comprehending the target user group's motivations was notably high, with 91% of the experts attesting to its effectiveness. Moreover, most of the experts also acknowledged the framework's contribution towards enhancing their productivity and facilitating the assimilation of motivations into their designs, with agreement percentages of 82% and 77% respectively.

Table 7 MSA analysis for the Usefulness construct.

	Q1 (se)	**Q2 (se)**	**Q3 (se)**	**Q4 (se)**	**Q5 (se)**	**Q6 (se)**	**Q7 (se)**	**QH**	**Scale H**
Q1		0.644 (0.210)	0.492 (0.210)	0.579 (0.225)	0.458 (0.219)	0.333 (0.270)	0.419 (0.240)	0.483 (0.196)	0.695 (0.102)
Q2	0.644 (0.210)		0.730 (0.161)	0.871 (0.099)	0.765 (0.114)	0.705 (0.147)	0.659 (0.147)	0.732 (0.097)	
Q3	0.492 (0.210)	0.730 (0.161)		0.801 (0.095)	0.808 (0.114)	0.685 (0.156)	0.790 (0.105)	0.729 (0.105)	
Q4	0.579 (0.225)	0.871 (0.099)	0.801 (0.095)		0.779 (0.103)	0.756 (0.112)	0.718 (0.108)	0.758 (0.097)	
Q5	0.458 (0.219)	0.765 (0.114)	0.808 (0.114)	0.779 (0.103)		0.805 (0.090)	0.764 (0.113)	0.740 (0.095)	
Q6	0.333 (0.270)	0.705 (0.147)	0.685 (0.156)	0.756 (0.112)	0.805 (0.090)		0.708 (0.109)	0.684 (0.114)	
Q7	0.419 (0.240)	0.659 (0.147)	0.790 (0.105)	0.718 (0.108)	0.764 (0.113)	0.708 (0.109)		0.691 (0.108)	

Q – Question

The findings also delineated a gradation of consensus among the experts on other facets of usefulness, with lower, albeit significant, agreement on aspects such as facilitating goal accomplishment (64%), meeting the experts' needs (68%), and fulfilling expectations (50%). The overarching agreement on the framework's usefulness was manifested 73% of the time across the various facets evaluated. The median usefulness score of 5, alongside the frequency of higher Likert scale ratings (6 and 7), further underscores the positive valuation of the framework.

The Spearman's Correlation coefficient analysis (Table *8*) furnished additional insight, revealing a strong positive monotonic correlation between questions 2 to 7[9] and the construct of usefulness, and a moderate positive monotonic correlation between question 1[10] (measures designer's perceived effectiveness in understanding the motivations of the target user group) and the usefulness construct. These statistical correlations signify a coherent and robust measurement of the usefulness construct through the deployed Likert items. The amassed evidence from this analysis accentuates the framework's potential to significantly augment the understanding and incorporation of user motivations in design processes, thereby amplifying the effectiveness and productivity in realizing the intended objectives.

Table 8 *Spearman's correlation coefficient for the Usefulness construct.*

[9] Q2 - It helps me be more effective in embedding their motivations in my design.

Q3 - It helps me be more productive.

Q4 - It is useful.

Q5 - It makes the things I want to accomplish easier to get done.

Q6 - It meets my needs.

Q7 - It does everything I would expect it to do.

[10] Measures designer's perceived effectiveness in understanding the motivations of the target user group.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7
ρ	0.592	0.862	0.853	0.887	0.894	0.822	0.766
P-value	0.004	2.444E-07	4.492E-07	3.903E-08	1.978E-08	2.747E-06	3.277E-05

9.3.2.2. Satisfaction from the Catalyst Framework

The presented analysis substantively elucidates the consensus among the experts regarding the satisfaction derived from the utilization of the proposed framework, as measured through six Likert items. MSA (Table 9) compellingly confirmed that these items are coherent in measuring the underlying construct of satisfaction, a validation further reinforced by the high internal consistency disclosed through the Cronbach's alpha (0.937) test. Most of the experts, 68%, expressed satisfaction with the framework, and a similar percentage conveyed their willingness to recommend it to fellow designers.

Table 9 MSA analysis for the Satisfaction construct.

	Q1 (se)	Q2 (se)	Q3 (se)	Q4 (se)	Q5 (se)	Q6 (se)	QH	Scale H
Q1		0.907 (0.061)	0.755 (0.123)	0.861 (0.081)	0.778 (0.103)	0.728 (0.137)	0.807 (0.082)	0.776 (0.080)
Q2	0.907 (0.061)		0.641 (0.164)	0.861 (0.063)	0.873 (0.057)	0.681 (0.112)	0.790 (0.073)	
Q3	0.755 (0.123)	0.641 (0.164)		0.766 (0.114)	0.588 (0.161)	0.878 (0.071)	0.722 (0.110)	
Q4	0.861 (0.081)	0.861 (0.063)	0.766 (0.114)		0.790 (0.101)	0.809 (0.097)	0.816 (0.069)	
Q5	0.778 (0.103)	0.873 (0.057)	0.588 (0.161)	0.790 (0.101)		0.773 (0.107)	0.754 (0.090)	
Q6	0.728 (0.137)	0.681 (0.112)	0.878 (0.071)	0.809 (0.097)	0.773 (0.107)		0.778 (0.081)	

Moreover, the framework was found to be engaging and pleasant to use by 64% of the experts, which not only reflects its user-friendly nature but also potentially its ability to provide an enjoyable user experience. The pragmatic functionality of the framework was endorsed by 59% of the experts who agreed that it operated according to their expectations, while a commendable 73% of the experts manifested their intention to incorporate the framework in future projects.

The cumulative agreement on the satisfaction derived from the framework was articulated 66% of the time across the assessed facets. The median satisfaction score stood at 5, with higher Likert scale ratings of 6 and 7 further accentuating the positive evaluation of the framework.

The Spearman's Correlation coefficient analysis (Table 10) bestowed additional validation on the robust measurement of the satisfaction construct, unveiling a strong positive monotonic correlation across all the Likert items. This statistical endorsement significantly underscores the reliability and coherency of the satisfaction assessment.

Table 10 *Spearman's correlation coefficient for the Satisfaction construct.*

	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**
ρ	0.896	0.900	0.853	0.892	0.864	0.855
P-value	1.786E-08	1.165E-08	4.653E-07	2.436E-08	2.126E-07	4.049E-07

In summation, the consensus among the experts potently advocates for the framework's favorable reception, its utility, and its potential for recommendation to peers. The broad-based satisfaction and the high degree of internal consistency among the Likert items solidify the framework's credibility and augur well for its adoption in future endeavors. The findings also embolden the potential for further academic and practical explorations aimed at refining and expanding the framework's applicability and impact across diverse design contexts and domains.

9.3.2.3. Perceived Understandability of the Catalyst Framework

The examination through MSA (Table 11) discernibly illuminates the multifaceted assessment of the perceived understandability construct as gauged through the ten Likert items initially deployed. The dissection revealed an anomalous misalignment with item 8, which exhibited a scalability coefficient below the threshold of 0.3, prompting its exclusion from subsequent analyses. The refined aggregation of nine Likert items, upon re-evaluation through MSA, demonstrated a coherent encapsulation of the underlying construct of perceived understandability. This coherence was further substantiated by the Cronbach's alpha test, which, with a coefficient of 0.923, underscores a high internal consistency among the Likert items within the satisfaction construct.

Question 8, probing the efficacy of color differentiation in the framework, was excised following the MSA analysis due to its anomalous scalability against all questions bar question 7, which explored term consistency. This scenario unfolds several interpretations. Firstly, it suggests that question 8 may not align with the increasing order of difficulty or severity inherent in other questions. Secondly, the colors deployed in the framework might not significantly influence its understandability. The pairwise scalability coefficient further underpins the anomaly, indicating a disconnect between question 8 and other questions on the supposed gradient of difficulty or severity, barring its association with question 7. The notably low item scalability coefficient for question 8 substantiates a minimal contribution to measuring the latent trait. This

resonates with the inference that the color scheme employed within the framework did not effectively delineate distinct concepts, hence failing to impact perceived understandability. This analysis not only underscores the need for possible re-evaluation of the color differentiation strategy within the framework but also propels a deeper examination of the coherence and relevance of each question in assessing the designated latent traits.

Table 11 *MSA analysis for the Understandability construct.*

	Q1 (se)	**Q2 (se)**	**Q3 (se)**	**Q4 (se)**	**Q5 (se)**	**Q6 (se)**	**Q7 (se)**	**Q8 (se)**	**Q9 (se)**	**Q10 (se)**	**QH**	**Scale H**
Q1		0.680 (0.167)	0.796 (0.114)	0.682 (0.114)	0.718 (0.106)	0.776 (0.100)	0.636 (0.154)	0.215 (0.211)	0.800 (0.128)	0.690 (0.133)	0.653 (0.075)	0.532 (0.057)
Q2	0.680 (0.167)		0.867 (0.110)	0.634 (0.123)	0.729 (0.128)	0.530 (0.145)	0.311 (0.207)	-0.280 (0.117)	0.250 (0.259)	0.530 (0.187)	0.467 (0.138)	
Q3	0.796 (0.114)	0.867 (0.110)		0.628 (0.119)	0.801 (0.124)	0.583 (0.124)	0.426 (0.140)	-0.115 (0.135)	0.170 (0.192)	0.638 (0.203)	0.531 (0.105)	
Q4	0.682 (0.114)	0.634 (0.123)	0.628 (0.119)		0.860 (0.070)	0.853 (0.077)	0.717 (0.159)	0.017 (0.212)	0.386 (0.216)	0.821 (0.090)	0.624 (0.070)	
Q5	0.718 (0.106)	0.729 (0.128)	0.801 (0.124)	0.860 (0.070)		0.890 (0.084)	0.635 (0.112)	0.130 (0.193)	0.518 (0.158)	0.814 (0.101)	0.675 (0.056)	
Q6	0.776 (0.100)	0.530 (0.145)	0.583 (0.124)	0.853 (0.077)	0.890 (0.084)		0.779 (0.088)	0.186 (0.202)	0.357 (0.231)	0.659 (0.101)	0.627 (0.049)	
Q7	0.636 (0.154)	0.311 (0.207)	0.426 (0.140)	0.717 (0.159)	0.635 (0.112)	0.779 (0.088)		0.597 (0.207)	0.486 (0.274)	0.586 (0.157)	0.586 (0.067)	
Q8	0.215 (0.211)	-0.280 (0.117)	-0.115 (0.135)	0.017 (0.212)	0.130 (0.193)	0.186 (0.202)	0.597 (0.207)		0.311 (0.254)	0.258 (0.191)	0.127 (0.149)	
Q9	0.800 (0.128)	0.250 (0.259)	0.170 (0.192)	0.386 (0.216)	0.518 (0.158)	0.357 (0.231)	0.486 (0.274)	0.311 (0.254)		0.581 (0.168)	0.419 (0.116)	
Q10	0.690 (0.133)	0.530 (0.187)	0.638 (0.203)	0.821 (0.090)	0.814 (0.101)	0.659 (0.101)	0.586 (0.157)	0.258 (0.191)	0.581 (0.168)		0.619 (0.078)	

The expert evaluations profoundly resonated with the conceptual clarity and logical structuration embodied in the framework. A significant 64% acknowledged the ease of understanding the presented concepts, and a compelling 77% concurred on the comprehensibility of the information flow across various steps. The logical sequencing of steps was overwhelmingly endorsed by 91% of the experts. Furthermore, the terminological clarity and the elaborateness of domain-specific explications were appreciated by 77% and 68% of the experts respectively. The specificity and consistency in domain-specific term usage were also positively acknowledged, garnering agreement from 73% and 86% of the experts, respectively. The language clarity and illustrative augmentations were notably applauded, with 95% and 82% approval rates, respectively.

Cumulatively, the expert consensus on the framework's satisfaction resonated 79% of the time, reflecting a substantial endorsement of the framework's ability to elucidate the conceptual underpinnings effectively.

The median usefulness score was registered at 6, recurring 79 times within the 154 total responses spanning questions 1 to 10 (excluding 8), while a Likert scale rating of 7 was observed 24 times.

The Spearman's Correlation coefficient analysis (Table 12) further emboldened the findings, revealing a strong positive monotonic correlation between questions 1 to 7 and 10, and a moderately strong positive monotonic correlation for question 9 concerning the construct understandability. These analytical revelations significantly underscore the framework's robustness in encapsulating the perceived understandability construct, thereby manifesting its potential to serve as an effective conduit for conceptual transmission and comprehension.

Table 12 *Spearman's correlation coefficient for the Understandability construct.*

	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q9**	**Q10**
ρ	0.822	0.759	0.749	0.871	0.907	0.864	0.731	0.521	0.822
P-value	2.755E-06	4.166E-05	5.988E-05	1.344E-07	5.777E-09	2.117E-07	0.0001	0.013	2.705E-06

9.3.2.4. Correlation between perceived and actual understanding

The scrutinization through MSA (Table 13) of the five questions aimed at assessing the actual understanding of the experts unveils an evident misalignment with questions 4 and 5, which exhibit scalability coefficients below the critical threshold of 0.3. Consequently, these questions were excised from the analysis, paving the way for a focused examination of the first three questions. The resultant Cronbach's alpha of 0.717672414 reflects a moderate internal consistency among these questions. An encouraging 79% accuracy rate was observed in the responses to questions 1 to 3, with questions 1 and 3 being answered correctly 77% of the time, and question 2 garnering an 82% accuracy rate.

Table 13 *MSA analysis for the Actual Understandability (Validity) construct.*

	Q1 (se)	**Q2 (se)**	**Q3 (se)**	**Q4 (se)**	**Q5 (se)**	**QH**	**Scale H**
Q1		0.672 (0.269)	0.475 (0.225)	0.067 (0.448)	-0.400 (0.460)	0.282 (0.211)	0.150 (0.160)
Q2	0.672 (0.269)		0.344 (0.295)	0.417 (0.469)	-0.167 (0.525)	0.370 (0.168)	
Q3	0.475 (0.225)	0.344 (0.295)		0.067 (0.448)	0.067 (0.448)	0.282 (0.190)	
Q4	0.067 (0.448)	0.417 (0.469)	0.067 (0.448)		-0.167 (0.213)	0.013 (0.204)	
Q5	-0.400 (0.460)	-0.167 (0.525)	0.067 (0.448)	-0.167 (0.213)		-0.167 (0.227)	

However, a pivotal revelation emerges from the point-biserial analysis (Table 14), which indicates an absence of a significant relationship between perceived understandability and actual understandability across questions 1 to 3. This dichotomy suggests that while experts may harbor a perception of having grasped the framework, this perception may not invariably translate into actual understanding. Nonetheless, the substantial 79% actual understanding rate posits a relatively low misapprehension rate, which is a promising indicator.

Table 14 *Point-biserial analysis of perceived understanding versus actual understanding questions.*

	Q1	**Q2**	**Q3**
Point biserial coefficient	0.047	0.254	-0.142
P-value	0.833	0.24	0.521

Question 4 presents a nuanced scenario requiring experts to prioritize between the most motivating factor and the project goals during Step 3 of the framework. The significantly low correct answer rate of 45% possibly illuminates a realm of ambiguity or misalignment between the framework's intended guidance and the experts' interpretations or expectations. The essence of the question seems to delve into a critical decision-making juncture, however, the framework, as per the analysis, doesn't provide a clear directive on making such a choice, which is often dictated by higher managerial decisions rather than a framework's guidance. The question might inadvertently steer experts into a quandary, as the dichotomy between adhering to project goals and pursuing motivational factors could be perceived as a common project management challenge rather than a theoretical or framework-guided decision. This could potentially explain the difficulty the experts had with this question, as the decision to prioritize either aspect may transcend the framework's purview and venture into the realm of organizational decision-making. Thus, this question should be dropped from the testing of the actual understanding of the framework.

Question 5 delves into a scenario entailing the embedding of a motivating factor, identified in a previous step, into a design decision and further queries the context in which this embedding occurs—whether operational or socio-linguistic. The notably low correct response rate of 41% underscores a potential gap in understanding among experts concerning the distinct terminologies and the framework's articulation in *Step 4: Ideation.* The question might have unveiled a nuanced area within the framework where the delineation between operational and socio-linguistic contexts may not have been adequately clear or intuitive to the experts. The scenario provided in the question is very specific and requires the experts to apply a multi-step logic based on the framework's guidelines, which might have posed a challenge if the terms or the process were not entirely clear to them. The feedback from Question 5, alongside the insights from the interviews, indicates a recurrent concern around Step 4 of the framework. It appears that this step, particularly the

terminology and perhaps the process of embedding motivating factors into design decisions, needs further elucidation or a more intuitive presentation to enhance comprehension and application by the experts and possibly the provision of more explicit guidance or tools.

9.3.2.5. Correlation between Usefulness, Satisfaction and Understandability

The data delineated through Spearman's Correlation coefficient analysis (Table *15*) significantly underscores the intertwined relationship between perceived usefulness, satisfaction, and understandability with respect to the evaluated framework. A robust positive monotonic correlation is observed between perceived usefulness and satisfaction (r=0.8891), elucidating that higher recognition of the framework's usefulness substantially aligns with increased satisfaction among the experts. This correlation reflects a critical coherence between the functional efficacy of the framework and the satisfaction derived from its utilization. A parallel strong positive correlation is noted between perceived understandability and satisfaction (r=0.8207), reinforcing that a clear comprehension of the framework potentially escalates the satisfaction among experts.

Table 15 *Spearman's correlation coefficient, correlating Usefulness, Understandability and Satisfaction construct.*

	Usefulness vs understanding	**Understanding vs satisfaction**	**Usefulness vs satisfaction**
ρ	0.614	0.821	0.889
P-value	0.002	2.887E-06	3.168E-08

However, a more moderated positive monotonic correlation between perceived usefulness and understandability (r=0.6139) suggests a nuanced relationship. While a better understanding of the framework tends to enhance its perceived usefulness, the correlation is not as potent, indicating other intervening variables might be at play or that understandability alone doesn't significantly drive the perception of usefulness.

These findings are crucial as they shed light on the pivotal dynamics between perceived understandability, usefulness, and satisfaction in the context of framework evaluation. The strong correlations between satisfaction and both perceived usefulness and understandability emphasize the importance of both these factors in enhancing the overall positive reception of the framework. Yet, the moderated correlation between perceived usefulness and understandability hints at a more complex interplay, suggesting that while comprehensibility is beneficial, additional factors may contribute to the perceived usefulness of the framework.

9.3.3. Conclusion from the Statistical Analysis

In summary, the empirical evaluations of the Catalyst Framework convey a persuasive validation of its usefulness, satisfaction, and perceived understandability by the expert participants. The high Cronbach's alpha values across the constructs demonstrate a strong internal consistency, substantiating the reliability of the assessment tools utilized. The framework's usefulness was strongly affirmed, with experts particularly endorsing its effectiveness in incorporating user motivations into design processes. The Spearman's Correlation coefficient analysis corroborates that the Likert items employed were effective in measuring the intended construct of usefulness. Similarly, satisfaction with the framework was notably high among the experts, with the majority expressing a willingness to use and recommend the framework in future projects. The positive correlation between perceived usefulness and satisfaction suggests that the more useful the experts found the framework, the more satisfied they were with it.

The construct of perceived understandability also received considerable support, although the exclusion of an item related to color differentiation signals an area for potential refinement. A strong positive correlation between understandability and other constructs was evident, indicating that when the experts found the framework understandable, they were more likely to find it useful and satisfactory. The interplay between usefulness, satisfaction, and understandability was discerned to be complex yet interrelated, with strong positive correlations between satisfaction and both usefulness and understandability. However, the moderated correlation between usefulness and understandability suggests that while understanding may be necessary for perceiving usefulness, it is not the sole contributor.

The investigation of actual understanding, however, revealed that actual and perceived understanding are not significantly correlated. However, actual understanding of the framework was reasonably high indicating its efficacy.

Overall, the collective findings endorse the Catalyst Framework as an effective tool for design processes, reflecting its practical relevance and potential for broader application. However, the notably low correct response rate of 41% underscores a potential gap in understanding among experts concerning the distinct terminologies and the framework's articulation in *Step 4: Ideation*. It appears that this step, particularly the terminology and perhaps the process of embedding motivating factors into design decisions, needs further elucidation or a more intuitive presentation to enhance comprehension and application by the experts and possibly the provision of more explicit guidance or tools.

All the raw data used in the above analysis is provided in Annexure 5.

9.3.4. Qualitative Feedback from Experts

The qualitative feedback from the experts provided detailed insights into various aspects of the framework, highlighting both strengths and areas for improvement. The feedback covered several key points:

Context Specification: Experts suggested that the framework should begin with a contextual explanation of the kind of behavior that can be targeted with the Catalyst framework.

Triangulation in Self-Reports: Experts emphasized the difficulty of relying solely on self-reports by users to understand their motivations and proposed adding layers of observation-based or task-based activities.

Greater explanation in Contexts of Meaning: There were uncertainties noted in Step 4, specifically regarding the contexts of meaning generation: "Operational Context" and "Socio-linguistic Context." Experts sought clarity in this step, indicating a need for more detailed explanations.

Statistical Analysis: Experts found it unclear how the graded scales of multiple interviewees were integrated into one composite scale using statistical analysis (we conducted Frequency analysis). They suggested providing more explanation or context to enhance their understanding.

Accuracy Testing: The experts proposed a quick "flame-test" for the framework, emphasizing the importance of evaluating the efficacy of their design solution in bringing about the expected behavioral change.

Building the Semantic Profile: Experts asked for more use case scenarios demonstrating how the semantic profile was built and what factors influenced the choice of elements to better understand the framework's applicability in real projects.

Clarity from Semantic Profile to Meaning Generation: Experts found a conceptual disconnect from the step in which the semantic profile is built to the last step in which the designer brainstorm on ways to embed meaning in the product or PSS. More explanation of exemplification was sought on how the final step can be conducted.

Usability: The experts stressed the need for clear, crisp reading with a linear flow of steps. They recommended labeling the framework as a theoretical framework and suggested improvements in readability, including the possibility to zoom in and a graphical roadmap with the persona of a designer.

Digital Transformation: The feedback concluded with suggestions to digitize the framework into a mobile app, emphasizing the benefits of digitization for better accessibility and usability.

In summary, the experts' feedback provided a comprehensive evaluation of the framework, offering constructive suggestions to enhance clarity, usability, and overall effectiveness. The recommendations aimed to make the framework more accessible and applicable in real-world design projects.

9.4. Efficacy Testing: Workshop

We tested the efficacy of the toolkit by holding a workshop with school children of the age group 11-13 years, in the vicinity of IIT Guwahati (St. Anthony's School). A hundred children were divided into two groups. Forty-three subjects were the control group and were given an ASP kit called as a DThinking kit (Figure 86) which was designed by a professional designer without using the Catalyst framework. The kit guides the user step-by-step to identify the problems or unaddressed needs in the current backpack and brainstorm ways in which the user can make a "dream bag" for himself or herself and prototype it using paper and stationery. Fifty-seven students were in the experimental group and were given the MUNKI kit (Figure 87) designed by expert designers, described in 9.2.2 (page 151) using the Catalyst framework. The designer who designed the DThinking kit was one of the designers of the MUNKI kit.

Forty-eight undergraduate Design students from second year were assigned the task of being coordinators. Half of them coordinated the control group. The other half were given groups of three school children each to coordinate. Though the initial plan was to take self-reports from the children about their perception of increase or decrease in *competence, autonomy* and *relatedness needs*, the subjects did not answer the questions in the questionnaire properly. This led us to take subjective answers from the coordinators describing what they observed during the workshop. We adopted the following measures to study how motivation levels changed for each group during the workshop.

Figure 86. Students taking part in the DThinking workshop.

Figure 87. Students making origami products with the MUNKI kit.

9.4.1. Observing User Psychology

a. **Behavioral Observations** - Behavioral observations focus on the direct monitoring of user actions and reactions in natural or controlled environments. This method allows researchers to gather empirical data on how users interact with products, services, or systems. Such observations can identify patterns in user behavior, highlight areas of frustration or confusion, and reveal unarticulated needs or preferences. By meticulously recording and analyzing these behaviors,

insights into user psychology—such as motivation, problem-solving strategies, and learning processes—can be derived, contributing to more user-centric design solutions.

b. **Content Analysis: Informal Discussions, Artifact Analysis of the products made by the school children** - Content analysis in the context of user psychology involves examining the communication content and artifacts produced by users, such as school children, to infer their cognitive and emotional states. Through informal discussions, researchers can capture spontaneous expressions of thoughts and feelings, providing a rich qualitative data source. Artifact analysis, on the other hand, examines the products made by children, such as drawings, writings, or digital content. This method can uncover insights into the children's creative processes, cognitive development stages, and emotional well-being. Both approaches combined offer a comprehensive understanding of user psychology from direct expressions to indirect manifestations in created artifacts.

9.4.1.1. Observing User Behavior

a. **Task Performance:**

i. **Task Persistence despite challenges** - This aspect focuses on observing how users, such as school children, continue to engage with a task despite encountering difficulties. It measures resilience and determination, providing insights into their problem-solving strategies and tolerance for frustration. Persistence can indicate high engagement levels and intrinsic motivation towards the task or subject matter.

ii. **Task Choice (between both the kits)** - Task choice involves observing which of the two provided kits users decide to engage with. This choice can reveal user preferences, interests, and perceived difficulty or accessibility of the tasks. Analyzing the factors influencing their decisions can offer valuable information on how product features or task design attract different user segments.

iii. **Freewill** - Observing whether users voluntarily continue with an activity beyond the allocated time can indicate high levels of intrinsic motivation and interest. This behavior provides insights into the engaging aspects of the task or product, highlighting elements that foster sustained engagement and user satisfaction.

b. **Effort Expenditure** - Effort expenditure looks at the amount of physical or cognitive effort users invest in performing a task. This can be measured through indicators such as time spent on task, the intensity of engagement, and the use of strategies to overcome challenges. High effort expenditure might reflect task complexity, high engagement, or both, and can inform adjustments needed to optimize task design for better user experience.

c. **Goal Setting and Achievement** - Goal setting and achievement involve observing how users set objectives for themselves and strive to meet them within the context of the task or activity. This behavior is indicative of users' ability to plan, organize, and execute actions towards a desired outcome. Monitoring these aspects can provide insights into users' self-regulation skills, ambition, and satisfaction derived from accomplishing goals, offering critical data for designing more motivating and rewarding user experiences.

We handed a structured questionnaire to the coordinators (Annexure 6, page 262). We qualitatively assessed their answers to the questions pertaining to user psychology through the process of closed coding using the following codes shown in Table 16.

Table 16 *The codes used in the closed coding of the semi-structured interviews conducted with the workshop coordinators.*

+C	Increase in *Competence*
-C	Decrease in *Competence*
+A	Increase in *Autonomy*
-A	Decrease in *Autonomy*
+R	Increase in *Relatedness Needs*
-R	Decrease in *Relatedness Needs*

We also gave a quantitative measure to the answers pertaining to user behavior on a 5-pont Likert scale from -2 to +2 depending on the intensity or frequency reported by the coordinators.

From the qualitative analysis, we observed that the participants in the MUNKI workshop experienced higher growth in *competence* and relatedness needs than the participants in the DThinking workshop. But in the case of *autonomy*, the DThinking participants experienced a higher perception of growth. Origami being a more difficult skill than prototyping with paper and coloring on it, might have been the cause of higher sense of *competence* in the former group but a lower sense of control of one's resources and surroundings. The design of the respective workshops also led to the difference in the levels of relatedness needs growth. The MUNKI workshop was designed to have one coordinator for every group of three students and minimal

written instructions. The product design and development were to take place through discussion and collaboration between the participant groups and the coordinators. Flow of ideas between the groups, was encouraged. The participants also demonstrated higher eagerness to share resources with other groups and the desire to make products that stand out was also at a group level. The designs of the MUNKI group were to be featured in the hallway in the school to foster relatedness needs.

The DThinking participants on the other head demonstrated higher mastery over the resources at hand, but less inclination to share resources or ideas. They also treated the workshop as a school assignment and scored higher on goal setting and achievement. Both groups scored equal in task performance and effort expenditure. But a qualitative assessment of their user psychology revealed different motivations for both the activities. MUNKI kit generated higher flow in the making activity and required higher levels of craftsmanship from the user. The DThinking kit on the other hand was viewed as a goal-oriented assignment by the participants and there was an urgency to finish rather than a proclivity to gain a new hands-on skill.

The content analysis, especially the artifact analysis of the products, helped us achieve triangulation in studying the change in motivation levels of both groups. Table 17 shows a snippet of the codes that emerged during the process of coding for each component of motivation and each ASP practice. The artifact analysis also indicated that the MUNKI kit could infuse a higher sense of growth in *competence* and relatedness needs than the DThinking kit. Figure 88 shows the products made by the students in the MUNKI group and Figure 89 shows the products made by the students in the DThinking group. There were more variations in product forms and functionalities than observed in the latter group. The departure from the design of a cube that was used for demonstration is also significant. The participants designed at a metaphorical level where they envisioned animal or familiar product forms through the abstract joining of the Phizz units. The participants wanted to innovate in form and stand out in their creative skills. We also observed a diffusion of ideas and a sense of healthy competition to create bigger and better products within the groups. On the other hand, the DThinking group participants showed low departure from the basic form of the bag. The focus was on higher self-expression through analogous thinking or by integrating elements from popular culture.

Figure 88. Products made by the students in the MUNKI group.

Figure 89. Products made by the students in the DThinking group.

Table 17 *Snippets of codes from the closed coding of structured interviews of workshop coordinators*

Code	What it signifies	DThinking	MUNKI
+C	Increase in *Competence*	Color palette, high expressionism, self-expression, personalization, greater use of stationery provided.	Variation in form, high functionality of products, skill-based craft, high craftsmanship, envisioning 3D forms, wanted the product to stand out from the other groups, wanted to make bigger and bigger 3D product, abandoned Phizz units and made other Origami products, wanted to take their products with them.

-C	Decrease in *Competence*	Low deviation from basic form of a bag, crafting with paper is an easy skill, viewed it as a school project, reported not learning a new skill, older students were busier in discussing other things, some designs were very simplistic, did not want to take their products with them.	Joining Phizz units is difficult leading to abandonments, making Phizz units is a tedious process, students who found it extremely difficult were hard to reengage.
+A	Increase in *Autonomy*	Higher use of stationery provided, mastery over paper-crafting, something they know from before.	Can join Phizz units in different ways to create products.
-A	Decrease in *Autonomy*	Resources provided were limited.	Phizz units retrict the product possibilities geometrically, color options are less, joining Phizz units is difficult,
+R	Increase in *Relatedness Needs*	They wanted to show their products to their parents, similar products were made within groups.	Interacted with coordinators, talked about many things outside of Origami, shared about career goals, design ideas were copied in groups, they wanted to show designs to friends and family, they were happy that their designs will be showcased in the school hallway.
-R	Decrease in *Relatedness Needs*	Was annoyed that his design was copied, did not want to share stationery, individual effort, could not start answering till a coordinator was sitting with them.	Some kids found it too hard and discontinued working with the group.

The Task Choice measure, however, clearly showed the difference in the jumps in the motivation levels to engage in the respective ASP practice of each kit. Twelve participants in the DThinking workshop wished to learn the Origami skill taught in the MUNKI workshop, whereas only two participants from the MUNKI workshop wished to explore the DThinking kit. None of the participants of the DThinking workshop desired to continue with the practice, whereas six participants of the MUNKI workshop expressed their eagerness to continue learning Origami.

In the MUNKI workshop, participants showed higher growth in *competence* and relatedness needs compared to the DThinking workshop, while DThinking participants exhibited greater *autonomy* perception. MUNKI encouraged collaboration, resource sharing, and innovative designs, fostering a sense of *competence* and

relatedness. DThinking, viewed as a school assignment, prioritized mastery, goal-setting, and achievement. Task Choice measure revealed higher interest in MUNKI's Origami practice, indicating varying motivations between the groups. It is to be noted that both the ASP kits were designed by the same expert designer who has extensive experience designing for adoption of a practice by school children. The difference in the quality of the motivation that each product could trigger is an important indication of the efficacy of the Catalyst framework.

The questionnaire handed out to the coordinators in provided in Annexure 6 (page 262).

9.5. Composite Scale and Subcultures - an Excel-based Toolkit.

In our research, we developed the Composite Scale and Subcultures (CSS) toolkit, an Excel-based tool designed for researchers and professionals involved in image or object ranking studies seeking insights from ranking data. This toolkit simplifies the process of managing rankings from multiple respondents, using statistical methods like Kendall's W to assess agreement and create a composite scale based on average positions. Apart from showing agreement levels, CSS provides a user-friendly way to visualize data, identify trends, outliers, and typical items. It allows a detailed look at user opinions on individual items and uses K-means clustering to uncover subgroups in the data, enhancing the analysis of perception and ranking behavior. The toolkit also visually highlights subcultures with diverse preferences.

The link to download this toolkit is:

https://drive.google.com/file/d/1ic4Geu4Y6X8ZDiGjtKRFc28WucEBb_fH/view?usp=sharing

9.6. Conclusion

The multi-stage evaluation of the Catalyst framework revealed several important areas for improvement in terms of usability and comprehensibility during the pilot tests and the experts' review processes. It also tested the framework thoroughly for usefulness, understandability, satisfaction, and validity during the experts' review. As the questionnaire we built for measuring the same were not standardized, we conducted MSA on the responses and refined the questionnaire first before conducting the descriptive statistical analysis. We also conducted user tests of the framework with two designers with varying degree of domain expertise: one, an amateur and the other, an expert. The user tests revealed that the framework, with its high degree of domain-specificity and integration of multi-disciplinary theoretical lenses, was more easily understandable and usable by the expert than the amateur. The difficulty experienced by the user in analyzing the ranking data of the motivational components, led us to design a toolkit named as the Composite Scale and Subcultures (CSS) toolkit. It not only aids designers in analyzing ranking data and constructing composite

scales, but it also aids them in detecting subcultures within a target group based on preferences of the ranked data.

In the final stage of the evaluation, we conducted a workshop with a hundred school children in the age group of 11-13 years to test the framework for its efficacy. The students were divided into a control group and an experimental group. The control group received an ASP kit that was designed by an expert designer without taking recourse to the Catalyst framework and the experimental group received a kit that was designed by the same designer using the framework. While it was difficult to quantity the difference in the levels of motivation of both the groups, the former showed more goal-driven motivation and viewed the activity as a school assignment. On the other hand, the experimental group showed was motivated to master the craft and showed higher inclination to adopt the practice. An important indicator of the efficacy of the framework came from the Free Choice measure. After the workshop concluded, a significantly higher number of students wished to take up/ continue with Origami that the DThinking method.

10. Key Research Findings and Design Contributions

Our research project that has extensively studied ASP practices in emerging economies and explored how meaningful interventions can be designed to facilitate its adoption, has brought forward several research findings. These findings do not just pertain to the theory behind the intervention design, but also a new conception of *Making*, a novel application of a statistical method in the field of Design, and a toolkit to construct an overview of ratings by users. Moreover, owing to the complexity of the research problem and the unique challenges faced by the researchers, we tailored the methodology in manner that is theoretically sound and most conducive to study communities, gather insights, and design interventions for them. The ontological bridging and methodological pluralism adopted in this thesis can also expectedly further the understanding about research design in the field of Design. In this chapter, we briefly describe the key research findings and design contributions from this project.

10.1. Research findings

The following are the research findings from this project that has significantly contributed to our understanding of the subject matter.

10.1.1. The Concept of Assisted Self-Production

Observing that the traditional conception of *Making* and the many definitions offered in literature do not fully encapsulate all the aspects of *Making* in emerging economies, we conducted field studies in five rural communities in Assam (a state in North-East India). We observed the various *Making* practices present in these communities, and the *skills*, *images* and *stuffs* that support them. We analyzed 40 cases from field and literature using Grounded Theory with three rounds of coding: initial, focused, and theoretical. The final round of coding showed all the common characteristics of such practices and aided us in putting forward a new definition for *Making* in such contexts. Moreso, the term "*Making*" with its connotation of self-consumption and production chiefly done using the maker's skills (unaided externally), was perceived to be inadequate. In emerging economies, often the products of *Making* are destined for markets. And modern-day *Making* is often aided externally through open-source knowledge. To include such aspects, we propose a new term: "Assisted Self-Production" to denote *Making* practices in rural and semi-urban communities of emerging economies and defined it as:

> ***Assisted Self-Production:*** *"Activities in which individuals or communities engage tools and materials from their surroundings to produce or physically transform material goods destined either for self-consumption or for the market, conducted outside the formal economy. Such activities can be assisted with skills or knowledge share through technology-enabled platforms."*

10.1.2. Observations Related to the Evolution of *Making* in Emerging Economies

Our field studies in India also revealed how ASP practices are supported with skills and materials and are evolving over time in rural and semi-urban communities. Our studies found that most of the ASP practices in such communities employ simple tools and local eco-materials and are usually supported by techniques and skills that are hard to replicate outside the community or the geographical context. But when we analyzed such practices through the lens of Practice Theory, we observed that one of the key components of a practice has been degenerating inter-generationally over time: *images* (meaning). The older generation viewed ASP practices as traditions that they learnt in early teen years, and which had the capacity to fulfill their material needs and equip them for better survival. The younger generation on the other hand did not view such practices as capable of making them competent for modern-day survival. Their sense of purpose was more oriented with global problems than community-level needs. They also demonstrated a higher propensity to academic or extra-curricular activities with the belief that such activities can confer higher competence. The nature of this evolution in meaning can be attributed to several factors: technological advancement, the advent of social-media, growth in primary education in India, Design philosophies such as Design for Base of the Pyramid, and the flooding of low-cost factory-made goods. This finding can change the way designers look at products and PSS intended for use by such communities. Given that the traditional ASP practices utilized local eco-materials and had higher sustainability, designers can also consider the possibility of meaningfully integrating traditional *Making* in consumption products.

10.1.3. Typology of Assisted Self-Production in Emerging Economies

Our field studies yielded rich data on ASP practices and the materialities, skills and meanings surrounding them. Given than the researchers were not from the demography that was being studied, we had to adopt a Double Diamond approach and phase our research into two stages: one, an open-exploratory stage, and a subsequent more focused phase. The data generated was vast and open-ended in nature. As such, we subjected the data to Grounded Theory Analysis. The *initial* and *focused* codes that emerged from the Grounded Theory analysis supported us in developing a typology of the various ASP practices that we observed from the field and in literature. It also aided us in coming up with the one factor that made the distinct types orthogonal, namely: motivation. Table 18 shows the distinct types of ASP practices along with the primary motivations that drive them. We also observed that the various categories of ASP practices did have overlapping characteristics in terms of skills and materialities. But it is meaning (motivational) that differentiates them into mutually exclusive classes. This observation is especially crucial in strategizing the design of ASP products and PSSs for communities in emerging economies. It brought to light the importance of focusing on latent motivations in such design, as opposed to approaches that focus only on upskilling and supporting with resources. The mental drive to engage in an activity is as crucial as the physical facilitators.

Table 18 *The distinct types of ASP practices and their primary motivations (differentiator).*

Type of DIY Practice	**Primary Motivation**
Jugaad	Cutting costs and cutting corners
Grassroots Innovation	Solving local problems
Bricolage	Tinkering and inventing with resources at hand
Crafts	Economic Benefit
Prosumption	Self-consumption

10.1.4. The Juxtaposition of Grounded Theory and the Double Diamond Method

In our fieldwork research, we were confounded with a unique combination of challenges: (a) The researchers did not belong to the demography that was being studies and as such demonstrated only a cursory understanding of the context and the existing ASP practices. As such the researchers did not have a clear understanding of where to begin the observational research, what parameters to study, what parameters to focus on, and how to structure the entire study. (b) The communities were not easily accessible and studying them posed logistical problems. (c) The data collected during the process was extensive and open-ended and required a structured coding and analysis process. In the uniqueness of this situation, we designed our pre-study phase carefully to capture the richness and diversity of the data and to do a rigorous analysis of it for developing actionable insights. As such, we combined the widely used Double Diamond model of fieldwork used in Design practice to structure the fieldwork into two phases: (a) an open-exploratory phase where the researchers gain cognizance of the kind of ASP practices in communities, their lifestyles, their institutions, and the social networks through which information about such practices flow. (b) An in-depth phase in which the insights gathered from the first phase were gleaned, a research gap and intervention area was identified, and such areas were studied in higher detail. This model helped us in effectively studying such communities economically, identifying our societal problem and gaining a base understanding of what kind of intervention is needed. However, the Double Diamond model could only optimize our field research. It lacks the scope to offer a method for rigorous analysis of the data. To achieve analytical triangulation, we subjected the same dataset to Grounded Theory Analysis and applied theoretical sampling to the cases that we collected from the field. To ensure that our search for cases is exhaustive and not limited to the practices observed in the communities that we visited, we also conducted a thorough literature review of *Making* practices in emerging economies. The juxta positioning of the Double Diamond Model and Grounded Theory (with cases from field as well as from literature) aided us in conducting the pre-study phase in an effective and economical manner. The process optimization of the Double Diamond method and the theoretical rigor of Grounded Theory together provided the research team with insights that could directly be translated to intervention design in the next phase of the DIR process. As such, this unique approach can be adopted by researchers

who are studying communities and target user groups with low initial understanding and the need to gain deep insights into a phenomenon.

10.1.5. Catalyst: Design for Motivation to Induce Behavior Change Framework

During our field studies and literature review, we observed all the three aspects of ASP practices in rural and semi-urban contexts: *skills, stuffs* and *images.* ASP practices have been a part of the lifestyle for such communities as either tradition or a means of collective survival. We however, also observed that the meaning that ASP practices had in such communities is perishing over time, endangering such practices. As consumerism rises in such communities, and cheap products specifically designed for them are reaching those markets, the younger generation no longer perceives such practices as meaningful or important for survival. We also gathered from our interviews with the people who do engage in ASP, that they learned such practices in their early teen years. As such, to facilitate adoption of such practices, we decided to aim for the adolescents in such communities as our target user group. We also view the readoption of ASP practices as a matter of behavior change as we aim to stimulate the target user from not doing anything (passive consumer) to doing something (engaging in an ASP practice). As such our design must be mindful of the other components of behavior change (from the COM-B) model besides motivation, namely: capability and opportunity.

In our research project, we inquired how the *intrinsic motivations* of the target group for an activity, or a practice can be studied and how they can be embedded in the design of the ASP product or PSS such that the practice is adopted by the target user group. The BCW enumerates various means to induce behavior change depending on the type of the behavior that the designer wishes to change. We, however, look at it more from a Design perspective and enquire how motivations can be subtly embedded as visual cues and meaning in the product or PSS. Accordingly, we design a framework, namely ***Catalyst: Design for Motivation to Induce Behavior Change***, to guide designers on how to understand the motivations of a target user group, map them on scales from most motivating to least motivating, pick the motivational factors to embed in the design, and then to embed them in the operational and socio-linguistic contexts. It also elicits the designer to be mindful of the capability of the target user and the opportunities afforded by the environment.

10.1.6. An Understanding of how Design for Behavior Change can be Achieved Through Product Semantics

Most behavior change theories focus on either of these two approaches: (a) to induce behavior change BCT's, (b) guidelines or system design (BCW). Both approaches emphasize on intangible design such as legislation, policies, communication, environmental restructuring, training, awareness generation, rewards,

and punishments, etc. However, none of the approaches foray into the domain of physical products and investigate how elements that catalyze behavior change can be embedded in the way products and humans interact generating meaning that evolves over time. In our research, we bridge the domains of Behavior Change from Psychology, and Product Semantics from Design and explore how products can have meaning for users that motivate them for a certain behavior. Meaning is a more subtle way of bringing change in behavior than guidelines, techniques, or tangible interventions. Though meaning generation in the operational or socio-linguistic contexts have been extensively studied, how such meaning can have a motivational undertone, or how users' motivation for a certain activity can be translated to meaning, have not been explored before.

In our research, we have not explored how meaning can be generated by designers, but we have studied in what contexts, designers can feasibly embed motivational meaning in products and PSSs. The Catalyst framework guides the designer up to the stage of knowing the various contexts which the elements of the semantic profile can be embedded. However, it is a matter of future research to understand the exact ways in which the designer can do so.

10.1.7. Design at a Reflective Level

The Catalyst framework aims to achieve behavior change through products and PSS's by understanding the latent motivations of a target user group for an activity (or an analogous activity) and embedding them as semantic devices. The framework guides the designer in a step-by-step manner in the process of investigating into the motivations, mapping the motivational matrix from most motivating to least motivating. An important point to note is that by focusing on *intrinsic motivations*, the framework delves exclusively into the reflective processes of human behavior. When a user is *intrinsically motivated*, s/he is likely to engage in reflective behavior: consciously considering his/her actions because s/he finds the activity meaningful and satisfying. This reflective process often reinforces his/ her *intrinsic motivations*, as s/he recognizes and appreciates the inherent value of the activity: the perceived growth in *competence/ autonomy/ relatedness*. Reflective behavior and *intrinsic motivation* are related in that both involve a deeper, more personal engagement with an activity.

In the field of Design, several techniques are used in subtly guiding the user towards the intended action. Nudging subtly influences behavior by adjusting design elements such as placement or color. Placing healthy foods at eye level to encourage better choices is an example of a nudge. Feedback loops provide real-time responses to actions, reinforcing positive behavior, such as a fitness app that rewards daily step goals. Gamification adds game-like elements such as points and rewards, making behavior change engaging and fun, as seen in recycling apps with leaderboards. Social proof leverages the influence of social norms by showing users that others are adopting the behavior, such as displaying messages about community recycling

rates. Commitment devices encourage users to set goals or make public pledges, helping them stick to desired behaviors. Personalization tailors the experience to individual needs, increasing motivation, such as meal planning apps that adjust to dietary preferences. Habit formation breaks down behaviors into small, manageable steps, supporting gradual change, such as apps that help users build healthier habits over time. Environmental design modifies the physical space to make desired behaviors easier, such as workplaces with standing desks to reduce sedentary habits. Finally, behavioral triggers use reminders or cues to prompt actions at the right time, such as smartwatch notifications to encourage regular movement. Combining these techniques can effectively drive behavior change across various contexts. However, none of these commonly used strategies probe into the reflective level of behavior.

Design strategies that consider *intrinsic motivation* involves designing experiences that tap into users' inherent enjoyment or sense of purpose, making the behavior itself rewarding. For example, a creative journaling app that encourages self-expression and reflection can make the activity intrinsically rewarding, motivating users to engage consistently because they find personal value in the process itself. However, such strategies do not interrogate into what the user finds inherently motivating and superficially supposes that enjoyment or a conferred sense of purpose can drive people to continually engage in an activity. The Catalyst framework, however, does not rest on such assumptions, but rather investigates into the motivational matrix of the users, component-wise. By integrating semantic devices that signal motivation to the user, the framework helps designers in eliciting the reflective processes of considering a product or activity, make a conscious decision to engage in it, and to sustain the practice over time.

10.1.8. Semantics in PSS level Design

One of the key research contributions of this thesis is the proposition that PSSs can be designed with infused meaning. While the field of Product Semantics explores in depth how meaning can be embedded in products as visual cues or semantic devices, there is not much research conducted in the field of how the same can be done in the case of PSSs. The concept of PSS started gaining attention in the late 1990s and early 2000s. Research in this area focus on methods of integrating products and services, functionality, business model innovation and sustainability. To the best of our knowledge, there is no research that studies meaning in PSSs. Though dormant, semantics provide a fertile area to investigate how PSSs can signal different meanings to diverse groups. Particularly in the field of Circular Economy, where the concept of PSS has been developed further, intangible meaning can be a tool for inducing behavior change and moving toward less waste and more efficient use of resources. Our framework goes as far as to infuse the observed motivations either in the operational context or the socio-linguistic context of a product or a PSS. It is a limitation of this research, that it does not answer the ontological question of how to translate the observed motivations into semantic devices. But we leave it as future research to explore how it can be achieved. A significant step is still in understanding that like physical products, PSSs can have meanings. The artifact

that was developed in this research using the Catalyst framework, and which was later tested on the experimental group, was designed as PSS. Our test results showed that this PSS was able to lead to higher adoption than the product that the control group received, validating that meanings can induce behavior change.

The PSS design philosophy posits that integrating services with functional products can enhance sustainability in production as well as consumption. Yet, just as this research shows, facilitation is necessary but not a sufficient condition for behavior change. Considering how Sustainability circles stress on behavior change on the part of consumers, PSSs can be a more effective tool in bringing sustainability, if it also includes the intangible world of meanings that people make from products and product service systems.

10.1.9. Introducing the concept of Community-Based PSS

At the onset of the research project, we conducted a literature review in which we studied the concept of PSS, and its typologies as envisioned that adoption of *Making* was likely to be PSS level design rather than just a product level design. We did not come across cases of PSS design where the community was actively involved other than as an end consumer. However, out fieldwork in rural India revealed a plethora of ASP practices in such communities that are inherently a PSS level design. Consider the case of a craftsman who makes products primary for sales. On days when he is unable to fulfill the orders that he receives, he promptly asks the neighboring craftsmen to help him in the *Making* process. On other days, he, being a craftsman with credible mastery over the practice, might train new apprentices in the locality. As such, the ASP practice (craft in this case) involves the community through collaborative redistribution of work, resource sharing, networked upskilling, and diffusion (Authority: Figure 34 and Figure 35). On the other hand, a woman making a granary for storing grains at home, who is being helped by a neighbor (Figure 27), is a case where existing normative expectations to help each other, mobilizes the community. Such community-led or community-driven aspects in PSSs have not been investigated to the best of our knowledge, yet such social elements can have profound possibilities in the design of PSSs, especially for communities in emerging economies, where investment for infrastructure is usually difficult to obtain. Understanding the natural dynamics in such communities can significantly alter the design of PSSs targeted for them and make such interventions more socially embedded and sustainable in such communities. In the scope of this thesis, we only introduce the concept of such Community-based PSS and leave it as future research as to how such PSSs can be designed.

10.1.10. Ontological Bridging and Methodological Pluralism

This thesis also adopted a unique approach in combining the Interpretivist, Constructivist and Positivist paradigms to study the societal problem in hand, gain understanding of community perspectives, identify an

intervention area, and design and test the intervention. In short, the DIR methodology applied to a context as vast, diverse, and rich as emerging economies, needed the researcher to assume different ontological stances during the various stages of the research. At the onset, as a researcher from outside the community, we embrace an Interpretivist approach, recognizing the communities construct and interpret their social realities. This reality varies from context to context and from culture to culture. During the Pre-Study and the Design phase of the DIR methodology, we also assumed a Constructivist stance. During our qualitative semi-structured interviews, we assumed that the subjects develop their own understanding of the world based on their experiences and that these interpretations can vary widely from one person to another. The meaning associated with *Making* for each subject is not simply an understanding to be discovered but is shaped by the experiences, interactions, and social contexts of the individual. In the final testing phase for our designed framework, we however adopt a Positivist approach. We conducted a usability evaluation of our framework and subjected it to statistical analysis. To test the effectiveness of our framework, we also designed a true experiment with a control group and an experimental group. Such analysis and experimentation helped to rigorously validate the effectiveness of our theoretical approach and designed framework.

We have also used a conjugation of theoretical lenses in designing the two-stage solution proposed in this thesis. These lenses often have different perspectives. Practice Theory is a sociological framework, the COM-B model of behavior change is rationalistic, Self-Determination theory is humanistic, and Product Semantics is interpretivist and contextual. Yet, through a detailed analysis of the units of observation, design and analysis, orientations (individual versus collective), and the reconciliation with the situatedness and materiality, we ontologically bridged these theories in the genesis of the solution. While this flow of reasoning and combination of theories might not be perfectly applicable to other contexts, our approach demonstrates how theories with different ontologies can be bridged with a clear understanding of their units, orientations, and contextual suitability.

The merging of different paradigms in the DIR methodology, and the methodological plurality adopted in this research, can however be adopted in other research projects as well.

10.2. Design Contributions

The following are the design contributions from this project.

10.2.1. Guidelines for Designers to Map a Concept as Abstract as Motivation for a Certain Activity

Intrinsic Motivation is an abstract mental concept. Furthermore, the motivation matrix (*competence, autonomy,* and *relatedness needs)* for any activity or practice varies from person to person. There is no method for designers to understand or map such an abstract concept, to the best of our knowledge. In our

project, we investigated into various methods in allied fields, that aids designers in mapping abstract concepts. The method that emerged to be most suitable for our context is the generative method proposed by Athavankar (2009) in which the designer uses cropped images of various things around a certain characteristic (e.g., feminine, sporty, etc.), and asks the user to arrange them in a scale from most typical to least typical. Accordingly, the designer can choose the objects with features that are the most evocative of the characteristic and can embed such features in the design. We adopt this generative method for the process of understanding and mapping motivations and guide the designer in the following step-by-step manner:

a. Conduct observational studies (semi-structured interviews) to broadly understand what the motivations of the target user are, for a certain activity or a similar activity.
b. Select cropped images that depict such motivations.
c. Ask the target user to arrange them along three scales: *competence, autonomy* and *relatedness needs* from the most motivating to the least motivating.

However, we do acknowledge that there are several challenges of using photographs and illustrations in research as they are not neutral items (Snyder et al., 2014) and this can be further explored in subsequent research in the future.

10.2.2. Application of Mokken Scale Analysis in the field of Design

Our research project uses the statistical technique MSA in the construction of user research questionnaires. MSA is a valuable tool for assessing the quality of measurement scales and improving their reliability and validity in a wide range of research settings. We conducted a thorough search in literature to find application cases of MSA in the field of Design. But our search did not yield any result. There are standardized questionnaires in Design such as System Usability Scale (SUS), User Experience Questionnaire (UEQ), User Interface Satisfaction Questionnaire (QUIS), Post-Study System Usability Questionnaire (PSSUQ), etc. But they do not check how reliably the questions measure the latent construct being measured.

MSA is widely used in the fields of Psychology, Health Sciences, Education, Social Sciences, Economics, Criminology, etc. to assess the underlying structure and properties of ordinal or categorical data, particularly in the context of measuring latent traits or constructs, such as attitudes, abilities, or behaviors. It is advantageous for several reasons. First, it provides a way to evaluate the reliability and scalability of items within a scale, ensuring that the items measure the same latent trait consistently. Second, MSA is non-parametric and does not require assumptions about the underlying distribution of data, making it robust and suitable for various types of data. Third, MSA can be used to identify items that may need modification or removal to improve the psychometric properties of a scale.

10.2.3. CSS Toolkit

In our final contribution, we introduce an Excel-based toolkit called CSS, which stands for "Composite Scale and Subcultures." This practical tool is intended for researchers and professionals working with image or object ranking and aiming to gain insights from image ranking data. CSS simplifies the process of recording and managing rankings of images and objects done by multiple respondents. It employs standard statistical techniques, such as Kendall's W, to assess the level of agreement among rankers, providing a measure of consensus within the ranking data. The CSS toolkit also provides the visualization of a composite scale of the various responses based on the rankings of the mean positions of the various images or objects. Additionally, CSS offers a user-friendly data visualization feature, helping users identify ranking trends, outliers, and whether an image or object is considered typical or atypical. It also allows for a closer examination of user opinions on individual images and objects. The toolkit utilizes K-means clustering to group users, aiding in the exploration of subgroups within the data, enhancing the analysis of image or object perception and ranking behavior.

The CSS toolkit goes beyond showing level of agreement among the respondents and a composite scale. It visually depicts the presence of subcultures with different preferences of images and objects when there is divergence amongst the data. Subcultures strongly emerge when a certain image or object peaks (calculated through frequency analysis and mode) at two or more positions. While a simple average smoothens such divergence, a frequency analysis, and a graphical representation of it can impart rich insights on the presence of subcultures to the designer. The toolkit also provides textual guidance to designers on how to interpret the visual representations.

During one of the design assignments in this research, the images chosen by the designer in the case described in 9.2.1 (page 134) was fed into the toolkit. Those images had been captioned, converted to stickers, and handed to 40 students to arrange along three scales: *competence*, *autonomy*, and *relatedness needs*, from most motivating to least motivating. The ranking data was then inputted into the toolkit for analysis. The toolkit built the three composite graded scales organizing the images from most motivating to least motivating, showed the level of convergence in opinion, and through frequency plots also showed the existence of subcultures (peaks of an image in two or more positions). Figure 90, Figure 91and Figure 92 show some of the snippets of the CSS toolkit.

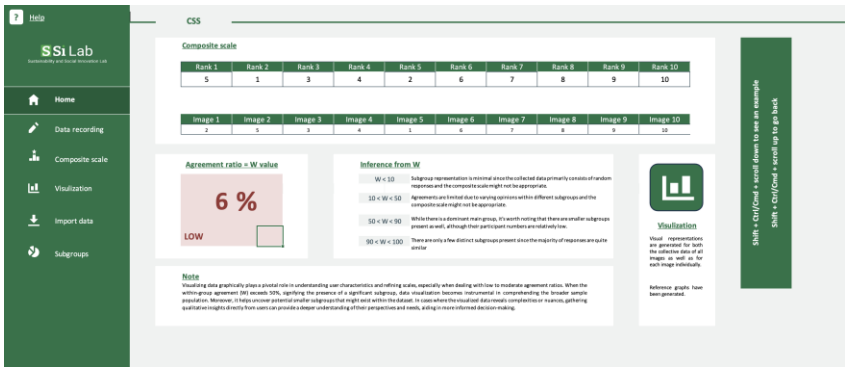


Figure 90. Arrangement of images along the composite graded scale and the level of convergence in opinion.

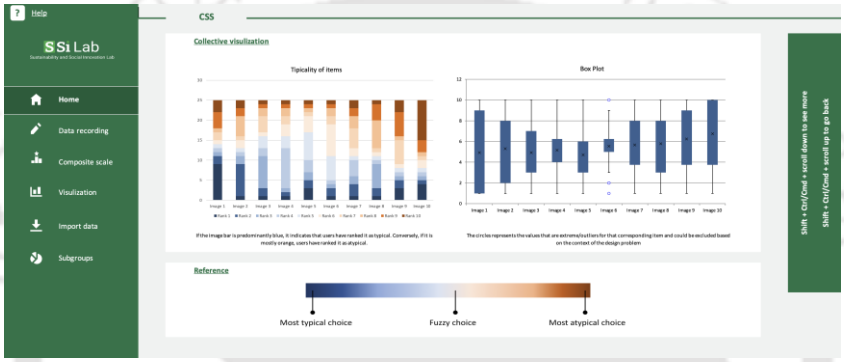


Figure 91. Image wise visualization of the preference of the participants represented collectively.

Figure 92. Image wise visualization of the preference of the participants represented individually along with examples to interpret the data.

Conclusion

This chapter has provided a comprehensive overview of the results obtained in this research project, shedding light on the specific research questions and hypotheses while also contributing to the broader body of knowledge within the field of Design. The Catalyst framework, application of Mokken Scale Analysis, and the CSS toolkit presented here can serve as a valuable resource for Design researchers and practitioners. The theoretical contributions demonstrate how research with extensive field studies can be designed by assuming multiple paradigms, combining theoretical lenses, and adopting methodological pluralism to achieve greater rigor and validity in the research. The research output also elicits thought on how design can reach a reflective level, can trigger conscious decisions, and motivate a behavior in a sustained manner. The knowledge contribution in this thesis will also expectedly further the understanding of how future researchers can restore ASP as an alternate sustainable production-consumption system, valorize local materials and embedded skills, and enhance sustainability.

11. Conclusion

The Industrial Revolution that brought about the mass production system, transformed active makers into passive consumers of factory-made goods. Prior to the Industrial Revolution, societies had agrarian lifestyles and actively engaged in *Making* practices for survival. Alvin Toffler refers to such societies as first wave societies in his famous book, "The Third Wave." But in the post-industrial society, there has been a distinct move from standardization to higher individualization. Production systems have incorporated services that emphasize on customization and personalization. However, with the advent of the Maker Movement towards the turn of the century and the coming of 3D printing technology, consumers have advanced further on the path of individuation. A significant proportion of Western consumers today wish to take part in the production process and make products centered around their creativity and personality, rather than being passive end-users. It is this counter-culture aspect of the Maker Movement that makes the scholarship in the field of Sustainability view it as an opportunity to make production and consumption more planet-friendly. It is more plausible to mold a production-consumption system that is at a proto stage than modifying one that has entrenched itself as the mainstream system since the Industrial Revolution. This is especially true for emerging economies such as India, Bangladesh, Brazil, etc. that have become the backend manufactures of global companies and have witnessed considerable environmental degradation and socio-cultural distortion as a result.

The Maker Movement that originated in the West, present several opportunities for infusing sustainability in emerging economies such as use of local eco-materials for production, harnessing the creativity and indigenous designs from the fringes and making designs that suit the contextualized needs and cultural sensitivities of artifacts. Unlike the West, the global south had a late rise into consumeristic culture. The West today seeks meaning in products and self-actualization through the process of making them. But the communities in emerging economies still see a growth in consumerism and loss of meaning of *Making* practices. In this research project, we investigated into what "*Making*" is in the context of emerging economies, what are its different types and what *images*, *skills* and *stuffs* support each type of *Making* practice. It emerged from our research that while the *skills* and *stuffs* surrounding such practices still exist, the *images* (meaning) that sustained such practices as a mode of collective survival, are decaying. Cheap factory-made good designed specifically for low-income communities flood the markets and make the practice of *Making* redundant and unmotivating.

In order to understand how we can make such communities readopt *Making* practices, we began our research by investigating into what *Making* is in the context of such communities, what are its different types, what are their characteristics and how they are differentiated. Accordingly, we collected 40 cases of *Making* practices in such communities from the field and literature and conducted Grounded Theory Analysis and a subsequent cluster analysis of the codes. Our fieldwork was conducted in five communities in rural Assam

in North-east India. To diversify our subject base, we selected communities with different ethnicities except for two of them. Our analysis showed the commonalities in such practices and gave us a working definition of *Making* in such communities as:

> *"Activities in which individuals or communities engage tools and materials from their surroundings to produce or physically transform material goods, destined either for self-consumption or for the market, conducted outside the formal economy. Such activities can be assisted with skills or knowledge share through technology-enabled platforms."*

However, modern day technology has changed the character of *Making* from an individual practice of skill and know-how to a collaborative practice with knowledge share and expanded the end-use from self-consumption to include selling of handmade products. As such, the term "*Making*" with its connotation of individual craftsmanship and self-consumption is no longer felt to be inclusive of all aspects of modern-day *Making*. Hence, we introduce the term "Assisted Self-Production (ASP)" that encompasses the assistance that technology affords. It also suggests that only production is done by an individual, the end-product might not be destined for self-consumption. We also arrive at a typology of such practices (Table 18) and observed that motivation was the chief factor that made all the categories mutually orthogonal, despite sharing other characteristics in terms of materiality and skill.

In the next stage of our research, we explore how meaning can be reinfused in such practices such that they are readopted by the communities in our context. As cheap factory-made goods and global distribution channels have changed people behaviorally from active doers to passive users of products, we view the societal problem of readoption of ASP as a matter of behavior change in our research. Through a systematic literature review, we studied several theoretical models and guidelines in the field of Behavior Change theory. But given that the behavior change in the readoption of ASP is at a conscious and reflective level, rather than at an involuntary or unconscious level, we select the COM-B model as an appropriate theoretical lens to address the research problem at hand. We also take recourse to the BCW method that presents an elaborate list of interventions based on what causes the reflective behavior that needs to be changed. But as noted before, why ASP practices are disappearing in such communities is more for the loss of meaning than the loss of skills and materialities. As such, we focus on the motivation component of the COM-B model and through Ryan and Deci's Self-Determination Theory, we investigate how *intrinsic motivation* for an activity can be broken down into components (*Competence*, *Autonomy* and *Relatedness Needs*). We also explore how motivations can be embedded as meaning in different contexts as proposed in the seminal book, "The Semantic Turn." Though the interventions that the BCW presents revolve around communication design or structural or policy level design, our aim is to infuse ASP products and PSS with subtle meaning that provide cues to the motivations of the user to engage in that activity. We assume higher reflectiveness

on the part of the ASPer and an interpretive intelligence to pick motivational cues from ASP products and PSSs.

With our understanding of behavior change, human motivation, and contexts for embedding meaning in products, we design the "*Catalyst: Design for Motivation to Induce Behavior framework.*" Our framework is designed to guide expert level designers in a step-by-step manner for the following:

1. Broadly observing the motivations of a target user group is to engage in an activity or behavior under the three heads: *Competence*, *Autonomy* and *Relatedness Needs*.
2. Selecting cropped images depicting such motivations with captions.
3. Asking subjects from the target user group to arrange the images from most motivating to least motivating along the three scales: *Competence*, *Autonomy* and *Relatedness Needs*.
4. Constructing a composite scale from all the ranking data and selectively picking elements along the scales to incorporate in the final design. The move should be toward most motivating with an eye for what the project goals are.
5. Constructing the Semantic Profile.
6. Brainstorming on ways the elements of the Semantic Profile can be embedded in the Operational and the Socio-Linguistic contexts.
7. Mindfully considering the opportunities afforded by the environment and the capability of the target user.

In the last leg of our research, we conduct a thorough evaluation of the Catalyst framework in terms of usability by expert designers and how effective it is in designing for motivation. At the onset, we conduct a pilot test by handing out our framework to six PhD candidates in the department of Design in IIT Guwahati and noting their qualitative assessment of it. We also ask two designer groups: first a novice designer and then, a group of two expert designers, to use the Catalyst framework and design ASP kits for children in the early teen group of low-income communities. We studied their designs and critiqued them. Also, in our first iteration, we modified our framework based on the feasible feedback from the pilot tests and our observations from the use cases. We, then handed the modified frameworks to 22 expert designers with a structured questionnaire designed to measure usability, satisfaction, understandability, and validity of the framework. The questions were designed as rating questions with 7-point Likert scales. The results were analyzed using MSA and the questionnaire was subsequently modified. The results of the modified questionnaire were then analyzed through Cronbach's alpha to test for internal consistence, Spearman's Rank Correlation Coefficient to test for monotonicity in the data, and Point-Biserial Correlation Coefficient to test for monotonicity between a continuous and a dichotomous set of data. We also qualitatively analyzed the statistical results for a deeper understanding.

Our analyses confirmed the Catalyst Framework's effectiveness, satisfaction, and perceived understandability, supported by strong internal validity. Experts endorsed its integration of user motivations into design processes, with high satisfaction levels and a positive correlation between perceived usefulness and satisfaction. While perceived understandability was positively reviewed, the color scheme emerged as an area for refinement. Despite an overall endorsement, the expert designers recommended an introductory explanation of the kind of behavior that can be modified with the Catalyst framework. They also asked for more explanation through examples of how meaning can be 'designed' in the final step. Overall, the experts required less detailing than what the framework offered and focused more on the theory behind it and the flow of information from one step to the other.

In order to test the efficacy of the framework, we designed a workshop to be held with school students. The workshop had 120 students, who were divided into two groups: a control group and an experimental group, with 60 students each. Fifty undergraduate students from Design were asked to act as coordinators in the workshop. The control group received a Design Thinking toolkit wherein they received step-by-step guidance on how to identify a need and develop paper prototype of a product that can satisfy that need. This toolkit was not designed using the Catalyst framework. The experimental group received an ASP kit that taught them the practice of Origami and demonstrated how a product can be built using it. This kit was designed using our framework. Both the groups received assistance from the volunteers. The latter workshop was carefully designed to have all the elements of the semantic profile.

At the end of the workshops, we distributed a structured questionnaire to coordinators, evaluating their observations of school children's psychology and behavior during the workshops. The analysis considered a qualitative assessment of the motivation levels, task performance, effort, goal setting, and achievement. Qualitative coding revealed that experimental group experienced higher growth in *competence* and *relatedness needs*, while the control group perceived greater *autonomy*. The kit received by the experimental group encouraged collaboration, resource sharing, and innovative designs, fostering a sense of *competence* and *relatedness needs*. The kit received by the control group, viewed as a school assignment, prioritized mastery, goal-setting, and achievement. Task Choice measure revealed higher interest in MUNKI's Origami practice, indicating varying motivations between the groups. The task choice measure, however, gave a clearer indication of which practice had greater likelihood of adoption, with a significantly higher number of children desiring to try the former kit or to continue with the practice it taught.

The comprehensive evaluation of the Catalyst framework affirmed its usability as well as efficacy in designing for adoption of ASP practices. However, though designed to facilitate adoption of ASP in our context, it can be used to design for other cases, where behavior change is expected to emanate from a reflective level.

While the Maker Movement is growing today, it presents opportunities for designers globally to push production and consumption systems in a more sustainable direction. So far, designers have looked at capability and opportunity to engage in ASP. Our framework aids designers to look at it from a more psychological point of view and design at a more subtle level.

12. Future Work

In this chapter, we discuss the potential avenues for further research in the field. While the present study has contributed valuable insights and outcomes, there remain unexplored areas and challenges that merit attention from future researchers and practitioners. This chapter outlines some of the key directions for future work, building upon the foundations laid by this study and addressing the evolving landscape of our subject matter.

12.1. Exploring Diffusion for ASP

The current study explores how ASP practices can be readopted by individuals in rural and semi-urban communities of emerging economies. However, it is important to note that many of these practices are traditionally conducted in a socially collaborative manner within these communities. Given this context, future research could delve deeper into understanding the socio-cultural dynamics and social network structures that influence the diffusion of such practices. By investigating these factors, researchers could provide valuable insights into how designers can more effectively facilitate the re-adoption and spread of ASP practices, tailoring their approaches to fit the unique social fabric and collaborative nature of these communities. Such research could ultimately contribute to more sustainable and culturally resonant design interventions in these contexts.

12.2. Development of a User-friendly Toolkit

The Catalyst framework we designed can be modified and further developed into a user-friendly toolkit, available in either physical or digital formats, based on the qualitative feedback we received from expert designers. This toolkit could include intuitive guides, templates, and practical examples that simplify the application of the framework. If designed thoughtfully, with a strong emphasis on imparting background knowledge derived from theory, this toolkit could be usable not only to experienced designers but also to novices. Additionally, it could be used for other behavior change applications across different contexts.

12.3. Guiding Designers on How to Study Motivations

The Catalyst framework begins with the designer conducting open observations to understand what motivates the target user group for a specific activity. While we suggest using semi-structured interviews as a primary method in this step, the framework allows for flexibility, enabling designers to choose other appropriate methods to study user psychology and motivations. These could include ethnographic studies, focus groups, or even digital analytics to gain a comprehensive view of user behavior. However, the choice

of method can significantly impact the insights gathered. Therefore, future work can explore and elucidate the various tools and techniques available to designers, providing detailed guidance on selecting and applying these methods effectively in the initial motivational study. This could enhance the framework's adaptability and effectiveness across different design contexts.

12.4. Expounding on Ways to Embed Meaning

The expert interviews revealed that while studying user motivations, categorizing them, and constructing the semantic profile were not particularly difficult processes for the designers, the final step of the Catalyst framework—embedding meaning in the operational and socio-linguistic context—posed significant challenges (as discussed in 8.2, page 125). Designers found this phase to be less intuitive, anticipating that it will not be straightforward to effectively integrate the abstract concepts into practical, contextual applications. Future work could explore this process in greater depth, developing more structured guidelines or methodologies to assist designers in embedding meaning more seamlessly and effectively within varied contexts. By addressing these challenges, the Catalyst framework could become a more robust tool for intervention design.

12.5. Designing Community-Based PSS in Emerging Economies

Future research can explore how community-based Product-Service Systems can be systematically designed, leveraging the inherent collaborative practices observed in rural communities. Investigating the social dynamics, norms, and resource-sharing mechanisms within these communities could provide valuable insights into creating PSS models that are socially embedded, sustainable, and economically viable. Such research could focus on how to structure and scale community-driven PSS, addressing challenges such as resource limitations, technological integration, and ensuring the sustainability of these systems. This exploration could lead to a new paradigm in PSS design, particularly in emerging economies, where conventional infrastructure investments are challenging.

12.6. Achieving Data Triangulation in Observing Motivations

In step 1 of the Catalyst framework, we suggest the use of semi-structured interviews for studying the motivations of the target user group. However, future research could focus on combining such self-reports with other data sources such as user preferences, task performance and behavioral analytics. This would help enhance data triangulation in studying user motivations, making findings more reliable and providing a deeper understanding of user motivations.

12.7. Guiding the Process of Image Selection in the Cropped Image Technique

The step 2 of the Catalyst framework involves using the cropped image technique to connect user motivations with visual imagery. However, there is currently a notable gap in guiding designers on how to judiciously select images that accurately represent the observed motivations. This lack of direction can result in inconsistencies in how motivations are translated into visual elements. Future research could focus on developing a more structured and systematic approach for image selection in this context. By creating guidelines or criteria for selecting visuals that effectively capture and communicate the intended motivational cues, designers could achieve more precise design outcomes. This exploration could also enhance the applicability of the Catalyst framework to other design contexts where creating a mental map is required.

12.8. Expanding the Scope

The current research focuses on how ASP can be stimulated at an individual level. However, in emerging economies, a significant portion of production occurs outside the formal industrial framework, within the informal sector. This sector operates with its own unique set of challenges and opportunities, often disconnected from formal industry practices. Future research can explore how ASP practices might not only coexist with but also collaborate with the existing factory system. By investigating synergies between these two modes of production, researchers can examine how they might collectively evolve into a Distributed Economy, fostering a more integrated and resilient production ecosystem rather than remaining as separate, parallel systems. This approach could reveal new pathways for sustainable growth and innovation in both formal and informal sectors.

Our research has provided valuable insights on ASP practices in emerging economies and on ways to facilitate their adoption, but there are unexplored areas and challenges that merit attention. Such studies will not necessarily only further adoption and diffusion of ASP practices, but also other practices that can move the current systems towards higher sustainability in future.

13. List of Publications and Planned Publications

The following are the research papers that have been published.

1. **Connected us! How Social Motives Determine DIY Behaviorism in Rural Base of the Pyramid Communities.**

Abstract: Social influence has long been known to be a powerful determinant of individuals' behavior. In collectivist societies such as rural Base of the Pyramid (BoP) communities, social influence can play an active role in the performances of need-based Do-It-Yourself (DIY) practices for survival. Several scholars have studied DIY communities though Ryan and Deci's Self-Determination theory that explained how relatedness needs motivate DIY in online forums, hackerspaces, and maker communities. However, not much research has been done on how social influence shapes DIY behaviorism. In this paper, we focus on the BoP and present a study conducted in five rural BoP communities in India. Our research studied how, in such communities, an individual's propensity to do DIY is influenced by others in their network. Through contextual enquiry, we investigated about the social motives that come to play when there is peer-to-peer influence for doing DIY. Our results indicate a strong disposition among the members of the community to engage in DIY activities that are pursued by others in their social milieu and the various motives that lead them to do so. In conclusion, we also discuss the implications of such social influences for design and how such motives can be leveraged for the diffusion of DIY products and product systems in such communities.

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2. **Motivation for Do-It-Yourself in Rural Base of the Pyramid Communities and the Changing Landscape**

Abstract: Making is a creative experience of imagination and tinkering through which one finds resourcefulness in surrounding objects and materials. The propensity to make has been widely studied through Ryan and Deci's self-determination theory that sheds light on how makers are driven by intrinsic and extrinsic motivational factors. However, most of these studies have focused on do-it-yourself (DIY) movements that originated in the West such as the maker movement, the steampunk movement, and

regenerative living. In this paper, we focus on the Base of the Pyramid (BoP) community from rural India and present a study that investigates into the motivational tendencies that catalyze DIY in such communities. We studied DIY practices in five BoP communities in rural India (Assam, a northeastern state of India) through contextual enquiry using semi-structured interviews. In the light of practice theory that considers *skills, images,* and *stuff* as the three components of a practice, we analyzed the motivational factors that give meaning to DIY in rural BoP communities. Furthermore, the observed inter-generational trend(s) showed how the linkages between these interconnected elements are changing over time and how new meaning might be required for DIY practices to sustain in such communities.

Authors:

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3. Lamps-'designerly ways' for sustainable distributed economy

Abstract: With the growing importance of resonating products with human behavior, the upcoming field of Design for Sustainability (DfS) is reorienting itself from a 'technical and product-centric focus towards more socio-technical systems' wherein people, their interactions and behavior play a crucial role. Scholarships in DfS have introduced a multitude of frameworks for sustainability-orienting design such as Methodology for System Design for Sustainability, Circles of Sustainability and LEED. However, during our experience of teaching these methodologies to Design undergraduate students, we observed that the frameworks, often fell short in fostering a "designerly way" of thinking and doing amongst novice designers. They struggled to see open space within these guidelines to explore, experiment and tinker. Hence, we designed a method, LaMPS (Locally available Materials, Practices and Skills), which could be used as a precursor to the more system oriented DfS course and can be introduced to students during their 1st Design Methodology course at the undergraduate level. LaMPS integrates observational studies and material exploration and characterisation using the Material Driven Design method, and translation of the same into products. LaMPS stresses on identification and incorporation of local materials, local skills and local practices, the three keystones of Distributed Economy (DE), in the designed system. Hence it serves as an introduction to the DfS course in the lines of DE.

Authors: Prarthana Majumdar, Sharmistha Banerjee, Jan-Carel Diehl, JML van Engelen

Citation: Majumdar, Prarthana, et al. "Lamps - 'Designerly Ways' for Sustainable Distributed Economy." Designing Sustainability for All - 3rd Lens World Distributed Conference. Eds. Ambrosio, Marcelo and Carlo Vezzoli. 1 ed. Vol. 1. Milano, Italy: Edizioni POLI.design, 2019. 245-50.

The following are the research papers are planned for submission.

4. Assisted Self-Production in Emerging Economies: An In-Depth Analysis of Do-It-Yourself (DIY) Cases from India

Abstract: The Maker Movement brought about a paradigm shift in the production-consumption systems around the world, encouraging personalization and individuality. A large body of scholarship has studied the Do-It-Yourself (DIY) Movement in the West. But few scholars have studied this new production-consumption system in the context of emerging economies. MIT's FabLabs have been established globally, but it remains unclear whether a deeper understanding of DIY in these communities is necessary to give meaning to these physical spaces. Our research aims to develop a deeper understanding and define DIY in the context of emerging economies and develop a classification of such practices in these communities. To achieve this, we conducted observational field studies in five rural communities in India and a thorough literature review of DIY cases from emerging economies. Our research resulted in a compendious definition of DIY in emerging economies, its classification, the differentiating factor, and a new, more inclusive term: "Assisted Self-Production," to denote such making practices. The motivation that drives the different DIY practices, emerged as the key differentiating factor. This signifies that it is essential to understand what meaning making has in the minds of the makers, rather than merely imparting skills and tools in such communities.

Authors:

Prarthana Majumdar, Sharmistha Banerjee, Jan-Carel Diehl & J. M. L. Van Engelen

5. Design for Motivation to Induce Behavior Change

Abstract: The twentieth century Maker culture brought in a new orientation in the minds of consumers. Its non-conformism with standard factory-made goods and passive consumerism empowered people to look for self-actualization through making. But several scholars believe, that beyond self-actualization, the Maker Movement has the potency to be the next wave in production systems. A glimpse of it has been visible during the global COVID-19 pandemic when essential medical supplies had to be manufactured by informal DIY-

producers to cope with the shortage of supply. Yet, in order to assume the dimension of a mainstream production system, DIY has to be implanted at a behavioral level of consumers who have become accustomed to products that require minimal effort in operating, let alone making. In this paper, we probe into frameworks for behavior change and associated intervention design and explore how designers can create DIY product service systems that evokes making at a behavioral level. Furthermore, we investigate how the motivational determinant of behavior can be strengthened, embedding such PSS's with semantic devices that signal intrinsic motivation to the user. Our proposed framework, 'Design for Motivation to Induce Behavior Change', is structured as a step-by-step guide to a designer to understand the intrinsic motivations of a user for a certain activity, embed such motivations as semantic devices in the PSS and provide necessary skills and materialities to induce behavior change. Our use case is Do-It-Yourself in the context of Emerging economies, which is counter-culture to the current consumeristic behavior of people. This framework might have implications in the design of other PSS's where behavior change at a conscious level is required such as energy use, sustainable commute, healthy eating, meaningful socializing, etc. and the designer needs to put special emphasis on the reflective determinants of behavior into consideration.

Authors:

Prarthana Majumdar, Sharmistha Banerjee, Jan-Carel Diehl & J. M. L. Van Engelen

6. Application of Mokken Scale Analysis in Design Research for Effective Questionnaire Design

Abstract: Questionnaire design is an integral part of Design Research. Researchers use a variety of techniques and best practices to design effective questionnaires such as identifying existing validated scales in literature, conducting pilot tests, choosing appropriate response scales, randomizing the order of questions, using visuals, etc. While the effort is usually to design the questionnaire in a manner in which the researcher can fulfil the research goals, understand the participants, avoid biases and provide a good user experience, in case of unvalidated questionnaires, it is often untested whether the questions measure the latent construct that the researcher is trying to infer from the observable data. For evaluating the quality and structure of the measurement instruments of a latent construct, a statistical technique called Mokken Scale Analysis (MSA) is used in the field of social sciences, particularly in the field of psychology and educational research. However, MSA has not been used in the field of Design Research. In this paper, we present a case of application of MSA to response data of a structured interview in a Design Research project, and the subsequent statistical analysis that has been conducted to measure certain latent constructs. We also discuss how MSA, with its ability to assess the scalability of items in a questionnaire the hierarchical order of item difficulty, can help Design researchers in constructing effective questionnaires.

Authors:

Prarthana Majumdar, Sharmistha Banerjee, Ankit Basak & J. M. L. Van Engelen

7. Composite Scale and Subcultures: A Toolkit for Analyzing Image/ Object Ranking Data

Abstract: This paper introduces the Composite Scale and Subcultures (CSS) toolkit, an Excel-based solution tailored for professionals and researchers immersed in the analysis of image and object ranking data. CSS simplifies the intricate task of recording and managing rankings from diverse respondents, employing statistical techniques such as Kendall's W to assess agreement levels and reveal consensus within the ranking data. The CSS toolkit offers an invaluable data visualization feature for composite scales, empowering users to discern trends, outliers, and gauge the typicality of individual images or objects. This visualization aids designers in obtaining a comprehensive understanding of the data. Furthermore, CSS employs K-means clustering to delve into subgroups within the data, unveiling subcultures with distinct preferences for images and objects. It helps in the identification of distinct personas based on their agreement with the composite scale, thereby discerning the specific persona affiliations of individual users. This nuanced exploration becomes particularly relevant when there is a divergence in the data. Notably, CSS goes beyond the conventional by spotlighting subcultures, especially when specific images or objects exhibit divergence at two or more positions. The toolkit enhances the analysis by providing in-depth insights, and its user-friendly features offer practical assistance to designers. By incorporating textual guidance for interpretation, CSS emerges not only as a powerful analytical tool but also as a supportive resource for designers seeking a nuanced understanding of image and object ranking data.

Authors:

Prarthana Majumdar, Ankit Basak, Sharmistha Banerjee & J. M. L. Van Engelen

8. Design for Motivation to Induce Behavior Change: An Experimental Evaluation of the Catalyst Framework

Abstract: The Maker Movement brought about a new paradigm in production and consumption systems around the world. Consumers today, live in an environment surrounded by products that impose an unsolicited passivity and an alienation from Making. The Maker Movement is an antithetic response to this industry-imposed passivity and seeks to reunite the maker with Making. Yet, when we look into the trajectory of this movement in the West and in emerging economies, we observe a clear divergence. The West is driven by the need for self-actualization whereas communities in emerging economies view Making as either a survival need or a traditional practice. It is this difference in meaning that makes adoption of Making in emerging economies a fundamentally different matter for Design, especially when the ‘need’ that necessitates it is relieved by economic wellbeing. Given this consideration, the ‘Design for Motivation to

Induce Behavior Change (Catalyst)' framework was developed. It guides designers on a step-by-step journey to understand user motivations to engage in Making and semantically embed them in products and Product Service Systems. This paper presents the results of a workshop conducted with100 school children, to test the efficacy of the *Making* kit, developed based on the Catalyst framework. A comparative analysis with the another *Making* kit (not designed using the Catalyst framework) reveals variations in motivation levels as well as the quality of motivation between the control group and the experimental group. We also observed that the experimental group showed higher likelihood to adopt the practice that they received exposure to than the control group. The findings highlight the framework's effectiveness in guiding designs based on user motivations and its positive impact on motivation among users. Though we tested the framework for its ability to facilitate the adoption of Making, it is rooted in fundamental theory from Motivational Psychology, Behavior Change and Product Semantics. As such, it is generic enough to be applied in other Design cases where the designer intends to bring about behavior change with a focus on user motivation.

Authors:

Prarthana Majumdar, Sharmistha Banerjee, Beda Prakash Das, Pankaj Upadhyay & J. M. L. Van Engelen

Submitted to 30th ISDRS Conference 2024.

9. Making in Emerging Economies

Abstract: Since its inception, the Maker Movement has moved Western societies towards personalization, identity creation through products, and self-actualization through Making. But when we trace the roots and the trajectory of the movement in the West and in Emerging economies, we observe a clear divergence in history. All societies were historically agrarian and actively engaged in Making practices for survival. But the coming of the Industrial Revolution in the West brought about a pivotal change to human society. In the West, labor moved from farms to factories and mass-produced goods began to alienate people from Making. Consumerism grew till the point when society began to question the sterility and lack of personal identity in products and the Maker Movement started towards the turn of the century. The trajectory of Making in emerging economies is, however, significantly different. While the West was being industrialized in the 18th and 19th century, most emerging economies were colonized and deliberately deindustrialized to serve as markets for finished goods from the colonial nations. Making remained as an essential survival skill until recently when offshore production in South-East Asia made products affordable for such communities. The growth in consumerism in such economies have further been accelerated by the new Design philosophy, "Design for Base of the Pyramid" that specifically designs low-cost products for such communities or includes them as co-producers. While the Maker Movement has been extensively studied in the context of the West, in this paper we study the history of Making in the context of one of the biggest emerging

economies: India and investigate the unique opportunities it presents to reshape the production-consumption systems in such communities. Countries such as India, China, Vietnam, and Cambodia are some of the most polluted countries in the world today. Through a thorough literature review, we seek to enquire if the Maker Movement can move production and consumption towards higher sustainability in such communities.

Authors: Prarthana Majumdar, Sharmistha Banerjee, Ravi Mokashi Punekar, Jan-Carel Diehl & J. M. L. Van Engelen

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Annexure 1: Initial Codes from the Grounded Theory Application Process and Sample Focus Code Formation

Table 19 The initial codes during the process of application of Grounded Theory on semi-structured interviews from the fieldwork.

Round	Case/ Home	Subjects	Initial Code	Examples of Conceptual Cluster	Concept/ Focus Code
1	1	3	Agrarian Livelihood	Ideation for new designs for weaving	Creativity/ Craftsmanship
			Simple tools for DIY	Penchant for artistic pursuits	
			Performance of DIY by women at home	Engagement in craftwork	
			Performance of household chores by women	Participation in creative DIY	
			Busy lifestyle of rural women	Penchant for artistic pursuits	
			Early start of the day		
			Performance of DIY for relaxation	Simple tools for DIY	Simple Tools
			Hardworking lifestyle	Simple procurement of tools	
			Lack of market availability of products		
			Seeking of increase in making skills	Interest in community work	Norm to help each other
			Labor intensive nature of DIY	Socializing with neighbors	
			Handing down of practice from one generation to another	Helping neighbors	
			Fast learning curve	Socializing with neighbors	
			Self-consumption of DIY products	Socially active community	
			Selling of DIY products by few people	Consideration of community work as privilege	
			Inability to conduct weaving DIY in monsoon	Socially active lifestyle	
			Lack of infrastructure in vilage		

			Lack of resources in homes		
			Socializing with neighbors		
			Socially active community		
			Enrollment in SHGs		
			Financial aid from government		
			Exclusion of the poorest from community and collaborative activities		
			Helping neighbors		
			Maintaining Vaishnavite traditions		
			Participation of rural people in political matters		
	2	1	Busy lifestyle of rural men		
			Socializing with neighbors		
			Helping neighbors		
			Maintaining Vaishnavite traditions		
			Consideration of community work as privilege		
	3	2	Learning of DIY skills during early teenage		
			Handing down of practice from one generation to another		
			Selling of DIY products by few people		
			Local and non-local customers		
			Assamese traditional designs		
			Agrarian Livelihood		
			Early start of the day		
			Performance of DIY for relaxation		
			Busy lifestyle of rural women		
			Socializing with neighbors		
			Sharing of knowledge about DIY practice with neighbors		
			Exclusion of the poorest from community and collaborative activities		
			No external of entertainment except DIY for women		

			Seeking of increase in making skills		
			Use of books for seeking inspiration for new designs		
			Ideation for new designs for weaving		
			Helping neighbors		
			Lack of community activity		
			Hardworking lifestyle		
			Unaffordability of available goods		
			Self-consumption of DIY products		
			Labor intensive nature of DIY		
	4	1	Early start of the day		
			Agrarian Livelihood		
			Participation of all family members in household chores		
			Ploughing of fields in summer		
			Close knit family structure		
			Socializing with neighbors		
			Hobbies around Vaishnavite culture like singing and music		
			Want to move to city for job opportunities		
			High school dropout		
			Inability to see DIY as a livelihood earning activity		
			Conferring of Model Farmer status		
			Adoption of farming techniques of model farmer by other farmers		
			Sharing of knowledge about DIY practice with neighbors		
			Honey rearing		
			Devastating floods in monsoon		
			Taking up of extra work for monetary benefits		
			Financially backward		
			Respect from the rural community		
			Helping neighbors		

			Performance of household chores by women		
			Acquisition of Government training in different departments of agriculture		
			Helpful Training sessions		
			Use of books for dissemination of knowledge about agricultural techniques.		
			Engagement in craftwork		
			Financial aid from government		
			Hindrance to DIY activities due to poverty		
			Penchant for artistic pursuits		
	5	1	Agrarian Livelihood		
			Inability to see DIY as a livelihood earning activity		
			Socializing with neighbors		
			Helping neighbors		
			Early start of the day		
			Performance of DIY for relaxation		
			Simple tools for DIY		
			Participation of all family members in household chores		
			Child marriage		
			Handing down of practice from one generation to another		
			inability to conduct DIY for selling purposes with age		
			Want to move to city for job opportunities		
			Hindrance to DIY activities due to poverty		
			Maintaining Vaishnavite traditions		
			Socializing with neighbors		
			Lack of knowledge of other forms of DIY		
			Socially active community		
			Helping neighbors		

			Unaffordability of available products		
			Financially backward		
			Hindrance to DIY activities due to poverty		
	6	1	Weaving done as relaxation		
			Lack of labor rights in jobs		
			Early start of the day		
			Want to move to city for job opportunities		
			Inability to see DIY as a livelihood earning activity		
			Performance of DIY for relaxation		
			Selling of DIY products by few people		
			Exchange of DIY products is encouraged in the village		
			Hindrance to DIY activities due to poverty		
			Want to move to city for job opportunities		
			Helping neighbors		
			Socializing with neighbors		
			Child Marriage		
			Ideation for new designs for weaving		
			Maintaining Vaishnavite traditions		
			Acquisition of weaving supplied from local markets		
	7	2	Agrarian Livelihood		
			Inability to see DIY as a livelihood earning activity		
			Hindrance to DIY activities due to poverty		
			Early start of the day		
			Poor health conditions		
			Participation of all family members in household chores		

			Taking up of extra work for monetary benefits		
			Stress on Education		
			Desire to acquire professional training in creative work		
			Socially active community		
			Lack of knowledge in use of technology		
			Desire to learn the use of technology		
			Limited use of cell phones in the rural community		
			Socializing with neighbors		
			Desire to stay abreast with current affairs		
			Sharing of knowledge about DIY practice with neighbors		
			Labor intensive nature of DIY		
			Lack of time to pursue DIY		
			Consideration of DIY as an essential life skill		
			Penchant for artistic pursuits		
			Want to move to city for job opportunities		
			Socially active community		
			Maintaining Vaishnavite traditions		
			Consideration of community work as privilege		
			Hobbies around Vaishnavite culture like singing and music		
			Continuation of Vaishnavite traditions by young people		
			Learning of DIY skills during early teeneage		
			Handing down of practice from one generation to another		
			Sharing of knowledge about DIY practice with neighbors		
	8	1	Early start of the day		
			Agrarian Livelihood		

			Weaving done as DIY		
			Hardworking lifestyle		
			Selling of DIY products by few people		
			Gifting of DIY products		
			Poor health conditions		
			Close knit family structure		
			Financially backward		
			Want to move to city for job opportunities		
			Child marriage		
			Lack of awareness of DIY materials in the market		
			Sharing of knowledge about DIY practice with neighbors		
			Maintaining Vaishnavite traditions		
			Performance of household chores by women		
			Diminishing interest in DIY due to lack of time		
			Participation of all family members in household chores		
			High school dropout		
	Teenagers and Children				
	1	1 F	High ambitions in career		
			Leaning DIY		
			Lack of social activity		
			Watching of television for relaxation		
	2	1 M	Penchant for artistic pursuits		
			Maintaining Vaishnavite traditions		
			High ambitions in career		
			Fascination with science		
			Socially active lifestyle		
			Want for acquiring leadership roles		
			Sharing of knowledge about hobby with peers		

			Medium use of technology such as cell phones		
			Involvement in extra curricular activities		
			Exposure to modern concepts such as reuse and recycle		
			Involvement in technology DIY		
			Participation in creative DIY		
			Enjoyment of experimentation with new things		
			Desire to gain higher knowledge about science		
			Desire to save the environment		
			Influence of peers in career choice		
	3	1F	Penchant for artistic pursuits		
			Desire to acquire professional training in creative work		
			Close knit family structure		
			Enjoyment of experimentation with new things		
			Interest in community work		
	4	1M	Interest in indoor activities		
			Interest in technology related products		
			High ambitions in career		
			Want to move to city for job opportunities		
			Interest in community affairs		
	5	1F	Interest in community work		
			Interest in political matters		
			Desire to stay abreast with current affairs		
			Socially active lifestyle		
			Close relationship with peers		
			Helping peers		
			Influence of online fashion trends		
			Online resources for design purposes		

			Use of technological resources for DIY		
			Interest in community affairs		
			Desire to learn the use of technology		
			Repurposing of old textiles to make new clothes		
			Participation in creative DIY		
			Contentment with life		
	6	1M	Penchant for artistic pursuits		
			Close knit family structure		
			Consideration of community work as privilege		
	7	1M	Socially active lifestyle		
			Involvement with peers		
			Desire to learn the use of technology		
			Exposure to modern concepts such as reuse and recycle		
			Desire to save the environment		
			High ambitions in career		
			Interest in community work		
			Socially inactive		
	8	1M	Interest in political matters		
			Want for acquiring leadership roles		
			Interest in community work		
			Interest in political matters		
			Use of technology for leisure purposes		
	9	1F	Penchant for artistic pursuits		
			Socially active lifestyle		
			Involvement with peers		
			Interest in community work		
			Lack of want to migrate to city		
	10	1F	Penchant for artistic pursuits		
			Hobbies around cultural activities		

			Promotion of DIY by schools		
			Involvement with peers		
			Enjoyment of experimentation with new things		
			Socially active lifestyle		
			Want to move to city for job opportunities		
			Desire to save the environment		
			High ambitions in career		
			Hardworking lifestyle		
			Wants upgradation in education system		
			Participation in creative DIY		
	11	1M	Upward movement in Value chain		
			Community wide work		
			Learning of DIY skills during early teenage		
			Government Training		
			Busy lifestyle of rural men		
			Satisfaction with rural life		
			Recognition valued		
			Sharing of knowledge about hobby with peers		
			Aspiration to train others		
			Small Exports		
			Competition with neighbors		
			Participation of all family members at work		
			Lack of resources in homes		
			Handing down of practice from one generation to another		
	12	1M	Learning of DIY skills during early teenage		
			Participation of all family members at work		
			Government Training		
			Aspiration of next generation to pursue work		
			Helping neighbors		

			Collaboration with other DIYers		
			Busy lifestyle of rural men		
			Taking up of extra work for monetary benefits		
	13	2M	Learning of DIY skills during early teenage		
			Community wide work		
			Participation of all family members at work		
			Employment of others in the neighborhood		
			Economic reasons to adopt DIY		
			Small Exports		
			Import of Raw Materials		
			Aspiration to move up the value chain		
			Labor intensive nature of DIY		
			Sharing of knowledge about DIY practice with neighbors		
			Providing tools to new entrants in the business		
			Enrollment in SHGs		
			Hardworking lifestyle		
			Collaboration with other DIYers		
			Lack community activity		
			Satisfaction with rural life		
			Self-procurement of tools		
			Socializing with neighbors		
			Helping neighbors		
			Stress on Education		
			Financial aid from government		
			Financially backward		
	14	1F	Learning of DIY skills during early teenage		
			Handing down of practice from one generation to another		
			Learning from neighbors		
			Aspiration to move up the value chain		
			Financial sustenance		

			Performance of household chores by women		
	15	1M	Satisfaction with rural life		
			Hardworking lifestyle		
			Busy lifestyle of rural men		
			Handing down of practice from one generation to another		
			Economic reasons to adopt DIY		
			Socially inactive		
			Ideation of own product design		
			Helping neighbors		
			Collaboration with other DIYers		
			Participation of all family members at work		
			Aspiration of next generation to pursue work		
			Independent work to ensure quality		
			Upward movement in Value chain		
	16	1M 1F	Busy lifestyle of rural men		
			Busy lifestyle of rural women		
			Labor intensive nature of DIY		
			Taking up of extra work for monetary benefits		
			Self-consumption of DIY products		
			Financially backward		
			Aspiration to move up the value chain		
			Helping neighbors		
			Socializing with neighbors		
			No external source of entertainment except DIY for women		
			Early start of the day		
			Lack of labor rights in jobs		
	17	1M	Learning of DIY skills during early teenage		

			Government Training		
			Interest in DIY for adoption		
			Economic reasons to continue DIY		
			Financially backward		
			High dissatisfaction with economic reward		
			Labor intensive nature of DIY		
			Seeks innovativeness		
			No external source of entertainment except DIY for women		
			Busy lifestyle of rural men		
			Want to move to city for job opportunities		
			Ideation of own product design`		
			Lack of desire to explore new DIY forms		
			Confidence in hands-on work		
			Wish to gain access to external resources for design purposes		
	18	1M	Handing down of practice from one generation to another		
			Socially active lifestyle		
			Taking up of extra work for monetary benefits		
			Stress on Education		
			Want to move to city for job opportunities		
			Adopts Make-do techniques at home		
			Satisfaction with rural life		
	19	2F 1M	Child marriage		
			Participation of all family members in household chores		
			Conduction of DIY only in free time		
			Busy lifestyle of rural men		
			Busy lifestyle of rural men		

			Watching of television for relaxation		
			Socially active lifestyle		
			No ideation for products		
			Seasonal demand		
			Unhelpful neighbors		
			Early start of the day		
			No Government aid		
			Hindrance to DIY activities due to poverty		
			Labor intensive nature of DIY		
			Community wide work		
			Stress on Education		
	20	1M	Inventive mind		
			Economic reasons to adopt DIY		
			Easily available components		
			Recognition valued		
	21	1M	Recognition valued		
			Cutting costs		
			Easily available components		
	22	1M	Hacking of existing technology		
			Cutting costs		
			Inventive mind		
			Contextualized solution		
			Addition to existing technology		
			Easily available components		
	23	1M	Cutting costs		
			Contextualized solution		
			Hacking of existing technology		
			Inventive mind		
	23	1M	Agrarian Product		
			Modification to existing technology		
			Single Innovator		
			Contextualized solution		
			Economic Driver		

			Increasing contextualization and productivity of existing product		
			Locally available resources		
			Resource constrained innovation		
			Hacking of existing technology		
			Solving a local problem		
			Response to critical local problem		
			Purpose is to solve a problem		
	24	1M	Single Innovator		
			Increasing contextualization and productivity of existing product		
			Non-local problems		
			Tinkering		
			Actively identification of intervention areas		
			Lack of willingness to commercialize products		
			Iterative design		
	25	Community	Locally available resources		
			Economic Driver		
			Hacking of existing technology		
			Diffusion of practice		
			Commercialization		
	26	Community	Locally available resources		
			Economic Driver		
			Contextualized solution		
			Solving a local problem		
			Ingenuity		
			Diffusion of practice		
	27	Community	Diffusion of practice		
			Contextualized solution		
			Solving a local problem		
			Resource constrained innovation		
			Hacking of existing technology		
			Economic Driver		
	28	1M	Single Innovator		

			Bricoleur		
			Non-local problems		
			Locally available resources		
			Hacking of existing technology		
			Lack of willingness to commercialize products		
	29	1M	Hacking of existing technology		
			Locally available resources		
			Ingenuity		
	30	Community	Locally available resources		
			Community level DIY		
			Diffusion of knowledge without ICT		
			Ancient practice		
	32	Community	Solving a local problem		
			Mechanical operations		
			Part of traditions		
			Locally available resources		
			Eco Materials		
			Handing down of practice from one generation to another		
			Community wide work		
			Cultural Artifact		
			Aesthetics		
			Ancient practice		
			Self-consumption of DIY products		
	33		Locally available resources		
			Eco Materials		
			Ancient techniques		
			Need existed before		
			Community wide work		
			Mechanical operations		
			Commercialization		
			Cultural Artifact		
			Self-consumption of DIY products		
			Many products from one material		

	34		Community wide work		
			Cultural Artifact		
			Ritual		
			Traditional Practice		
			Handing down of practice from one generation to another		
			Aesthetics		
			Self-consumption of DIY products		
	35		Community wide work		
			Traditional Practice		
			Eco Materials		
			Locally available resources		
			Aesthetics		
			Commercialization		
			Self-consumption of DIY products		
			Simple tools for DIY		
	36		Community wide work		
			Self-consumption of DIY products		
			Ancient techniques		
			Simple tools for DIY		
	37		Community level DIY		
			Eco Materials		
			Many products from one material		
			Ancient techniques		
			Handing down of practice from one generation to another		
			Utility		
	38		Cultural Artifact		
			Ritual		
			Symbolic Value		
			Utility		
			Traditional Practice		
			Eco Materials		
			Aesthetics		

			Community wide work		
	39		Solving a local problem		
			Locally available resources		
			Commercialization		
			Response to critical local problem		
			Curiosity		
			Ingenuity		
			Entrepreneurship		
			Tinkering		
	40		Entrepreneurship		
			Locally available resources		
			Economic Driver		
			Purpose is to solve a problem		
			Tinkering		
			Response to critical local problem		

Annexure 2 Focus Codes and Theoretical Codes from the Grounded Theory Application Process.

Table 20 The focus and theoretical codes during the process of application of Grounded Theory on semi-structured interviews from the fieldwork.

Focused Code	**Theoretical Code**	**Motivation (Differentiator)**
Local materials/ resources	Prosumption	Self-consumption
Simple tools		
Tradition		
Learnt in early childhood		
Products for daily usage		
Not available in the market		
Performance of DIY for relaxation		
Norm to help each other		
Simple techniques		
Creativity/ Self-expression	Craft	Self-expression/ craftsmanship
Local materials/ resources		
Simple techniques		
Tradition/ Handed down intergenerationally		
Products for daily usage		
Products for selling		
Growth in Carftsmanship		
Diffusion of ideas in the craft community		
Simple tools		
Learnt in early childhood or teenage years		
Local materials/ resources	Jugaad	Cutting Edge and Cutting Corners
Local problem/ unaffordability of product		
Local problem/ unavailability of solution		
Dilapidated use of technology		
Inventiveness		

Low cost solution		
Cutting edge and cutting corners		
Simple/ non-simple technique/ technology		
Local problem/ unavailability of product	Grassroots Innovation	Solving local problems
Local problem/ unavailability of solution		
Inventiveness		
Innovativeness		
Local/ non-local materials/ resources		
Simple/ non-simple technique/ technology		
Entrepreneurship		
Inventiveness	Bricolage	Tinkering/ Inventiveness
Innovativeness		
Local/ non-local materials/ resources		
Problem solved local/ non-local		
Tinkering with materials		
Tinkering with technology		

Annexure 3: Questionnaire for experts to be filled before viewing the Catalyst Framework

Name _____

Email _____

Have you ever designed a product or a product service system where you needed to consider the motivation of the target user?

Yes **No**

Describe how you designed the product or the product service system so that it motivates a certain behavior in your target user.

_____

_____

_____

_____

On a scale of 1-10, how do you rate yourself as a designer, 1 being a novice and 10 being an expert?

	1	2	3	4	5	6	7	8	9	10	
Novice	O	O	O	O	O	O	O	O	O	O	Expert

Annexure 4: Questionnaire for experts to be filled after viewing the Catalyst Framework

The following is the structured questionnaire handed to experts to be filled after they view the Catalyst Framework.

Name _____

Email _____

It helps me be more effective in understanding the motivations of the target user group.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It helps me be more effective in embedding their motivations in my design.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It helps me be more productive.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It is useful.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It makes the things I want to accomplish easier to get done.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It meets my needs.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It does everything I would expect it to do.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

I am satisfied with the toolkit.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

I would recommend it to another designer.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It is fun to use.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It works the way I want it to work.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

I think I will use it in a future project.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

It is pleasant to use.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The concepts presented in the framework are easy to understand.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The flow of information from one step to the next is easy to understand.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The steps are in logical sequence.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The terms used in the framework are easily understandable.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The domain specific concepts are explained with enough elaborateness.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The domain-specific terms are understandable.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

There is consistency in terms used.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The colors used in the graphics help to differentiate the concepts.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The language used in the framework is easy to understand.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

The illustrations help in understanding the concepts better.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

You are given an assignment to design a swimming pool for a township in India where there are hundreds of children in the 5-10 years age group. Is the "Capability" of the children for this behavior (swimming), same as their perceived "*Competence*"?

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

For your design assignment, you decide to adopt the Design for Motivation framework. You begin by conducting unstructured interviews with a few children in the 5-10 years age group in the township. How will you use that data?

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

In Step 2, will you intervene in the process where the participants are arranging the images along the scales from the ‘Most Motivating’ to the ‘Least Motivating’?

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

In Step 3, you are deciding on what components of *Competence*, *Relatedness Needs* and *Autonomy* you will embed in the design. What will you prioritise: picking the most motivating factor or the project goals?

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

You observed that “Winning accolades in sports events” has been rated as the most motivating factor under *Relatedness Needs* (step 2). Let us consider that in step 3, you pick this factor to be embedded in your design. In your design of the swimming pool, you include a display area nearby where the achievements of the children will be highlighted. Have you embedded meaning in the operational context or the socio-linguistic context?

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

Annexure 5: Raw data from expert evaluation

Table 21 *Raw data from the expert evaluation of the questions measuring effectiveness/ usefulness of the Catalyst framework. (1 – Strongly disagree, 7 – Strongly Agree)*

Usefulness							
Participant Id	Q1	Q2	Q3	Q4	Q5	Q6	Q7
	It helps me be more effective in **understanding the motivations of the target user group.**	It helps me be more effective in embedding their motivations in my design.	It helps me be more productive.	It is useful.	It makes the things I want to accomplish easier to get done.	It meets my needs.	It does everything I would expect it to do.
P1	6	5	5	6	5	5	6
P2	5	6	5	6	4	5	4
P3	5	6	7	6	6	7	5
P4	6	6	6	6	4	5	5
P5	7	4	5	5	4	3	3
P6	5	4	5	4	3	3	4
P7	7	7	7	7	7	5	4
P8	5	6	3	5	5	5	3
P9	7	7	6	7	7	6	6
P10	7	6	5	4	5	5	4
P11	5	6	6	5	6	4	5
P12	7	7	5	6	4	5	5
P13	5	5	5	5	5	5	5
P14	4	3	2	3	1	2	2
P15	6	7	6	7	6	6	5
P16	4	4	3	4	3	3	2
P17	5	4	5	5	5	6	4
P18	6	5	4	5	3	4	2
P19	5	6	6	6	7	6	5
P20	7	6	5	6	6	5	5
P21	5	6	6	6	5	4	5
P22	7	6	7	7	5	5	3

Table 22. Raw data from the expert evaluation of the questions measuring satisfaction of the Catalyst framework. (1 – Strongly disagree, 7 – Strongly Agree)

Satisfaction						
Participant Id	Q1	Q2	Q3	Q4	Q5	Q6
	I am satisfied with the toolkit.	I would recommend it to another **designer.**	It is fun to use.	It works the way I want it to work.	I think I will use it in a future project.	It is pleasant to use.
P1	6	6	6	6	5	6
P2	4	4	6	4	5	5
P3	6	6	7	6	5	5
P4	5	5	4	5	6	4
P5	4	4	4	4	4	4
P6	3	4	4	3	3	4
P7	4	5	5	4	6	5
P8	6	6	4	4	6	4
P9	6	7	7	6	7	7
P10	5	4	5	3	4	5
P11	6	6	4	4	6	4
P12	5	5	7	5	6	7
P13	5	5	5	5	5	5
P14	2	3	2	2	3	2
P15	6	6	5	6	7	6
P16	2	2	2	3	3	4
P17	5	4	5	5	4	4
P18	4	6	3	5	6	5
P19	6	6	7	6	7	6
P20	6	7	6	6	6	6
P21	6	6	5	5	5	5
P22	6	7	7	5	7	6

Table 23 *Raw data from the expert evaluation of the questions measuring understandability of the Catalyst framework. (1 – Strongly disagree, 7 – Strongly Agree)*

Understandability										
Participant Id	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
	The concepts presented in the framework are easy to understand.	The flow of information between various steps is easy to comprehend.	The steps are in logical sequence.	The terms used in the framework are easily understandable.	The domain specific concepts are explained with enough elaborateness.	The domain-specific terms used are specific.	There is consistency in terms used.	The colors help to differentiate the different concepts.	The language used in the framework is easy to understand.	The illustrations help in understanding the concepts better.
P1	6	6	6	6	6	6	6	5	6	6
P2	3	6	6	4	3	3	4	3	3	4
P3	5	5	6	7	6	6	7	7	5	7
P4	5	5	5	5	4	5	5	5	6	5
P5	5	3	6	4	4	5	5	6	5	5
P6	4	6	6	6	6	6	6	6	6	5
P7	3	3	5	5	3	4	6	5	5	3
P8	6	6	6	5	5	6	6	6	6	5
P9	7	7	7	6	7	7	7	4	6	5
P10	3	4	5	4	5	3	4	5	6	5
P11	4	5	6	5	5	5	6	6	6	6
P12	7	5	6	6	5	5	7	7	7	7
P13	6	6	6	6	6	6	6	6	6	6
P14	3	2	2	4	2	4	5	6	5	3
P15	5	5	5	6	6	6	6	4	6	7
P16	4	4	4	3	2	2	5	6	6	4
P17	5	6	6	6	4	4	4	1	6	5
P18	4	5	5	6	5	6	6	4	5	6
P19	7	6	6	7	7	7	6	6	6	7
P20	5	5	6	6	5	6	6	5	6	5
P21	5	6	6	6	5	5	6	6	6	6
P22	6	6	6	6	6	6	6	5	6	6

Table 24. *Raw data from the expert evaluation of the questions measuring whether the experts actually understood how to use the Catalyst framework. (0 - Wrong answer, 1- Right answer)*

Validity					
Participant Id	Q1	Q2	Q3	Q4	Q5
	You are given an assignment to design a swimming pool for a township in India where there are hundreds of children in the 5-10 years age group. What will you consider when you consider the capability and the perceived ***competence*** **of these children to learn swimming?**	For your design assignment, you decide to adopt the Design for Motivation framework. You begin by conducting unstructured interviews with a few children in the 5-10 years age group in the township. How will you use that data?	In Step 2, **will you intervene in the process where the participants are arranging the images along the scales from the 'Most Motivating' to the 'Least Motivating'?**	In Step 3, you are deciding on what components of ***Competence, Relatedness Needs*** **and** ***Autonomy*** **you will embed in the design. What will you prioritise: picking the most motivating factor or the project goals?**	You observed that "Winning accolades in sports events" has been rated as the most motivating factor under ***Relatedness Needs*** **(step 2). Let us consider that in step 3, you picked that factor to be embedded in your design. In your design of the swimming pool, you include a display area nearby where the achievements of the children will be highlighted. Have you embedded meaning in the operational context or the socio-linguistic context?**
P1	1	1	1	1	0
P2	1	1	1	0	0
P3	1	1	1	1	1
P4	1	1	0	1	0
P5	1	1	1	1	0
P6	0	1	1	1	1
P7	0	0	1	0	1
P8	1	1	0	0	1
P9	1	1	1	1	0
P10	0	0	0	0	0
P11	1	1	1	0	1
P12	1	0	1	0	0

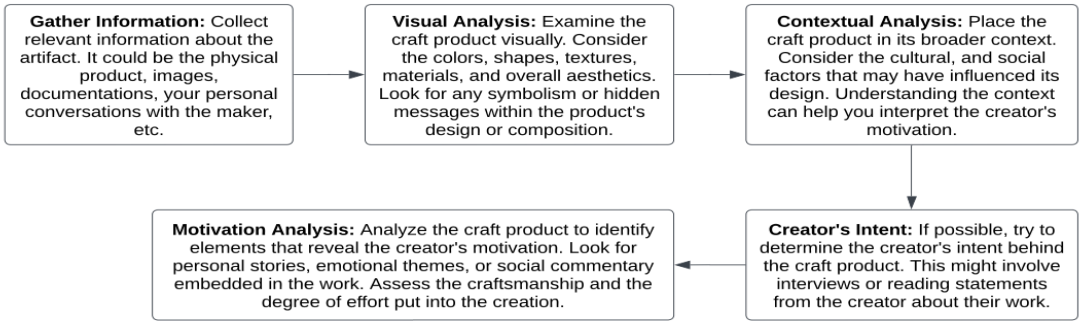
P13	1	1	1	1	0
P14	1	1	1	0	1
P15	1	1	1	0	0
P16	1	1	1	0	1
P17	1	1	1	0	0
P18	1	1	1	1	0
P19	0	1	0	0	0
P20	1	1	1	0	1
P21	0	0	0	1	1
P22	1	1	1	1	0

Annexure 6: Questionnaire handed to Undergraduate Students who acted as Coordinators at the Workshop

Questions:

1. What was your role in the workshop conducted in St. Anthony's school on 7 Nov 2023?

Artifact analysis in Design refers to the process of examining and studying designed objects, products, or artifacts to understand their form, function, and the underlying design philosophy. This analysis is used to gain insights into how well a design meets its intended purpose, the thought processes behind the design, and its overall effectiveness. The steps for artifacts analysis are as follows:



2. Using the images in the next pages and all other information available to you (including personal conversations with the students and your experience using the kit), conduct an artifact analysis of the two groups of products. Use the flow chart steps to do the same.

Images for Artifact analysis for MUNKI kit products

Images for Artifact analysis for DThinking kit products

3. Now present a comparative artifact analysis between the two groups. For the comparison use the groups as the basis for comparison and not individual artifacts. Use the flow chart steps to do the same.

4. Behaviour refers to the observable actions, reactions, or conduct of individuals. What did you observe in the behavior of the school students that showed their motivation and/ or lack of motivation for the DIY activity that they were engaged in?

5. Did your informal discussions and interactions with them show anything related to their motivation or lack of motivation for the DIY activity that they were engaged in? Elaborate.

6. Recall your observational study and answer the following questions.

    a. How long did they continue working on the activity despite challenges or obstacles?

    b. Did they show an inclination for one kit or the other during or after the workshop?

    c. Did they continue working on it or tinkering with it after the final product came out?

    d. How much effort were they willing to invest in bringing out a final product?

    e. Did they set any goal for themselves and work towards it?

7. With the above analysis and any other information that you have, create the persona of a student from that school.