CONTEXTUALIZING SUSTAINABLE PRODUCT-SERVICE SYSTEM DESIGN METHODS FOR DISTRIBUTED ECONOMIES OF INDIA

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ABSTRACT

This paper presents a strategic analysis tools that can help a designer in Sustainable Product-Service System Design with an intervention focus on Socio-Economic Ecosystems (SEE) that seem typical of multi-cultural and diverse communities engaged in distributed economic activities. The research questions for this paper are:

1. To what extent the MSDS (Methodology for System Design for Sustainability) is applicable for design of S.PSS for SEE?

2. What could be a possible sustainability-orienting design approach for S.PSS in the context of SEE, which caters to its unique nature?

Using Design Science Research Methodology, we redesigned the strategic analysis part of MSDS. The redesigned strategic analysis consists of various tools suited for design of S.PSS in the context of SEE. The proposed tools are for identifying the actors and their activities in the ecosystem; understanding the infrastructure and needs of the actors; clarifying the goal, problem statement definition, design brief and unit of satisfaction using participatory method; and, finally for competitor analysis.

Key Words: Socio-Economic Ecosystems, MSDS, Distributed Economy, Sustainable Product-Service System Design.

1. INTRODUCTION

(C. Vezzoli et al., 2014) Design for Sustainability using a Sustainable Product-Service System (S.PSS) approach has a potential role to play in promoting and facilitating system level innovations that can bring environmental benefits while being economically viable and socially equitable. In order to design an S.PSS, a designer should be able to design both products and services, promote and facilitate innovative interactions between stakeholders who can orient the designed system towards eco-efficient and socio-efficient ends, and operate or facilitate a participatory design process involving the project-relevant stakeholders. Since the number of parameters involved in the DfS (Design for Sustainability) considering all three dimensions of sustainability are large and complex, it is important to have tools and methods that can guide and aid the designer during the design process. The Methodology for System Design for Sustainability (MSDS) offers a modular framework to the designer that can aid in conducting a strategic analysis, exploring sustainability orienting opportunities, designing and engineering sustainability oriented system concepts and communicating the same. MSDS has been conceptualised so that it can be used for a scenario where-in the project has project proposers who can be companies, public institutions, NGOs, research centres, or a mix of these. It is a modular method consisting of stages, processes and sub-processes wherein the designer can choose to use the most appropriate stages and tools from MSDS, integrate other tools and activities into it and also give varying degree of contextually appropriate priority to each dimension of sustainability. In this paper, we discuss the applicability of MSDS in designing S.PSS for Socio-economic ecosystems (SEE).

The two research questions for this paper are:

[R1] To what extent MSDS is applicable for design of S.PSS for socio-economic ecosystems (SEE) where "the economic activities of the community is deeply ingrained in the socio-cultural ways of living", is a multi-stakeholder ecosystem and the economic activities are distributed in nature?

[R2] What could be a possible sustainability-orienting design approach for S.PSS in the context of SEE that cater to its unique nature?

1.1. Defining Socio-Economic Ecosystems (SEE)

According to Banerjee et. al 2019, "A SEE is a context where the economic activities of the community is deeply ingrained in the socio-cultural ways of living." Authors suggest that there are some major challenges in designing for such contexts. Specifically, one challenge is to orient the systemic solutions to the socio-ethical and environmental dimensions of sustainability such that they are in the "economic interest of the system stakeholders". Another challenge is the difficulty in identification of "project promoter". A SEE by nature is a distributed economy; it is a network of actors that function in a distributed manner for design, knowledge generation and manufacturing for economic gain of individual stakeholders. These systems have developed over time to be sustainable on many fronts of their functioning. In such a multi-stakeholder system, it is difficult to identify a single "promoter" who can become a solution provider without buy-ins from other influential actors in the context. Additionally, due to the distributed nature of a SEE, a single 'promoter ' may not be able to support or implement a unifying solution that is sustainable for the entire SEE. Thus, it becomes very important to understand the existing traditions along with the ecological and social knowledge systems for a designer to be able to provide any sustainable design intervention. Moreover, the designer needs a deeper understanding of the context so that the intervention can be integrated to the existing local cultures. (Banerjee, Upadhyay, & Punekar, 2019)

1.2. Sualkuchi Silk Handloom Industry as a SEE

Sualkuchi is a cluster of 16 villages in the Kamrup District of Assam, India and is located on the banks of the river Brahmaputra about 35 km away from the city of Guwahati. Its population is more than one hundred thousand and it is globally known for its silk handloom industry (called the "Manchester of Assam"). It also has a trademark – Sualkuchi's. The handloom industry of Sualkuchi has its mention in the works of Kautilya who lived from 371 – 283 BC but mostly took its current shape during the Ahom Dynasty from 1228 – 1828 AD (Phukan, 2012). Typically, each household in Sualkuchi contributes to silk weaving and owns at least one loom for production of silk fabric. Post-independence of India, the industry began to flourish and reached its peak during 1981 – 2001 when looms per household increased from 2 to 6, on an average (Saikia, 2011). This is also the time when many households shifted their operations towards entrepreneurship, owning 50 or more looms, employing weavers rather than using the family members as weavers. There are four major categories of actors in the ecosystem: owners, weavers, reelers and helpers. The owners might be small (< 5 looms) or large (> 50 looms) and own the instrument of production, the Jacquard loom. The small owners mostly weave and reel themselves with their family while others hire weavers, reelers and helpers. The contracted weavers are paid on the basis of length of garment woven and the number of design elements. They learn weaving on the job and come from all over Assam. Some of them stay back in Sualkuchi while others go back to their native place to start their own handloom setup. The reelers are also contractual and perform pre-loom activities like reeling and spinning of yarn while the helpers are paid on a monthly basis for helping the other three actors. There are other standalone actors who support the ecosystem: designers, loom makers and servicers, middle men, distributors, shopkeepers (selling raw materials, selling finished products), government support units for low cost raw material for small owners, silk testing lab, Sualkuchi Tat Silpa Unnayan Samity and so on. The biggest strength of the existing system is its distributed nature in terms of design and manufacturing (it has very few large units). Due to unorganized production systems, enough attention is not being paid to technology, de-

sign and business model upgradation, which has led to stagnation. Also rising cost of raw materials and lack of supportive financial support system, the small owners are slowly disappearing leading to possible centralized economic models kicking in. To get a glimpse of Sualkuchi, visit https://goo.gl/sLxNtS.

1.3. Bordowa as a SEE

Bordowa is the birthplace of a 16th century saint, Sankardeva who was an artist, dramatist and the founder of Vaishnavism in Assam, India. It's a village in the Nagaon district and is 140 KM away from Guwhati and 18 km from the nearest town, Nagaon. Vaishnavism, as propagated by the saint, is a religion marked with simplicity and openness, without rules or restraints and requires only love and devotion to the God expressed through chanting and performing Bhaona (theatrical performance) (Goswami). The village attracts thousands of tourists during the weeklong celebrations of Holi and Janmasthami and smaller numbers throughout the year. It does not have any restaurants or hotels but during the festival mobile toilets and temporary eating points are built in. Despite the large numbers of tourist visiting the place, the local lake (Akashi Ganga) is never polluted due to the religious beliefs associated with it. The major occupation of the village is agriculture and tourism. People here traditionally follow many sustainable practices. For example, each household has two ponds, one for water and fish while another for throwing compostable wastes. The compost then becomes manure for their household vegetable garden, fish feed and agricultural fields. The offering to deity is made of mostly sprouts and other fresh fruits, which are good for the health of the people receiving it. Unfortunately, due to modern ways of living creeping in, this balance is being disrupted. For example, plastic wrappers are dumped in the composting pond since no municipal collection of these wastes happen. Similarly, the influx of ever-increasing number of tourists also pose a sustainability challenge. To get a glimpse of Bordowa, visit https://goo.gl/GvjZLT.

2. METHODOLOGY

In order to answer the research questions, we used Design Science Research Methodology (DSR) as the research approach. DSR is a design-oriented research approach (Peffers et al., 2006). It follows the generic iterative design process: research, analysis, synthesis and evaluation; until we achieve a satisfying balance between the intended outcome and practical realization (Plomp & Nieveen, 2013).

Applying DSR, three separate exercises were conducted where we applied the existing MSDS methodology and updated it based on the learnings in each instance. The exercises were conducted with undergraduate and postgraduate students enrolled in the "System design for sustainability" course at IIT Guwahati, during the months of January-April in 2015, 2017 and 2018.

For answering R1, two design exercises were conducted in Bordowa and Sualkuchi, where MSDS was applied to uncover design opportunities and develop S.PSS concepts. Filed visits were undertaken, whenever necessary, to enable a deep understanding of the context. The challenges uncovered in applying MSDS were noted during each exercises. Similar challenges were found in conducting the 'strategic analysis' for both the SEE context due to various reasons (see section 3). Based on this, parts of the 'strategic analysis' was modified and used to suit the context during each exercise.

Based on the outcomes of the first two exercises, the 'Strategic analysis' part of MSDS was modified to accommodate the challenges faced. To answer R2, the modified methodology and tools developed for its application were implemented in the third exercise conducted at Sualkuchi. We discuss the application of the modified methodology and tools in the discussion section (section 5).

3. NEED FOR CONTEXTUALIZATION OF THE STRATEGIC ANALYSIS STAGE OF MSDS

In a SEE context, the design opportunity or need for intervention may originate internally within the stakeholders or externally from other actors. In either of these cases, the ownership of the solution is on a group of actors who have equal influence and stake in the SEE. Unfortunately, this means that there is no single project promoter. Moreover, the group may define the scope of design without considering its implication on other stakeholders or actors. Thus, it becomes important to identify all actors along with their needs and motivations and decide the scope in a way that it is in the economic interest of all SEE stakeholders and suits their current socio-cultural settings.

The MSDS methodology was conceived primarily for designers, companies and additionally for public institutions and NGO's (C. A. Vezzoli, 2010, p. 219). Since there is no single clearly identifiable project proposer, it becomes difficult to conduct the promoter analysis as prescribed in MSDS (Banerjee et al., 2019). Moreover, one implicit assumptions of MSDS is that the promoters appreciate a PSS model and considers it suitable for their context, which may not be the case for an SEE. The actors may not consider PSS as a viable solution or individually may not have the influence to implement an S.PSS for the SEE.

An important consideration for a SEE context is the infrastructure that is available and used within its boundaries. Currently MSDS methodology suggests the analysis of the 'socio-technical regime' (C. A. Vezzoli, 2010, p. 223) as part of analysing the context reference. Although this may entail the study of infrastructure capabilities, it is not explicit nor considered important. In an SEE context, a designer must acknowledge the capabilities of existing infrastructure and suggest the necessary transformation of the infrastructure to support an S.PSS solution.

The nature of competitors in a SEE context may be very different from those of typical organizations. Example, a prominent product of Sualkuchi is Muga silk sarees and Mekhela Sador(a traditional dress) which are used by the bride in marriages. Considering the marriage budget, a competitor for the silk products is gold, because people divide their investment between buying gold jewellery and Muga silk. Thus, a standard competitor analysis based on product innovations and market segmentation may not be applicab and/ or feasible for a SEE. Moreover, besides a direct product competitor, the entire SEE may have a competitor that produces comparable products, or may have competitors from established industries. Therefore, the design team needs to uncover such atypical competitors before a competitor analysis can be done (e.g using Porters 5 forces model).

Another challenge faced in application of the MSDS for SEE, is the difficulty in defining the scope of a design intervention, an S.PSS problem statement, a design brief and a unit of satisfaction. This is amplified if the designers do not know the reference context. Moreover, since the group of promoters do not come forward with a PSS requirement, it becomes more difficult.

Considering such challenges, the design team should use co-design methods and approaches to understand the reference context. Additionally, the analysis of project promoters, their context of operation, the technological and cultural dynamics, carrying structure of the system and the sustainability best practices should be modified suitably to meet these challenges. The next section, thus, presents the refined contextually appropriate strategic analysis tool for a SEE.

4. THE STRATEGIC ANALYSIS TOOL (SAT)

We propose changes in the first two processes of the strategic analysis from MSDS, as detailed out in table 4.1 below. The modifications are explained in the following two sub-sections.

4.1. Process 1: Project Socio-Economic Ecosystem Analysis

Since in case of SEE, there is no one clearly identifiable project proposer but a group of actors who will together own the project, the first step is to identify all the actors and their aspects of activity. Also identifying all the actors is very difficult for a designer since many a times entry into the ecosystem might be challenging due to trust or other socio-economic barriers and also time consuming. Thus, it is best to conduct the process of identification of actors and their activity by interviewing local administrators/ visionaries. Local administrators can be anyone from the Panchayat/ block/ district administration. Local visionaries can be local elders/ thought leaders/ NGOs etc. They are able to quickly provide the designer with the main value proposition of the local ecosystem, its problems and an understanding of all the actors and their activities. We have developed a tool, Awesome Actors Tool (https://goo.gl/f7ow7f) to guide the designer in collecting the data. The next challenge and potential barrier/ support for any S.PSS design for SEE is the infrastructure (knowledge, financial, physical or social). Again interviewing the local administrators/ visionaries helps in achieving information on service, product-service and infrastructure transformations planned and required in the local ecosystem. We have developed a tool, KFPS Knowledge Mining Tool (https://goo.gl/JeZvc6) to guide the designer in collecting this data. Once this preliminary information and understanding of the SEE is attained, the designer can move into meeting the actual actors and understand their needs. The needs can be captured, mapped and analysed using the Empathy Map (Gray, 2017), AEIOU Map (https://goo.gl/tskziS), Value Opportunity Analysis (https://goo.gl/Xx7vY7), SWOT, PESTLE and System Map. Table 4.1 details each sub-process, the expected results and links to the tools developed/ suggested.

[Table 4.1] Strategic analysis to study SEE [2] [Process 1 and 2 are the proposed modifications; [a] Marked are from MSDS]

Process	Sub-process	Result	Tools
1. Project Socio-economic ecosystem analysis	Preparatory questionnaire for socio-economic ecosystems	Identification of actors and aspects of their activity	Awesome Actors Tool - https://goo.gl/f7ow7f
	Infrastructure analysis	Identification of existing infrastructure and required transformations	KFPS Knowledge Mining Tool - https://goo.gl/JeZvc6
	Project Actor Analysis	Need analysis of the actors	Empathy Mapping - (Gray, 2017) AEIOU Mapping - Value Opportunity Analysis - https://goo.gl/Xx7vY7 SWOT; PESTLE; System Mapa
2. Defining intervention context	Clarifying design goals	S.PSS problem statement, design brief, unit of satisfaction	Co-design using "Clarify Your Goal" section of Frog Collective Action Toolkit - (Frog Design, 2016)
	Competitor analysis	Competition space knowledge	Competitor analysis on form, category, generic, budget level - https://goo.gl/iXGyxt Porter 5 forces analysis if applicable

3. System carrying structure analysis[a]	General macro-trends analysis	Report on (social, economic and technological) macro-trends and their influence on the reference context.	
4. Analysis of cases of excellence for sustainability[a]	Identification and analysis of cases of excellence	Summary of cases of excellence analysis describing offer composition and interaction with the user Actors who produce and deliver the offer Sustainability characteristics	Interaction table (storyboard) Animatic System map SDO toolkit – checklist best practices
5. Analysis sustainability and determine priorities for the design intervention in view of sustainability[a]	Existing context analysis from an environmental, socio-ethical and economic point of view	Summary of the existing system analysis	SDO toolkit – checklist existing system
	Defining the design priorities	Definition of design priorities for each dimension of sustainability	

4.2 Process 2: Defining Intervention Context

Post identification and analysis of the SEE's socio-economic ecosystem, the designer needs to define the intervention context. A participatory approach, involving as many actors of the SEE as possible, needs to be organised by the designer to clarify the design goal. This will provide better chance that the proposed S.PSS is grounded in the context as well as acceptable to all the actors. Also, since a SEE has evolved over a long period of time, the actors have evolved certain degree of harmonious living with the ecosystem which can be captured through a participatory process. At this stage, clarification of the design goal will result in identification of a S.PSS problem statement, design brief and unit of satisfaction. The participatory goal clarification can be done using the "Clarify Your Goal" section of Frog Collective Action Toolkit - (Frog Design, 2016).

In light of the selected problem statement, a competitor analysis forms the second sub-process. The competition analysis is done on two ecosystem parameters: the local ecosystem's main value proposition and the design intervention goal. The 1st parameter helps to identify the form, category, generic and budget level competitions to the SEE as a whole (in its current form) while the 2nd parameter deals specifically with the proposed S.PSS. We have developed a tool to aid the process and can be accessed at https://goo.gl/iXGyxt. Detailed explanation of tool application can be found at: https://youtu.be/mzzudwyOczs and https://youtu.be/MM9lYvWVXho. Table 4.1 details each sub-process, the expected results and links to the tools developed.

5. DISCUSSION AND FUTURE SCOPE OF RESEARCH

The redesigned strategic analysis for MSDS, SAT, consists of tools which first identify the actors and their activities in the ecosystem; then infrastructure and needs of the actors; clarifies the goal, problem statement definition, design brief and unit of satisfaction using participatory design tools; and, finally a tool for competitor analysis. Currently the tool has been designed and tested on two SEE contexts, both located in Assam, India. Despite the similarities of geographical location, the nature of both the SEE is very different. Sualkuchi SEE has a local to global context of operation while Bordowa SEE has a local to local context. Thus, SAT might be generalisable over a variety of SEE contexts but more research is required to further develop and refine it.

Applying the tools and the MSDS in the classroom context may also have some challenges, which are discussed at length by Banerjee et al. (2019).

Another challenge of SAT as well as MSDS is data, time and resource intensiveness. But also the key characteristics of S.PSS is to create an offering using inventive interactions between actors of the ecosystem. SEE has multitudes of actors and if we try to map its sustainability intervention requirement, it will lie at the spatio-social and socio-technical innovation levels in the "DfS evolutionary framework" mapped by (Ceschin & Gaziulusoy, 2016). Hence, a designer will require to invest heavily on resources. However, we see a scope in improving the visualisation of the data through appropriate tool design and using software aids in future.

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