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IDENTIFYING AND MANAGING DILEMMAS FOR SUSTAINABLE DEVELOPMENT OF RURAL INDIA

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ABSTRACT
In this paper, we present a method for identifying conflicts (`Dilemmas`) that have zero-sum solutions among the three aspects (`Drivers`) of sustainability, namely, social (people), environment (planet), and economic (profit) values. We develop the value proposition that is anchored in sustainable rural development by converting these zero-sum solutions to positive-sum solutions. Rural development is difficult, and it must be initiated from within the communities with the involvement of local people. We hypothesize that social entrepreneurs can serve as the proverbial lynchpin between the rural population and other agencies (government, non-government, banks, and industry). Hence in this paper, we use the constructs of a dilemma triangle and spheres of sustainability to propose a method to identify and manage `dilemmas` associated with creating a sustainable eco-system. We use example of a village in India to illustrate the method and to develop the value proposition for the village. The focus in this paper is on the method, rather than the results *per se*.

KEYWORDS
Social Entrepreneurs, Sustainable Development, Dilemma Triangle, Sustainability Triangle, Rural Development.

GLOSSARY
Sustainable Development: Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future [1].
Zero-Sum Solution: A solution that will have a positive effect on one of the drivers and negative effect on other drivers.
Positive-Sum Solution: A compromise solution to have a small positive effect on all drivers.
Value Proposition: The product/service/idea that a social entrepreneur provides to people for improving their socio-economic standards.
Composite Village: A composite village is represented in Appendix A. We have collected data from multiple villages and developed a composite village to show how the implementation of the method would be.

1. FRAME OF REFERENCE
1.1 Sustainable Development – Accounting for People, Planet, and Profit
According to the United Nations, sustainable development is the guiding principle for economic, environmental and social development that is anchored in the notion of 'meeting the needs of the present without compromising the ability of future

generation to meet their own needs' [1]. The concept of sustainability is anchored in an integrated approach that takes into account the aspects of the environment (planet), economics (profit) and society (people) as the three fundamental dimensions [1].

Billions of people in the world are living in poverty and lack basic amenities. There is a huge disparity of wealth and power. Along with this are issues of natural resource depletion, fresh water scarcity and loss of biodiversity that become a blockade for the development of people. [2]

A social enterprise plays a key role in uplifting the condition of the poor and facilitating community development [3]. Our focus is on social entrepreneurs, as they provide appropriate leadership in social enterprises that result in achieving a sustainable advantage, thereby achieving their social mission [3].

In Figure 1, developed by Cisco IBSG, 2011, we represent the basic difference between a business and social entrepreneur. We focus on social entrepreneurs rather than the business entrepreneurs due to the difference between the goals that each of the entrepreneurs has for their enterprises, the growth path they choose and the profit motives they have. A social entrepreneur is motivated to have a reasonable cash flow that will be required by him/her in order to sustain the enterprise and help society, and improve people's standards of living, whereas, business entrepreneur strives to maximize his/her profit.

Jay and Gillian in their paper [4], express the need for sustainability in social enterprises to have long term survival and growth. According to Jay and Gillian "the role of the social mission goes hand in hand with the sustainability of the organization. Sustainability resulting from a balance of the entrepreneurial drivers of innovativeness, proactiveness and risk management is not seen as an end in itself, but sustainability is focused on ensuring the continuation of the organization because of its social mission." [4].

In order to sustain a social enterprise, and have a sustainable outcome, it is necessary to adopt the concepts of sustainable development in each process of the enterprise. From the setup of the social enterprise, development of the value proposition the enterprise offers, to the implementation of service, and or, production of the product. As mentioned earlier, each of these processes must be developed consciously by integrating all the three pillars (`Drivers`) of sustainability, that is, social (people), environment (planet), and economic (profit).

	Business Entrepreneurs	Social Entrepreneurs
Goal	Capture a market securely	Fill a market gap; change the world
Objective	Build a business; earn profits	Create sustainable solutions for social change
Profit Motive	Maximize shareholder value; profit as an end	Advance social aims; profit as a means to financial sustainability
Risk	Basic business risk	Basic business risk plus social aspect
Links to social problems	Indirect	Direct
Feedback	Established consumer and market information sources	Need to be creative in obtaining market and responses
Competition	"Win" for one business over others in a market	Exists because no one else adequately solving problem, "win" for society
Growth	Competitive for one company	Collaborative for societal impact
Capital	Benefit from robust financial and managerial services	Contend with unpredictable and fragmented financing

Figure 1: Business vs Social Entrepreneur [Online Image, http://www.slideshare.net/CiscoIBSG/the-business-of-social-entrepreneurship].
Retrieved February 15, 2017.

1.2 Spheres of Sustainability

Given the importance of sustainable development, the main issues are the application of this concept across multiple fields [5]. Since the inception of the sustainable development construct, various authors have used the concept of spheres of sustainability to implement and develop sustainable solutions. The spheres of sustainability, as shown in Figure 2, is a representation of the balance between three drivers of sustainability, mapping as one cohesive unit [6]. In Figure 2, the authors represent the three drivers of sustainability and their subsequent interactions with the prompts to develop solutions that are

anchored in achieving sustainable eco-system [6]. This is further generalized in Figure 3. Here we observe that the solution must be `bearable` between social and environment driver, `equitable` between the social and economic driver and `viable` between economic and environment driver to achieve sustainable development. A `bearable` solution is one that can be endured or accepted from social and environmental perspective. A solution is termed as `equitable` if it is developed to deal equally and fairly with both economy and social perspectives. A `viable` solution is one that can be developed adequately for functioning, or is developed for existence and development as a unit and has the capability to be implemented practically for the environment and economic perspective. In this paper, we continue to use these concepts of spheres of sustainability.

1.3 Need for a Win-Win-Win Approach

Bringing for-profit businesses together for the development of rural areas is getting attention internationally. In 2003, the United Nations had implemented the UN Public-Private Alliance for Rural development (UN Alliance). In UN Alliance the focus was to identify and promote successful business policies that would bring the Public and Private Organization together and are profitable from the social and economic standpoint for the people in rural areas [7]. To have a long and sustained partnership it is important that each of the partners gain through the partnership (either economic or social). Therefore, it is necessary to explore ideas and value propositions that combine the profits and the development benefits for all the stakeholders involved.

A win–win-win solution is achieved when all the stakeholders identify the requirements of each other and work towards developing solution wherein everyone wins. A win–win-win solution can either be a compromise or a selection. A selection solution is defined as "a solution that is preferred among several feasible alternatives, based on multiple attributes" [8]. A compromise solution on other hand is defined as "an improvement of feasible alternative through modification" [8]. In Public-Private Partnership, more than three stakeholders are involved from multidisciplinary areas. Hence, achieving a solution that satisfies all the stakeholders is not possible. Therefore, our focus in this paper is to seek win-win-win (compromise) solutions. A compromise solution embodies trade-offs wherein each stakeholder gives up something to achieve a solution acceptable to all [9].

1.4 Gap Analysis

For India to develop its rural areas, the key could be to have a Public-Private partnership that is anchored in developing sustainable solutions. The social enterprise must be sustainable and this requires the development of enterprise by connecting the three drivers together as represented in Figure 4. For an entrepreneur to acquire these partnership requirements are to develop a sustainable value proposition.

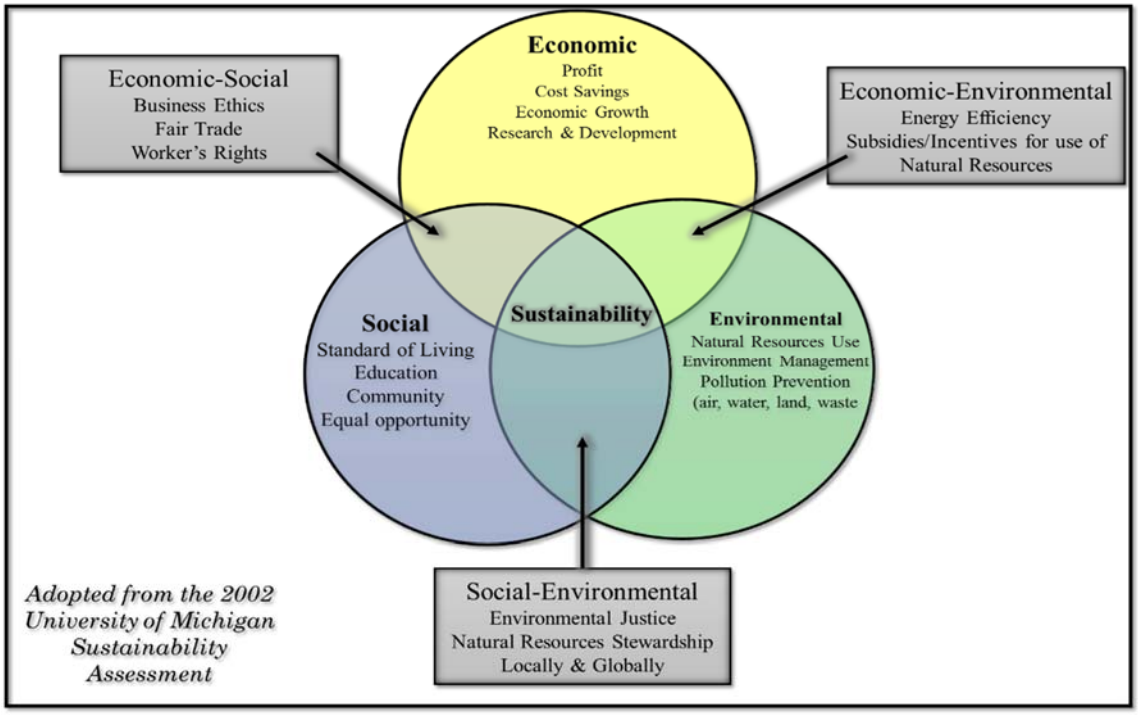

Figure 2: The Spheres of Sustainability

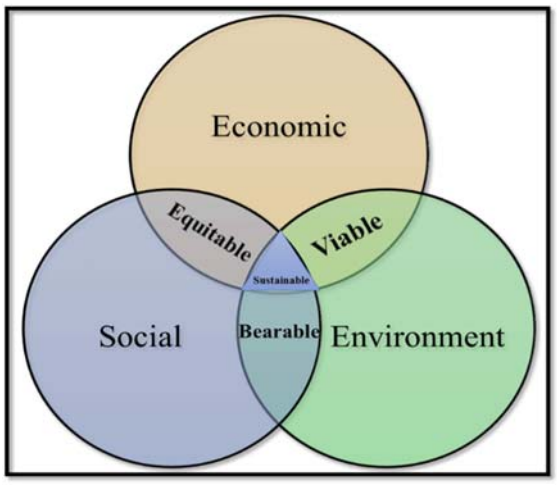

Figure 3: Pillars of sustainability [Online Image, http://www.thwink.org]. Retrieved February 7, 2017.

As mentioned, a win-win solution for all the stakeholder is important in order to achieve a sustainable and long term development. The current literature on social entrepreneur ranges widely based on various context and phenomena [10]. A social entrepreneur takes either *top down* approach, wherein people with higher degrees and connection solve social problems affecting a large population. Then there is *bottom up* approach taken by people at the bottom of the pyramid starting enterprises to help themselves, and fellow community members, improve their quality of life. In this paper, we focus on the latter [11].

"Opportunity recognition (OR)" is a method used in entrepreneurial literature to identify opportunities in the given space [10]. Many authors state OR as an integral part of venture creation. Some scholars go beyond that statement and define it as the basis for entrepreneurship. However, most of the work done in OR is specific to business entrepreneurship and very few connections are available for OR in social entrepreneur context [10].

Another term that is used in entrepreneurship literature is "Entrepreneurial thinking (ET)". ET is divided into two categories: *Causal reasoning* and *Effectual reasoning.* Causal reasoning is 'Given that the goal is known how well can someone identifies the means to achieve this goal'. Whereas, effectual reasoning is based on "Given the means how well can someone identify the goal that can be achieved"[12]. The approach of effectual reasoning is built on the identification of the market that is unknown and the problem that is unknown.

Authors continue to argue that social entrepreneur opportunities are different from for-profit ventures. The area where social enterprises are established is different from business enterprises based on their orientations and social aspects[10]. Therefore the tools for social enterprises must also be developed accordingly. Social enterprises are placed in civil society and require collective action of multiple actors working together to create social value.

Most of the literature on OR and ET is based for business entrepreneurs. The framework that can be adopted by social entrepreneurs (especially) using bottom-up approach are not available. Based on our literature review and interaction with an entrepreneur in India we identify that there is a need to develop a method for developing a value proposition by taking into consideration the three drivers of sustainability.

Relationship conflicts and task conflicts are common in enterprises [13]. Solving relationship conflicts can keep the backing of stakeholders intact. Solving task conflicts helps the entrepreneurs working towards their goals. For social entrepreneurs, there are also conflicts involving the drivers of sustainability.

Sometimes these conflicts become `dilemmas` leading to zero-sum solutions. Due to `dilemmas`, either stakeholder withdraws their support from enterprise or enterprises shut down thereby resulting in a loss for the people involved [14]. On another hand, social entrepreneurs who are able to solve these dilemmas are successful in sustaining their enterprises and continue to have a positive impact on the people and societies [14]. We believe that identifying and managing these dilemmas can help social entrepreneurs in developing the value they can offer to the people and also the support they need from various stakeholders.

In this paper, we use the construct of `dilemma` triangle to identify the `dilemmas` between multiple stakeholders to develop a compromise solution. The dilemma triangle construct has been previously used to identify dilemma between any two drivers of a process. Dilemma triangle method saw its roots from the identifying new knowledge by Master's and Ph.D. students [15]. Amirhossein and co-authors in their paper [15], had developed the basis of `dilemma` triangle for identifying the knowledge between any three drivers as an initial step for drawing the boundary for their research. In this paper, we elaborate the work on `dilemma` triangle to identify the gap that needs to be filled by a social entrepreneur in a society for the development of people. We saw a connection between `dilemma` triangle associated with three drivers and sustainable development established on the three pillars of sustainability. In this paper, we are using this construct along with the concept of spheres of sustainability to present a method that social entrepreneurs can use to develop a value proposition establishing a balance between the three pillars of sustainable development.

In Section 2, we propose a method for identifying `dilemmas` and developing a value proposition that is anchored in the sustainable development construct. In Figure 6, along with the steps for identifying dilemmas, we also include steps for managing dilemmas. A description of the steps involved in managing dilemmas is beyond the scope of this paper. In Section 3, we apply this method for a village in India that currently does not have access to electricity. In this section, we develop a value proposition and evaluate it with respect to spheres of sustainability. Our focus in this section is to demonstrate how the method will work, by the way of an example. In Section 4, we discuss the method developed in this paper and briefly the result obtained from Section 3. We conclude this paper by generalizing the method developed for complex systems and expressing the need for this method in the 21st century.

2. THE DILEMMA TRIANGLE METHOD

In the 21st century, as engineered systems become more complex the number of dilemmas to be addressed increases. As the number of dilemmas increases, it becomes increasingly

important to identify and manage these dilemmas. A dilemma is a difficult choice from two options, each of which is (or appears) unacceptable or unfavorable. It can be expressed as a choice among

- Two unfavorable options one of which must be chosen, OR
- Two favorable options, only one of which is possible at this time.

A dilemma represents a zero-sum outcome.

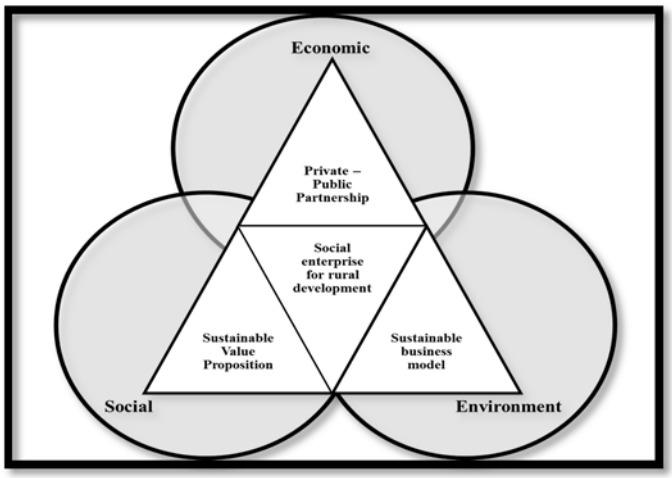

Figure 4: Requirements for sustainable rural development

To identify a dilemma in a complex system that has three drivers with three or more goals, we use the construct of dilemma triangle. By using this construct a designer can identify dilemmas that could arise in a system, and then work towards managing these dilemmas. Designers can use this construct in a complex system with more than three drivers just by increasing the number of nodes. In Figure 5, we present this concept with three drivers and therefore term it as dilemma triangle.

The dilemma triangle construct is illustrated for identifying and managing dilemmas in a dynamically changing workplace environment of the 21st century [16]. Designers have also used dilemma triangle construct to identify conflicts between two stakeholders by taking into account the three drivers of sustainability. The construct is anchored in the triple bottom line metrics that are used to measure the sustainability of projects and programs [16]. The authors indicate that the method is generalizable to other applications.

In this paper, we expand and particularize the method presented in [16] to create a value proposition for sustainable development of rural areas. In our problem, the three drivers are economic, environment and social. The three pillars when replaced by the drivers in the dilemma triangle establish the context of the problem. The focus in each of three drivers states the boundary of the problem. While developing the value proposition it is necessary to identify the gap in the market, and for our problem, the market is anchored in the drivers of sustainability. The dilemmas that arise within these drivers are the gaps that are required to be filled by the social entrepreneurs in order to sustain their enterprises. The method presented in Section 2.1 has been developed by us and can be considered as work in progress. Each step is defined to clearly and explicitly state the requirements thereby reducing the ambiguity from the method of misinterpretation.

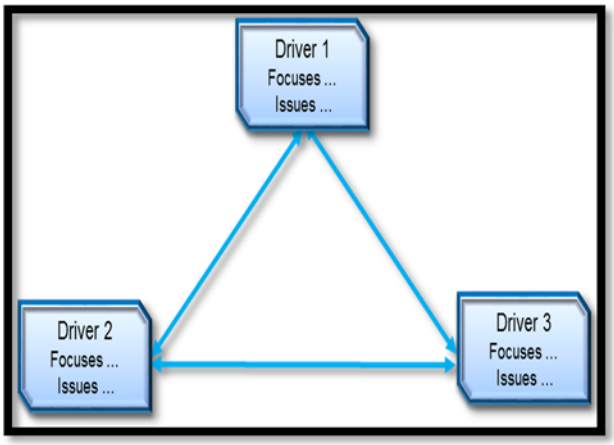

Figure 5: The Dilemma Triangle

2.1 Method to Identify Dilemmas

The method is divided into two parts, the first part is generic and can be used for all the complex systems, the second part of the method is specific to our problem, wherein we combine the concepts from spheres of sustainability with the construct of dilemma triangle. For all engineered complex systems that are anchored in the sustainable development construct, we embrace both the parts of this method. In Figure 6, we represent the steps of identifying dilemmas. Later we explain each step in Sections 2.1.1 and 2.1.2, respectively. Before this method can be used, a social entrepreneur must define the problem in the form of a Problem Statement together with the data that characterizes the village.

2.1.1 Part 1 – Identify Dilemmas

Step 1a – List the `perspectives` from which we plan to evaluate the problem.

- To solve a problem in a complex system it is necessary to draw boundary before the problem can be solved. In dilemma triangle construct, we use various perspectives to define the boundary of the problem. Based on the perspectives, we find if there are any dilemmas in each of these perspectives.
- If we draw the boundary around a problem that is too small, then there is likely to be no dilemma for us to address. If we draw the boundary around a problem that is too large, then the outcome is likely to be in action.

Step 1b – For each `perspective,` we define the `drivers` in terms of `focus` and `issues`

- Once we have defined the boundary by identifying the perspectives we would like to explore, the next step is to define the `drivers` for each of these perspectives.
- The `focus` for each driver must be written as a sentence that drives the solution, as presented in Figure 7.

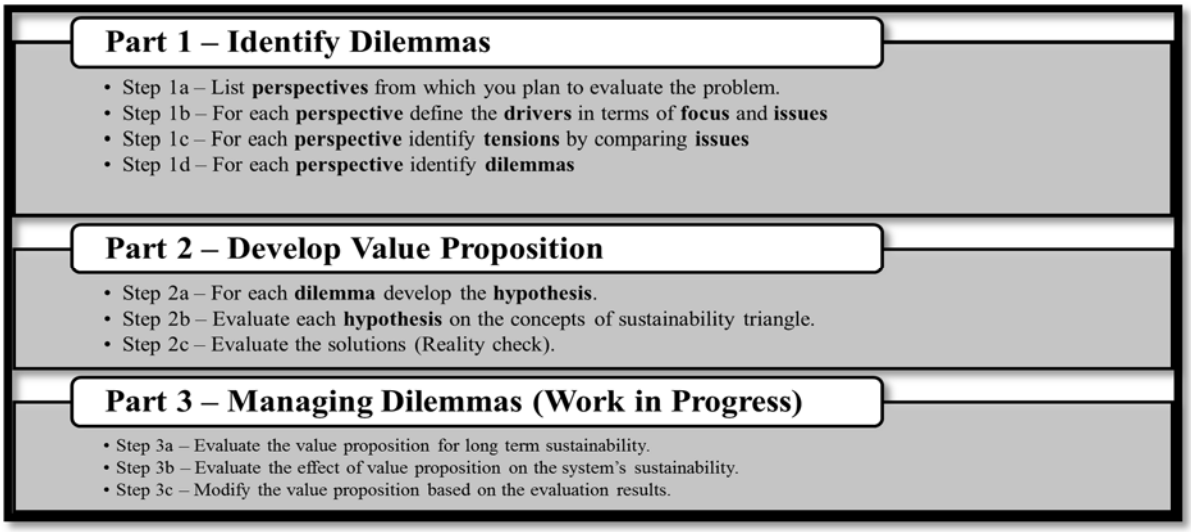

Figure 6: Steps to identify and manage Dilemmas

The `issues` are factors that are embodied in the `drivers`. Issues are hindrances in achieving the focus. Typically, words or verb/noun combination

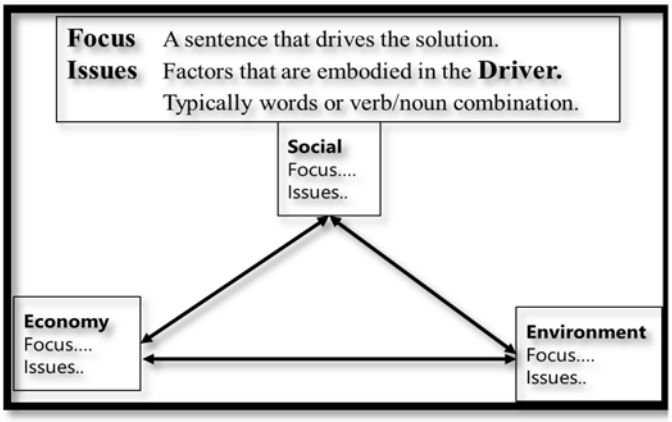

Figure 7: Dilemma triangle for our drivers

Step 1c – For each `perspective,` we identify `tensions` by comparing `issues`

- `Tensions` are potential dilemmas, `tensions` between two `drivers` are determined by comparing a pair of issues (one from each driver), see Figure 8.
- To identify tensions in each perspective, we compare one issue from one of the `drivers` with all the other issues in other two `drivers`. We repeat this process for all the issues. In Figure 9, we represent a tensions matrix that we use to compare the issues.
- For a given perspective there may be no tensions. Hence, there is no dilemma.

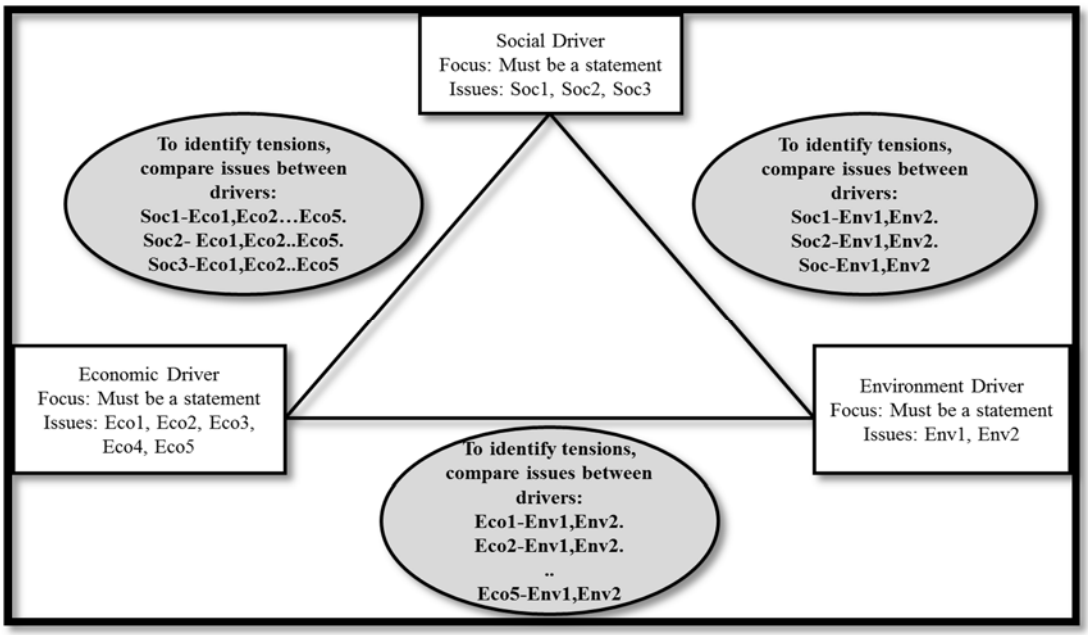

Figure 8: Comparison of issues

Drivers			Driver 1			Driver 3	
	Focus		Focus 11	Focus 12	Focus 13	Focus 31	
			Issue 1	Issue 2	Issue 3	Issue 1	Issue 2
Driver 2	Focus 21	Issue 1					
		Issue 2					
	Focus 22	Issue 3					
		Issue 4					
Driver 3	Focus 31	Issue 1					
		Issue 2					

Figure 9: The Tension Matrix

Step 1d – For each `perspective,` we identify dilemmas.

- To identify the dilemmas, we need to first prioritize the `tensions` and analyze them one by one.
- If tension can be resolved by adopting a policy or buying / installing something, then there is NO dilemma.
- If tensions cannot be resolved by adopting a policy or buying installing something, then we have a dilemma.
- A dilemma involves two drivers and embodies a zero-sum solution. We need to come up with a `hypothesis` that will allow us to transform the zero-sum solution into a positive-sum solution.

2.1.2 Part 2 – Develop Value Proposition

To develop a value proposition for socioeconomic development that is sustainable and has a long-term impact, it is necessary that the value proposition is created by considering the three `drivers` of sustainability. To achieve sustainability, it is necessary that the solutions are `bearable, equitable` and `viable`. We take this concept of sustainable development and combine it with the construct of dilemma triangle.

The solution to the dilemmas that a social entrepreneur will encounter in rural development must be `bearable` if the dilemma is between social and environment driver, `equitable` if the dilemma is between the social and economic driver, and `viable` if the dilemma is between environment and economic. This is represented in Figure 11, the sustainability triangle. The developed value proposition is then fed into the steps for managing dilemmas in order to evaluate the value proposition and modify it, resolve the conflict and achieve the required goal.

Step 2a – For each dilemma, we develop the `hypothesis.`

- For this case, the dilemma would be between any two `drivers` of sustainability and would embody a zero-sum solution. We would need to come up with a `hypothesis` that will allow us to transform the zero-sum solution into a positive-sum solution.

Step 2b – Evaluate each `hypothesis` considering concepts of sustainability.

- Positive sum solutions that are developed to have a win-win solution MUST satisfy the test that the outcomes are `Bearable, Viable` and `Equitable` for it to be a sustainable solution.

Step 2c – Critically evaluate the solutions (Reality check).

- In the process of designing and developing a new solution for complex systems, it is always important to do a reality check on whether the solution is probable based on the resources available.
- Similar to the complex systems, solutions created for rural development must also go through a set of reality check based on the resources available. If the solution is not possible, the social entrepreneur must develop other value proposition that is possible and sustainable.

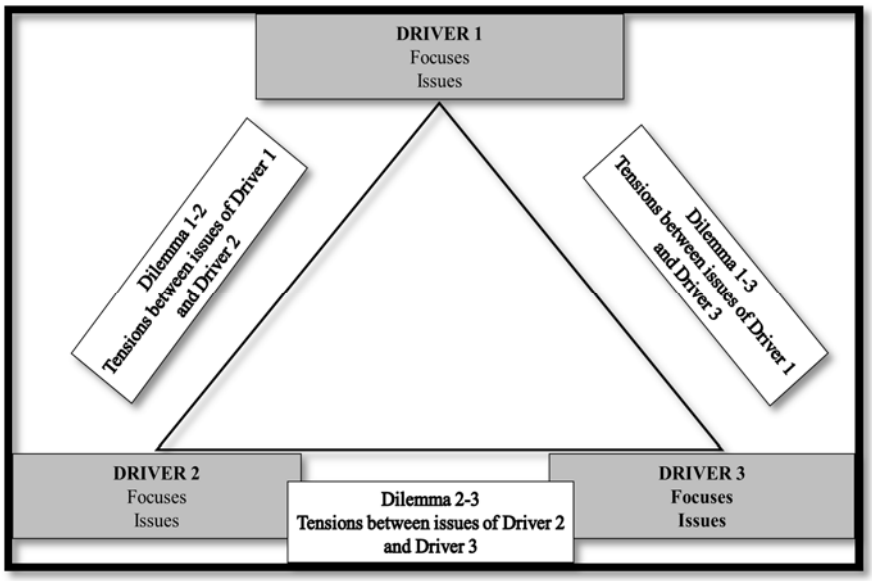

Figure 10: Identification of dilemmas

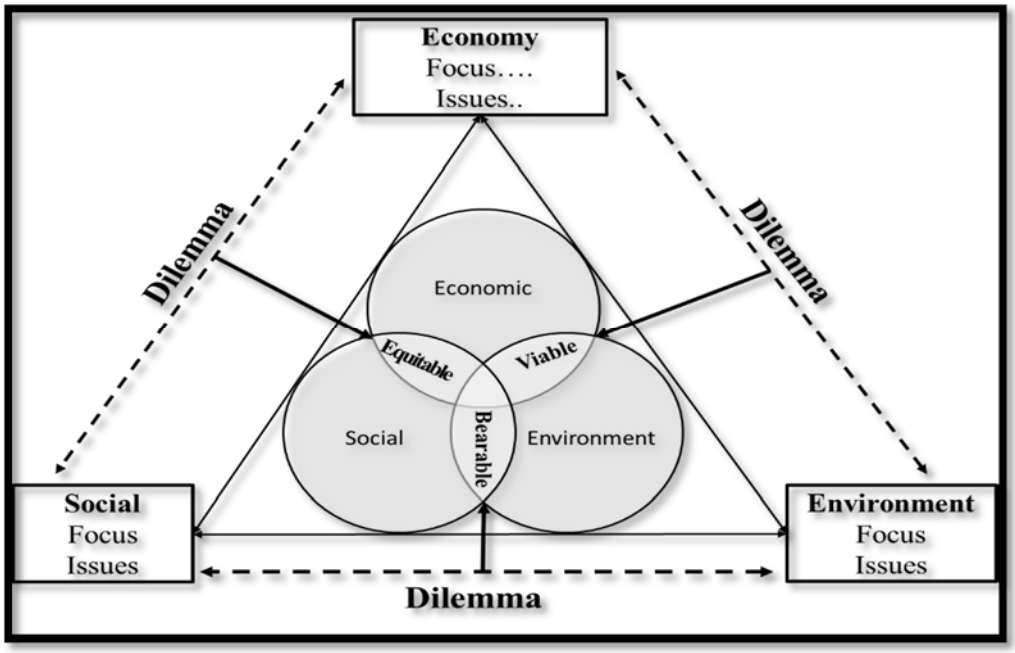

Figure 11: The Sustainability Triangle

3. IMPLEMENTATION OF THE DILEMMA TRIANGLE METHOD

In this section, we implement the method proposed in Section 2, Figure 6. We take a composite village located in India as an example. But, first, let's understand the challenges of development in India.

According to India's latest census, 67% of Indian population resides in rural areas [17]. Nearly 74 percent of India's rural population, constituting the majority of India's poor, is not fully integrated into the national economy [18]. Two major challenges are geographical accessibility and lack of resources. It is difficult for the government alone to undertake the task of rural development. To overcome these challenges the government is pulling in private organizations in the development of societies through corporate social responsibility (CSR) bill [19].

The Indian government is also focused on bringing social entrepreneurs in rural areas to develop small and micro enterprises [20][21]. The reason is, it is observed, that development of enterprises in a community leads to the creation of jobs and overall economic enhancement of the community and its people [4].

One of the key enablers of socio-economic development of villages is access to electricity. It is observed that economic development is directly correlated to access to electricity [22]. Hence, the development process can start by providing villages with access to electricity. The Indian government in recent years has been focused on the projects and policies that provide electricity to rural areas [21]. We demonstrate the method for identifying dilemmas between `drivers` for a village that has no access to electricity.

The problem statement: *Given a village in an off-grid area that lacks access to electricity, what is the value proposition that a social entrepreneur must develop to improve the socio-economic status of villagers without destroying the nearby forest and animal habitat?*

We implement this method from the standpoint of a social entrepreneur who is working towards the development of a sustainable value proposition. For a social entrepreneur, the first step is to collect data of the target village. In Appendix A we present data that we collected for our composite village to understand the social, environmental and economic condition. From Appendix A, we get the following data:

"The total population of the village is 2000, 50% of which are under the age of 25. The primary source of income is farming with 75% of households involved in some part of the farming process. There is a school in the village for primary education for children up to the age of 12 but only one-third of the children under the age of 12 are able to attend school. There is discrimination due to the caste system and gender. This is part of the cause of our three distinct classes which are upper (consisting of 50 households), middle (consisting of 300 households), and lower (consisting of 50 households). There are a significant number of the lower class households that have a food shortage and don't have proper housing. Only 50 households of the upper class have proper sanitation facilities and electricity which is generated from fossil fuels and nonrenewable resources. There is high caste and gender inequality. The village also currently lacks healthcare facilities. Surrounding the village and farmland is an environmentally sensitive forest with subtle animal habitats and plant life."

Among many issues, the village lacks access to electricity. We take providing electricity as an example task for the social entrepreneur. Electricity plays a very important role in any community if a community has electricity, small and micro enterprises can be established in the community, children can study more and villagers can work till late in evening to increase their economic standards. Therefore, considering the social entrepreneur has to provide electricity access to the people of the village we move forward.

Once the data is collected for the village we find various perspective for the social entrepreneur to identify dilemmas in the village. In Section 3.1 we implement the method presented

in Section 2.1 of this paper and in Section 3.2 we implement the method from Section 2.2.

3.1 Implementation of Part 1 – Identifying dilemmas

Step 1a: List `perspectives` from which we plan to look at and frame the problem.

Perspectives must be selected based on the goal a social entrepreneur wants to achieve in particular scenario. We take one perspective and show the implementation of the method.

1. Village/Villagers: We select the perspective of village/villagers to identify their requirements and the issues that could arise within the community. By taking village/villagers as perspective we also find the gap in the market that can be used to develop the value proposition.

Step 1b: For the `perspective,` we define the `drivers` in terms of `focus` and `issues`, also represented in Figure 12.

The focus for a driver must be a sentence that drives a solution of the goal social entrepreneur wants to achieve in selected perspective.

`Driver: Social`

`Focus:` To Improve the standard of living for the villagers.

`Issues`

1. Gender and cast inequality – In the village women are discouraged from holding jobs and primarily work with handcrafts and are homemakers. A hierarchy exists in the village based on old customs where villagers in the upper class of our village are seen superior to the villagers in the lower class.
2. Lack of education – The village contains a primary school and only 30% of children attend it. There are no opportunities for most of the children to continue education after primary school.
3. Income inequality – The caste system exists, where the upper class, consisting of 50 households, controls most of the wealth.
4. Affordability – The electricity provided by the entrepreneur must be affordable to the people.
5. Lack of technical knowledge – Due to the lack of education in the village, no technical knowledge exists among the villagers.

`Driver: Environmental`

`Focus:` To create a power system that does not disrupt the surrounding ecosystems.

`Issues`

1. Wild animal interference – From the surrounding forest, many animals walks in the village at night, destroying crops.
2. Lack of water resources – As mentioned in Table 1, there is a seasonal water scarcity.
3. Weather/Natural disasters – Monsoons and cyclones affect or damage the equipment used to generate power.
4. Village's farmland – Villagers will not allow the plant to be set up in the village farmland that is nearby to the village.

`Driver: Economic`

`Focus:` To develop a microgrid that is a profitable enterprise to sustain and grow.

`Issues`

1. Cost per unit – For the enterprise to sustain and grow cost per unit must increase with time.
2. Startup cost – The cost required to start the social enterprise will be high, the more expensive the startup cost, fewer villagers will be able to afford it. However, if inferior components are used to minimize startup cost, the quality and reliability of the product will suffer.
3. Managing demand – Micro-grid can only provide a constant amount of electricity per/day. In order to grow gradually and sustain it is necessary to manage the demand efficiently in a way that gives maximum output.
4. Unscheduled maintenance – In order to sustain and keep the micro-grid running, it is important that unscheduled maintenance are taken care of properly.
5. Reliability – The less reliable the product the more expensive the maintenance will be, resulting in higher cost of electricity and lower consumer satisfaction

Step 1c – For each `perspective,` we identify `tensions` by comparing `issues.`

`Tensions` are the conflicts that might arise between two issues. This will create an obstruction in achieving the focus for the perspective. In Figure 13, we show all the tensions for the village/villager's perspective of this example.

`Tension 1 -` Between high startup cost and wild animal interference in the village: Cost of equipment is very high for micro-grids. If wild animals enter the village near grid area, they might damage the equipment or destroy the whole grid. This becomes a tension as repairing grid is not a feasible solution and since the village is in forest alarming away wild animals is not possible.

`Tension 2 -` Between high startup cost and natural disaster: Similar to tension 1, the village is situated in disaster prone area, and precautionary measures must be taken to protect the grid from getting damaged. To increase the safety of grid from natural calamities designing the grid might be costly. The tension here is to choose between the additional cost for designing safe grid or repairing the grid when it gets damaged.

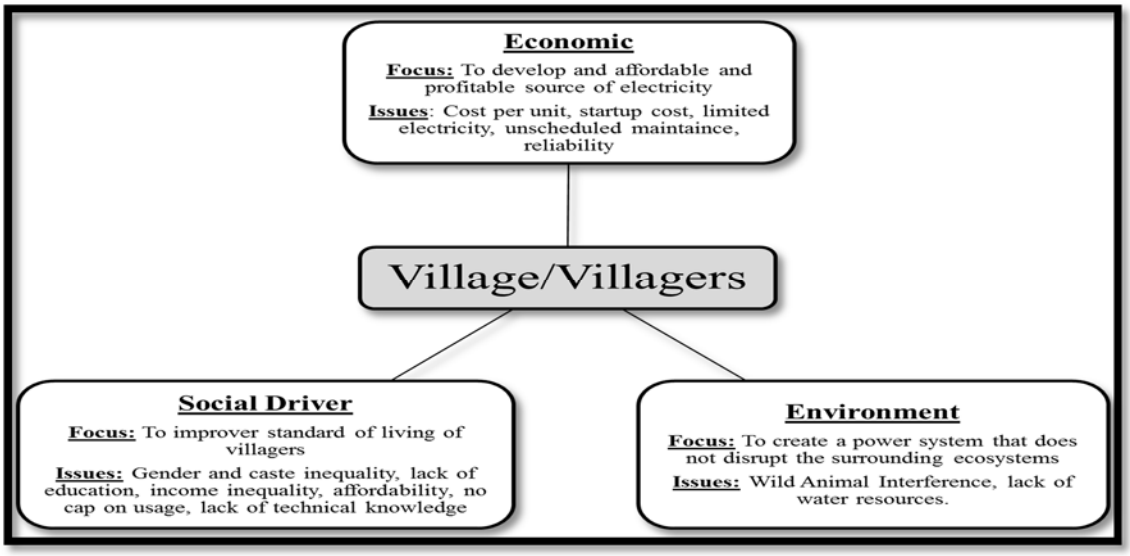

Figure 12: Dilemma Triangle of Village/Villagers Perspective.

`Tension 3 and Tension 4 -` Between cost per unit of electricity, income inequality and affordability of the villagers: These two tensions are interconnected and solution to one of the tension can solve the other tension simultaneously. In order to sustain the grid enterprise, a minimum cost per unit must be charged to each household and business, but most of the lower income household cannot afford the cost of electricity. The tension here is to either go in loss initially or provide electricity to lower income people or to grow the enterprise and not give growth opportunities to lower income households.

`Tension 5` - Between managing demand, and lack of technically skilled villagers: Microgrids when installed, will have limited capacity, as the demand increase, need of managing demand becomes important. To manage demand, we need a technically skilled labor in the village to evaluate and manage the supply. The tension here is either to lose the unmet demand and improperly manage the supply of electricity produced or to hire a skilled labor to stay and manage the demand.

`Tension 6` - Between unscheduled maintenance and lack of technically skilled villagers: There could arise a situation when an urgent maintenance is required in the enterprise. The social entrepreneur cannot be available 24x7 on the ground and there is a lack of technically skilled labors. The tension here is whether to let the unscheduled repair decrease reliability of the grid or to hire an experienced skill person in village 24x7.

Step 1d – For each `perspective,` we identify dilemmas. To identify the dilemmas, we need to prioritize all tensions and evaluate each of them to find if tension can be resolved by adopting a policy or buying / installing product. In this part of paper, we prioritize the tensions based on the path of developing the micro-grid, that is, which tension we need to resolve first in order to establish the micro-grid. On this basis, we prioritize and evaluate the tensions.

`1. Tension 1 and Tension 2:` These tensions become our priority as we need to resolve these tensions in the planning phase of the enterprise. Both the tensions are related to high startup cost and can be resolved by using a proper alarm system and proper plant layout respectively. Both the solutions will increase the startup cost but are useful in the long run.

`2. Tension 3 and Tension 4:` These tensions arise in the next phase of development; here social entrepreneur must establish the cost per unit of electricity based on the estimated break-even point. If the cost per unit is not affordable for the villagers, then either the project must be scraped or lower cost per unit must be charged. For a social enterprise to sustain both the choices are unfavorable and this tension cannot be resolved by implementing a policy or solutions. Therefore, this becomes our first dilemma.

`3. Tension 5 and Tension 6:` Both of these tensions can be solved by hiring an experienced person in the village. Another solution is to teach the villagers all the technical details, but this might not solve the problem as unscheduled maintenance might require an expertise. Since these tensions cannot be resolved with the policy or solution present currently, it becomes our 2nd dilemma.

3.2 – Implementation of Method - Develop Value Proposition.

Step 2a –For each dilemma develop the `hypothesis`.

The dilemma would be between any two `drivers` of sustainability and would embody a zero-sum solution. We need to come up with a hypothesis that will allow us to transform the zero-sum solution into a positive-sum solution.

Drivers			Environment				Economic				
	Focus		To create a power system that does not disrupt the surrounding ecosystems.				To develop an affordable and profitable source of electricity				
		Issues	Wild animal interference	Lack of water resources	Weather/natural disaster	Villagers farmland	Cost per unit	Start-up cost	Managing demand	Unscheduled maintenance	Reliability
Social	To Improve the standard of living for the villagers.	Gender and caste Inequality									
		Lack of education									
		Income inequality					Tension 3				
		Affordability					Tension 4				
		Lack of Technical knowledge							Tension 5	Tension 6	
Economic	To develop an affordable and profitable source of electricity	Cost per unit									
		Start-up cost	Tension 1		Tension 2						
		Limited electricity									
		Unscheduled maintenance									
		Reliability									

Figure 13: Tension Matrix for Village/Villagers Perspective

In this part, we will state both of our hypotheses to transform the dilemma into positive-sum solution.

`Hypothesis 1` for `Dilemma 1`: To develop ideas for small and micro enterprises within the village that were not possible due to lack of access to electricity to improve economic standards of villagers thereby increasing the number households that can afford the electricity.

`Hypothesis 2` for `Dilemma 1:` To charge a different cost per unit of electricity for each household based on their income and standard of living.

Dilemma 1: The dilemma is between the social and economic `drivers`. Here dilemma is to choose between people's affordability and enterprise's economic sustainability. Villagers cannot afford to pay for the electricity as their economic status is low. If we provide electricity in developing the infrastructure and small business in the village, then the economic standard might increase for the villagers and they can pay for the subsidized electricity.

`Hypothesis 1` for `Dilemma 2:` To have a social entrepreneur visit the village more frequently than required and to scheduled maintenance more frequently than required respectively.

`Hypothesis 2` for `Dilemma 2:` To make the micro-grid connected with the cloud computing in order to manage all the essential function online, such as online control of the distribution of electricity. By keeping the sensor at all important locations in the micro-grid, experienced technicians can identify the source of any problem (if it occurs) and can help inexperienced technician in the village to perform the necessary task.

Dilemma 2: The dilemma is between social and economic driver. Here the plant established is in off-grid location and availability of experienced technician is not possible if not planned. In such cases, the reliability and efficiency of the enterprise and its services decrease.

Step 2b – Evaluate each `hypothesis` considering concepts of sustainability.

- Each hypothesis that is developed to have a positive sum solution MUST satisfy the test that the outcomes are `Bearable, Viable` and `Equitable` for it to be a sustainable solution.

`Hypothesis 1` for `Dilemma 1:` To develop ideas for small and micro enterprises within the village that were not possible due to lack of access to electricity to improve economic standards of villagers thereby increasing the number households that can afford the electricity.

Evaluation: The dilemma is between social and economic `drivers` and therefore the hypothesis must be `equitable`. Based on this hypothesis the small and micro enterprises must be developed within the village that was not possible due to lack

of access to electricity. From social driver, this will help villagers in improving their standards of living as the development of enterprises increases the flow of resources and is fair for the villagers and social focus when compared to economic focus. From economic driver, improvement in the standard of living will help villagers in paying the cost of electricity that is desired by the entrepreneur, this will help entrepreneurs in sustaining the enterprise for the long run. Therefore, we consider this as a solution that is `equitable.`

`Hypothesis 2` for `Dilemma 1:` To charge a different cost per unit of electricity for each household based on their income and standard of living.

Evaluation: Based on this hypothesis the social entrepreneur should charge a different cost per unit for the households with different income levels. From the economic driver, this is affordable for the people and is also helpful for sustaining the enterprise. From the social driver, this hypothesis is not fair or equal to the focus of economic driver, as the cost per unit is not consistent. Therefore, this solution is not equitable and cannot be adopted.

`Hypothesis 1` for `Dilemma 2:` To have a social entrepreneur visit the village more frequently than required and to scheduled maintenance more frequently than required respectively.

Evaluation: The dilemma is between the social and economic driver and must be `equitable`. From the social aspect, this hypothesis is possible as a frequent visit to the village will help in the smooth process of the enterprise. From an economic aspect, this is not a feasible hypothesis. Therefore this hypothesis cannot be adopted.

`Hypothesis 2` for `Dilemma 2:` To make the micro-grid connected with the cloud computing in order to manage all the essential action online, such as online control of the distribution of electricity.

Evaluation: This hypothesis requires the development of new technology and will help the entrepreneur in managing the access of electricity online. This will help villagers improving their efficiency in different occupations. This hypothesis is fair as the investment done on technology will be useful in increasing the efficiency of another process in the village and as the time progresses, there will be a return on investment in terms of sustainable development and preservation of natural resources. Development of technology will also implement sustainability in all the processes of the enterprise. Therefore this is considered as an `equitable` solution.

Step 2c – Evaluate the solutions (Reality check).

- In the process of designing and developing a new solution for complex systems, it is always important to do a reality check on whether the solution is probable based on the resources available.
- Similar to complex systems, solutions created for rural development must also go through a set of reality check based on the resources available. If the solution is not possible, the social entrepreneur must develop other value proposition that is possible and sustainable.

4. DISCUSSION

In this section, we comment on the hypotheses that are developed in Section 3.2 based on the dilemmas obtained. We create a value proposition from the proposed hypothesis and then later in this section we state our assumptions.

From the perspective of village/villagers, the hypothesis is (a) creation of small and micro enterprises that were not possible before and (b) to have cloud computing (internet of things) to manage various features of the micro-grid enterprise.

The value proposition that can be created from the hypothesis is (i) this village being an agricultural society, the entrepreneurs need to develop ideas of micro enterprises that are useful for farmers, such as food grinding machines, where farmers can grind the grains and sell it in the market. Based on this, an entrepreneur can also develop an idea for a micro packaging enterprise, where women of the village can work and help in packing the grains that are taken to the market. Similar to this, for Dilemma 2 the value proposition that can be created is: (ii) since the social entrepreneur has to connect the micro-grid and all the sensors through cloud that would require establishing a server, a computer, and the internet in the village, he/she can take next step by educating the children to use the computer.

The above-mentioned value proposition is obtained by taking one perspective of the village/villagers. This method has to be used for various perspectives that are involved in rural development. There will be a change in value proposition once we use the method for the different perspectives. Other perspectives we could take into consideration to use the method for rural development are:

1. Stakeholders involved in the setup of micro-grid.
2. State and local government.
3. Demographics of the village, etc.

As our focus in this paper is on the method and its implementation more than on the results, and also due to the limitation on the content that we can include in this paper, we showcase the implementation of the method for only one perspective of rural development.

The solutions that are developed to achieve sustainable development must be `bearable, equitable` and `viable` with respect to the dilemmas and the `drivers` that they are generated in as represented in Figure 11. People can argue that the solutions proposed by them are `bearable, equitable` and `viable` as the definition of these three words is not exact, but sustainable development can only be achieved when the integrity is maintained and based on this assumption that "user of this method will maintain integrity we propose in this solution". Another key point that we focus on is that, sustainable rural development is achieved by social entrepreneurs by generating minimum cash flow that will allow them to improve the standard of living of the people, society, and help in protecting the environment.

The method that we present in this paper is used to support human decision making, that is, it can be used by social entrepreneur's (designers) to support their decision making. This method must not be and cannot be used for decision-

making, wherein a social entrepreneur (designer) inputs some data and gets an output value that is then used without qualification to recommend a particular course of action. The method is to be used support a decision made by the social entrepreneur together with the other stakeholders. Foundational to the proposed method is the premise that all stakeholders strive to do what is in the best interest of the villagers in both the short and long terms.

As the method discussed in this paper is developed by taking into account the culture, the tradition, ways of earning an income by the villagers, the solutions for each village is different from another village. For example, if the village's economy is based on agriculture, the dilemma for that village will be based on farming and therefore, the value proposition developed for the village will be based on farming.

Social entrepreneurs applying bottom-up approach lack tools that can be used by them to develop sustainable enterprises and successful collaborations with public and private stakeholders. We are working towards filling this gap by providing a quantitative tool kit for social entrepreneurs that is adaptable and robust. Work presented in this paper is a part of the larger framework that is being developed. Once a value proposition is developed by a social entrepreneur, he/she needs to further evaluate the long term sustainability of the proposed value proposition and its effect on the village where this will be implemented. This is accomplished using village sustainability index. This index is modeled using three nodes (socio, economic and environment), and is used to combine the value of each of these nodes to come up with a sustainability index number. In Figure 14, we outline the sustainability index with a maximum index value of 1. We recognize the limitation of indices when they are used to make decisions. Our intent is to provide a framework for social entrepreneurs to develop this index for a village of interest and avert the trap of subscribing to the one size she fits all adage.

5. CLOSING REMARKS

In this paper, we present a method that the social entrepreneurs can use to identify the conflicts (dilemmas) and create a value proposition for their enterprises that are established for rural socioeconomic development. Each rural area is different from the other in terms of social, economic and cultural aspects, and is situated in different environmental conditions as well. It is observed that social entrepreneurs fail to take into account these aspects (`Drivers`) together while developing a value proposition. We, therefore in this paper, present a method that social entrepreneurs can use to consciously take into account these three drivers (socio, economic and environment) for each target village.

In a process of sustainable development, whenever these three drivers are integrated together, they have both positive and negative impacts. In order to sustain the enterprise, it is necessary for the entrepreneur to identify the dilemmas that arise in a rural setting. We postulate that while managing the dilemmas the social entrepreneur will be able to identify the value proposition required for rural development.

In Figure 6, along with the steps for identifying dilemmas and developing a value proposition, we also include steps of managing dilemmas. We believe it is important to manage dilemmas associated with sustainable development as characterized by the synergistic interactions between three drivers, namely, people, planet, and profit. As indicated earlier, the description of the method to manage dilemmas is beyond the scope of this paper.

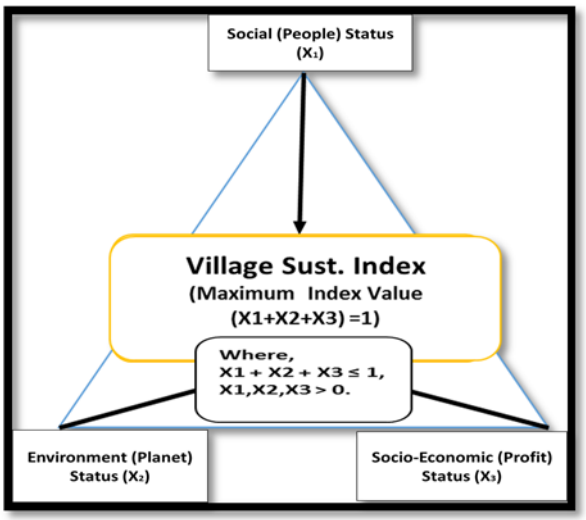

Figure 14: Village Sustainability Index

In closing, we suggest that dilemma triangle method can be used in multi-disciplinary fields and is a tool that can be used by designers from different disciplines to collaborate with each other. The method of identifying dilemmas that we present in the paper is in generic form and can be adopted by designers of the systems that has three `Drivers.` Once the designers internalize the method, it can be used for the systems that are driven by more than three drivers.

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APPENDIX A: Composite village data

The data provided in the table below is the collection of various aspects of a village. Data from this table is used in Section 3 as a description of the village to provide context to the reader about the village for which we have implemented our method in Section 3.1.

Social Status			
		Value	Comments (Justification)
Population			
	Total Population	2000	
	Number of households	400	5 people per household on average
	Male	1030	From the census data, there is a 51.5% male population and 48.5% female population.
	Female	970	
	Youth (14-25)	400	From the census data, 20% of the population is youth (14-25) and 30% are children (Below 14).
	Children (Below 14)	600	
Electricity			
	Is there Electricity in this Villages	Yes	Some of the villagers have diesel generators.
	Source of Electricity	Non-Renewable	
	Number of houses having electricity	50	
Education			
	Is there a school present in village	Yes	Primary
	Is there a school present in nearby villages?	No	This is a remote village and there is no other village nearby
	Number of Children going to school	200	Mostly those coming from upper-class families with a few coming from middle-class families
	Is there higher education in village or nearby villages	No	This is a remote village and there is no other village nearby
Communication and Entertainment			
	Is there connectivity in the village? (Mobile/Landline)	No	
	Number of people having connection (Mobile/Landline)	N/A	
	Number of Households having Television connection	25	Only the rich villagers can afford to have television sets in their homes.
Food and Water			
	Number of households having food scarcity	20	Average depends on season
	Number of households having water scarcity	20	Average depends on season
	Is there any action taken to decrease food scarcity /What level	Yes	Food sharing program
	Is there any action taken to decrease water scarcity / What Level	Yes	H20 organization gave straws to village
Housing			
	Number of families having proper housing	350	Many villagers in among the lower class have insufficient housing
Sanitation			
	Number of Households having proper Sanitation Conditions	50	The lower class families who have insufficient housing also do not have proper sanitation conditions
Equality			
	Is there Caste equality in village	No	As majority of the population of the village is not well educated, they lack modern thinking and so inequality exists
	Is there Gender equality in village	No	

Health			
	Is there a hospital in village	No	The village is poorly educated and does not have the means to run a hospital
	Technology present in hospital, mention in comments	N/A	
Cooking			
	Number of households using firewood, kerosene stoves and LPG in Village	50 – LPG	As firewood is easily available and affordable, it is used by many villagers.
Environmental Status			
Pollution			
	Level of Air pollution	low	Pollution is not a problem in this small remote village
	Level of Water pollution	medium	
	Level of Soil Pollution	low	
Degradation			
	Land Degradation	low	The village is a farming community
	Soil Degradation	low	
	Forest Degradation	medium	
	Underground Water Level Degradation	medium	The underground water is the main source of drinking water our village has
	Water Body level degradation	N/A	The village is landlocked and there is no nearby lake or pond
	Wildlife Degradation	medium	
	Fishery Degradation	N/A	The village is landlocked and there is no nearby lake or pond for our villagers to fish in
Socio-Economic Status			
	Current GDP of the village	-	Data Not Available
	Ratio of (GDP of village/GDP of State in which village is present)	-	Data Not Available
	Number of Households which are below the half of total village's GDP value.	-	Data Not Available
Agriculture			
	Number of households involved in farming	300	This village is a farming village and 75% of households are involved in farming, half of the households own their own farm while the rest work as laborers.
	Number of households having their own farms	200	
	Number of households working as daily labors in farm	100	
	Number of crops in a year	2	
	Average Income per household	Rs. 13,000 ($200.00)	
Small Business			
	Number of Households involved in Business	10	
	Number of Households involved in Handlooms and Handicrafts	N/A	
	Number of Households involved in Family business (High-income households)	50	This contains the entirety of our upper class
	Average Income per household	Income varies based on business and the average will not give an adequate description	
Labor			

	Number of households working as laborers	150	Most of the available jobs are as laborers which are a low education and very low-income job
	Number of people working as laborers	300	
	Number of children working as child labors (Not attending schools)	75	
	Average income of Labors	₹5,000 (<$100.00)	
Fishing			
	Number of households involved in fishery	0	The geographic location of the village does not support a fishing industry
	Number of households having their own fishery farms/tanks	0	
	Number of households involved as labors for fishery	0	
	Average income of fishery	0	
Government Employment			
	Number of Households involved in Government Employment	3	Being a remote village, many facilities for the same are available at district headquarters.
	Average Income	₹13,000	
Employment Credibility of Youth			
	Skill and Education of Youth	20% of youth have the opportunity to of primary school in the village but 5% have the ability to continue education outside of the village. Most youths have skills in farming or handicrafts.	