**APPENDIX: AI Implementation of the Business Planning Method – Focus on the Dilemma Triangle and SDG Evaluation**

Our primary objective in sharing this information is to illustrate how ChatGPT applied the Dilemma Triangle Method (DTM) during Phase 2 of our process. To provide a structured overview, we have organized ChatGPT’s responses in the Appendix into six parts. Parts 1 through 5 detail the step-by-step implementation of DTM (Phase 2), while Part 6 highlights ChatGPT’s role in Phase 4, where it analyzed and refined the preliminary Business Model Canvas (BMC) based on the Sustainable Development Goals (SDGs).

In the remainder of the Appendix, we present these six parts, each accompanied by a brief introduction.

**Part 1** – The demonstration begins with Phase 2, following Figure 3, where ChatGPT systematically applies the Dilemma Triangle Method (DTM). We start by showcasing ChatGPT’s responses to Prompt 2.5, where it identifies key issues for each focus area. Below are the results from the first three steps of DTM, including the identified focuses and corresponding issues for each driver:

*People (Social Impact) – Empower villagers with reliable electricity, education, and economic opportunities.*

* *Lack of Technical Knowledge – Villagers have little experience with managing and maintaining energy systems.*
* *Affordability of Electricity – Many families have low incomes and may struggle to pay for power.*
* *Limited Economic Opportunities – Without proper training and infrastructure, new businesses may not succeed even with electricity.*

1. *Planet (Environmental Sustainability) – Provide clean energy while protecting the forest, wildlife, and natural resources.*

* *Wildlife Disruption – Bringing electricity could lead to habitat disturbance and human-wildlife conflicts.*
* *Sustainable Energy Sourcing – Ensuring that energy production methods (e.g., solar, battery storage) do not harm the environment.*
* *Resource Management – Managing land use, water consumption, and waste disposal to prevent ecological degradation.*

1. *Prosperity (Economic Viability) – Develop a financially sustainable energy and business model.*

* *High Startup Costs – Establishing Smart Nanogrid™ infrastructure requires significant upfront investment.*
* *Revenue Generation – The energy system must generate enough income to cover maintenance and expansion.*
* *Market Demand for Businesses – Even with electricity, villagers need access to markets and customers for their micro-enterprises to be profitable.*

**Part 2**– The following tension matrix represents an early attempt by ChatGPT, in which it did not implement the matrix correctly. To improve its accuracy, we provided a second paper and instructed ChatGPT to revise the matrix based on the guidance from that source. This version, generated in response to Prompt 2.8, is not directly comparable to ChatGPT’s initial attempt, as its understanding and implementation significantly improved after reviewing the second paper:

*🚀 Step 4: Tension Matrix for Chhotkei*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Drivers | Lack of Technical Knowledge | Affordability of Electricity | Limited Economic Opportunities | Wildlife Disruption | Sustainable Energy Sourcing | Resource Management | High Startup Costs | Revenue Generation | Market Demand for Businesses |
| Lack of Technical Knowledge | - | ⚠️ | ⚠️ | ⬆️ | ⬆️ | ⬆️ | ➕ | ➕ | ➕ |
| Affordability of Electricity | ⚠️ | - | ⬆️ | ⬆️ | ⚠️ | ⬆️ | ⚠️ | ⚠️ | ➕ |
| Limited Economic Opportunities | ⚠️ | ⬆️ | - | ⚠️ | ⬆️ | ⚠️ | ⚠️ | ⬆️ | ⚠️ |
| Wildlife Disruption | ⬆️ | ⬆️ | ⚠️ | - | ⚠️ | ⚠️ | ⬆️ | ⬆️ | ⚠️ |
| Sustainable Energy Sourcing | ⬆️ | ⚠️ | ⬆️ | ⚠️ | - | ⬆️ | ⚠️ | ⚠️ | ⬆️ |
| Resource Management | ⬆️ | ⬆️ | ⚠️ | ⚠️ | ⬆️ | - | ⬆️ | ⬆️ | ⬆️ |
| High Startup Costs | ➕ | ⚠️ | ⚠️ | ⬆️ | ⚠️ | ⬆️ | - | ⚠️ | ⚠️ |
| Revenue Generation | ➕ | ⚠️ | ⬆️ | ⬆️ | ⚠️ | ⬆️ | ⚠️ | - | ⬆️ |
| Market Demand for Businesses | ➕ | ➕ | ⚠️ | ⚠️ | ⬆️ | ⬆️ | ⚠️ | ⬆️ | - |

*🔹 Explanation of Symbols*

* ⚠️ *(Tension/Conflict) – Solving one issue may negatively impact another.*
* ⬆️ *(Inter-Dependent Relationship) – Improving one issue can also help another.*
* ➕ *(Potential Synergy) – A strong positive relationship that can be leveraged for a win-win solution.*

*🔍 Key Identified Tensions (Conflicts)*

* 1. *People vs. Prosperity 💰*
* *Affordability vs. Revenue Generation – Villagers need low-cost electricity, but the system must be financially sustainable.*
* *Limited Economic Opportunities vs. High Startup Costs – Developing businesses requires funding that is difficult to secure.*
  1. *People vs. Planet 🌍*
* *Limited Economic Opportunities vs. Wildlife Disruption – Expanding business activities (e.g., flour mills, solar-powered pumps) may lead to deforestation and human-wildlife conflicts.*
* *Lack of Technical Knowledge vs. Resource Management – If villagers are not trained, they may mismanage energy resources, leading to inefficiencies or environmental harm.*
  1. *Planet vs. Prosperity ⚡*
* *Sustainable Energy Sourcing vs. High Startup Costs – Eco-friendly energy solutions (solar, batteries) require high investment.*
* *Sustainable Energy Sourcing vs. Revenue Generation – Renewable energy takes time to become profitable compared to cheaper, unsustainable alternatives.*

**Part 3 -** Regarding Prompt 2.9, ChatGPT completed Step 5 of the DTM by identifying dilemmas that are deemed to be correct:

*Step 5: Identifying True Dilemmas*

*Now, we’ll analyze the tensions in the matrix to pinpoint true dilemmas—situations where improving one driver (People, Planet, or Prosperity) negatively impacts another. These are the critical areas that need careful management for a balanced, sustainable solution.*

* 1. *True Dilemmas (People vs. Prosperity)*
* *Affordability of Electricity vs. Revenue Generation ⚠️*
  + *Dilemma: Villagers need affordable electricity, but the Smart Nanogrid™ system must also generate revenue to remain financially viable.*
  + *Impact: Lower electricity prices may make it unaffordable to sustain the energy system, but higher prices could lead to economic hardship for the villagers.*
* *Limited Economic Opportunities vs. High Startup Costs ⚠️*
  + *Dilemma: Micro-enterprise development requires significant upfront investment, but there are limited economic opportunities for villagers to raise capital.*
  + *Impact: Without initial investment, businesses will not grow, limiting the economic development potential for Chhotkei.*
  1. *True Dilemmas (People vs. Planet)*
* *Limited Economic Opportunities vs. Wildlife Disruption ⬆️*
  + *Dilemma: Expanding business activities, such as farming or setting up new micro-enterprises, may lead to deforestation and affect wildlife.*
  + *Impact: Economic growth may come at the cost of ecological degradation, threatening the long-term sustainability of the area and its biodiversity.*
* *Lack of Technical Knowledge vs. Resource Management ⬆️*
  + *Dilemma: If villagers lack the necessary skills to manage the energy system, it may lead to inefficient use of resources, affecting the environment.*
  + *Impact: Poor resource management could lead to environmental degradation, such as improper energy usage or misuse of natural resources, which is unsustainable.*
  1. *True Dilemmas (Planet vs. Prosperity)*
* *Sustainable Energy Sourcing vs. High Startup Costs ⚠️*
  + *Dilemma: While renewable energy like solar or wind is ideal for sustainability, these solutions often come with high upfront costs, making it harder to generate immediate profits.*
  + *Impact: The financial burden of installing sustainable systems may limit the viability of these solutions, especially if the economic model is not sufficiently robust.*
* *Sustainable Energy Sourcing vs. Revenue Generation ⬆️*
  + *Dilemma: Renewable energy sources may be slow to generate income, requiring a long-term strategy to balance profit and sustainability.*
  + *Impact: Focusing on long-term sustainability may conflict with short-term revenue goals needed to keep the energy system operational and the micro-enterprises viable.*

*Key Dilemmas Summary:*

1. *People vs. Prosperity:*
   * *Balancing affordability with financial sustainability of the energy system.*
   * *Addressing high startup costs while fostering economic growth.*
2. *People vs. Planet:*
   * *Expanding economic opportunities may harm the environment if not done sustainably.*
   * *Lack of technical skills could lead to resource mismanagement.*
3. *Planet vs. Prosperity:*
   * *High upfront costs for renewable energy vs. long-term sustainability.*
   * *Balancing revenue generation with environmental protection.*

**Part 4** – First, we present ChatGPT’s response to Prompt 2.10, where it implements Step 6 of the DTM. Following that, we showcase the results from Step 7, based on ChatGPT’s response to Prompt 2.11

*Step 6: Developing Value Propositions*

*Now that we've identified true dilemmas, let's develop value propositions—solutions that transform these zero-sum conflicts into positive-sum outcomes where all three drivers (People, Planet, and Prosperity) benefit.*

* + 1. *People vs. Prosperity 💰*

*Dilemma: Affordability of Electricity vs. Revenue Generation  
✅ Value Proposition: Implement a tiered pricing model*

* *Households pay a low base rate for essential electricity (lighting, cooking).*
* *Micro-enterprises pay a higher rate for commercial use, ensuring system sustainability.*
* *Introduce community-based financing (e.g., microloans or cooperatives) to help villagers pay for electricity.*

*Dilemma: Limited Economic Opportunities vs. High Startup Costs  
✅ Value Proposition: Establish a Micro-Enterprise Zone (MEZ) with shared resources*

* *Set up shared facilities (e.g., flour mills, cold storage, co-working spaces) powered by the Smart Nanogrid™.*
* *Offer government & NGO grants to subsidize initial costs.*
* *Provide business training & mentorship to help villagers develop sustainable income streams.*
  + 1. *People vs. Planet 🌍*

*Dilemma: Limited Economic Opportunities vs. Wildlife Disruption  
✅ Value Proposition: Promote eco-friendly livelihoods*

* *Encourage solar-powered irrigation instead of expanding farmland into forests.*
* *Develop sustainable tourism (eco-lodges, guided tours) to create jobs without harming wildlife.*
* *Implement reforestation incentives, rewarding villagers who plant trees near their farms.*

*Dilemma: Lack of Technical Knowledge vs. Resource Management  
✅ Value Proposition: Create a Community Energy & Sustainability Hub*

* *Train local youth to maintain the Smart Nanogrid™ (job creation + sustainability).*
* *Introduce digital monitoring tools (e.g., mobile apps) to track electricity and resource usage.*
* *Partner with universities or NGOs to provide technical workshops & sustainability education.*
  + 1. *Planet vs. Prosperity ⚡*

*Dilemma: Sustainable Energy Sourcing vs. High Startup Costs  
✅ Value Proposition: Use a Public-Private Partnership (PPP) Model*

* *Government & NGO funding covers initial infrastructure costs.*
* *Private-sector investors support long-term maintenance and expansion.*
* *Explore carbon credits & green financing to reduce financial risks.*

*Dilemma: Sustainable Energy Sourcing vs. Revenue Generation  
✅ Value Proposition: Develop a Hybrid Energy Model*

* *Start with a solar-diesel hybrid system, gradually phasing out fossil fuels.*
* *Implement prepaid energy meters to ensure revenue collection.*
* *Introduce productive-use applications (e.g., cold storage, electric vehicles) to make energy more profitable.*

*Step 7: Evaluating Value Propositions Using the Sustainability Test*

*Each value proposition must pass the Sustainability Test, ensuring it is:  
✅ Bearable (Socially Acceptable) – Does it respect people's needs and improve quality of life?  
✅ Equitable (Fair Balance Between Economy & Society) – Does it fairly benefit both individuals and the community?  
✅ Viable (Economically & Environmentally Feasible) – Can it sustain itself financially and ecologically over time?*

* 1. *People vs. Prosperity 💰*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dilemma | Value Proposition | Bearable? | Equitable? | Viable? | Final Verdict |
| Affordability vs. Revenue Generation | Tiered Pricing Model – Basic electricity is low-cost, businesses pay more. | ✅ Yes, ensures access for all. | ✅ Yes, balances community needs. | ✅ Yes, businesses sustain the grid. | ✔️ Highly Feasible |
| Limited Economic Opportunities vs. High Startup Costs | Micro-Enterprise Zone (MEZ) – Shared resources, grants, business training. | ✅ Yes, villagers gain economic independence. | ✅ Yes, fair opportunities for all. | ✅ Yes, attracts investment & grants. | ✔️ Highly Feasible |

* 1. *People vs. Planet 🌍*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dilemma | Value Proposition | Bearable? | Equitable? | Viable? | Final Verdict |
| Limited Economic Opportunities vs. Wildlife Disruption | Eco-friendly livelihoods – Sustainable tourism, solar-powered irrigation, reforestation incentives. | ✅ Yes, new jobs without harming nature. | ✅ Yes, fair benefits for villagers & conservation. | ✅ Yes, tourism & eco-agriculture generate income. | ✔️ Highly Feasible |
| Lack of Technical Knowledge vs. Resource Management | Community Energy & Sustainability Hub – Local training, digital monitoring, sustainability workshops. | ✅ Yes, villagers gain valuable skills. | ✅ Yes, empowers locals to manage their resources. | ✅ Yes, partnerships with NGOs/universities ensure success. | ✔️ Highly Feasible |

* 1. *Planet vs. Prosperity ⚡*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Dilemma | Value Proposition | Bearable? | Equitable? | Viable? | Final Verdict |
| Sustainable Energy Sourcing vs. High Startup Costs | Public-Private Partnership (PPP) Model – Government & private investment. | ✅ Yes, ensures villagers don’t bear costs. | ✅ Yes, shares risk among stakeholders | ✅ Yes, long-term financial & technical support. | ✔️ Highly Feasible |
| Sustainable Energy Sourcing vs. Revenue Generation | Hybrid Energy Model – Solar-diesel transition, prepaid meters, productive use applications. | ✅ Yes, reliable energy without sudden price hikes. | ✅ Yes, balances environmental & economic goals. | ✅ Yes, revenue from micro-enterprises covers costs. | ✔️ Highly Feasible |

*🔍 Summary: All Value Propositions Passed the Sustainability Test!*

*Each solution is Bearable, Equitable, and Viable, meaning it is practically implementable in Chhotkei! 🎉*

**Part 5 -** Here, ChatGPT has completed the DTM and Phase 3 of the method by answering Prompt 2.12:

*“Step 8: Reality Check – Assessing Challenges, Risks, and Refinements*

*Before implementation, we must validate the feasibility of each value proposition by identifying potential risks and creating mitigation strategies to ensure success.*

* 1. *People vs. Prosperity 💰*

|  |  |  |
| --- | --- | --- |
| Dilemma | Potential Challenges/Risks | Refinement Strategy |
| Affordability vs. Revenue Generation | - Low-income households may struggle with even minimal payments.  - Businesses may not initially generate enough revenue to sustain the grid. | - Introduce flexible payment plans or work-for-energy programs (villagers contribute labor in exchange for reduced bills).  - Start with subsidized rates, then gradually increase pricing as micro-enterprises grow. |
| Limited Economic Opportunities vs. High Startup Costs | - Initial investment for MEZ (Micro-Enterprise Zone) may be difficult to secure.  - Villagers may lack business skills to run successful enterprises. | - Partner with impact investors, government grants, and CSR (Corporate Social Responsibility) funds.  - Implement business training programs before launching enterprises. |

* 1. *People vs. Planet 🌍*

|  |  |  |
| --- | --- | --- |
| Dilemma | Potential Challenges/Risks | Refinement Strategy |
| Limited Economic Opportunities vs. Wildlife Disruption | - Increased economic activity may lead to deforestation and land degradation.  - Farmers may resist switching to sustainable practices. | - Establish eco-tourism regulations (limit development, protect key habitats).  - Provide incentives for sustainable farming & agroforestry (e.g., payments for ecosystem services). |
| Lack of Technical Knowledge vs. Resource Management | - Villagers may be hesitant to adopt new technologies.  - Maintenance of energy systems may require external expertise. | - Use peer-to-peer training (train local champions who then train others).  - Establish remote monitoring & troubleshooting systems to reduce reliance on external technicians. |

* 1. *Planet vs. Prosperity ⚡*

|  |  |  |
| --- | --- | --- |
| Dilemma | Potential Challenges/Risks | Refinement Strategy |
| Sustainable Energy Sourcing vs. High Startup Costs | - Securing large-scale funding for infrastructure can be challenging.  - Delays in installation may slow down impact. | - Use a phased implementation approach (start small, scale up).  - Leverage carbon credits & green bonds to attract investors. |
| Sustainable Energy Sourcing vs. Revenue Generation | - Businesses may take time to become profitable, affecting energy revenues.  - Prepaid meters might be unfamiliar to villagers. | - Implement energy usage subsidies for businesses in the first few years.  - Conduct awareness campaigns on prepaid meters & financial literacy. |

*🔍 Reality Check Summary*

*✅Most challenges are solvable with strategic interventions.  
✅Gradual implementation and strong community engagement are key.  
✅ Funding diversification (grants, investors, carbon credits) is essential.*

**Part 6 –** In this section, we present our evaluation of ChatGPT’s implementation of Phase 4 in response to Prompt 4.1. We analyzed how ChatGPT identified the Sustainable Development Goals (SDGs) considered, assessed its rationale for including or excluding each goal, and determined its recommendations for incorporating SDGs 6, 10, and 15 into Chhotkei’s BMC to enhance its alignment with sustainable development.

*Phase 4 - “Evaluation of the Chhotkei Smart Nanogrid™ Village Business Model Based on the United Nations Sustainable Development Goals (SDGs)*

***1. SDGs Considered in the Business Plan***

*The business model aligns with several SDGs, primarily focusing on sustainability, economic empowerment, and social well-being:*

|  |  |
| --- | --- |
| ***SDG*** | ***Alignment with Business Model*** |
| *SDG 1: No Poverty* | *Affordable and reliable electricity supports income generation for rural communities.* |
| *SDG 2: Zero Hunger* | *Powering irrigation systems and food storage improves agricultural productivity.* |
| *SDG 3: Good Health & Well-being* | *Clean energy reduces indoor air pollution, decreasing respiratory diseases.* |
| *SDG 4: Quality Education* | *Reliable electricity enhances learning by providing lighting and digital access.* |
| *SDG 5: Gender Equality* | *Women benefit from access to clean energy, improving safety and business opportunities.* |
| *SDG 7: Affordable & Clean Energy* | *Core focus—providing renewable energy to underserved areas.* |
| *SDG 8: Decent Work & Economic Growth* | *Enables small businesses, promotes job creation in maintenance, sales, and operations.* |
| *SDG 9: Industry, Innovation & Infrastructure* | *Introduces smart nanogrids, fostering technological advancement.* |
| *SDG 11: Sustainable Cities & Communities* | *Enhances rural sustainability and resilience through local energy independence.* |
| *SDG 12: Responsible Consumption & Production* | *Promotes efficient energy use and waste management (e.g., battery disposal strategies).* |
| *SDG 13: Climate Action* | *Reduces dependence on fossil fuels, decreasing greenhouse gas emissions.* |
| *SDG 17: Partnerships for the Goals* | *Requires collaboration with governments, NGOs, and private sector stakeholders.* |

***2. SDGs Not Explicitly Considered***

*While the model touches on multiple SDGs, it does not directly address the following:*

|  |  |
| --- | --- |
| ***SDG*** | ***Reason for Limited Consideration*** |
| *SDG 6: Clean Water & Sanitation* | *The project focuses on energy access rather than water infrastructure. However, solar-powered water pumps could be an extension.* |
| *SDG 10: Reduced Inequalities* | *Although it improves rural development, there is no explicit mechanism to reduce systemic inequalities (e.g., policies for marginalized groups).* |
| *SDG 14: Life Below Water* | *The business model does not directly involve marine ecosystems.* |
| *SDG 15: Life on Land* | *While land use for solar panels is mentioned, broader conservation efforts are not a primary focus.* |
| *SDG 16: Peace, Justice & Strong Institutions* | *Governance and policy advocacy are not a core part of the business strategy.* |

***Recommendations to Strengthen SDG Alignment***

1. *Integrate Clean Water Solutions (SDG 6) – Introduce solar-powered water purification or irrigation systems.*
2. *Strengthen Social Inclusion Policies (SDG 10) – Target marginalized communities explicitly through subsidies or training programs.*
3. *Biodiversity Considerations (SDG 15) – Implement strategies to minimize land impact, such as agrovoltaics (farming under solar panels).*